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By ROBERT LUCE.

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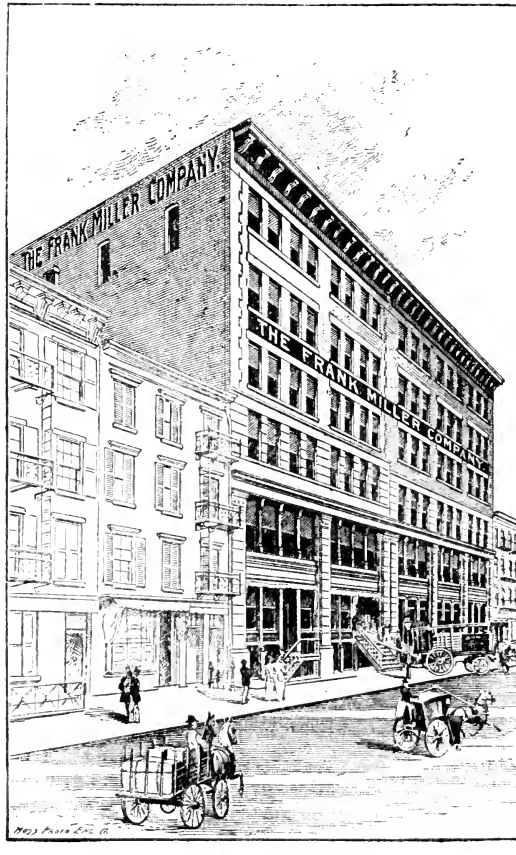

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THE MATERIAL for this book has been gathered from many sources, and as the author claims for its statements little originality, it has been deemed superfluous in most cases to designate the authority quoted. It is hoped that few errors have crept into the compilation, and that the putting of this material into compact and well-ordered shape will prove serviceable to many owners of horses.

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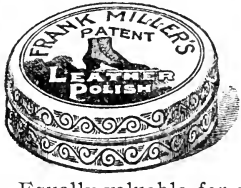

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CONTENTS.

CHAPTER I. Page

THE FUNCTIONS AND COMPOSITION OF FOOD..... ... 7

CHAPTER II.

THE VARIOUS FOODS.....21

CHAPTER III.

THE PREPARATION OF FOOD..... 71

CHAPTFR IV.

FEEDING AND RATIONS 76

CHAPTER V.

THE ART OF FEEDING..... ...89

CHAPTER VI.

WATERING.....100

CHAPTER VII.

FEEDING STALLIONS.....105

CHAPTER VIII.

FEEDING BROOD MARES.....108

CHAPTER IX.

COLT FEEDING.....110

CHAPTER X.

FEEDING SICK HORSES.....124

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HORSE FEEDING.

CHAPTER 1.

THE FUNCTIONS AND COMPOSITION OF FOOD.

Food has two functions, one the furnishing of material, the other the furnishing of power. In its first capacity it makes and maintains the body; in the second, it enables the body to live and work. It is partly staple, partly fuel.

These functions, however, are not clearly distinct. They overlap, since some of the materials of the body may in the end become fuel. The bear goes into winter quarters fat: he comes out lean. He has lived on his own tissues during his long sleep. Take a plump horse, feed him light, work him hard, and he gets thin. Why? The fuel in his food has been less than the work required, and he has made up the lack by consuming part of himself.

Only the bones are not consumed, either as waste or fuel, to any extent worth considering. They therefore affect the feeding problem only during the growth of the young animal. Likewise the supply of material for the cartilages, skin and hair is of relatively small importance. What chiefly concerns us is the supply of those materials that make up the working part of the body, the blood, the muscles, and the tendons, together with the body's own fuel supply, the fat.

On chemical examination it has been found that these have for their chief constituent water, which, like the minerals of

the bones, is so nearly universal in all foods that no account is taken of its presence in them, and therefore it may be left for independent consideration when we take up the matter of drinking.

Next of the chemical constituents in quantity, and in reality the most to be considered, are nitrogen and carbon. Nitrogen is chiefly a tissue maker; carbon, a heat maker, a life sustainer, a fuel supply. Nutritive food is that which contains these ingredients in such shape that they can be assimilated by the body, transformed into it, or consumed by it.

Distinguish clearly between growth and nutrition. In growth proper no change of form or composition takes place: parts merely increase in weight, and usually in size; and if they obtain more power, it is only more power of the same kind they before enjoyed. Nutrition, on the other hand, maintains parts that are constantly changing, preserves in them the same general form, size and characteristics they have already attained, though modifying them somewhat according to the nature of the nutrition itself.

The nutritive parts of food, technically known as its nutrients, in reality furnish both growth and nutrition, but it is well to remember that these are separate functions. Such a discrimination, for instance, has its use in impressing the fact that during the period of growth the nitrogen elements of food are relatively more important thanthe carbon elements. Later on when nutrition proper takes the chief place, when work is to be done and life is to be sustained merely that work may be done, the fuel value of the carbon elements assumes far greater prominence.

Upon classifying the nutritive elements of food, the nutrients, we find that only a part contain nitrogen. They have a distinctive name, or rather two names used interchangeably, proteins and albuminoids, meaning much the same thing. The numerous substances grouped under these names are alike in being composed of hydrogen, oxogen, nitrogen, carbon, and sulphur. What is commonly known as *albumen* is a typical example. It is most commonly thought of as the chief ingredient in the white of an egg, but it is found in vegetable substances as well as in animal, and in relation to horse feeding it

is more important to know that it is the edible or useful part of many seeds, notably those that go under the American name of *grain* and the English name of *corn*, i. e. wheat, maize, oats, rye, barley, etc. In these cereals it is *mealy* or *farinaceous*. When found in peas, beans, and similar plants it is known as *legumen*. The albuminoid in milk is known as *casein*, and is derived from the albumenoid or protein of the food, and in its turn becomes food.

Washed lean meat is another example of protein, and this suggests why as a food ingredient it so important, for it makes up the greater part of the flesh of the horse, or for that matter of any animal. Likewise the organic part of the bones, the ligaments and muscles that bind together and move the bones, the skin, the internal organs, the blood, brain and nerves, in short, all the working machinery of the body is composed chiefly of protein.

Be it remembered, too, that as the various parts of the body are consumed and thrown off with the undigested part of the food as excreta, manure, the most important element therein is again the protein, or rather its nitrogen constituent.

Besides the albuminoids there are present in plants certain other compounds containing nitrogen. These are known as amines, amides and amido-acids. They doubtless have a different feeding value from the real albuminoids, but as the amount of these substances is usually small in the common feeding stuffs, it has been customary to disregard these and to calculate all the nitrogen present as albuminoids. It has been suggested that these minor nitrogen compounds might well be termed the "*portable form*" of the albuminoids, since the albuminoids in the seed or plant are converted into this form to be transported to other parts of the plant for re-deposition. In this respect they are analagous to the *peptones*, the soluble form into which the nitrogenous portion of the food is changed in the stomach of the animal, and in which form it can be taken into the circulation for the rebuilding of tissue, and its other functions.

It has been found that the albuminoids all contain about 16 per cent. of nitrogen. As $16 \times 6.25 = 100$, it is customary to determine the amount of albuminoids or protein in any given

quantity of food, by ascertaining through chemical analysis the amount of nitrogen and multiplying it by 6.25.

Next in importance to the albuminoids comes the group of nutrients composed of hydrogen, oxygen, and carbon. These are the fuel ingredients, and are either consumed directly or stored as fat to be burned as occasion demands. They contain starch, sugar, gums, fats or oils, and woody fibre or cellulose. As a group they are subdivided into *carbohydrates*, *fats*, and *crude fibres*.

The *carbohydrates* comprise chiefly the starches, sugars and gums. They are frequently classed together under the name of *nitrogen-free extract*, and sometimes as *non-nitrogenous matter*. Its percentage in any given food is found by subtracting the sum of the ash, fibre, fat, and protein from 100.

The *fats* or oils of organic substances are separated in analysis by the use of ether as a solvent. Since in the analysis of vegetable foods this ether also removes some of the coloring matter of the plant, and from some substances like ensilage, some organic acids, the whole is generally designated as *crude fat* or simply as *ether extract*. The fats are considered to have two and one-half times the feeding value of the substances contained in the starch, sugar, and gum group, i. e. the carbohydrates. Cotton seed oil, linseed oil, corn oil, etc., are common examples. *Crude fibre* is the woody portion of vegetable matter which is unacted upon by dilute acids or alkalies. Crude fibre has little or no *direct* nutritive value to the animal. Paper is a good illustration of almost pure fibre.

Besides the substances mentioned, food is found on analysis to contain but one other group of substances, the inorganic or mineral, known as the *ash*. This is the part that remains unconsumed by burning. Its ingredients form the solid matter of the animal frame-work, bones, and occur, also, in small quantities in the muscles, blood, etc. Lime, phosphoric acid, potash, etc., constitute the mineral elements of the ash. They are found in all the fodders commonly used, and are generally held to be in all in sufficient quantity, except as to the matter of ordinary salt. Yet some hold that even their relative abundance is a matter worth consideration in feeding. To illustrate this it is cited that a goat fed at Proskau on being deprived of

lime and phosphoric acid in its food died after fifteen days. Some pigeons were fed by Liebeg on wheat exclusively for two years, with the result that the skeleton disappeared, owing without doubt, to the very small amount of lime and magnesia salts furnished by this grain. The same point is brought to bear in argument that oats are the best grain for young stock, inasmuch as they contain about eight times as much of the salts of lime and magnesia as wheat contains, five times as much as rye contains, and twice as much as barley. Hence it is argued that to the part played by oats in the formation of the skeleton, is due the fact that young thoroughbreds can be put to severe exercise almost before they mature. However, most investigators of the subject of feeding have not thought it necessary to attach much importance to the mineral constituents of food.

It is not enough to determine the proportion of nutrients in food. Beyond this, and of nearly equal importance, is the determination of how large a proportion of them the animal can utilize. In other words, what the animal digests must be considered as well as what he eats.

The digestible percentage of food is termed the *digestion co-efficient*. To illustrate, take the following analysis of clover hay:—

	Analysis per cent.	Digestion co-efficient.
Water	15.35	..
Ash	5.50	..
Albuminoids	12.05	63
Crude fiber	25.99	49
Carbo-hydrates	37.63	71
Fat	3.48	60

The first column shows us that this clover hay contained 15.35 per cent. of water, 12.05 per cent. of albuminoids, etc.; or in other words, 100 pounds of this hay had a little more than 15 pounds of water, something over 12 pounds of albuminoids (nitrogenous matter), and so on as to the other constituents. In the second column is shown what part of these albuminoids, etc., the animals can take out of the hay to be made into flesh,

blood, and heat to keep the body warm, sustain life, etc., etc. Now if we multiply the figures in the first column by those in the second, we shall see at once how much of the albuminoids, fat, and carbohydrates the animal can use.

Suppose the horse-owner finds his horse is eating ten pounds of this hay a day and he wants to khow how much of each of these several ingredients is being eaten. He will simply multiply the figures in the column of analysis by ten and find at once the amount as follows:—

	Per cent.		Hay eaten, pounds.	Pounds of each eaten.
Water	15.35	x	10	1.53
Ash	5.50	x	10	.55
Albuminoids	12.05	x	10	1.20
Crude fiber	25.99	x	10	2.59
Carbohydrates	37.63	x	10	3.76
Fat	3.48	x	10	.35

That is, the ten pounds of hay contained a little more than a pound and a half of water, a little more than two and a half pounds of crude fiber, etc. If we want to know how much of these the horse can use, we have only to multiply these last figures once more, by the figures given in the column of digestion coefficients, thus:—

	Pounds eaten.		Per cent. digested	Pounds digested by the animal.
Albuminoids	1.20	x	63	0.75
Crude fiber	2.56	x	49	1.25
Carbohydrates	3.76	x	71	2.68
Fat	0.35	x	60	0.21

In the last column we see how much of the ten pounds of clover hay the horse can use: three-quarters of a pound of albuminoids; one and one-quarter pounds of crude fiber; about two and two-thirds pounds of carbohydrates; and nearly one-quarter pound of fat. In just the same manner the horse-owner can work out the amounts digested with other feeds.

If we want to know the nutritive ratio of the fodder, it can now be easily found. First, fat is said to be worth two and a

half times as much for feeding as the starchy portions of the food. So we multiply the fat by this number, $0.21 \times 2\frac{1}{2} = 0.52$ pounds. Add together now this fat, the crude fiber and the carbohydrates, $0.52 + 1.25 + 2.68 = 4.45$. Divide this last by the amount of albuminoids, $4.45 \div 0.75 = 5.93$; that is, the nutritive ratio is 1 : 5.93. By this we mean that for every pound of albuminoids there are five and ninety-three hundredths times as much other matter of the same feeding value as starch, — that is, nearly six times as much carbonaceous as nitrogenous matter.

After determining the relative proportions of the nutrients in food, and their respective digestion values, it is next in order to determine what may be called their energy value. This, however concerns only the use of food for fuel. No way has yet been devised to measure accurately its utility in building up the body and repairing its wastes, but as fuel it can be studied with almost the exactness of the mechanical engineer in his determination of the energy developed by burning coal under a boiler.

This has come to pass only within a few years, since the investigators began experiments with animals in the respiration apparatus, to learn the proportions in which the several classes of nutrients do work in serving as fuel in the body. At the same time time experiments have been made with the calori meter to determine the heats of combustion of the same material. The results obtained with the respiration apparatus and with the calorimeter have agreed very closely. That is to say, in supplying the body with fuel, the protein, fat, and carbohydrates of the food have been found to replace each other in almost exact proportion to their heats of combustion.

The unit commonly used is the Calorie, the amount of heat that would raise the temperature of a kilogram of water one degree centigrade (or a pound of water four degrees Fahrenheit). The same word, calorie, but spelled with a small c, is used to designate the heat required to raise the temperature of a gram of water a degree. One Calorie is thus equal to 1,000 calories. Instead of this unit of heat we may use a unit of mechanical energy, for instance the foot-ton, which is the force that would lift one ton one foot. One Calorie corres-

ponds very nearly to 1.53 foot-tons.

Taking ordinary food materials as they come, the folllowing general estimate has been made for tne average amount of energy in one gram of each of the classes of nutrients:

POTENTIAL ENERGY IN NUTRIENTS OF FOOD.

	Calories	Foot-tons.
In one gram of protein	4.1	6.3
In one gram of fats	9.3	14.2
In one gram of carbohydrates	4.1	6.3

These figures mean that when a gram of fat, be it the fat of the food or body-fat, is consumed in the body, it will, if its potential energy be all transformed into heat, yield enough to warm 9.3 kilograms of water one degree of the centigrade thermometer, or if it be transformed into mechanical energy such as the steam-engine or the muscles use to do their work, it will furnish as much as would raise one ton 14.2 feet or 14.2 tons one foot. A gram of protein or carbohydrates would yield a little less than half as much energy as a gram of fat. In other words when we compare the nutrients in respect to their fuel values, their capacities for yielding heat and mechanical power, an ounce of protein is just about equivalent to an ounce of carbohydrates; and a little over two ounces of either would be required to equal an ounce of fat. The potential energy in the ounce of protein or carbohydrates would, if transformed into heat, suffice to raise the temperature of 113 pounds of water one degree Fahrenheit, while an ounce of fat, if completely burned in the body or in the calorimeter, would yield as much heat as would warm over twice that weight of water one degree. It would be wrong to assume that such figures as these are absolutely accurate, but we are doubtless warranted in using them with the distinct nnderstanding that they are tentative and subject to such revision as future research shall indicate.

The application of these figures to estimating the fuel values of food is simple. A gram of digestible protein or a gram of digestible carbohydrates is assumed to yield 4.1 and a gram of digestible fat, 9.3 Calories of energy. A given weight of digestible fat is thus taken to be equivalent in fuel value to 2.27

(9.3 4.1 = 2.27) grams of digestible protein or carbohydrates.

The potential energy or fuel value of a given quantity of feeding stuff, or of a daily ration, is calculated by multiplying the number of grams of digestible protein and of digestible carbohydrates by 4.1 and the number of grams of digestible fat by 9.3 and taking the sum of these three products as the number of Calories of potential energy in the materials. The computation is made more convenient by taking each per cent. of each nutrient as equivalent to one hundredth of a pound of that ingredient in a pound of the feeding stuff and multiplying by the number of Calories in .01 pound. As .01 pound equals 4.536 grams, .01 of a pound of protein or carbohydrates would thus be assumed to yield (4.536x4.1) 18.6, and each .01 pound of fats 42.2 Calories.

Applying this method of calculation to the figures given by the German (Wolff's) standard for feeding moderately worked horses of 1,000 lbs. weight, under which the daily ration would contain 1.7 pounds of digestible protein, 10.4 pounds of digestible carbohydrates, and 0 6 pounds of fats, we find that the protein will yield 3,162 Calories, the carbohydrates 19,344, and the fat 2,532, a total of 25,038 Calories.

Very likely further experiments may modify the figures now used in these estimates, but if the general theory is correct one important point at least is established, viz. that in the matter of fuel the protein, fats and carbohydrates are interchangeable. In other words, different foods may have the same fuel value though varying much in the relative proportions contained of these ingredients. Or two foods with the same amount of protein and carbohydrates will vary much in fuel value if their fat constituents vary much. Or two foods alike in fat and protein, but differing in carbohydrates, will have a correspondingly different fuel value.

But though the proportions of the ingredients may vary and yet produce similar results, it does not follow that there is no limit to the variance possible. It might be inferred that a diet all fat, or all carbohydrates, or all protein could be successfully used, but that is not the case. For example, a hungering animal has been found to consume its own flesh and fat, the

nitrogen of the former re-appearing almost wholly in the urine, and the fat in the exhalations from the lungs as carbonic acid gas and water. If now a moderate amount of protein is fed, the rate of loss of flesh is not materially lessened; moreover, the amount of excreted nitrogen in the urine is not only equal to that previously found, but is increased by nearly the whole of that in the added protein. Only by feeding protein in enormous quantities can this loss of flesh be even temporarily prevented.

If under like conditions we try to feed fat alone, it neither prevents nor lessons the loss of flesh, though the total amount of fat in the body may be thereby increased. If long enough continued, the animal dies. In a similar case by feeding exclusively carbohydrates, the loss of flesh is lessened, but cannot be entirely prevented. The carbohydrates serve, however, to protect the fat of the body by suffering oxidization in its stead. By combining fat and carbohydrates in such a case the loss of flesh still continues. In fact experiment has conclusively proved that only by feeding a combination of protein, fat, and carbohydrates can an animal be kept for any length of time without a loss of flesh or health.

Futhermore it must be remembered that circumstances may vary somewhat the effect of all these theories in their application. For instance, it has been found that the addition of easily digestible food like potatoes and roots to other fodders lowers the digestibility of the constituents of the latter. The digestibility is not appreciably lowered, however, if the amount of dry matter of the roots, etc., does not exceed 12 per cent. of the whole amount. In case it amounts to quarter of the whole amount, the digestibility of the protein, which is most seriously affected, is lowered one-tenth; if increased to two-thirds of the total dry matter, the digestibility of the protein is lowered one-fourth.

Again, German investigators have tested the digestibility of different fodders with the various classes of animals, and for horses, cows, and swine, for example, wide variations have been found.

Further impediments are thrown in the way of exact measurement and accurate deduction by the fact that animals at work exhale more carbonic acid gas and water than when at

rest; they exhale less of each in the dark than in the light; an exposure to low temperature has the same effect as labor; the radiation of heat from the animal varies as the surface, and hence proportionately more food is required for four animals weighing together one ton than for but two of the same total weight; excessive consumption of water leads to a greater excretion of nitrogen and consequent waste, and too much salt leads to the same result.

These things are cited to show that feeding is by no means an exact science. Nevertheless its principles have been determined with sufficient accuracy to warrant their general use, and for all practical purposes it is safe to apply them as here outlined to the questions in hand.

One omission will doubtless have been noticed in the foregoing attempt to give a systematic method for valuing horse foods. No standard has been set for the protein or albuminoid constituents in their function of making body material and repairing wastes, i. e. in contradistinction to their fuel function. This omission has been due to the very nature of the subject. Horses are not bred or kept for the profit to be derived from the sale of their flesh, their hair, their hides, or their milk. Therefore the use of food to these ends is not a pertinent matter in this relation, and it is not thought necessary to treat the protein elements in the food with scientific accuracy except so far as they are energy producers. In fact it is almost wholly for his energy, his work, that we breed and feed the horse. Provided, then, his food contains a reasonable amount of protein and mineral elements, it will be satisfactory, and as ordinary rations contain these, they need be referred to only in a general way.

There is another theoretical aspect of food value, however, that should be considered in detail before we proceed to the discussion of individual foods. That is its fertilizing aspect. In other words, the science of feeding demands not only the determination of the value of foods as foods, but also their value as manure. And that the subject may not be treated in detail again, let us here, though at the risk of digression, consider the manure question both theoretically and practically.

To be sure, many of the fourteen million horses in the United

States are not kept even secondarily for the value of this bye-product, but just as many, probably more, are owned by people to whom fertilizing material has a considerable cash value. Every horse owner who cultivates land is concerned to see that his manure heap is as valuable as he can make it. To him the question of economy in horse feeding is not settled when he has learned the direct values of various foods in furnishing horse material and horse energy. He should go further and learn how much of these values he can utilize again as manure.

The importance of the matter can be seen by the consideration of a single statement, which will surprise many readers, viz. that at least one feeding material is actually worth more when transformed into manure than it cost in the first place, and there are several materials that go through, feed, and maintain animals, and are then worth for fertilizing purposes more than half what they cost as food. As we spend nearly a billion dollars a year in maintaining our horses and mules, there is an enormous money investment at stake in this matter of manure.

A great deal of it is wasted through being excreted on the highway, but much more of it goes into the manure heap.

Tests made at one of the experiment stations with nine horses, two of them light driving horses and the rest grade Percheron horses of from 1200 to 1400 pounds weight, showed the average amount of solid and liquid excrement voided in 24 hours to be 56 ⅓ pounds. Upon analysis this was found to contain 0.51 per cent. of nitrogen, 0.21 per cent. of phosphoric acid, and 0.53 per cent. of potash. At the price of commercial fertilizers this percentage of nitrogen in a ton of manure was worth, at 17 cts. a lb., $1.73; of phosphoric acid, at 7 cts. a lb., $0.29; of potash, at 4 cts., $0.43; a total of $2.45.

From 75 to 80 per cent. of the manurial value of food is recovered in the manure. In other words, from one-fifth to one-quarter goes into the making of tissue, bone, etc., or is expended as fuel, and the rest is excreted. Leaving this out of account, for the sake of exactness, it was found by the New York experimenters that the value of the fertilizing elements in 12 hays when averaged amounted to 63 per cent of their cost; of 9 straws, to 66 per cent.; 6 green foods, 60 per cent.;

5 roots, 30 per cent.; 7 grains, 24 per cent.; 12 mill feeds, 53 per cent. Assuming that a quarter is lost, the conclusion is that hay at $11 a ton will yield manure worth about $5; grain at $30 a ton, manure worth $5.40, and so on.

These figures differ somewhat from those of Director H. P. Armsby of the Pennsylvania Experiment Station, who finds even more importance in the manure question. In his report for 1890 he gave the following table which shows the manurial value, not of equal weights of the different crops, but of an equal number of dollars worth at average prices:—

MANURE VALUE OF $10 WORTH.

Meadow hay,	$5.10
Timothy hay,	5 99
Hungarian hay,	6.10
Clover hay,	9.07
Bran,	7.78
Wheat,	2.58
Barley,	2.96
Oats,	3.86
Corn,	3.78
Cotton-seed meal,	10.12
Oil meal,	7.54
Potatoes,	.12
Milk,	.88
Butter,	.01
Cheese,	.69
Skim milk,	.41

It is clear, then, that in examining the various foods individually it will be worth while to note tne manure value of each, as indicated by its nitrogenous and mineral constituents.

Let it be noticed in passing that it pays to care for the manure heap. The manure gathered in the New York test referred to above shrank after six months exposure from 529 pounds to 372 pounds, almost 30 per cent. Besides this there was gain in the percentage of water and a loss in the percentage of valuable fertilizing elements. A ton of manure worth $2.45 when fresh, would nave been worth only $1.42 after six months exposure, a loss of 42 per cent. Other tests were made, the results of the season's work seeming to show that horse manure thrown in a loose pile and subjected to the action of

the elements will lose nearly one-half of its valuable fertilizing constituents in the course of six months; that mixed horse and cow manure in a compact mass and so placed that all water falling upon it quickly runs through and off is subjected to a considerable, though not so great loss; and that no appreciable loss takes place when manure simply dries.

CHAPTER II.

The Various Foods.

Proceeding to the separate examination of the foods customarily and occasionally given to horses, we naturally take up hay first, for although perhaps in the stables of the land grain plays the more important part, in the barn it is the hay that is foremost, and the barns outnumber the stables ten to one, — yes a hundred to one.

Taking into account all kinds of stall-fed animals, hay is the most economical food, as it is the commonest, but its worth is not appreciated. The New York Experiment Station has demonstrated that its food value is nearly half as large again as its cost, whereas the food value of grain is only three-quarters of its cost; and that a hundred dollars' worth of good hay will upon the average furnish half more digestible food than one hundred dollars' worth of mill feed upon the average, besides ten dollars' worth more of fertilizing materials. The conclusion is, that for twenty-five years at least, hay and straw have been worth, as sources of animal and plant food, at least twice their market prices, and if to anybody to the farmer himself, who has animals and fields both needing these supplies of food. Furthermore, on the average the grain foods barely return in food and fertilizing material an equivalent of their market value, and this is due to the relatively high prices they command in the market. And finally, for the past twenty-five years, the average amount of hay which could be bought for ten dollars in New York, has contained an amount of nitrogen, phosphoric acid, and potash that was worth $6.37, so that the farmer has sold an average of fifteen dollars' worth of food for $3.63, and while this has been going on, many million dollars' worth of commercial fertilizers have been bought in that state alone.

The following table gives the result of the analysis of various grasses and hays, as made by the New York State Experiment Station. Let the reader recall that *ash* means the mineral element; let *albuminoids* remind him of lean meat, the white of an egg, or gluten, the gummy part of wheat; let him remember that *nitrogen-free extract* and *carbohydrates* are the same thing, sugar and starch being their purest forms; and let him think of paper when he sees the term *crude fiber*. The figures represent the percentage, or may be taken as the number of pounds of each in 100 lbs. of the food. To illustrate, take the first, Timothy grass; the table means that in 100 pounds of this green grass there were found 57 31-100 pounds of water, 2 8-100 lbs. of ash, 3 23-100 lbs. of albuminoids, and the same for all the other parts. Remember that the *coefficient of digestibility* is the digestible percentage of any given element of the food. The table styled PER CENT. DIGESTIBLE MATTER is found by bringing the figures in Table B to bear on those in Table A, and shows the number of pounds of digestible matter in 100 pounds of the various foods:

TABLE A.

Grasses, Clover, etc., in bloom.	Water	Ash	Albuminoids	Crude fiber	Carbohydrates	Fat
Timothy, 1887	57.31	2.08	3.23	13.38	22.64	1.36
Timothy, 1888	67.09	1.41	2.50	11.54	16 36	1.10
Timothy, seed formed	48.14	2.25	3.28	18.16	26.72	1.45
Orchard grass	71.48	2.14	2.65	10.23	12.29	1.21
Ky. blue or June grass	58.76	2.03	3.18	13.29	21.27	1.47
Meadow Fescue	68.70	1.97	2.44	10.93	14.82	1.14
Tall Meadow oat	69.46	1.73	2.60	10.63	14.38	1.20
Meadow Foxtail	72.63	1.71	3.12	8.66	12.72	1.16
Fort Bellingham	62.58	2.35	3.33	12.49	17.96	1.29
Wood Meadow grass	55.55	2.16	2.86	16.29	21.82	1.32
Bennett's Native Wild	57.62	1.88	3.31	16.30	19.44	1.45
Sweet Vernal grass	67.41	1.57	2.10	10.74	17.02	1.16
Ox-eye daisies	78 46	1.59	1.28	5.62	12.16	.89
Buttercups	79 20	1.45	1.56	6.24	10.56	.99
Medium red clover	68 34	2.05	4.51	9.77	14.03	1.30
Alsike clover	77.29	1.95	3.66	5 32	10.76	1.02
White clover	78.23	1.79	4.42	4.70	9.44	1.42
Bokhara clover	69.20	1 61	3.52	13.12	11.45	1.10
Lucerne or Alfalfa	67.46	2.95	5.91	10.51	12.02	1.15
Yellow trefoil	78.52	1.37	3.40	6.31	9.29	1.11

Chess or cheat	60.35	1.85	3.17	13.05	20.46	1.12
Hays						
Timothy in bloom	15 35	4.16	6.59	26 88	44 33	2.69
Timothy in seed	15.35	3.65	5.34	29.95	43.65	2.36
Orchard grass	15.35	6.13	8.12	31.14	35.73	3.53
Mixed hays	14 80	4.92	6 37	32.30	39.15	2.46
Red clover in bloom	15.35	5.50	12.05	25.99	37 63	3.48
Alsike clover	15.35	6.55	11.44	24.95	38.37	3.34
Clover rowen	14.33	6.23	11.08	28 80	36.36	3.20
Lucerne or Alfalfa	15.02	6.69	13.81	27.28	34.97	2.26

TABLE B.

COEFFICIENTS OF DIGESTIBILITY.

Food.	Dry Substance	Albuminoids	Crude fiber	Carbohydrates	Fat	Determination made by
Timothy	65.7	60.4	62.1	71 8	51.5	Jordon
Timothy	54.1	55.5	51.7	61.0	34.6	Jordon
Timothy	—	42.1	52.0	65.7	47.6	Jordon
Timothy	51.6	45.2	42.8	58 9	55.0	Jordon
Orchard grass	60.0	60.0	66.7	57.3	57.4	N.Y.Ex. Sta.
Orchard grass	57.5	60 9	60.0	55.3	55.4	N.Y.Ex. Sta.
Orchard grass	54.4	58.5	57,5	54 4	51.2	Jordon
Red top	57.6	60.4	61.2	59.1	44.2	Jordon
Witch grass	59.9	64.2	67.6	62.1	60.0	Jordon
Wild oat grass	59.6	48.6	65 1	62.1	38.2	Jordon
Blue joint	39.9	56 5	36.5	43.2	37.0	Jordon
Mixed hay	—	49.0	49.0	58.0	50.0	Sturtevant
Mixed hay	54 3	46 9	46.8	55.8	50.0	N.Y.Ex.Sta.
Clover hay (red)	51.7	49.4	47.5	57.6	42.6	Armsby
Alfalfa hay	59 4	68.8	43.3	71.8	48.4	N.Y.Ex. Sta.
Alfalfa hay	—	77.0	49.0	64.0	54.0	O'Brine
Alsike clover	61 9	64.0	51 0	74.1	35.1	Jordon
White clover	66.0	73.2	60.6	69.5	50.6	Jordon
Buttercup	56 1	56 3	41.1	66.9	69.7	Jordon
White weed	57.8	58.4	45.5	66.7	62.0	Jordon

TABLE C.

SHOWING PER CENT. DIGESTIBLE MATTER.

Grasses, etc.	Dry Matter	Albuminoids	Crude fiber	Carbohydrates	Fat	Nutritive ratio
Timothy (in bloom)	18.33	1.22	5.75	10.26	.54	1:14.2
Tim'thy (seed form'd)	28.88	1 60	9.06	16 75	.71	1:10.9
Orchard grass	16.11	1.56	6.19	6.79	.65	1:9.4
Kentucky blue	23.65	1.92	8.13	12.57	.65	1:11.1
Medium red clover	16 37	2.23	4.64	8.08	.55	1:6 3

Alsike clover	12.87	2.11	2.52	7.17	.50	1:5.1
Lucerne or Alfalfa	19.32	4.06	4.55	8.63	.56	1:3.6
Hays						
Timothy (in bloom)	47.15	3.21	13.38	27.79	1.32	1:13.9
Tim'thy (seed form'd)	47.15	2.60	14.76	26.37	1.16	1:16.9
Orchard grass	47.83	5.28	18.53	19.66	1.90	1:8.1
Mixed hays	46.26	3.05	15.47	22.47	1.23	1:13.4
Red clover	43.76	5.95	12.36	21.67	1.48	1:6.3
Alsike clover	48.00	6.59	11.82	25.55	1.62	1:6.3

(The *nutritive ratio* is the ratio of the albuminoids to the total of the crude fiber, carbohydrates and fat, counting the fat as two and a half times more valuable than the fiber and carbohydrates.)

TABLE D.

MANURE VALUE OF HAYS.

(Figures show number lbs. in one ton, 2000 lbs.)

	Phosphoric Acid	Potash	Soda	Lime	Magnesia	Nitrogen.
Timothy	5.0	27.5	4.4	7.2	1.7	21.0
Orchard grass	8.2	38.5	4.7	8.3	2.0	22.0
Kentucky blue grass	7.3	29.2	—	4.0	1.3	21.1
Meadow oat grass	6.4	34.4	5.5	7.0	1.5	23.2
Meadow foxtail	8.8	43.8	9.5	8.4	2.4	30.8
Medium red clover	5.2	22.4	9.6	33.2	4.6	38.6
Alsike clover	7.5	48.5	—	37.6	6.5	36.5
Alfalfa	9.3	27.8	1.7	54.6	3.2	40.2

(This table also has a bearing on the relative value of hays in the formation of bone.)

TABLE E.

FOOD VALUE OF HAYS.

(New York Experiment Station Calculation).

	Market value per ton	Food value per ton	Fertilizing value per ton	Total value per ton	Total value per cent of cost
Timothy	$11.00	$14.80	$4.47	$23.59	176.
Orchard grass	11.00	14.86	6.08	25.28	190.
Kentucky blue grass.	11.00	14.68	4.85	23.82	178.
Tall meadow oat grass	11.00	14.68	5.26	24.23	182.
Meadow foxtail	11.00	13.82	7.08	24.93	189.
Meadow fescue	11.00	14.47	5.07	23.76	178.

Hungarian grass....	$11.00	$15.54	$5.00	$25.21	187.
Mixed grass.....	10.00	14.70	5.38	24.37	201.
Red clover.....	8.00	13.96	7.25	26.58	278.
White clover.....	11.00	16.39	9.40	30.58	234.
Alsike clover.....	8.00	15.52	8.07	28.12	295.
Alfalfa...	10.00	15.64	7.96	28.17	236.

Study of the foregoing tables will show that although hays do not on the whole differ enough to make the choice a very serious matter, yet the figures have a significance. For instance, Table D shows clearly the superior value of clover as a bone maker for young stock, and the inferiority of timothy as a manure producer. Table C shows that timothy and Kentucky blue grass are the best fatteners, alfalfa and clover the best muscle makers. The careful student can draw many other conclusions.

Practical feeders differ somewhat as to which is the best hay for horses. Many argue with Dr. Michener that it is timothy. Others think that Kentucky blue grass deserves its reputation. Still others argue for clover, and their arguments deserve consideration. They point to the superiority of clover in its mineral elements, those that go to make the bone; and its albuminous elements, those that go to make the muscles and the flesh. They urge that it makes the best manure; that it comes nearer a perfect ration complete within itself than any other crop; that it can be most cheaply produced; that it is both a summer and winter food; and that it develops most rapidly and economically the whole animal structure. But even the friends of clover admit that blue grass should not be discarded, and that it is very valuable for early and late pasture and feeding lots. They urge merely that its importance has been overestimated.

It would, however, appear that the choice between the various hays is affected by various considerations. We have seen that age is one factor. Work is another. Farm horses and all heavy workers need the fat making hays. Roadsters, trotters, and thoroughbreds do best on the hays where the proportion of albuminoids is greater. Then, too, the horse owner raising his own hay has the circumstances of his farm and his location to take into account. He finds timothy commended to him by

its habit of growth and productiveness. He finds that blue grass is not fitted to produce a good hay crop in the east, though furnishing excellent pasturage when well mixed with other grasses; through the Mississippi and Ohio valleys it is a general favorite. If he wants to renovate his soil, clover is rightly his preference. Alfalfa is getting to be better known and better liked through all the country, though here and there criticism of it is heard. Marvin, for instance, says his experience with it has not been satisfactory. "It does very well," he writes, "for brood-mares and youngsters; but it is a washy grass and affects the kidneys of the horses in training. At least such has been my experience. Alfierella, commonly called filaree, is a rank growing grass that horses are very fond of, and that I consider preferable to alfalfa for turf horses. The natural wild-oat of California provides excellent forage, and animals take much to burr-clover after it is ripe and dry."

All agree that any hay should be crisp, clean, fresh, with a sweet, pleasant smell. It is best fed when not less than one year nor more than two years old. New hay is hard to digest and produces much slobbering and sometimes purging and irritation of the skin. If new hay is fed at all, it should be mixed with old. When hay is kept too long, it loses part of its nourishment, and although it may not be positively injurious, it is hard, dry, and less digestible. Second crop or aftermath is not held to be good hay for horses.

The value of hay depends on the time in cutting, as well as the care in curing. It ought to be cut when in full flower, but before the seeds fall; if left longer, it becomes dry, woody, and lacking in nutrition. The analysis at the New York Experiment Station showed that timothy cut after the seeds had formed contained 10.2 lbs. less of ash in the ton than that cut when in full bloom; 25 lbs. less of albuminoids; 13.6 lbs. less of carbohydrates; 6.6 lbs. less of fat; and 55.4 lbs. more of crude fibre. Evidently there was serious loss in both nutritive and digestible value. If Hungarian grass or millet is allowed to ripen before cutting, a great deal of the nutriment goes into the seed, thereby making the stems a sort of straw rather than real hay. It will be a little more difficult to make hay of grass cut so early as this, but it will cure in the cock

for the most part. The result should be a first-class hay with no danger whatever from the seed.

It is important to keep hay in the field as short a time as possible after it is cut. Smith asserts that one hour more in the sun than is necessary results in a loss of from 15 to 20 per cent. in the feeding value. On the other hand, hay spoils in the mow or rick when harvested too green or not dried enough. When from this cause it has become "mow-burnt," it has a very brown color, and will probably be here and there blotched with very dark seams, almost black, running through the mow or rick, showing how very nearly it has come to getting on fire. Hay that has so suffered always has an over-sweet, sickly smell, and there are many people who, knowing no better, suppose that because of this sweet smell such hay is necessarily very good. Horses will eat it greedily, and so the idea gains ground. But such hay is not fit food for horses at all. It affects their kidneys and bowels, causes them to fall off in condition, and may, if fed continuously, produce serious disease.

Hay should be neither too brittle nor too dusty. If dusty, it should be dampened before feeding.

Bad hay and the bad use of hay cause many of the ailments of horses. For instance, musty or mouldy hay has often been said to produce that peculiar disease known variously as cerebro-spinal meningitis, putrid sore throat, or choking distemper. To the same cause is often due the disease known as broken wind, or heaves. Spooner, writing in 1842, said: "The immediate cause of broken wind is obviously the circumstance of sudden exertion on a full stomach. In proportion to the indigestible nature of food is the disease likely to occur. Thus, musty and damaged hay is a very frequent cause; and this hay being frequently given to agricultural horses accounts in great measure for the disease being more frequent with them than with any others. Nimrod, the celebrated sporting writer, says the disease is extremely rare in France, where he now resides; and this he attributes to the fact of sweet straw being generally used instead of hay, particularly amongst farm horses."

Professor Williams, of Edinburgh, says: "To give my own opinion I have no hesitation in asserting that broken wind is generally due to improper food, more particularly to bad,

musty, or coarse hay, containing a large quantity of woody fiber, from being allowed to become too ripe before being cut, and to a superabundant allowance of hay of any kind, with an insufficient supply of corn."

Dr. Smith, of Toronto, says: "A common cause is from riding or driving fast immediately after feeding, or drinking a large quantity of water. It is also produced by feeding on dusty clover hay; it is also a sequel of some of the diseases of the air passages, and of the chest."

Professor Law, of Cornell University, says: "The causes of heaves are overfeeding on clover hay, chaff, cut straw, and other bulky and innutritious foods. In Arabia, in Spain, and in California, where there is no long winter feeding on hay, and in our Territories, where clover is not used, heaves is virtually unknown; it has advanced westward just in proportion as clover hay has been introduced as the general fodder for horses, and it has disappeared in England, and in New England, in proportion as the soil has become clover sick, and as other aliment had to be supplied. The worst conditions are when a horse is left in the stable for days and weeks eating clover hay, or even imperfectly cured, dusty hay of other kinds, to the extent of thirty pounds and upwards daily, and is suddenly taken out and driven at a rapid pace."

Not alone for the reasons suggested in these extracts, but for others equally potent, it has come to be the general opinion that less hay should be fed. Chief among them is the fact that the horse has but one stomach, and a small one at that. Cattle and sheep are ruminants, chew the cud, and have four stomachs. They are the animals that can make the best use of coarse, bulky food. The horse makes poorer use of it, and when it is his chief ration his stomach gets so distended as to make him clumsy and hard of motion. This result is seen in the spiritless horses of many of our hay-feeding farmers. Even when horses are at light work, if kept entirely on hay they soon become pot-bellied, fall off in flesh, and do not thrive. Unless colts are fed some grain, they grow up to be long, lean, and awkward, never making as good horses as those that have not been restricted in food to grass and hay.

Therefore the rule is laid down that the average horse,

getting grain, should be allowed from 10 to 12 pounds of good hay a day, fed once or twice.

Grass and Green Forage.— Although grass is the natural food for horses, little need be said of it, for under present conditions it is seldom eaten except in the pasture. There the horse can look out for himself. It is true, though at first glance it may seem strange, that none of the grasses will suffice for horses at work. Consideration will show that while grass is the natural food, work is not the natural condition of the horse. It is an artificial condition, forced on him by the needs of man, and must be met in artificial ways. Therefore it is that horses fed on grass soon tire on the road or at hard work in the field. They are soft, sweat easily, and purge. Nevertheless, grass is almost indispensible during the period of growth, and any horse will profit by being turned out to pasture now and then. Inasmuch as grass acts as an alterative on horses accustomed to grain and hay, when it is fed caution should be used at first. If cut for the horse, it should be fed fresh or but slightly wilted. Professor Michener says that during febrile diseases grass acts almost as a medicine, lessening the fever and favoring recovery; and some chronic diseases, chronic cough, for instance, disappear entirely when the sufferer is at grass.

Green forage is very cooling in hot weather, but should always be given quite fresh. Beans and peas may be mixed with the corn where horses are doing hard work, especially after they come in from a long day.

Straw, Fodder, Etc.— It is not easy to classify further the bulky horse foods, for popular usage of the terms does not agree with the botanical sub-divisions. Already we have wandered from the strictly scientific course by mentioning clover under the head of hay and grass. The fact is that fresh clover is not the one and dried clover is not the other. Clover is a plant of the pulse family, the botanical order known as *leguminosæ*, and is allied to peas, beans, etc. All farmers, however, think of it and treat it as a grass or a hay, and for all practical purposes that is legitimate. The scientific phase of the case, nevertheless, is to be remembered when you notice clover later on in a table of the food value of straws.

There is another term inexactly used. Ordinarily we think of straw as the dried stems of such cereals as wheat and oats. But the name is also applied to maize, peas, beans, etc.

"Fodder" is a still more uncertain term. It may mean any or all of the food material supplied by man to domestic herbivorous animals. It may include hay or roots. Where to distinguish between it and *forage* is not clear. But for our purposes these terms may in the main be confined to such grasses or plants as are commonly known as hay or straw.

Maize stover is the name now accepted for the stover, stalks, or straw of corn, being what remains after the ears of ripe corn have been removed; it has been generally known as *corn fodder*. On the other hand, *fodder corn* denotes the product when corn is grown as a fodder, whether harvested when mature or at an earlier stage of growth; fodder corn contains the ears if such are formed. Maize stover is best classified as a fodder.

The straws are not much fed to horses in America, but abroad they are commonly mixed wtth hay, and are coming to be used more here, especially on the farm. So it is worth while to note their composition. Analyses have shown it to be as follows:

	Water	Ash	Albuminoids	Crude fiber	Carbohydrates	Fat
Wheat straw	17.86	4.16	2.98	42.74	31.04	1.22
Oat straw	16.28	4.83	2.35	36.77	37.97	1.80
Maize stover (field cured)	49.01	3.62	3.25	18.78	24.13	1.21
Maize stover (in barn)	22.63	5.35	6.47	28.43	35.87	1.25

The per cents of digestible matter are:

	Dry matter	Albuminoids	Crude fiber	Carbohydrates	Fat	Nutritive ratio
Wheat straw		.77	22.22	12.42	.33	1:46
Oat straw	42.11	.42	21.18	20 20	.69	1:102.3
Maize stover (f'ld cur'd)	31.61	1.64	12.49	15.08	.76	1:17 9
Maize stover (b'rn c'rd)	47.97	3.26	18.91	22.42	.78	1:13 3

The analyses of both the wheat and oat straw were of samples from field stacks; hence the water percentage is somewhat higher than for similar straw that has been protected from the

weather. Wheat straw is held to be less valuable for feeding than good oat straw, one reason being that the grain is allowed to ripen before being harvested and so the straw becomes more woody. Oat straw, too, is more easily digested. The maize stover contains more of the albuminoids than either the wheat or oat straw, and shows a larger percentage of digestibility in respect to all the valuable elements. Its worth as fodder has not been recognized as it should be.

Comparison of the analyses of straw and hay will show that straw is inferior both in albuminoids and carbohydrates. Therefore more bulk must be consumed to get the same benefit. That is why straw is less advantageously fed to horses than to other stock. Yet when horses are idle, as in the case with most farm horses in the winter, the straw-stack can be utilized with economy and without harm. The horses come to like it, but will do so the quicker if at first a little salt water is sprinkled over it.

When used to mix with hay, it will be wise to choose that hay which contains in excess the elements in which straw is deficient. Clover, on account of its abundance of nitrogen, answers the best. A ton of clover properly mixed with a ton of straw will equal in feeding value two tons of timothy. Cut straw and bran form a better ration than either alone. Straw can be used, too, with great advantage when roots are fed. The English custom, when mixing hay and straw, is to take two parts of hay and one of straw. It should be remembered that only clean, bright straw is nutritious, and that which is mouldy and weather-stained should be used for littering.

It will be interesting to note before leaving the subject what one of our best writers on the horse, "Aurelius," has said of straw. In discussing the food of colts he wrote: "I have learned to value wheat straw as well as skim milk. If wheat straw be cut when the berry is ripe, but before it is old and dry, before the sap and green have left the stalk and the straw has become woody, I may say that the grain will not only make better flour, but the stalks or straw will make excellent feed, nutritious and healthy, which the stock will eat readily. It would be better than half the hay which is fed to city horses, gathered after it has been wet, and which is productive

of the heaves. With such wheat straw, and with skim milk and with ground oats and bran, with carrots every day, I would run my risk of getting a colt into condition to exhibit any where."

Another writer testifies: "A short time ago a valuable horse, an imported draft stallion, was fed all the hay he would eat with dire result. It took an experienced horseman months to correct the mischief done by a season's stuffing with hay. Since that severe lesson I have had constantly the care of work-horses and have found that fully as good results in feeding were had where good bright straw, of which the animals ate little, was used for roughness and variety, but no greater quantity of grain was fed than when hay was a large and constant part of the diet."

A writer from Iowa says: "The teams we are working this winter are keeping in good flesh on oat-straw three times a day and two quarts of corn twice a day. The fact of the matter is, under our conditions we can keep a brood mare cheaper than we can keep a cow, and we can raise a good draft colt as cheap as we can raise a steer."

Maize stover (or corn fodder) is a better feed for horses than is commonly supposed. But it must be bright and well cured. It should neither be left standing for months in the fields nor be stored in the barn loft while damp, and there allowed to mould and rot. In either case it then becomes both unpalatable and unhealthy. Properly harvested, cured and kept, horses are very fond of it. On account of its excess of fat making materials it is best used as a winter food, when the horses are comparatively idle, and at such times it can be safely and economically substituted for much of the hay ration, especially if fed with clover or some other highly nitrogenous food. There is much difference in its quality, and some varieties are relished much more than others. Fodder from sweet corn is always eaten with greater apparent relish than the common field variety or that grown from large Western corn.

Analyses of corn fodder show that nearly half of the dry matter is contained in the ears, and of this one fifth is in the cob. The leaves and husks contain one-third of the total, and there is three times as much of the remainder in the butt, or

harder and tougher part, as in the tops. When fodder is fed whole there is more or less waste of the butts by the animal. From the results it would seem that this loss would be from ten to fifteen pounds in every 100 pounds of dry matter. Practical experience proves that much of this may be saved by cutting up the cured fodder or putting it in the silo.

An Ohio breeder, who has been experimenting with timothy, clover, and corn fodder, sums up his experience as follows: "Last summer we made considerable clover hay, cured it nicely and put it in the barn. We also put up some timothy, of which we fed until late in the Fall, saving a part to feed this Spring when the horses will have hard work to do. We began feeding the clover hay in November, and continued the practice most all the time till the first of March; but for some reason the horses did not do as well as they should. Their coats became dry and rough, and they did not seem to relish their ration.

"We had occasionally to give them a feed of corn fodder or timothy hay to dry up the slabbers, one of them slabbering so bad at times that nothing would do her any good but a change in her feed. We fed the hay because we had plenty of it in the barn, and it can scarcely be given away in these parts at present; also we didn't need to bestow so much labor upon our corn fodder to save it.

"For a while now we have been feeding corn fodder, and although the fodder is not as bright and clean as it should be (for there isn't much good fodder this Spring) our horses relish it exceedingly, doing considerably better with less grain ration than when we fed clover hay. Their appetites have improved, their hair and skin are becoming soft and smooth, and they are gaining remarkably in flesh. For several Winters previous to this we have been feeding corn fodder to our horses with good results; they come out in the Srping with better wind for hard work than when fed on most any other food.

"Some farmers object to feeding fodder in the stable. They say it leaves too many stalks to deal with, but if they take a little time each evening just before their feeding and clean out the stalks that have accumulated, throwing them in a lot for the reception of corn stalks, waste straw and everything else

that helps to increase the manure heap, the matter is remedied.

"The awkwardness some feeders display when putting in fodder to the horses is enough to make the bystander's eyes water, especially if said bystander 'knows how.' Some will take a bunch of fodder nine feet long and try to put it in a manger 4 ½ feet long. And this is easily done if you understand how. Place the left arm under the bunch two-thirds of the way from the butts, with the right arm over the centre, and break; then it will just fill the manger nicely.

"There is no better supplement to short pastures during the latter part of Summer and early Fall than well-grown succulent corn fodder cut just as the ears are coming into milk, and fed green. Most brood mares and young stock are very fond of it. Stowell's ever-green sweet corn gives the best satisfaction of any we have ever tried. It is a vigorous grower, tender and sweet."

Waldo F. Brown, another Ohio farmer, says:—

"I have found that I could winter a full-grown cow or horse on the fodder from an acre of good corn, and the cost of saving this acre and putting it in the barn is usually less than half a ton of hay would sell for; and when hay is high, a quarter ton will sell for enough to pay it. As an example of the economy of corn fodder as compared with hay, I will give the figures of my last year's crop. I grew 12 acres of corn, and it cost me $18 to have it put in shock at 6 cents a shock of 120 hills each. To husk it and bind the fodder in bundles cost 8 cents a shock or $24 for the 300 shocks, but from this we deduct 3 cents a bushel for husking 500 bushels of corn, which reduces the net cost to $9. It took three days for two hands and a team to put this fodder into the barn, which at regular wages for such work would be $10, making the entire cost of this fodder in the barn $37. We wintered on this six horses and four cows, and from Sept. 1 to March 1 (six months) did not feed a pound of hay. The first of March our fodder was gone, and in the following six weeks the stock ate hay that would have sold for more money than the fodder had cost me, and were not in as good condition as when we made the change in food.

"To get the best results from corn fodder it must be well cured and put into the barn early, and then fed in a warm

'stable in racks or mangers so arranged that none of it will be wasted. If fodder is left in the field until mid-winter or spring, and then fed on the ground with cattle tramping over it, it usually does not pay for handling. It should be cut about the time the ears begin to glaze — which in my latitude is usually from the first to the middle of September. Set the shocks up firmly and tie the tops securely so they will stand, and just as soon as the corn is dry enough for the crib, husk it, bind the fodder in medium sized bundles, and store it at once in the barn. I have proved by many years' observation that corn can be cribbed about three weeks earlier from the shock than if left on the stalk without cutting up. We usually crib all our corn in October, escaping cold and snow, which so often trouble in November.

"Counting that my horses and cattle would have eaten only 12 pounds of hay each a day, my $37 worth of fodder saved nearly 11 tons of hay — or to be exact, 21,600 pounds, and I sold the hay for $10 a ton."

Care must be used in letting horses have access to corn-stalks, to see that they are not affected by the corn-stalk disease. The same germ that causes this disease will bring death to horses as well as to cattle. The disease on the corn-stalk is usually apparent after midsummer and appears as brown spots on the part of the leaf nearest the stalk. These spots are dead and vary in size from that of pin-heads to several inches, and in these the microscopic organism is always to be found. Usually the diseased corn is confined to clearly marked areas — not infrequently in low places recently broken from the sod of wild grasses. Sometimes instead of being confined locally, scattered stalks throughout a field may be affected, while in rare cases it may be evenly distributed over all the field. Affected corn presents a stunted appearance. The lower leaves prematurely die, and this is more especially the case if the plant becomes invaded when quite young. In cases where large stalks are found affected the invasion usually takes place after the plant has attained a more or less mature growth.

A Minnesota farmer gives his experience with flax straw: "Last winter I fed flax straw to my stallions, mares and colts, also to sheep and cows, with good results. The machine left

about three bushels of seed in each ton of straw. I feed hay once each day to all, and a very small feed of oats to my work horses and stallions twice each day. All my stock came through the winter fat and fine."

Another says: "My neighbors here raise a good deal of flax, and some of our best stockmen tell me that stock of all kinds eat it with a relish after they get used to it, and do better on good flax straw than on any other straw. We hear of no bad results from its use with brood mares."

Chaff cannot be so unreservedly approved. Indeed, wheat and rye chaff should never be used as food for horses. The beards frequently get lodged in the mouth or throat, and make more or less serious trouble. In the stomach and intestines they often serve as the nucleus of dangerous soft concretions. Oat chaff, if fed in small quantities and mixed with cut hay or corn fodder, is not so objectionable and is very much relished by horses. It is not to be given in large quantities, lest it cause the troublesome and sometimes fatal diarrhœa that follows free access to a pile of oat chaff.

The New York Experiment Station calculation of the food value of straws is as follows:

	Market value per ton	Food value per ton	Fertilizing value per ton	Total value per ton	Total value per cent. of cost
Oat straw	$9.00	$14.04	$3.20	$21.34	192.
Wheat	9.00	13.53	2.01	19.49	172.
Rye	11.00	13.63	1.83	19.44	141.
Barley	9.00	13.77	2.14	19.93	177.
Buckwheat	5.00	16.15	6.75	27.61	458.
Pea	6.00	14.93	4.40	23.69	322.
Bean	6.00	15.56	7.85	27.95	390.
Clover	6 00	14.78	5.81	24.91	343.
Maize stover	6.00	13.10	3.43	20.35	275.

Forage Plants, Fodder, and Ensilage.

Analysis of various forage plants has shown their chemical composition to be as follows:

	Water	Ash	Albuminoids	Crude fiber	Carbohydrates	Fat
Sorghum, av'ge of 3	84.00	.77	.97	5.23	8.60	.43
Sorghum, amber cane,	82.44	.74	1.17	5.94	9.32	.39

Fodder corn	80.65	.99	1.54	6.10	10.14	.58
Ensilage, maize fodder	84.14	.96	1.00	5.14	7.92	.84
Ensilage, maize stover	59.29	1.72	3.62	8.11	24.80	2.46
Ensilage, H'ng'r'n gr's	60.51	2.75	3.30	13.60	17.51	2.33
Cow pea	84.06	1.83	3.12	3.48	6.91	.60
Soja hispida	69.87	2.38	3.34	8.36	14.90	1.15
Prickly comfrey	84.36	2.45	2.94	2.61	7.13	.51
Rye forage	79.04	1.47	2.85	7.77	7.82	1.05
Oat and pea forage	74.81	1.66	3.97	7.98	10.32	1.26
Hungarian grass	73.49	1.72	3.45	7.81	12.43	1.10

Percentages of digestible matter have been determined as follows:

	Albuminoids	Crude fiber	Carbohydrates	Fat	Nutritive ratio
Sorghum, av'ge of 3	.60	3.14	6.71	.37	1:17.9
Sorghum, amber	.73	3.56	7.17	.33	1:15.9
Ensillge, maize fodder,	.49	3.54	4.90	.76	1:21.2
Ensilage, maize stover,	1.77	5.60	16.61	2.21	1:15.7
Fodder corn	1.12	4.39	6.79	.44	1:19.7

Fodder corn (or maize fodder) has been cut at nearly all stages of growth for feeding, but there is no question that it possesses the greatest nutritive value as it approaches maturity. By comparing its analysis with the analyses of other plants, it will be seen that it contains a very large percentage of water, and that its proportion of nitrogenous matter (shown by the nutritive ratio) is greater than that of the straws, but less than that of the hays, and much less than that of the grasses. Its excess of carbohydrates, just as in the case of the straws, though to a less degree, makes it desirable to feed it, either green or dry, mixed with clover, bran, or other nitrogenous food materials. It is eaten with a better relish if cut up, crushed, moistened, and mixed with bran, oil-meal, or cotton-seed meal. It should be planted thick in drills, or hills, yet thin enough so that the stalks will have room to bear an ear. The nearer mature the grain while the stalks are yet green, the better is the quality of the feed. Green fodder is not so desirable, containing more water and less protein and carbo-hydrate elements than corn that is well advanced toward ripe ears. Up to the time the ear is in silk, the per cent. of these constituents is small. It is only during the period when the entire energies of the plant are devoted to seed formation that the

food elements are stored in the concentrated form, such as starch, sugar, fats, and the albuminoids.

Ensilage is attracting almost as much attention from horse breeders as it is from dairymen. This is not so much because of its chemical composition — it will be seen that its nutritive ratio does not differ materially from that of fodder corn — as because of the fact that it bids fair to supply the want long felt of some succulent food less costly and more useful than carrots or other roots for winter feeding. Within only a few years has it been demonstrated that fodder corn stored in the silo makes a winter food that horses both profit by and learn to be fond of. Like most other animals they prefer it to the best dry forage. The cost of preserving a given crop of ensilage does not materially differ from curing the same crop by drying in a suitable season, but crops can be ensiloed and preserved in seasons when they would be lost if drying was attempted. All things cousidered, Indian corn makes the most economical and satisfactory ensilage in most parts of the United States, and with a crop of 20 to 25 tons to the acre when cut, which is a good average, the ensilage may be made, ready for use, at a total cost of $2 a ton, and for less under favorable circumstances. An acre of corn as ensilage will weigh four times as much as the dried fodder. But an acre of corn, field cured, stored in the most compact manner possible, will occupy a space eight or ten times as great as if in the form of ensilage.

It is claimed that any crop suitable for feeding in the green state will make good ensilage. Peas, oats, millet, rye, clover, sorghum, and other forage plants have strong advocates of their merit for ensilage, but corn undoubtedly ranks first. It yields less, and the ensilage will be more acid and less palatable.

Good, sweet corn is just as safe as grass to feed to horses, and in cases where it is supposed to have been injurious the effects of grass would have been the same, except that if the ensilage was very sour it might have produced a more aggravated fermentation than grass. But all experienced horsemen know that they must be cautious when horses are changed from dry food to grass. If the horses are at work, in the winter season the ensilage would have to be fed in smaller quantity.

Professor W. A. Henry, of the Wisconsin Agricultural Experiment Station, on being asked if corn ensilage was injurious to horses, replied: "Every now and then we read of horses dying from eating corn silage, though the reports are not as frequent as formerly. Writers seem to forget that a great many horses have died after eating good hay and clean oats. In most of the cases I doubt if the corn silage had anything to do with the animals' dying. Corn silage is a succulent feed, somewhat washy in its nature, and is only suitable for horses living under certain conditions. Horses not hard worked and brood mares and colts can be fed a considerable amount daily of good silage with good results. Work horses can be fed a few pounds a day as a relish, but no large quantity should be given, just as one would not expect to keep them thriving in summer time on green cornstalks. It is surprising to see how long the prejudice against using corn-fodder in any form for horses holds out."

An English correspondent of the London Live Stock Journal gives the following testimony: "This winter two of my cart horses have had three parts silage and one part hay cut up into chaff; they have had no corn since November; they are in better and healthier condition than many of my neighbors' horses, and also better than what I usually have them at this time of the year. I feel quite sure that a properly-made silage of a good crop — as rye-grass and clover, brown and sweet — is a better food for horses than the same crop in its green state, or made into the best hay. I have also three horses doing fast work in the town; they have three parts of silage and one part hay, with their usual amount of corn, viz. 8 pounds of oats, 2 pounds of maize, and 2 pounds beans daily for each horse. I never had them in better condition, or got through a winter with less trouble, not one of the horses ever having had a day's or an hour's illness since we began to feed largely on silage."

Sorghum is a fodder that can hardly yet be said to be well-known, but its use is spreading and in some portions of the country it has begun to play a part in feeding. It was less than forty years ago, indeed, that its seeds were first brought to this country, and prior to 1851 it had been almost unknown in Europe, though it had been grown from time immemorial in

Africa and China. It is a grass closely allied to the sugar-cane and has been propagated here primarily for the sake of its sugar, but it is now coming to be used also for feeding. It is sown in drills or hills like Indian corn, and its mode of cultivation is essentially the same. It will grow in any place where maize succeeds, but rarely ripens its seed north of the 41st degree. The investigations of the Agricultural Department show that as a crop for sugar the localities in which it can flourish are confined to the semi-arid region of the country, notably beginning in Central Southern Kansas and extending southward indefinitely. This limitation, however, does not appear to apply to its use as a fodder crop, inasmuch as favorable reports concerning it are to be found in the Agricultural Reports as coming from several of the Northern States. For instance, the Ohio report of the Seed Division for 1889 regarding sorghum read as follows: "The Early Amber ripened evenly and grew to the height of 8 feet. Cows eat it greedily, and given to a sick horse it acted like a tonic and invigorated its whole system."

As a feed stuff sorghum has naturally received the most attention in the Southwest. At first in some sections the heads alone were appreciated, and in others it was the stalk that was supposed to make up the value of the plant. Happily farmers are now everywhere grasping the fact that the entire plant is valuable for forage. As material for silage it grew rapidly in favor, not only because of its large yield to the acre, but also because of its richness and resultant fattening properties. The Texas Experiment Station reports that as a hay it is palatable and readily eaten by horses and cows, and when nearly ripe, or quite so, by hogs. If cut and fed during its growth in its green state, it becomes a most valuable adjunct to corn.

The use of sorghum seed for food would more naturally be discussed with that of cereals, but for convenience we may give here the conclusions of the Agricultural Department regarding it. The chief objection to its use for food, says the Report of 1889, has been on the supposition that it contained tannin, or some bitter principle, which would prove injurious to stock. A careful examination of sorghum seed has failed

to discover the presence of tannin, and the only possible injurious principle which it can contain is the coloring matter of the glumes. A careful examination of this coloring matter has been made and its composition determined. It consists of 33.5 per cent. of carbon, 6.6 per cent of hydrogen, 7.2 per cent. of nitrogen, and 52.5 per cent. of oxygen. Any possible ill effects of this coloring matter, when seed is used for food, can be removed by the removal of the glumes, which would not be a difficult mechanical process. Compared with maize and oats, the seed itself is shown to be of fair quality, equal in food value to either.

Analyses were made of a great many different varieties of seed, but the chief difference in the varieties is shown in the percentage of coloring matter rather than in the composition of the seed itself. If sorghum should be raised for seed alone, those varieties producing a pure white seed, like the White Mammoth, should be preferred to those producing highly colored seeds, like the Early Amber and most of the varieties of Chinese cane. The percentage of moisture in sorghum seed is about 10, the actual percentage found being 9.59 as a mean of 48 analyses. The percentage of albuminoids was found to be 11.71; of fat, 3.35; of substances soluble in ether, 0.50: the soluble carbohydrates, 3.37; of ash, 1.70; of indigestible fibre, 1.89; of starch and insoluble digestible carbohydrates, 68.03. These analyses will compare favorably, in regard to the food value, with those of maize. They were based on the seeds from which the glumes had been removed.

The value of sorghum seed as a food for man and other animals is found to be fully equal to that of maize and oats, and but little inferior to wheat. When fed, excepting to poultry, the seed should be either ground or boiled; otherwise much of it will pass the digestive organs untouched.

Furze, otherwise known as whin or gorse, may be spoken of here, though it is as much a straw as clover, to which it is very closely allied in its botanical aspect. This shrub, very common in Europe, is not so well known here, but one variety of it, at least, has become thoroughly established on many of our sterile hills, especially in the East. Abroad it has been much used for forage; and in some parts of Wales, chopped

and bruised, it forms the principle part of the winter fodder for horses. It is most extensively cultivated, however, in Flanders. In some places it is sown to yield green food for sheep and other animals, but it is preferable to other crops only on dry sandy soils where they could not be advantageously cultivated. As might be expected from a plant akin to the clover, its percentage of albuminoids is high. Its nourishment is available when it iswell crushed, and especially when it is mixed in a chaff cutter with good hay or oat straw. Unless so mixed it is too heating and apt to cause founder in horses and inflamation of the udder in cows. It gives a fine coat to horses, and the milk taken from cows fed on it makes butter that even in winter has a fine rich color. You can chop up any other forage with it, and a little mucilage made from oil-cake added will very much improve the feeding. The principal precaution to be taken is to use at first very little furze, increasing th proportion as the animal gets used to it. When they get used to it, horses may be kept all winter on furze without hay, provided they get a bran mash about twice a week, and now and then a little green feed such as carrots or half-boiled potatoes. But if the horses are worked they should also get oats. Furze as feeding is about three-quarters the value of the same weight of good hay.

Roots, Tubers, Etc.—Allied to forage in their feeding uses are the roots, tubers, etc. Though not extensively given to horses, it is worth while putting here for reference the following table of their composition:—

	Water	Ash	Albuminoids	Crude fiber	Carbohydrates	Fat
Sweet potatoes	74.38	1.34	3.56	2.14	17.98	.60
Potatoes	78.49	.84	2.42	.68	17.51	.06
Cabbage, out'r leav's	89.86	1.35	1.83	2.98	3.54	.47
Tusnips	92.40	.72	1.25	1.20	4.20	.23
Pumpkins	92.27	.63	1.11	1.49	4.34	.16
Mangolds	94.41	1.09	1.03	1.00	2.40	.07
Carrots	91.13	1.00	1.08	1.41	5.09	.29
Okra	87.41	.74	1.99	3.42	6.04	.40
Onions	89.26	.45	1.09	.65	8.31	.24
Tomatoes	91.26	.73	1.00	.70	5.84	.47
String beans	83.46	.83	2.75	2.58	10.04	.34
Apples, sweet	77.30	.46	.50	1.27	19.96	.41

It has not been thought desirable as yet to go into the extensive experiments needed to determine the digestible percentages of most of these foods, and indeed they do not usually play an important enough part to demand it. Potatoes, however, are much used in certain regions, and it may be desirable to know that they contain 16.56 per cent. of digestible dry matter; 1.07 per cent. of digestible albuminoids; 15.91 per cent. of digestible carbohydrates; and 0.08 per cent. of digestible fat; giving the nutritrive ratio, 1:15. If potatoes are fed raw and in large quantities, they often produce indigestion. Their digestibility is favored by steaming or boiling. They possess, in common with other roots, slight laxative qualities. As they contain much water, it will be prudent when feeding them to horses to any extent to curtail the supply of water somewhat. Professor Low claimed that 15 lbs. of potatatoes would yield as much nourishment as 4½ lbs. of oats; Von Thayer asserted that three bushels are equal to 112 lbs. of hay; and Curwen, who tried potatoes extensively in the feeding of horses, said that an acre goes as far as four acres of hay. Recent calculations of the New York Agricultural Experiment Station, however, show that for general stock-breeding purposes potatoes have a food value of only $5.57 a ton, and a fertilizing value of $1.66 a ton, making a total of $7.23, so that whenever they sell at $10 a ton, the market value given in this calculation, it is manifestly poor economy to feed them for stock unless some other considerations prevail, such as their influence on health and condition. Some who have tried them, however, say that for feeding to horses the small potatoes are about as good as the merchantable ones, and of course it often happens that the small ones can be procured at very low prices. They are said to put a polish on the coats of horses and neat cattle such as is given by few other foods.

Carrots, in spite of being nine-tenths water, have a considerable food value, or perhaps it would be better to say medicinal value. In fact, though useful at any time as a change of diet, they are most excellent during sickness. Their effect is to improve the appetite and increase slightly the action of the bowels and kidneys. They possess also certain alterative qualities. When they are fed to horses the coat becomes smooth

and glossy. Some veterinary writers claim that chronic cough is cured by giving carrots for some time. Stewart in his "Stable Economy" said: "They form a good substitute for grass, and an excellent alterative for horses out of condition. To sick and idle horses they render corn unnecessary. They are beneficial in all chronic diseases connected with breathing and have a marked influence upon chronic cough and broken wind. They are serviceable in diseases of the skin, and in combination with oats they restore a work horse much sooner than oats alone." These characteristics make it natural that in the spring, when horses cannot be turned out to grass, they should then be fed a few at a time, two or three times a week. Horses are very fond of them, liking them best when they are sliced and mixed with cut hay. Used purely as food their composition shows them to have a food value of $2.70 a ton, and a fertilizing value of $0.98, a total of $3.68, being 93 per cent. of their cost, if that be $4 a ton.

Feek, the trainer, thinks carrots are of "too refrigerating a nature to feed in cold weather." He doesn't like to feed them or any other roots when it is freezing.

Parsnips have nearly the same composition as carrots, except that they contain an even larger percentage of water. In England and France they are fed in the same way as carrots.

Sweedish turnips are much fed to horses in Scotland, but are comparatively little known or used as an article of diet for the horse in the Southern counties of England or in America. They are said to be not only easy of digestion in themselves, but also to cause cut straw to be relished by farm horses.' They fatten a horse quickly, producing a smooth glossy coat and a loose skin. They are best given once a day, boiled along with barley and a little oil-meal, and preferably at night. Turnips are an economical food, as their composition gives then a general food value of $1.83 a ton and a fertilizing value of $0.85 a ton, a total of $2.68, which is 68 cents above the market value set by the New York Station table.

Beets, apples, celery, cabbage, squashes, etc., are sometimes fed, and are as welcome to the horse as sauces are to the man. But they should be given as condiments rather than as rations. Apples are particularly useful for young or enfeebled

horses in the early spring, and as a corrective at any season sour apples have a medicinal value not to be despised. All the succulent foods are beneficial for mixing with the dry foods, especially when the change is made from pasture to barn, making that change less abrupt and dangerous. The practice of European stock raisers, with whom the matter of root supply has nearly as much weight as that of grain and dry forage, suggests that perhaps we are not as thoughtful in this respect as we should be.

A Washington farmer reports that his horses running in a field got at a pile of onions and ate about 300 lbs. Since then they seem to eat an onion as readily as a carrot. The onions grown there, however, are very mild and sweet. The fact that the horses ate them is the best proof that they were agreeable, and there appears no reason why they should not occasionally be fed.

An Iowa farmer who has experimented with artichokes says: "For many years I have grown the Brazilian and large French artichokes for hogs. As swine harvest the tubers and save labor, I have never gathered them to feed to other stock. But having some on hand last spring after planting a new lot, I let a neighbor have them to feed to a valuable stallion that seemed a trifle out of condition. The horse ate them readily, and beside an excellent effect as food and improving his coat and general health, it was noted that he passed worms freely. In a short time he was in fine condition. Although the effect on swine has many times been similar, it was accepted as an ordinary fact. This experiment would indicate that for horses, under like circumstances, this tuber would be quite as valuable. The labor of growing a quarter of an acre for use in the horse barn would be a small matter, and the ease with which the large variety can be gathered and stored (freezing is no damage) commend the matter as worthy fair trial. They may be left in the ground until the frost is out, and would furnish a soft bite to the horses, brood mares, and colts, just when needed, and at one-tenth the cost of growing and storing the same weight of carrots."

Grain. — Grain, everybody knows, is the staple food of the horse, just as in the form of bread it is the staple food of man.

The following table shows the composition of the various kinds:

	Water	Ash	Albuminoids	Crude fiber	Carbohydrates	Fat
Oats	10.94	2.97	11.38	9.85	60.05	4.81
Corn	10.51	1.54	10.55	2.09	69.85	5.45
Wheat	10.54	1.86	11.80	1.80	71.89	2.11
Buckwheat	12 55	2.00	10.00	8.70	64.50	2.25
Barley	10.92	2.38	12.39	2.57	69.88	1.86

The digestible percentages of three of these (remember the figures are equivalent to the number of pounds of digestible matter in 100 pounds of food) have been found to be:

	Albuminoids	Crude fiber	Carbohydrates	Fat	Nutritive ratio
Oats	8.76	1.67	44.44	3.94	1:6.4
Corn	8.44	2.09	60.77	2.29	1:8.1
Barley	9.91	2.57	60.80	0.78	1:6.6

A glance suffices to show that oats and barley contain the more protein, i. e. albuminoids, nitrogenous matter; and that corn excels in carbohydrates, the fat-makers. In fat itself, note that oats lead with barley making a very small showing. To be sure, barley leads in percentage of digestible crude fiber, but according to the latest investigations crude fiber does not seem to have any value for horses anyway.

The conclusion from the figures harmonizes with that from experience to convince beyond a doubt that oats combine in best proportions the ingredients necessary for the complete nutrition of the equine body; that corn is superior to oats for fattening; and that barley is better yet for this purpose.

The value of the grains, computed theoretically and wholly on the basis of the commercial value of their digestible elements, is given by the New York Experiment Station as follows:—

	Market value per ton	Food value per ton	Fertilizing value per ton	Total value per ton	Total value per cent. cost
Corn	$25.00	$22.22	$6.22	$28.44	114.
Oats	35.00	21.89	6.58	28.47	82.
Rye	30.00	21.04	6.80	27.84	93.
Buckwheat	27.00	20.67	5.11	25.78	96.
Barley	27.00	20.68	6.07	26.75	99.

Oats.—Oats are the favorite food for horses because of several qualities. They contain more nitrogenous matter than the other grains; their nutrients are combined in the best ratio; they are more digestible, partly because the fibrous husk in which the grain is enclosed serves to split up the mass in the stomach and expose it to the action of the digestive fluids; and common belief credits them with holding a peculiar compound that is gently stimulating to the nervous system. This belief, however, has not as yet scientific basis enough to warrant the general acceptance it has met. Although early investigators found what they thought an albuminoid peculiar to the oat grain which they named avenine, later studies with superior methods have not confirmed the discovery and we have not yet any conclusive evidence that the oat kernel contains any characteristic nitrogenous compounds not to be found in other grains. Perhaps it does contain avenine, and perhaps avenine is a nerve stimulant, but for neither is there yet more proof than a somewhat generally accepted opinion, which is here cited for what it is worth.

There are oats and oats. And there are different ways to feed them.

Good oats are clean, hard, dry, sweet, heavy, plump, full of flour, and rattle like shot. They have a clear and almost metalic lustre. Each oat in a well-grown sample is of nearly the same size. There are but few small or imperfect grains. The hard pressure of the nail on an oat should leave little or no mark. The kernel, when pressed between the teeth, should clip rather than tear.

The skin should be thin. The size of the kernel will be less in proportion as the skin is thick. Bearded oats must have an excess of husk. Oats are not necessarily bad because they are thick-skinned or bearded; but they must contain a less amount of flour per bushel than thin-skinned oats without beards.

The weight is a very important matter. Thirty-two pounds constitute a legal bushel, but good samples weigh much more, running sometimes as high as 44 pounds to the measured bushel. Six quarts of the heaviest will weigh as much as a peck of the lightest, and therefore contain almost a third more nutriment, quart for quart. Therefore leaving out of account

the extra tax on the horse's digestive powers by the oats that have much bulk in proportion to their nutritive powers, it is evidently a matter of no small economy to buy the heavier grain.

In buying oats by weight without the use of scales insist that the measure be filled quickly. A shrewd, tricky dealer will by slowly filling and shaking the measure, apparently accidentally, make oats weigh some two or three pounds more to the bushel than is their average weight.

Short, plump oats are preferable to large, long grains.

In color oats are white, black, or gray. Some say white oats have the thinner skin; others, the black. It really signifies little what the color is, unless it has been produced by bleaching. It is not rare to hear advice against feeding oats bleached by kiln-drying, and the advice is sound if it is certain or possible that the oats have been kiln-dried because they were previously damaged. No doubt such oats have produced inflammation of the bladder and of the eyes, and mangy affections of the skin, but the blame is not necessarily to be laid at the door of kiln-drying. As Youatt says, there is no fear from the simple drying, if the grain was good when it was put in the kiln. If any doubt exists as to whether oats have been so treated, it may be easily set at rest by rubbing some of the questionable grains between the palms of the hands, when the smell of the sulphur used in the kiln to bleach them will be noticeable on the hands if the oats have been kiln-dried. Such oats, even if not bleached, shrink unduly from the points of the husks, and have a brown look at the points, and so they can be readily detected.

The age of oats is a very important consideration. New oats are indigestible and liable to give colic. They ought never to be fed when less than three months old, and are at their best when a year old. After that, danger begins again, for oats that have sprouted or fermented are decidedly injurious, and mouldy oats like mouldy hay and straw, not only produce serious digestive disorders, but have been the undoubted cause of outbreaks of that dread disease, known variously as cerebro-spinal meningitis, putrid sore throat, or choking distemper, characterized by inability to eat or drink, sudden paralysis, and death.

To distinguish between new and old oats one must rely mainly on the smell. The new have a fresh, earthly odor that is wanting in the old. To be sure, old oats newly thrashed out may smell fresh, but they lack the earthy odor. As a rule, however, they smell rather musty, and frequently of rats.

In new oats the outside of the husk in well saved samples is bright and shining, having almost a glazed appearance, especially in the black variety. In old oats this glazing is lost. The outside, though it may be perfectly clean, is dim, and the ends of the husks in white oats, and the point of the kernel in both white and black oats, are always a little darkened. Badly saved new oats may in these respects resemble old oats; but in such cases they will probably be distinguished by their softness.

The taste of the new oat is fresh and somewhat milky, and its flour, when moistened in the mouth, readily adheres together. The taste of the old oat is slightly bitter. In the mouth the flour feels dry, and is not easily moistened. About the flour from the new oat there is a certain degree of juiciness, sweetness, and milkiness. In very dry seasons these distinctions are less observable than in ordinary years.

New oats as a general rule are softer than old; but here again the season, the state of the weather for some time preceding the samples' coming to market, and the dampness perhaps of the place in which they have been stored, may cause old oats to handle as soft as new. On the other hand, in very fine seasons new oats may come to the market almost as dry and hard as old in average years.

The skin of the kernel of a new oat is covered with a very fine prickly down composed of very minute hairs. In the old oat the kernel appears and feels more smooth. If the husks are stripped off, this distinction will be quite perceptible to the palate in chewing a few grains of each.

The best oats are those that are cut about one week before being ripe. Not only is the grain richer at this time in nutritive materials, but also there is less waste from "scattering" than when it is left to become dead ripe.

As to whether oats should be fed whole or crushed, there is much difference of opinion. The truth seems to be that the

right way to feed depends upon circumstances. To give crushed oats to horses whose teeth permit of completely crushing the whole seed is not to be advised, but it is always advisable with horses that eat greedily. Under these conditions it will be advantageous to mix the oats with chopped straw in a moderate proportion. By this means the horse is kept from blowing the chop away by breathing on it from above, and from picking out the grain in order to eat it without the straw. Crushed oats are also preferable for h es having a defective dentition, or when the digestion is weak and the stomach does not decompose and dissolve whole oats satisfactorily. Crushed oats are also to be recommended for young foals that have not yet all their teeth; also for horses whose teeth are worn out and for those whose teeth are damaged or decayed. On the other hand, with healthy horses, having teeth capable of perfectly crushing the whole oats, experience demonstrates that oats are invariably more serviceable when given whole than they are when crushed.

A Western farmer who has tried saving the trouble of even so much as separating oats from the straw, reports: "Last Winter, having a good stock of young Percherons from one to four years old, I did not thresh my oats but fed them to the stock in tight mangers — one medium sized sheaf to each horse and four ears of corn twice a day. They did splendidly; I never wintered horses so cheaply. This winter I am doing the same with the same success. I cut the oats when the straw is a little green, so it is hay, and thus save the expense of threshing, which is no small item."

The average horse should be fed about 12 quarts of oats a day, or about 16 pounds if the oats weigh 40 pounds to the bushel. Ten quarts make a small ration if the horse is 1000 to 1100 pounds weight and is used much. The English practice favors about 12 pounds for a harness horse in regular work. The allowance for race-horses in training at Newmarket is from 14 to 16 pounds a day.

Corn.—The grain that all Americans know as "corn" and that all Englishmen call "maize," is a valuable horse food when rightly used. Our forefathers adopted it from the Indians as the national food for both man and beast, and to no other

one cereal do we owe so much. When we think of the vast corn crop and observe its use everywhere on the farm and in the home, it is hard for us to realize that our European ancesters had never seen an ear of it, that for centuries they had relied on the small grains, oats, wheat, barley, and that even to-day maize is almost unknown in many parts of Europe and little used anywhere.

We learned early how to use it. They don't understand it yet.

That is why it is possible for an English writer on the horse to say: "While there are so many other economical articles of feed to turn to, it will not be found worth while to resort to the use of maize for horses, however useful the grain may have been found in the case of the other animals of the farmyard." Or for another to write: "It is over-strong as food for a gentleman's stable." But it is only fair to note that its use is spreading abroad, and some day no doubt there will be a demand for it from Europe proportionate to the demand here for home consumption.

The failure of foreigners to appreciate Indian corn does not surprise us so much when we observe how many of our own people are even yet ignorant of its proper use. When we find an American writing that "corn is the bane of the farm horse, as it is also of the horse doing any other sort of work," we must conclude that our cousins beyond the water are not the only people who deserve pity and need education.

Corn is indeed the bane of the farm horse or any other horse, when injudiciously fed, but rightly fed it is one of the most economical and generally useful of foods.

To use corn properly, it must be understood that corn is a fattener, a fuel provider, and not primarily a muscle maker. It is not true, however, that it has none of the elements which go to make strength of muscle. Reference to the table of grain analyses will show that in every 100 pounds of corn, there are 8.44 pounds of digestible albuminoids, which is less than a quarter of a ponnd below the showing made by oats. The important difference between the two is not that corn contains less nitrogenous matter than oats, but that it contains more carbohydrates, 16¼ pounds more in the hun-

dred. The natural inference is that corn contains more nutritive matter than oats, and so indeed it does, but unfortunately its nutritive elements are not found combined in so useful a proportion. That is why oats are a better all-round feed, taking into account all sorts of horses and all sorts of conditions. For some horses, nevertheless, and for many horses under some conditions, corn is more useful and economical. It is clear that corn can be fed with advantage to horses doing little or no work, and therefore requiring the fuel carbohydrates rather than the strength giving protein. It is likewise clear that corn is a better food in winter than in summer, because more heat is needed in winter. Equally certain is it that corn properly mixed with foods containing an excess of nitrogen, will make a ration the equal of oats, leaving out the question of digestibility.

The fact is, however, that corn is not as generally digestible as oats are. Experience shows that while one horse will do full work on corn, eating it three times a day, and continuing this through the year, regardless of the weather, he may have a mate whose digestion will be greatly disturbed by being fed two or three rations of corn. There are, indeed, very few horses whose stomachs can accommodate themselves quickly to corn when they have been unaccustomed to it, and therefore it is never safe to begin feeding corn to horses in large quantities. And in continuing its use, even mixed with other foods, the constitutional characteristics of the horse's digestive organs as demonstrated by the results of feeding corn, must be observed and regarded.

The chemical nature of corn makes it unfit as an exclusive food for young and growing horses. They need an excess of nitrogenous, muscle-making food, rather than of a fattening food like corn, and futhermore corn is deficient in the salts needed for the growth of bone. As Professor Stewart says, "the great objection to Western and Southern horses has been the fact that they have been grown too largely upon corn, which is our highest type of fattening food, but the poorest food to develop young animals, because it has very little of the element of bones, and horses fed too freely upon corn have tender feet and cannot stand city pavements or hard roads. One

pound of wheat bran contains as much bone material as four pounds of corn."

Corn is fed whole, on or off the cob; coarsely ground, "cracked," with or without the cob; or finely ground, in the shape of corn meal, again with or without the cob.

The value of the cob is a debated question. That it has nutritive properties, is, however, beyond dispute. Director Goessmann of the Massachusetts Experiment Station, has said of it: "The composition of the cob is similar to that of the corn stalk, and the relatively large per cent. of the soluble constituents places corn cobs equal in point of nutritive value to potatoes, and many of our grains, and they will compare most favorably with the straw of most of our winter and summer grain." Other authorities have likened its value to that of second grade upland hay. Professor Goessmann further writes: "I have recommended the grinding of kernel and cob together for fine or grain feed rations, believing even that its addition to corn-meal favors the digestion of the corn on account of its fibrous, mechanical condition." But he admits that thus far he has not experimented in its use by horses.

On the other hand, it is urged that the feeding value of such food, as estimated by its chemical constituents, is not a safe guide, and that in fact horses do not easily digest the cob, whether eaten whole or ground. As to its use one horseman gives his experience as follows: "I had a seven-year-old mare, that last fall was as smooth as a piece of new satin. I began to feed her cob meal and corn on the ear, she eating the cob every time. In less than a week every hair stood up straight and soon I could not drive her five miles without her scouring badly. She also began to grow poor and lost her energy and looked discouraged and out of sorts. I stopped the cob meal short off and began to give her three quarts, at a feed three times a day, of oats and corn ground together. In a little while she could shake her head and play a little and in a few weeks was all right again, but her coat looks very bad. About this time a neighbor remarked that there was nothing like new corn on the cob to give a horse a good coat and keep him in good condition. He began to feed it to a nice little bay horse with an unusually thick, bowed up neck. It was only a

short time till the horse looked worse than mine. His coat was going in every direction and the proud arch of the neck was all gone. I think in each case it was the cob that did the mischief."

Whole corn on the cob is commonly and beneficially given to horses afflicted with "lampas." If it is old and is to be fed in this manner, it ought to be soaked in pure, clean water for ten or twelve hours.

Dr. C. E. Page advises a trial of corn on the cob for cribbing horses. "This gives them," he says, "honest gnawing and less excuse, need, or desire for that which works mischief. Besides, this form of diet is in other ways good for whatever ails them. It is eaten slowly, masticated thoroughly, and will, therefore, be more perfectly digested."

Under ordinary circumstances, however, it cannot be said that experience or experiment yet encourage the regular feeding of corn and cob, whole or ground.

Not so much caution is to be expressed about feeding whole corn off the cob, but it is clearly poor economy to use it in order to save the cost of grinding. The trouble is that whole corn is rarely masticated enough for digestion, and therefore it frequently acts as an irritant to the bowels, causing colic.

Cracked or coarsely ground corn is the least dangerous as an independent food. When finely ground, in the form of corn-meal, it should be mixed with other food. Corn-meal fed by itself becomes in the stomach a plastic, adhesive mass, nearly impenetrable to the gastric juice, and frequently causing severe and sometimes fatal colic. Even when mixed with ground oats, it is not a safe food, the mixture making too dense a mass in the stomach. Coarser materials should be used for admixture, such as cut hay or cut straw. It is wise to moisten the hay so that the meal will stick to it. But whoever ventures to feed meal by itself, would better feed it dry than wet, because a horse can swallow wet meal after very little mastication, but dry meal he must first moisten with saliva, and saliva aids digestion.

Barley.—Barley is not a common horse food in America, and by far the greater part of our horses have never tasted it, though it is the principal article in the diet of horses of many

other parts of the world. The Arabs feed their horses largely on barley; the French in Algeria have adopted from them the same practice; and mixed with other materials it is much used on the Continent of Europe. In this country, too, wherever it has been used by skilled feeders, it has in the main been mixed with something else, barley and oats ground together having been one of the rations that has found favor.

A glance at the table of grain analyses before given will show that barley contains more digestible matter to the hundred-weight than either corn or oats; that in percentage of digestible carbohydrates it is almost exactly equal to corn, and yet contains nitrogenous matter enough to make its nutritive ratio very close to that of oats, bushel for bushel, so that when ground with either corn or oats the mixture should be made on the basis of weight, not bulk.

We have to go abroad to learn how to feed it, and find that Youatt says the quantity should not exceed a peck daily. It should always be bruised, and when the straw is cut it should be mixed with an equal quantity of hay. If the farmer has a quantity of spotted or unsaleable barley he wishes thus to get rid of, he must very gradually accustom his horses to it, or he will probably produce serious illness among them. Indeed, barley very often does not agree at all with hard-worked horses, Youatt says, and not so well as oats with horses generally.

This grain has sometimes been given to horses just recovering from sickness and has been found to recruit the strength and tempt the appetite. Under such circumstances it is best given in the form of mashes, water considerably below the boiling point, yet hot, being poured upon the grain, and the vessel being kept covered with a cloth for half an hour or so. In this form it is easily digested.

Wheat and Rye.—Wheat and rye are not important enough as horse foods to demand much attention. Professor Michener says they should not be used in any but small quantities, bruised or crushed, and mixed with other grains or hay. If fed alone, in any considerable quantities, he says they are almost certain to produce digestive disorders, laminitis (founder), and similar troubles. He thinks they should never

constitute more than one-fourth of the grain allowance, and should always be ground or crushed.

On the other hand there are doubtless other farmers who would give much the same testimony as this one in Iowa gives. He says: "Early in the spring of 1857 our corn was exhausted and we resorted to boiled wheat to feed six yoke of work oxen, four head of horses, and a few head of cows. All of this stock did so well upon the wheat ration that we were convinced it was very valuable for feed and not too expensive to use. Then for the next few years our large wheat crops were moved to a distant market by teams and wagon, and a part of these teams were fed exclusively on wheat-bran, and we observed then that the teams thus fed were always in far better condition than any of the other teams. And later on we observed in reading the reports of feeding tests that whenever bran was made a part of the ration for a part of the animals being fed and not for the other part, those receiving the bran in their ration generally gave the best results. So ten years ago we became thoroughly convinced that it would be very stupid in us not to recognize these facts. Therefore we mixed our seed oats with 20 per cent. of wheat, and have never sown any oats since that were not one-fourth to one-fifth wheat, and are now thoroughly convinced, first, that both the wheat and oats are thus improved in quality; secondly, that the yield per acre is greater; thirdly, that two bushels of this mixed grain are worth more to feed than three bushels of all oats; fourthly and last, that we cannot afford to raise oats without mixing wheat with them. For mares in foal and mares and colts we have found it superior to any other ration and have never had a case of abortion. We have eight mares on the farm now, due to foal this spring and in fine condition, and we think that this grain is what does it. We always have one or more stallions, and have had the best of results by feeding them on this mixed grain. Our work-horses are fed exclusively on this grain, except a little corn in winter for variety."

Besides this, English testimony might be quoted to the effect that if wheat be given at first in small quantities and afterward fed with discretion, horses will thrive on it.

It should be borne in mind that a horse ought not to be al-

lowed to drink water immediatly after eating wheat.

Professor Henry says that rye may be fed ground into a meal and mixed with bran to make it lighter, and then sprinkled over moistened hay. If it must be fed clear, he prefers rolling the grain rather than reducing it to a powder by grinding. The practice of boiling rye he thinks advisable in at least a limited way, and he notes that the feeding of a little grain boiled, especially to growing colts, is a practice tenaciously adhered to by some of our best horsemen.

The French idea is to give rye only to those horses that suffer most from fatigue. It should not be given to mares in foal.

Says a correspondent of the Breeders Gazette: "I have fed my work horses and young horses (except brood mares in foal and weanling colts) unground rye for the last three years. I give one pint per feed with four quarts of oats to my work teams, and they do better on that feed than on six quarts of oats. They keep in better flesh and spirits and are as slick as moles. To young horses I feed half the amount. I never feed it to my brood mares in any case. I am afraid of the smut."

Bran.—Just as there is a variety of opinion about the use of wheat whole or crushed, so there is a variety of opinion about the use of that part of it known as bran, but with this difference, that the weight of authority is against wheat and in favor of bran. This material consists of the husks or shells from ground wheat, being obtained during the process of grinding by separation from the finer flour. To be sure, the husks of other grains are also known as bran, but it is wheat bran that is mainly fed to horses, and what may be said for or against wheat bran applies equally to the other kinds.

Analysis shows wheat bran to be made up as follows: Water, 13.71 per cent; ash, 5.53; albuminoids, 14.56; crude fibre, 10.83; carbohydrates, 52.26; fat, 3.11. A hundred pounds of it contain 12.81 pounds of digestible albuminoids; 2.71 pounds of digestible crude fibre; 41.81 pounds of digestible carbohydrates; and 2.41 pounds of digestible fat: making its nutritive ratio 1:3.9. Recalling that the nutritive ratio of medium red clover is 1:6.3; of oats, 1:6.4; of corn, 1:8.1: re-

calling and comparing these figures we rightly infer that wheat bran is nearly twice as nitrogenous, so to say, as the common foods held to be the muscle makers, and more than twice as nitrogenous as the fattener, corn. Note, however, that it contains more than ten per cent. of crude fibre, and though a little more than one-fifth of this is set down as digestible, it is doubtful if it does horses any good at all. To be sure, oats have nearly as large a percentage of crude fibre, but corn has only one-fifth as much, all of which is supposed to be digestible.

Furthermore, and not of least consequence, note that whereas oats contain a trifle less than 3 per cent. of ash, and corn but a little more than 1½ per cent., wheat bran contains more than 5½ per cent. of this, the material that goes to build up bone. For the same reason, and because of its excess of nitrogenous elements, bran ranks near the top as a manure producer.

It is this excess of nitrogenous elements that makes bran both a food of doubtful utility when used alone or as the chief factor in a ration, and at the same time a food of unquestionable u ility when mixed with other foods. Horsemen have so long thought of it with only its medicinal qualities in mind,—of which more later on,—that they are slow to realize its advantages as a food pure and simple, but these exist and are coming to be recognized. It is manifest, indeed, that the horse owner will hunt far before he finds material as cheap and easy to be procured that contains as much virtue for balancing the nitrogenous defects of hay, straw and corn. Nor will he speedily find a material that can be so economically used to give to ordinary rations the variety that is really so desirable in animal feeding.

One farmer writes that he believes "there is no better ration for horses, milk cows and calves, than corn meal, ground oats and wheat bran in equal parts. This ration will cost less than corn and oats fed without grinding. One hundred pounds of wheat bran is worth as much for feeding as three bushels of oats. A good ration for horses not working too hard, is equal parts of corn-meal and bran. This is also good feed for milk cows and calves."

Another declares that "one of the most valuable and suitable foods for young horses is bran, and this food at about $7 a ton

cannot be considered an expensive one. The following mixture is suitable for other winter and summer feed: One-third crushed oats, one-third crushed corn and one-third bran, with a plentiful supply of hay or corn fodder."

Still another advises: "For growing horses from yearlings up, make free use of bran with a little oil-meal, say not over a pound and a half to a thousand weight of animal, with a little corn for variety."

A fourth testifies: "For the horse, bran mixed with corn meal will serve to assist digestion, while incidentally it will make more valuable manure."

A fifth writes: "Calves and colts are easily kept fat and apparently in good condition when fed on corn meal and hay but to grow rapidly, and put on muscle, they must be fed in addition wheat bran, oilcake, or oats. Wheat bran, everything considered, answers the purpose better than any of the more highly concentrated foods, and for young animals it is beyond all question the best. It is easily digested, and supplies the growing animals with all the muscle necessary."

And Professor Henry sums up an article on bran by saying: "I think there is evidence enough, both on the scientific and practical side, to show that, intelligently used, bran is a very valuable food article for most any kind of live stock."

Nevertheless so experienced a horseman as John Splan has put himself on record as opposed to bran for trotters, and it is but fair to say that he is not alone in his opinion. To offset it Professor Henry recalls that when he visited the famous Ashland farm, the former home of Henry Clay, near Lexington, Ky., then in possession of H. C. McDowell, he saw a bunch of colts, some twenty in number, many of them sired by Dictator, gathered about a long feeding box in a blue-grass pasture, which was being filled with a mixture of about two-thirds oats and one-third bran, by weight. Other breeders of fast horses, too, are making much use of bran. Charles Marvin, for example, in his able work on "Training the Trotter," says: "I once gave it up altogether, and substituted boiled oats, with a little oil-meal in it, for horses that did not sweat out freely and scrape well. However, for the past few years I have used considerable bran with good results. Good, clean bran, well-

scalded, may be used judiciously to great advantage where a horse's bowels seem to need a little loosening."

Whatever opinion may be entertained of bran as a regular article of diet, there is but one opinion of its value as an occasional adjunct to any ration, because of its medicinal qualities. Bran is a laxative, correcting tendencies to constipation, promoting digestion and saving many a dose of physic. To make most advantageous use of this peculiarity of bran, it is commonly given in the shape of a mash, best at night before a day of rest, as the immediate effect is somewhat weakening. Saturday night is the usual time for giving it.

Here is an American recipe for a bran mash: "Take four quarts of pure wheat bran, and two teaspoonfuls of salt, pour over it boiling water, and stir quickly till all is wet, but not too thin, cover closely to confine the steam, let it stand until cool, and give in the place of the regular feed."

Here is an English recipe: "Put the required quantity of bran into a stable-rubber and tie it up, and then let it steep for a short time in a bucket filled with enough boiling water to be absorbed by the bran. Wring the water out of the mash by twisting the neck of the rubber. Open the rubber and spread it out, so as to allow the mash to cool a little before giving."

A. J. Feek, the successful trainer and conditioner, says on the subject: "I do not approve of *hot* mashes when a horse is well. When a horse is sick it is many times necessary to give him a hot mash to steam out his head and throat and warm him up in case of a bad cold or other sickness; but when a horse is well, let well enough alone. I have had horses in good health which became sick, that is to say took cold from the steam and heating propensities of a hot mash; it opened the pores and they contracted a cold on their next exposure to a colder temperature or on giving them a drive. Throw away hot mashes, soaking tubs, and blanket sweats, for they have been proved an injury and have been abandoned by all first-class trainers for years."

Sour bran is not to be given horses under any circumstances. It disorders the stomach and intestines, and may produce serious results.

Linseed and Cottonseed.—The composition of linseed

and cottonseed meal is as follows:—

	Water	Ash	Albuminoids	Crude fibre	Carbohydrates	Fat
Linseed meal	9.83	5.13	31.52	11.54	34.95	7.03
Cottonseed meal	11.06	7.39	40.56	3.56	23.86	13.57

The percentages of digestible master, or the number of pounds of each element digested in 100 pounds of food, are:—

	Albuminoids	Crude fibre	Carbohydrates	Fat	Nutritive ratio
Linseed meal	27.42	3.00	31.80	6.40	1:1.9
Cottonseed meal	35.77	——	16.06	13.57	1:1.4

Linseed is the seed of lint or flax, and out of it are made linseed oil, oil-cake, and linseed meal. To make these products the seeds are first bruised or crushed, then ground, and afterward subjected to enormous pressure in an hydraulic or screw press, whereby all of the oil but about 10 per cent. is pressed out. The pressed material forms a cake about two feet long, eight or ten inches wide, and an inch thick. This is "oil-cake." It is usually shipped to England in this form. Before feeding the cake is broken up and ground to a coarse meal. This is called oil-meal, oil-cake meal, and sometimes, perhaps improperly, linseed meal. In this country that cake designed for home consumption is usually ground at the mills and sold in sacks.

Cottonseed meal is produced in the same way, being the by-product in the manufacture of cotton seed oil. It is only within a very few years that its value for stock food has been realized, and even now great quantities of it go to waste, either on the plantation in the uncrushed seed or at the side of the oil-mill. But enough oil and meal have already been utilized to show that few discoveries of the present century bid fair to do more good to mankind than the discovery of the virtues of the seed of cotton. Yet many Southerners can recall the time when a team of oxen hauling loads of cotton away from the gin, where hundreds of bushels of seed were rotting, would have also to pull enough corn to eat on the trip, and it might be the same wagon would return from town loaded with West-

ern corn to feed the horses to make the next crop. Cotton seed was then thought to be unfit for oxen. Even still the South is paying literally millions of dollars for horses, mules, corn, meat, hay and other products of other regions, while the oil mills of the South are burning a million tons annually of the finest feed (cotton seed hulls) for want of purchasers at $2 to $4 a ton.

Flax-seed or linseed is rarely fed whole. As is natural to suppose, so fine and slippery a seed is not well digested. If not more than a gill or half a pint of this sort of feed was used daily, perhaps the ground flaxseed would be superior to oil-meal, but a larger quantity would furnish too much oil. The oil-meal contains all the muscle and bone elements of the flax-seed with a smaller proportion of oil, but there is enough oil in it to cause it to have a very excellent effect on the digestive tract, so that it would be unwise to feed in its stead flaxseed, ground or unground, except in rare cases.

In England it has lately been a good deal used in feeding farm horses, the farmers boiling it with roots. The best way to do this is to keep it in a bag by itself, so that it may not get mixed with the other feed in the vessel in which it is put. In gentlemen's stables it is used for mashes, and is held to be, where horses will eat it, a most desirable addition to the *menu*, especially after a hard day's work, such as hunting. For a mash it requires long and careful cooking, until it is like jelly. Therefore, when a horse leaves the stable on a hunting-day, his linseed mash may be at once set on to cook, and it will not be ready any too soon for him, whatever time he may come in.

The merit of linseed lies chiefly in the fact that, whereas it is a laxative, gentle and soothing, its use by no means weakens the strength of a horse, its laxative powers being more than compensated for by its nutritive qualities. Its analysis shows that it has a tremendous proportion of nitrogenous elements, being exeelled in this by scarcely any food except cottonseed. In the capacity for muscle-making the two are incomparably at the head.

The skins of horses fed upon linseed are usually very fresh and bright looking, and this fact has been taken advantage of by horse-dealers and others who want to improve the appear-

ance and general condition of animals that have returned from grass out of condition, with rough coats and lean bodies. Too free a use of it for this purpose, however, is decidedly injurious.

Ground linseed, like the whole seed, is occasionally fed with other foods to keep the bowels open and to improve the condition of the skin. It is of peculiar service during convalescence, when the bowels are sluggish in their action. Linseed tea is very often given in irritable or inflamed conditions of the digestive organs.

Cotton-seed meal has so far been fed much more to cattle than to horses, and it is difficult as yet to draw satisfactory conclusions as to its adaptability as a horse food. Northern authorities seem to think it should be used only in small quantities and with great caution. Southern experimenters do not express themselves so strongly in the matter of caution, but say that it is not wise to depend on it to displace grain entirely. They think it a valuable supplement to the home-raised foods that are poor in albuminoids, such as straw, hay, corn-fodder, etc. Perhaps nothing more satisfactory can be given in addition to this than quotations from two recent contributions to Southern papers. One says: "With eight cents a day in cottonseed meal and hulls, I can put all the flesh on a thousand-pound steer that his frame will hold, or get all the work out of him he is capable of doing. 'Why do we not do the same with mules and horses?' has often been asked. Horse feed is very expensive, and especially so here where all the corn, oats, and hay are bought. Now, cottonseed meal is not only cheaper, pound for pound, than corn, but contains about three times as much nutriment and hulls cost only one-fifth of the price of hay. The more hulls and meal a horse can be made to eat, then the less expensive will be the ration. I have been experimenting on this line, and, for the benefit of others, give something of the results. I began with a horse and a mule, and by mixing only the smallest quantity of meal and hulls with corn chops and bran, induced them to eat it. The amonnt was increased from day to day till they now eat three pounds of meal and enough hulls to furnish sufficient roughness. I confidently expect in a year's time to be able to feed horses on 10 or 12 cents a day,

instead of 30 or 40 cents . Corn meal and cotton seed meal and hulls make an excellent combination. Corn fed alone is too heating and contains too little of the albuminoids, or muscle-producing elements. Cottonseed meal is exceedingly rich in these. The two mixed will make the complete ration."

Another writes, starting with his experience in feeding cattle: "While cotton seed hulls are admitted on all sides to be an excellent rough feed, I do not think they have been estimated high enough in comparison with hay or other provender. Having fed large quantities for two years, I regard them as being worth more, pound for pound, than average Bermuda or other grass hay. I feed about 8 to 12 pounds hulls a day, four pounds wheat bran and four pounds cotton seed meal, thoroughly mixed together, with very satisfactory results. This ration is very cheap, about 10 cents a day, and the yield and quality of milk are highly satisfactory. Hulls are much more easily handled than hay, and there is less waste in feeding, as the cows eat up the hulls very clean.

"In the spring of 1890, about the time I thought there was getting to be abundant grass in pasture, my hulls gave out. The milk yield began to fall off so that I increased the bran and cotton seed meal, but never did I, during the whole spring, get as good results as when I used hulls. So I consider hulls (fed in connection with bran and cotton seed meal) equal to tolerably ample Bermuda pasture as a milk producer.

"Having found them such an excellent food for cattle, and knowing that cotton seed meal is being fed to some extent to horses, I reasoned that hulls ought also to be good for horses. So I procured some corn meal, and by mixing only a very small quantity of cotton seed meal and hulls with bran and corn meal, succeeded in making them eat it. The quantity of the hulls and meal was increased gradually until each animal consumed about three pounds of meal and considerable hulls."

It has been found hard to make concordant analyses of cotton seed hulls, because of their considerable variance in composition, the amount of lint remaining, and mechanically enclosed particles of meal or parts of seed. Below are the analyses of three samples:

	1	2	3
Water	9.96	10.03	9.98
Crude fibre	66.95	55.15	52.71
Crude fats	2.27	2.25	2.28
Albuminoids	5.06	5.37	5.37
Nit'g'n fr'e ext'ct,	12.41	22.19	26.74
Ash	3.35	4.01	2 92

Nos. 2 and 3 agree very closely, while the crude fibre in No. 1 is largely in excess.

In many instances unfavorable results have followed the feeding of spoiled cotton seed or cotton seed meal. It is quite probable that these are sometimes due to the poisonous influence of ptomaines. It will be well to remember that fresh cotton seed meal from good seed has a bright yellow color, a fresh pleasant smell, and granulates readily. Older meal or fresh meal if made from spoiled seed, has a darker color, something of a musty odor, and is inclined to adhere in lumps.

As might be expected from the composition of cotton seed, its manurial value is great. Analysis shows the following:

	Nitrogen		Phosphoric acid		Potash	
	Per cent	Pounds in a ton	Per cent	Pounds in a ton	Per cent	Pounds in a ton
Cottonseed meal	7.03	140.6	3.28	65.6	1.88	37.6
Cottonseed meal	7.38	147.6	3.08	61.6	2.03	40.6
Average	7.20	144.0	3.18	63.6	1.96	39.1
Linseed meal	4.92	98.4	1.98	39.6	1.14	22.8
Linseed meal	5.65	113.0	1.80	36.0	1.11	22.2
Average	5.29	105.8	1.89	37.8	1.31	22.5

As we have seen, the Pennsylvania Experiment Station calculates the fertilizing value of cotton seed meal at $10.12 for every $10 worth. The New York Station estimate is a trifle lower, putting it at $25.09 a ton on a basis of $26 a ton for market cost of the meal. As its food value is theoretically $33.47, the sum total of the two, $58.56 is enormously out of proportion to what it costs to buy the article. If it should turn out safe to use it extensively as a horse food, it is plain that horse-owners will profit greatly by adopting it.

Cottonseed hulls have a very inferior manurial value, only

$2.42 a ton, according to the Vermont Experiment Station calculation.

Beans, Peas, and Minor Foods.—Beans are a food much less given to horses now than formerly, and much less here than abroad. This fact gives occasion for a striking illustration of the change in sentiment that sometimes takes place in regard to such matters, and the variance in opinions held in different countries as well as at different times. Youatt, writing in England sixty years ago, (and the editor of the edition published in 1865 approves his language by retaining it,) made the following statements :-

"There are many horses that will not stand hard work without beans being mingled with their food, and these are not horses whose tendency to purge it may be necessary to restrain by the astringency of the bean. There is no traveller who is not aware of the difference in spirit and continuance of his horse whether he allows or denies him beans on his journey. They afford not merely a temporary stimulus, but they may be daily used without losing their power, or producing exhaustion. They are indispensable to the hard worked coach horse. Washy horses could never get through their work without them; and old horses would often sink under the task imposed upon them."

Nevertheless, without tasting a bean from year's end to year's end, thousands of American horses do the hardest of work and yet survive, phenomenal as it might seem to Youatt if he were alive. We have hardly enough coach horses left to say whether the bean is as indispensable to them as to the Bostonian, but what there are seem somehow to get along without it. Neither do our travellers appear delayed greatly because the absence of the bean from the morning meal has dispirited the horse.

The modern American idea is that when beans are fed at all they should be given with great discretion. They are recognized as heating and astringent by nature, and therefore often to be given with advantage to horses liable to purge, but they are by themselves too stimulating and binding. Therefore they should never be fed at all to horses that are not working. They are injurious when given alone, and should not be fed for

any length of time as their prolonged use is liable to cause swelled legs, humors, and itchiness. They should never be fed when less than a year old, and should be hard, not soft. Old beans in good condition are very hard. They ought to be crushed before being fed.

Peas have all the advantageous properties of beans without their harmful qualities, and where such food is required, they should be given the preference over beans. They, too, should be given in moderation, and not long steadily. The white peas are best suited for horses. They are somewhat expensive as a horse-food, but they are a good addition to the *menu* at times and they put heart into a weakly horse and muscle on him. Like beans they are better crushed, as on account of their rounded shape they are otherwise likely to escape the grinding of the teeth and be swallowed whole. Many think it unadvisable to give them to horses from whom full speed is demanded, and hold they are better adapted for draught horses. Some horses will eat peas very greedily when they get the chance, and as peas when exposed to the warmth and moisture of the stomach, swell considerably, the result is that when eaten to excess they painfully and injuriously distend it, and instances have been known of its actually bursting in consequence. This is to be as much guarded against as the meagrims, or staggers, caused by beans.

In some countries pea-meal is frequently used, not only as an excellent food for the horse, but as a remedy for diabetes.

Vetches or tares are plants closely allied to the pea, that are much cultivated in Europe for fodder, but that have not become popular in America, and are rarely grown here. Yet their analysis justifies their popularity abroad, for they are quite the equal of clover in nutritive principles. Youatt says that of their value as forming a portion of the late spring and summer food of the stabled and agricultural horse there can be no doubt. But remembering what he said of beans, we are not inclined to accept this verdict unreservedly. He says they are cut after the pods are formed, but a considerable time before the seeds are ripe "They supply a larger quantity of food for a limited time than almost any other forage crop. The *vicia sativa* is the most profitable variety of the tare. It is very nutritive, and

acts as a gentle aperient. When surfeit-lumps appear on the skin, and the horse begins to rub himself against the divisions of the stall, and the legs swell, and the heels threaten to crack, a few tares, cut up with the chaff, or given instead of a portion of the hay, will afford considerable relief. Ten or twelve pounds may be allowed daily, and half that weight of hay subtracted. It is an erroneous notion that, given in moderate quantities, they either roughen the coat or lessen the capability for hard work."

Millet-meal is spoken of by Stewart in very high terms, and he deems it proper food for young or mature horses. It has a higher proportion of albuminoids than oats, but less oil. "It is found," says Stewart, "when well ground, (and it cannot be properly fed without grinding,) to be one of the best rations for horses, being particularly adapted to the development of muscular strength."

Sugar and molasses are not familiar horse foods to horse owners in this country, but in some parts of the world they have long been fed with safety and profit. We are told that in the course of the Peninsular War sugar was tried on ten horses, each of which got 8 lbs. a day at four rations. They took it very readily, and their coats became fine, smooth, and glossy. They got no corn and only 7 lbs. of hay instead of the ordinary allowance, which was 12 lbs.

Of late years sugar and molasses have been much used in Australia, South America, and elsewhere for getting horses into condition for sale, and also colts while wintering in the yard. In the case of horses "off their feed," or to induce them to eat their food that they would otherwise reject, sugar may be used. The average quantity of sugar a day for a horse in poor condition is about a pound and a half. This should be mixed with cut hay or chaff and turned over a few times, leaving it for a few hours to allow the sugar to be absorbed. Seven pounds of sugar to 56 pounds of hay is a good proportion.

There are many special foods on the market for which somewhat startling claims are made. Many of them are asserted to have a medicinal or tonic value, and in some cases this is doubtless true, but it is always safe to buy feed and medicine separately. Moreover, such foods are generally sold much

above their feeding value. It is a rare feeder that can afford to pay transportation on a ton of feeding stuff for a few pounds of material having a medicinal value. Nor is the indiscriminate feeding of foods containing tonics of unknown quality, kind, and quantity to be encouraged. Few of the so-called special and concentrated feeds have a higher feeding value than bran, and in general it is not to be considered a good investment to pay more for them than the nominal feeding value of bran.

Salt. — The ordinary food of the horse, like the food of man, contains some salt, but not enough. Its presence in its natural form in the diet of either is not merely desirable as a condiment, a seasoning,—it is practically a necessity, for although animals will not perish if they do not get more than their food contains, they will suffer and not thrive. Therefore it is natural for them to crave it. As an illustration of what they will do to get it, the fact may be cited that in India horses have been known to eat away at the stable walls and mangers, (which are generally made of mud bricks dried in the sun,) to get the saltpetre that is everywhere present in Indian soil.

Almost everybody now agrees that the best way to give it to horses is in the form of a lump of rock-salt in the manger or the pasture. This is preferable to feeding it at irregular intervals in large quantities, or to mixing it crushed with the feed, because when the horse is salt-ravenous he eats more than he ought, and when he swallows it with his ration, more or less loose salt gets into the stomach undissolved, causing irritation and consequent illness. Many instances of colic caused by an over-dose of common salt are well authenticated.

Some recommend that the hay be sprinkled with water in which salt has been dissolved, but this plan is laborious, and has the same danger of furnishing too much or too little. The lump method of salting is easier, cheaper, and devoid of risk. A lump costs but a trifle, and lasts a long time, as the horse only licks it as he needs it, and his desire is satisfied by a very little. Better still, this expedient makes it impossible that the horse shall suffer from the neglect of attendants to supply him with this food so essential to his comfort and his health. Some enthusiasts go so far as to express a belief that there would not be one case of colic or the heaves where there are a hundred

now, if lump salt were always kept handy for the horses. Doubtless this is an exaggeration, yet nevertheless it is certain that the lump of salt will ward off much sickness. Even if this consideration did not affect the pocket-books of horse-owners, they ought to be moved by the humane aspect of the matter, remembering that "a merciful man is merciful to his beast."

CHAPTER III.

The Preparation of Food.

Foods are prepared for consumption in order that they may be more easily taken into the stomach; that a greater proportion of them may be digested; that they may be more easily digested; that they may receive some new property; or that they may be preserved. These are all praiseworthy objects, but as the preparation of food is laborious and more or less costly, it is clearly not worth while to undertake it if none of these objects will be accomplished or if their benefits are not proportional to the trouble. To determine this, however, is not always easy. In some cases, as in the cutting of hay, and especially straw, opinion is nearly unanimous in favor of the work, while in the matter of cooking, the weight of opinion seems to be adverse. Again, what may be profitable in the case of a large car-horse stable or breeding farm, where small economies count up, may be the opposite of profitable for the owner of a single family horse or for the average farmer. Therefore circumstances must be allowed to affect the application of whatever rules may be laid down. A little common sense will be a useful thing here.

There is no doubt that hay and fodder are economized when cut in short pieces. The horse eats more in a shorter time; he wastes less by pulling it from the manger and dropping it on the floor; and he masticates it more thoroughly, which is conducive to better digestion. Two horses fed by Professor Sanborn on cut hay for 85 days gained 99 pounds, but two others fed on uncut hay gained only 62 pounds. Then he reversed the feeds for 48 days, during which the lot fed on cut hay gained 75 pounds, but the other lot lost 5 pounds. The test was made with lucerne and clover.

Bad hay should never be cut simply because in that form more of it will be eaten; bad foods are dear at any price and

should never be fed. Some long and uncut hay should be given to horses that bolt their food, even though a certain amount of hay or straw is cut and fed mixed with the grain.

The different grains are more easily eaten when ground or crushed. In England it is generally held to be the best plan to bruise even oats. Though a strong horse in his prime will be able to masticate them easily enough, it is thought often worth while to save the time and work required for the operation; and bruising all grain is thought especially desirable for old horses with defective masticating powers and for greedy horses that bolt their food. Rye or wheat should never be given whole, and even corn wastes less when ground, and, in common with all other grains, is more easily digested than when fed whole. Marvin says on this point:—

"I am aware that some horsemen do not believe in feeding cracked or ground food, but my experience convinces me that a limited proportion of it is beneficial in all cases and quite essential in some. Horses that are inclined to bolt their oats and horses in whose dung is observed whole grains will, for obvious reasons, get more nourishment from broken than from whole grains. Unmasticated food can afford little nourishment, and when a horse will bolt his oats without masticating they should be given it in the broken form."

A test of the comparative values of whole and ground grain is reported from the Iowa Experiment Station. It was made with six imported colts, two each of Shires, Percherons and French Coachers. They were foaled in the spring of 1891, and reached the college farm late in September. The test did not begin until March 1, but in passing it is interesting to note the results of feeding from October until that time. It is stated that during October, November and December the colts were fed nine pounds each of grain a day, consisting of four pounds oats, two pounds corn, two pounds ground wheat or barley, and one pound of oil-meal; the other food consisted of 14 pounds of hay, two pounds of cut fodder tops, two pounds of carrots during the first six weeks, and five pounds of fresh whole milk. During November they also had 30 pounds of cooked barley, fed warm, each. The gains from Oct. 1 to Jan. 1 were: Shires, 322 pounds; Percherons, 400 pounds; and Coachers, 281 pounds.

During January and February the grain food was: 150 lbs. oats, 50 lbs. corn, 25 lbs. ground wheat, and 25 lbs. oil-meal mixed together, each colt getting six and one-half pounds of the mixture a day. The rough food was mostly cut stover and sheaf oats, about 15 pounds each a day, and three pounds each of timothy and clover hay, fed at night. The gain for these two months is given as: Percherons, 179; Shires, 157; and Coachers, 150. During this latter period separated milk was used in place of the whole milk of the preceding period. The carrots appeared to give good results and were liked by all the colts, but an attempt to substitute sugar beets when the carrots were all fed gave evidence that they were less acceptable to the colts than the carrots. Several unsuccessful attempts to get the colts to eat the beets were made during the winter, although they were freely eaten by the sheep and cattle.

From the first of March until the 19th of May the colts were divided into two lots, one of which was fed ground grain mixed with a small amount of moistened cut hay, and the other had the same amount and kind of grain fed whole and not mixed with hay. The grain ration was made up of 150 lbs. oats, 50 shelled corn, 25 barley bran, and 25 oil meal. The results of this trial show a slight advantage in grinding the grain and mixing with cut hay, and it is stated that the additional gain made on the ground feed was equivalent to a saving of 307.5 lbs. of grain, and 533 lbs. of hay. The average gain a day each for the six colts from Oct. 1 to May 18 is given as 1.74 lbs.

Drying preserves the different foods and changes some of their properties, notably removing the laxative tendencies of most of them.

Cooking stock feed is not as popular as it was some years ago. Of late there has been a feeling abroad that after all there may not be much gained by it; that if the digestibility of the feed is increased at all by cooking, which has not been satisfactorily proved, the gain is so small that it does not pay for the extra work as well as the interest on the steaming apparatus, and for this reason one hears but little nowadays about the advantage of boiled dinners for stock. As Professor Georgeson put it, cooking cannot add anything to the food. It can neither increase nor diminish the amount of nutritive matter. If the

process is of benefit at all, the benefit must occur in one or both of two ways; either by rendering the nutritive matter the food contains more digestible, so that a larger amount of it can be appropriated by the system; or secondly, by rendering the food more palatable, so that the animal will eat more. It is a pretty well established fact that the coarse fodders, hay, straw, corn fodder, etc., do not gain in digestibility by cooking or steaming. Some foods actually lose. This is, for instance, the case with bran. Dry wheat bran is more digestible than steamed or soaked bran. On the other hand, the food may be rendered more palatable by being moistened, and we may thus induce the stock to eat somewhat more than would be the case with dry fodder.

Professor Michener says that boiling or steaming grains is to be recommended when the teeth are poor, or when the digestive organs are weak.

Maj. A. T. Fisher, in his book on "Through Stable and Saddle Room," expresses his belief in the advantages arising from the use of cooked foods, and cites his experience with them on a mare he could not get in as good condition as he wished. Never, he says, was a change more rapidly or completely effected for the better. She at once began putting on good, firm flesh, and certainly no horse could have been more fit to go, or looked in higher condition than she did in the course of a very few weeks, and she carried him brilliantly through the rest of the season. Despite this fitness, her dung was always loose, so much so as to be an annoyance, especially in the hunting field, and so he did not continue the use of the cooked food, though convinced of its efficiency.

In the early spring some horsemen begin to soak the corn for the horses. They say the stock like it better and that it is more easily masticated, and hence better digested. The horses are said to sweat less than when fed dry corn. The corn should soak twelve hours but not longer and the water should be changed every day.

Roots should be steamed or boiled, both to make them less liable to produce digestive disorders and to make them clean. In North Britain the custom of giving steamed roots to farm horses is much approved, especially for old horses with defec-

tive mastication. Steamed Swedish turnips and potatoes are used, mixed with cut oat-straw, and even cut wheat-straw, the practice being to give this food from the middle of October to the end of May.

Boiled food is thought by many preferable to steamed food. The experience of people in Scotland where both boiled and steamed food was fed to large numbers of horses, showed fewer casualties among those getting the boiled food.

W. C. Edwards, M. P., of Rockland, Ont., has introduced a system of feeding horses that in practice he has found to work very well. It is substantially as follows: The hay is cut and put into a box, the oats are ground and spread over this, and bran is added. The whole is then mixed and water is applied until the mass is saturated. It is then allowed to stand for twelve hours and is fed in two feeds per day. The amount of ground grain is increased or lessened according to the object sought. The ration is given to colts, brood mares, and working horses. As the colts advance in age some dry oats are given to them, and the work horses get a dry ration at noon. For horses that are not to be driven fast and long distances, not more than one feed of the mixture should be given during the day. Mr. Edwards is quite satisfied that this ration is a very economical one, and he has tried it now for several years. The distinctive feature of this system is the amount of water applied. It has been frequently recommended to moisten cut food given to horses, but we seldom find it recommended to saturate it with water, and then allow it to undergo a sort of mild fermentation. This, however, Mr. Edwards has tried. It has got beyond the domain of theory with him, for he is so satisfied regarding the advantages of the system that he would practice it with all the horses used at many points in connection with his large lumbering business if this were practical. The results have been most marked in the development of young horses.

CHAPTER IV.

Feeding and Rations.

The problem in feeding a horse is to get out of him as much work as possible as cheaply as possible.

It is quickly stated but the answer is not so simple. Many considerations affect it, and not the least of them is the factor of health. The well horse does the most work. The dead horse does no work.

Then there is the factor of individuality, that which in man we sometimes speak of as personal equation. The time-worn saying that what is one man's meat is another man's poison, has not equal force in its application to horses, because horses lack the mental variations that affect the regulation of human lives, yet nevertheless there is great variety in the equine organization, making individual characteristics necessary to be taken into account in the application of every general rule.

Were it not for the factors of health and individuality, we could regulate horse-feeding as precisely as we can regulate the feeding of a locomotive engine. Knowing the composition of the various foods, the proportion of digestible elements in each, and their cost, we could adapt the ration with almost mechanical accuracy to the ends to be accomplished. Even as it is, the factors of health and indivinuality are not potent enough to vitiate general principles, but can merely modify their application.

Therefore it is both theoretically and practically wise to ascertain what are the true principles on which to base a feeding ration, irrespective of their special application. In other words, it is useful to determine what ought to be and may be fed to an average horse, assuming normal conditions.

The scientific aspect of this truth has been recognized only within the last half of the present century. Previously, the whole world had been content to answer all the problems in

stock-feeding by the uncertain and unthrifty teachings of unorganized experience. Men fed their animals thus and so because their fathers had fed them thus and so. Now and then accidental success or disaster following some unscientific or unintentional experiment, brought into irrational favor or disfavor some particular food. Everywhere prejudice and waste went hand in hand.

All this began to be changed a little more than thirty years ago, when Bischof and Voit in Munich, Henneberg and Stohmann in Weende, Wolff in Hohenheim, and other German investigators undertook the experiments that have led to our present theory of nutrition and methods of estimating the nutritive values of feeding stuffs and planning rations for domestic animals on the basis of the quantities of protein, fats and carbohydrates. The feeding standards of Wolff, now generally current, have been in vogue for twenty-five years or thereabouts. It is, however, only twenty years since the first exposition of the subject was made in the English language, and it is less than fifteen years since the details were made available to students and practical farmers in the United states; yet such is the readiness with which new ideas are received and put in use in this country that for the past ten years the German feeding standards have been in common use in the United States and the method of calculating rations for domestic animals on the basis of the chemical composition of feeding stuffs has become an every-day matter.

To illustrate what this method is and how it is applied, let us work out an example on the basis of the feeding standard for horses as determined by Wolff, which is as follows:

POUNDS PER DAY REQUIRED FOR 1000 LBS. LIVE WEIGHT.

	Digestible Constituents of the Fodder.					
	Total dry organic matter	Albuminoids and Amides	Total carbohydrates and fibre	Fat	Amount of nutritive matter	Nutritive ratio
Horses at light work	20.	1.5	9.5	0.4	11.4	1:7
H'rs's at medi'm w'k	21.	1.7	10.7	0.6	13.0	1:7
Horses at hard work	24.	2.4	12.5	0.8	15.7	1:6

This means that a 1,000 lb. horse at light work will thrive best if he eats 20 lbs. a day of dry organic matter, of which 11.4 lbs. will be digestible, being made up of 1.5 lbs. of albuminoids, 9.5 lbs. of carbohydrates, and 0.4 lbs. of fat; and that in food so constituted the protein would be to the carbohydrates and fat as to nutritive value in the ratio of 1 to 7.

Be it understood that these are standards for a maintenance ration, i. e. one which sustains the mature animal without gain or loss.

With the foregoing in mind let us examine, for instance, the ration of the street-car horses of Toronto, which are fed 7 lbs. corn-meal, 6½ lbs. chopped oats, 1½ lbs. wheat bran, 11 lbs. cut hay. References to the analyses previously given will show that 100 lbs. of each of these foods will contain:

	Dry organic matter	Albuminoids	Fibre and carbohydrates	Fat
Corn	87.95	8.44	62.86	2.29
Oats	86.09	8.76	46.11	3.94
Wheat bran	80.76	12.81	43.98	2.41
Hay	80.49	3.21	41.17	1.32

Applying these figures to the number of pounds of each food as given in the case under consideration, makes this showing:

	Dry organic matter	Albuminoids	Fibre and carbohydrates	Fat
7 lbs. corn	6.15	0.59	5.80	0.16
6 ½ lbs. oats	5.59	0.57	3.00	0.25
1 ½ lbs. bran	1.21	0.19	0.66	0.04
11 lbs. hay	8.85	0.35	4.53	0.14
Total	21.80	1.70	13.99	0.59

Nutritive ratio 1:9

Comparing the results with the German standard we see that this ratio contains 0.8 pounds more of dry organic matter than the standard allows for horses at medium work, — a difference not material. In protein the two are alike. The Toronto ration has a considerable excess of carbohydrates and a very slight deficiency in fat, making its nutritive ratio 1:9 instead of 1:6 as in the standard. (Remember that the nutritive ratio is found by multiplying the fat by 2½, adding the carbohydrates and

dividing by the protein.) We have assumed that the hay is timothy. If it were clover, which has a larger share of protein, the nutritive ratio would be much nearer that of the standard. If timothy, the amount of oats should be increased and corn meal diminished to make this a well balanced ration.

This illustration will suffice to show how the theoretical value of any ration can be determined, and the more this method is applied, the more intelligently and economically will horse-owners feed. In such work the following table, copied from Whitcher, will be found convenient:

WEIGHT OF GRAINS.

	Per ½ Bushel		Per quart	
	lbs.	oz.	lbs.	oz.
Corn meal	23	8	1	7
Cotton seed meal	25	8	1	9
Shorts	11	4	0	11
Middlings	18	0	1	2
Ground oats	12	0	0	12
Gluten meal	26	0	1	8
Corn and cob meal	22	0	1	6
Cracked corn	21	0	1	12
Whole oats	16	0	1	0

Or stated in another way:

1 pound of corn meal equals		0.7	quarts
1 " " cotton seed "		0.625	"
1 " " shorts "		1.48	"
1 " " middlings "		0.90	"
1 " " oats "		1.33	"
1 " " gluten meal "		0.617	"
1 " " corn and cob "		0.73	"
1 " " cracked corn "		0.57	"
1 " " whole oats "		1.00	"

The choice of foods for combination in a daily ration for an average horse is affected by many considerations, among which economy and convenience are prominent. A ration that is cheap on the farm may be costly in the city. The family horse in town will rarely get a taste of corn fodder. The Minnesota horse is more likely to have linseed meal in his diet and the Southern horse is more likely to have cottonseed meal. It is manifestly impossible to say here what will always or even in most cases be found cheapest and best. The best that can be done is to describe some combinations that have been found national and economical.

Here are eight rations given in a circular by the New York State Agricultural Society:

HORSES AT LIGHT OR MEDIUM WORK. — Per 1,000 Pounds Live Weight.

No 81– 20 pounds silage, 10 pounds clover hay, 5 pounds wheat bran, 3 pounds corn meal, 1 pound linseed meal. Nutritive ratio, 1 : 6.1.

No. 82– 16 pounds mixed hay, 5 pounds pulped turnips, 6 pounds corn meal, 4 pounds wheat bran.

No. 83– 10 pounds clover hay, 10 pounds wheat straw, 5 pounds oats, 3 pounds corn, 2 pounds oil cake. Nutritive ratio, 1 : 7.

No. 84– 8 pounds clover hay, 4 pounds straw, 4 pounds corn meal, 4 pounds ground oats, 6 pounds wheat bran.

HORSES AT HEAVY WORK.—Per 1,000 Pounds Live Weight.

No. 85– Add 5 pounds corn meal and 5 pounds ground oats to No. 84.

No. 86– 10 pounds timothy hay, 10 pounds oats, 5 pounds corn meal, 5 pounds linseed meal, Nutritrive ratio, 1 : 5.4.

No. 87– 10 pounds silage, 5 pounds timothy hay, 5 pounds oats, 6 pounds corn meal, 6 pounds linseed meal. Nutritive ratio, 1 : 5.4.

No. 88– 8 pounds clover hay, 6 pounds corn fodder, 10 pounds corn meal, 6 pounds rye bran, 2 pounds linseed meal.

Youatt gives the proportion usually fed in England for agricultural cart-horses at 8 pounds oats, 2 pounds beans, and 20 pounds chaff, made of equal parts hay and straw cut together. The grain is mixed with the cut seed. By this means, said Youatt, the animal is compelled to chew his food, he cannot waste the straw or hay; the chaff is too hard and too sharp to be swallowed without sufficient mastication, and while he is forced to grind that down the oats and beans are ground with it, and yield more nourishment; the stomach is more slowly filled and therefore acts better on its contents, and is not so likely to be overloaded. The increased quantity of saliva thrown out in the lengthened mastication of food softens it and makes it fit for digestion.

Street-car and omnibus companies of course feed with what their managers think the maximum of economy, and the results

of their experience are therefore well worth studying. The street-car horses in New York city get during the summer season 8 pounds chopped oats, 8 pounds corn meal, 12 pounds cut hay. During the winter they get 16 pounds corn meal, 12 pounds cut hay. The winter ration was formerly used during the summer, but was considered too heating. It is too strong in fat and carbohydrates, and not strong enough in muscle-producing matter. It is said by the company that its horses wear out very quickly, lasting on an average only four years. This is due to some extent to the want of muscle-producing matter in their food. They sweat easily, their muscles are not firm and hard, and they have not so much power to endure hard work.

In another American city, the horses, required to make 24 miles a day at a jog trot, in heats of six miles each, are fed almost entirely a grain diet, being given only enough hay to secure good digestion. The common ration is crushed corn and wheat bran mixed with close cut hay. Of this about half a bushel is fed dry at one mess. Whole hay is sometimes fed and the grain ration is varied to maintain a vigorous appetite. With this feeding the horses are kept in vigorous condition under the constant and severe strain of the car service.

The rations fed street-car horses in seven British cities are given as follows in "The Book of the Farm":

	London South	Dublin	Glascow	Edinburgh	Birmingham	Liverpool	London St.
Oats	7	3	6	8	10	—	3
Maize	7	14	11	4	6	12	12
Beans or peas	1	—	—	4	4	4	1
Hay	11	12	8½	14	12	14	11
Straw	3	—	1	2	—	—	—
Bran	—	½	½	—	—	1	1
	29	29½	27	32	32	31	28

The London Omnibus Co. found that 3,000 horses fed on 16 pounds of ground oats, 7½ pounds of cut hay and 10½ pounds of cut straw, did as much work and kept in as good condition as another 3,000 fed on 19 pounds of whole oats and 13 pounds of uncut hay. Thus a saving of 6 pounds of feed a day for work horses was made by grinding the grain and cutting the

hay — a saving, in the feeding of 6,000 horses, amounting to $300 a day.

Henry William Herbert said: "For a gentleman's carriage-horse or roadster, at ordinary work, in its own stable, 8 pounds, and from that up to 10, of the very best, richest and most succulent hay is amply sufficient, with 12 quarts of good heavy oats, as a daily allowance."

Lyman F. Abbott reports the following ration to have kept a family horse in Maine in fine condition and good spirits for eight years: Morning at six o'clock, 1 quart of cracked corn, ½ pound new process linseed meal, 1 quart bran, 4 pounds hay. Noon, 1 quart of cracked corn and 1 quart of bran. Night ration same as morning. For summer feed, oats are substituted for the main part of the corn, and the night ration of linseed meal discontinued, and 1 quart of bran or one pint of middlings added.

In a bulletin of the Louisiana Agricultural Experiment Station, the following ration is suggested for work horses or mules weighing 1,000 lbs.: Shelled corn, 7 pounds; oats, 3 pounds; peas, 3 pounds; hay chopped, 13 pounds. The ingredients of this ration are mixed together, making a total of 26 pounds, and divided into at least three feeds. The writer says: "Of course, the preparation of this would necessitate the use of a little machinery in the form of a hay chopper, corn crusher, etc., and all this chopping and mixing may seem very unnecessary and expensive, but, depend upon it, on a large plantation, or in fact, in any place where a large number of work stock are to be fed, the first cost would be the greatest, because I have no hesitancy in saying that what would be saved in feed and the reduction of mortality in work animals would more than doubly repay for any extra trouble and outlay."

Speaking of a trotter going through a racing season, Feek, the trainer, says: "As you increase his work, increase his feed proportionately. Horses differ. Some require more feed, hay and oats, than others to keep them strong and in good flesh, which is necessary to stand a campaign. The amount of oats required ranges from 10 to 14 quarts, with plenty of good timothy hay; perhaps in addition a little cracked corn, rye or wheat. Corn will sometimes loosen a horse's bowels too

much; if so, change to wheat or rye. Do not use your muzzle any more than is absolutely necessary, as I think there are five used where only one is needed. Rye straw is very hard to digest, and if your horse insists upon eating it you had better tie him up after he has finished eating his hay rather than annoy him with a muzzle. If he is very hearty, give him plenty of hay and he will eat less straw; and put the muzzle on only the night before a race or stiff work. We should always look to the comfort of our horses, and a leather muzzle placed over one's head on a hot night or day must be torture, and the wire one is no good except to chafe, as he can eat through it. There is occasionally a gross feeder, or pig, as he may be called, on whom it would be necessary to keep a muzzle, as he never knows when he gets enough, and you could not get him emptied out and ready in a week for fast work. In such cases I think it better to bed with pine shavings, if convenient."

W. H. Tourtellotte, of the Bates farm, Watertown, Mass., where many fine horses have been bred, said in a private letter written in June, 1891: "Some of my brood mares I can keep in condition by feeding one peck of grain a day; others will require half a bushel. This is made up of two thirds bruised oats and one-third shorts, the best I can get. I give them all the hay they want to eat, anywhere from 25 to 40 lbs. each day. I have one mare that has twins, and I feed her 24 quarts of grain and I think about 40 lbs. of hay. My weanlings I feed not less than one peck of grain each day, if they will eat as much. That is made into a mash fed twice a day morning and night, two-thirds bruised oats and one-third shorts. I feed my stallions about twelve quarts each day, — four quarts of oats and one of corn in the morning; four quarts bruised oats and two of shorts with a little corn at night, made into a mash. I never had one to which I have been obliged to give more than that to keep him in good condition. I water all my stock except the driving horses and stallions twice a day; the driving horses and stallions I water four or five times a day. I also give my stallions a small allowance of grass in its season, twice a day."

That able trainer, Marvin, says: "Give the colts all they can eat up clean, but it is not so easy to fix the quantity with

horses. Horses differ in the amount of food they do best with, just as they differ in the amount of work they require. No absolute rule can be laid down. One horse may keep right on hay alone, while another will require ten or twelve quarts of oats a day in addition to keep him right. The only rule I can formulate is to give the horse in training all that is necessary to keep him stout and strong. A horse, to be in proper track condition, will carry a certain fair amount of flesh, and if you reduce him below that he will become weakened."

To a correspondent of the Country Gentleman asking for a ration for horses four years old, weighing 1,000 pounds, used on farm, ration to be from timothy hay, oats at 50 cts. a bushel, bran, oil meal, and corn meal at $20, Professor Stewart answered: "12 lbs. cut timothy hay, 5 lbs. cob meal, 4 lbs. wheat bran, 1 lb. linseed meal. This will be a good ration for light work in the winter. When they are put to hard work, add 1 lb. to the bran and 1 lb. to the linseed meal. This is a day's ration to be given in three feeds, smallest at noon, or two-fifths may be given in the morning, one-fifth at noon, two-fifths at evening, and if these rations are properly fed, all stock will keep in fine condition."

To a correspondent of the Breeder's Gazette Professor Henry answered: "Eight pounds of oats are a light grain feed per horse per day, while a peck at a feed three times a day is too much grain. With oats at the present price I should not feed over a peck and one-half a day, using shorts and bran mixed for the balance of the grain ration. Feed two-thirds of a peck at a feed morning and night, and at noon give five or six pounds of bran and shorts mixed. The variety of feed will be a good thing, with somewhat reduced expense."

Here is other editorial advice: "For field work, not travel, give him 12 pounds of mixed hay daily, which may well include some clover, and, as do the English, you may make it a part straw and 12 pounds grain, made up of one-half to two-thirds corn or corn-meal, and the balance preferably in oats and a little old process linseed meal, to keep the bowels in good order. One-half to one pound daily or a pound or two of bran may be given. Some give ground peas and oats, a good food. Let the chief diet of hay be at night, and least, if any, at noon."

Still another writer says: "Variety is the spice of life, and nowhere is it better demonstrated than in the feeding of animals; hence it is a good plan to vary the mixture of concentrated food, giving one week mixed with ground oats, the next week using wheat bran with the meal, and it is beneficial to the horse to add to either mixture a few pounds of oil-meal, which is very rich in albumen, to counteract the excessive starch in the corn."

To the owner of a horse who complained that while his horse ate ten quarts of oats, he was not filled out, Professor Stewart very truly said that not half of the horses thoroughly masticate oats. Let his oats be ground and then make up his ration as follows: 7 pounds of ground oats, 4 pounds fine bran, 1 pound linseed meal. Let this be well mixed together dry. A part of his hay should be run through a cutter to mix this ground food with. The 12 pounds ground feed should be mixed with 6 pounds cut hay, without wetting, and the horse will eat the hay with the ground feed although all is dry. This ground feed and cut hay should be given morning and evening, and a little long hay at noon. The man does not mention the weight or age of his horse, or how much he is ridden a day. The combination here given will be likely to give him a start in filling up and rounding out his form. After feeding this for a few weeks it will probably be necessary to add another pound of linseed meal. Feeding it dry will cause better mastication and better digestion. The oil-meal will cleanse and soothe the digestive organs and give a sleek coat.

A contributor to another paper says: "My oats having all been fed, I was buying. Oats were dear, and ground oats suspiciously full of hulls. I reasoned whether I could not compound an honest, cheap ration from wheat bran, oil-meal, or cottonseed meal, and corn meal, for all my horses. I wrote to Professor E. W. Stewart. He replied that for roadsters oil, or cottonseed meal two parts, corn meal two parts and bran six parts, with ten parts of cut hay or straw, all by weight, was about right for twenty-four hours in three feeds. Well, I stopped buying oats and have saved money. But I have done more,—the particular horse mentioned has improved as a driver and continues to improve. He looks and acts more am-

bilious and has a better disposition. For this I credit myself. The weighing led me to try less and less hay, while not increasing the grain ration, with the above favorable result. The horse had a good appetite and only a small stomach. As a consequence he was uncomfortable, cross, and indisposed while on the road. Now, I am not only saving money in grain, but in hay, and have a better driver."

Many farmers are coming to think that they feed too much grain. One of them in Illinois writes: "I believe that one-third of us feed too much grain to our horses at all times. I know of some men who do not expect a horse to eat any roughness when at spring and summer work. In fact, they give him no roughness to eat. The mangers are empty for weeks, while so much grain is put into the boxes that frequently it is not all eaten. To make the matter yet worse this grain is exclusively of corn, or almost so. Yet these men wonder why their horses grow poor and do not stand up to work. Of course, none of us are guilty of such feeding; yet I believe that one-third of us feed horses too much grain, and especially during the winter. I can say honestly, and can bring my neighbors to witness the truth of it, that no horses on any farm in the county do more hard work than mine, and that they are not so poor or as badly worked down as at least three-fourths of the farm horses of the county. They are above the average of Illinois horses in size, — big enough for two of them to draw a 14-inch plow easily. Yet when at hard work in spring or summer they get only seven or eight ears of corn at a meal or a little more than a gallon of oats. They are given all the hay they want, and it is first-class hay. They are given 90 minutes for their noon meal. If they get through their meal in an hour, as they generally do, they have 30 minutes at least for digestion before they begin their work.

"Now I know some farmers who give their horses as much grain during the winter as I give mine during the spring and summer, although farm horses are idle the greater part of the time during the winter. The horses do not need much grain during the winter, and it is more expensive feed than roughness. When idle and fed so much rich food, their appetite for it is cloyed and their digestive organs are debilitated by spring;

hence, one frequently hears their owner complain that they do not eat well. Neither do they digest well. If given a little grain during the winter they have a keen appetite for it during the spring and will eat readily all they should, and will digest it well. When my horses are not at work during the winter, they get two ears of corn in the morning, a quart of oats at noon, and two ears of corn or a little bran at night. They are given all the bright hay they will eat and are comfortably housed. They meet the spring fat and sleek, and with muscles in good trim. Their grain feed is increased two or three weeks before hard work begins."

Another farmer says: "I would discourage the practice of heavy grain feeding in preparing the team for spring work. This so overtaxes not only digestion but the entire system that the ill condition of these organs makes it impossible many times to keep up flesh even if a large amount of grain be given throughout the season. The better way is to give light day's work for a time before and after spring work begins. Then a light grain ration will not only maintain good flesh but the system will also be retained in good condition so that as it becomes necessary to require large day's work the grain ration may be increased to correspond with the work required without overtaxing the system and getting the team out of fix, as many times results when grain is fed heavily for a long time.

"I now maintain better flesh in my teams on 8 ears of corn at a feed than formerly on 12 ears, because they are never overfed and with impared digestion; hence they really get more nourishment out of the 8 ears than they otherwise would out of 12 ears or more. It is not what stock eat but what they digest and properly assimilate that produces strength and flesh. My observation leads me to believe many farm teams grow poo under heavy grain feeding, while if half the amount were fed judiciously there would be much less difficulty in retaining reasonable flesh. While there is no doubt that oats is the best muscle-former and gives the horse greater strength and endurance than any other grain feed, yet if supplies of this are not at hand, I question if it will pay the average farmer to buy this grain for his teams at current prices to supplement or displace cheap corn already on hand. If the hay consists of a

mixture of timothy and clover and is of good quality, there should be no difficulty in maintaining a fair condition in the teams if corn alone constitutes the grain ration. If pure timothy is fed, especially if inclined to be woody from over-ripeness, it will be found very beneficial to add some oats and bran to the corn for the stomach's sake."

CHAPTER V.

The Art of Feeding.

To feed intelligently, one must know something not only of the nature of foods, but also of the nature of the feeder. In other words the equine structure must be understood, so far at least as it is concerned with the consumption and disposition of food.

The first thing to be understood, — and it is a thing of primary importance, — is that the digestive apparatus of the horse extends from one end of him to the other. Not merely the stomach is active in digestion, nor the intestines, but also all the rest of the channel through which the food passes. Even at the entrance physiological conditions have a direct bearing on practical feeding, for it is the sense of smell that governs the horse in taking the food. This sense is far more delicate than is commonly thought, — so delicate, in fact, as to make it essential that the mangers and breeding troughs should be kept clean. Untouched food should be removed less it become sour, when most horses will positively refuse to eat it.

Supplementary to the sense of smell is the sense of touch, exercised by the delicate nerves of the lips. A horse will carefully select the food in the manger he likes best and shun any part he dislikes. That is one reason why cutting hay, straw, etc., and mixing it thoroughly with the grain, is advantageous. He will be the less likely to escape eating that part of the ration he does not relish.

In the mouth the food is masticated and mixed with the saliva secreted by the different glands. There is also a secretion of mucus in the mouth. There are three pairs of salivary glands grouped around the jaw and they are to a great extent under the control of the nervous system. The saliva is secreted in great abundance, and has a peculiar solvent, lubricating power on the food, besides a chemical action converting starch

into sugar. This moisture very materially assists mastication, showing us how necessary it is that eating should be performed slowly, allowing the food to mix with the saliva. Here is another reason for mixing grain with cut hay, — it cannot be bolted. Fast feeders generally suffer from indigestion; with them the stomach has to perform the function assigned to the teeth and salivary glands in addition to its own. If the grain and hay are fed separately, give the hay first, especially if the horse is very hungry or exhausted, because he must take longer to masticate the hay.

From the mouth to the anus the food passes through what may be called a tube, the first section of which, after leaving the larynx, is known as the œsophagus or gullet. This, like all the rest of the tube, stomach and all, is lined by mucus membrane throughout its entire course. It is studded with glands or follicles, which secrete a viscid fluid called mucus. This serves to lubricate its surface, thereby preventing its being injured by substances passing along it. Mucus also assists in the formation of chyme and chyle, and the process of digestion in general. It can be readily seen that interference with these secretions along the alimentary tube, as by eating food that irritates the mucus membrane, produces a disordered condition unfavorable to the digestive process.

The dilation or expansion of the alimentary tube known as the stomach is very small compared to that in other ruminants, its average capacity being only three and a half gallons. Furthermore, the horse has one stomach where the ox has four, the capacity of which averages from 50 to 55 gallons. The ox and the other ruminants are also remarkable for their faculty of swallowing their food imperfectly masticated, causing it to return over and over again for remastication, (the process known as *chewing the cud*,) previous to its being finally swallowed and passed on to be acted upon by the gastric juice. The horse can chew his food but once, and so it is natural he should eat coarse food slowly. With his small stomach he must digest his food with comparative rapidity, and that furnishes another strong argument to the advocates of mixing grain with hay. They point out that when hay is fed alone, especially if it is in the form of meal, it is liable to collect in the stomach in a glut-

inous ball or mass that prevents the penetration of the digestive fluids and agents to the centre of the mass, thereby not only preventing complete digestion but also encouraging colic and other troubles of the digestive system. But if it is fed with hay, they argue, the hay divides the grain and admits freer action for the gastric juice.

To test the matter, at one of the experiment stations a horse and a mule were fed against a horse and a mule for 46 days. Nos. 1 and 2 received two parts of cob meal and one part of bran mixed with 20 lbs. of cut hay; 21 lbs. of the meal were eaten daily. Nos. 3 and 4 had the same quantity, but the hay and grain were fed separately.

The weights were as follows:

	Mar. 13 lbs.	Mar. 20 lbs.	Apr. 2 lbs.	Apr. 9 lbs.	Apr. 16 lbs.	Apr. 27 lbs.	Apr. 29 lbs.
No.1, horse.....	1126	1100	1105	1075	1070	1067	1072
No.2, mule..... ..	991	990	950	948	947	933	950
No. 3,horse.....	1200	1196	1175	1135	1131	1135	1123
No.4, mule.... ...	994	985	952	945	945	933	925

At the beginning of the trial the horse and mule receiving their foods in separate rations. At the end of the trial there was but 47 lbs. difference in their weight. The horse and mule receiving their hay and grain in a mixed ration, therefore, held 30 lbs. over those receiving their rations separately. In other words mixing seems to pay for horses.

Professor Michener points out, however, one objection to feeding cut hay mixed with ground or crushed grains, and wetted that must not be over-looked during the hot months. Such food is apt to undergo fermentation if not fed directly after it is mixed, and the mixing trough even, unless frequently scalded and cleaned, becomes sour and enough of its scrapings are given with the food to produce flatulent colic.

In the natures of their digestive apparatus may be found the reason for the essential difference that should be made, but too often is not made, in feeding horses and cattle. Bulky unprepared food is better fed to the cattle; concentrated, prepared food to the horses. This however, is a general rule and not to be applied too literally. It does not mean that

horses should be fed no bulky food and cattle no concentrated food. It does mean that on the whole horse food should be more concentrated, less bulky than cattle food. Horses must have some bulky food to detain the grains in their passage through the intestinal tract; bulk also aids distention, and thus mechanically aids absorption. On the other hand it is clear that an excessive supply of comparatively innutritious food to compensate for deficiency in quality is not only embarrassing to the stomach, but distresses the horse by its bulk and weight. Farmers particularly do not pay enough attention to bulk in feeding horses. It is painful to see a horse plunging into heavy work with the stomach abnormally distended with bulky food. Especially for fast work should food be concentrated. The slower a horse's work, the more can he be fed hay, straw, and fodder.

Another lesson to be learned from the size of the stomach is that the horse should be fed in small quantities and often. He is not built for fasting. To keep him long from food and then let him gorge himself results in distending the stomach, causing irritation of that organ, over-taxing the digestion, and upsetting the system generally.

In the horse, as in man, when the food enters the stomach and is admitted to the solvent action of the secretions, the stomach is in constant motion effected by its muscular walls, which keep the contents in a constant state of agitation, and bring every portion of it into contact with the walls of the stomach, so as to be subject to the action of the fluid that is poured forth from the walls during the digestive process, and the movement of the stomach continues untill the organ is completely emptied, when it ceases until food is again introduced. This is work, and not the lightest of work either. It makes a draft on the horse's energy that does not leave him enough to do rapid or severe work without injury. In other words, the horse, like man, cannot work well on a full stomach.

But the task of digestion does not end with the stomach. Indeed, in the horse digestion takes place principally in the intestines. The stomach begins to empty itself into them very soon after the horse starts feeding, and the process continues rapidly while he is eating. Afterward the passage is slower,

and several hours are required before the stomach is wholly empty. This is the reason why food should be fed in smaller quantities to horses from which rapid, severe labor is to be asked, and given to them preferably two hours before they are called upon to perform it. Even horses intended for slow work must never be gorged with bulky food, slow of digestion, before going to labor.

Some foods pass through the stomach quicker than others. Hay and straw, for instance, travel faster than oats. It follows that when not mixed, hay should be fed before oats, for otherwise the hay would drive the oats forward into the intestines before the stomach had performed all its functions upon them, and the bad results of indigestion would follow.

In noticing the character of different foods we have seen that at the best a proportion of each remains undigested. Therefore under any circumstances a part of the food passes through the animal and is excreted. By feeding the horse more than he can digest, we not only waste the excess, but also call upon his digestive apparatus for an unnecessary expenditure of vital force. It follows that, paradoxically as it may seem, we can actually feed a horse so much as to make him poor. Even if the results do not go so far as that, but show themselves merely in a super-abundance of fat, still harm is done. For fat is fuel, not muscle, and too much fuel is both burdensome and dangerous. Too much fat indicates weakness in the horse as well as in the man. Adiposity predisposes to sickness. It has been well said that nothing is more conducive to disease, nothing more fatal to speed and endurance, than a full fed, plethoric condition of the system, unless it be the other extreme of involuntary starvation. Among the great knights of the sulky, Charles Green, of Babylon, Long Island, has been noted for many years as a superb conditioner of lasting campaigners. His uniform rule, when famous horses in his charge like Lucille, Golddust, and Sprague Golddust, seemed to loose all ambition or capacity to improve in speed, is to reduce their daily allowance of feed to one-third the usual quantity for a week, and then to restore the full amount. The stomach and digestive organs, he claims, are thus thoroughly rested. In all cases, he affirms, the results are beneficial. The spirit of the horse is renewed, the

ambition quickened, and the capacity for speed remarkably increased.

Many horses kept for pleasure driving are greatly injured by over-feeding. A high-spirited horse, driven only a few miles occasionally, should not be fed as freely as an animal driven long distances daily. He does not need so much and cannot properly digest and assimilate it.

Indeed there is little more important in the management of horses than the judgment required to maintain a just balance between food and work, as indicated by the condition of the animal, and the horse owner should be prompt to increase or diminish the allowance of concentrated food in accordance with the work required of the horse. The greater the exertion the greater the waste of animal tissue, and the necessity of an increased supply of nutritious food. Should a horse require more food than usual to supply the extra waste of tissues caused by hard work, give it by all means, but let the excess be in albuminoids, (i. e. in grain rather than in hay,) let the horse be fed oftener and not in increased quantities at a time, and let the change be made gradually.

The attempt often made by novices to put horses in condition for hard work by suddenly increasing the feed, always ends disastrously.

More food is needed in cold weather when the body is exposed to rapid abstraction of heat or vicissitudes of temperature than in warm seasons.

An animal in poor condition needs more food to enable him to perform a certain amount of work than one fairly fat. When an enforced idleness from lack of work, or wounds, interferes with the horse's activity, a continuance of full rations of concentrated food predisposes to and frequently results in fatal disease, such as lymphangitis, azoturia, etc.

Professor Michener says that when a horse is to do less work, or rest entirely from work a few days, he should receive less feed; and he thinks if this were observed even on Saturday night and Sunday there would be fewer cases of "Monday morning sickness," such as colics and lymphangitis.

Dr. C. E. Page observes: "It is quite customary to keep up the feed of trotting horses between seasons, permitting them

to become somewhat fat, and then when they are to be fitted for sharp work, this fat is worked off and out while muscle is being worked on. In other words, the horse is forced to take on disease by feeding him in excess of his work, and then is cured by restoring the just balance between work and feed. This is, in my judgment, very bad policy, proving in the end exhaustive of vital force, ruining a great many valuable horses and injuring all that are thus treated. 'Little work, little feed,' should be the rule; unless indeed, the horse-owner feels the necessity of keeping up the appearance of his animals, whether they get much exercise or not."

On the other hand it should not be forgotten that the horse, on getting an easier time of it as regards labor, is building muscle and tissue, and in every way repairing himself for another turn of hard work, and the extra quantity of feed that he consumes during the easier time, if not too great, is often a decided gain, and not a loss to the animal's owner; for by it he is kept in proper condition, and is in better saleable form at any time his owner may want to turn him into money.

Over-feeding sometimes causes refusal to eat. Short rations for a day or two will remedy this. The manger of an animal in this condition should be watched, and whenever, after a reasonable allowance of time for eating, the manger is found to contain untouched food, that food should be immediately removed, the succeeding feed being reduced a corresponding quantity. So treated the animal is allowed just as much food as it will eat up clean. There is no more certain way to cause an animal to refuse its food than to give more than is wanted and then leave the surplus in the manger from one meal time to another. Most horses, however, will eat more than is good for them if they have the chance, and therefore should not be fed all they will eat.

It often occurs that food is refused for no apparent reason, the animal at the same time becoming thin and weak, simply for want of food enough. Dr. F. E. Rice, in discussing the subject in a bulletin of the Rhode Island Ag. Exp. Station, says it is in these cases that the numerous "condimental" and other proprietary foods appeal to the owner—and in many cases to the animal. Now it has been proved repeatedly that the nutri

tive value of these foods, as compared with the common, uncombined food-stuffs, is not increased by the condiments they contain: but on the other hand it is true the condimental foods are not without value, coming from the fact that such foods do rouse the appetite, and by exciting an increased flow of the digestive juices, they do, for a time at least, give an impetus to nutrition.

The following formula is given as one that is useful in the greater number of cases: Ground or crushed oats and corn meal, of each, 5 pounds; oil meal, ¼ pound, common table salt. 2 ounces. If the animal seems in need of a tonic or is troubled with intestinal worms, there may be mixed with each ration as above given, a desertspoonful of powdered gentian, and a small teaspoonful of the dried sulphate of iron; these are to be had of any druggist.

If as sometimes occurs, the animal refuses the ration containing the iron and the gentian, a little starvation is all that will be required to cause him to take it; the dislike ceases once the animal has been persuaded to take of the mixture.

Of course the food ingredients may be changed to meet the indications of individual cases, and as intelligence may direct.

All of the so-called condimental foods are based on attempts to apply the principles included in the foregoing formula, but the results of these attempts have been, in some cases, an absolute failure, the "food," as shown by analyses made at the Connecticut Experiment Station, containing less nutriment, pound for pound, than common bran. And, as noted in the bulletin of the Station referred to, "the extravagant claims made by the proprietors of these foods may well excite suspicion as to their value."

Dr. Rice quotes from Professor Stewart the following formula, said to be held in high repute in England. It is given here as it shows rhe real value of the better class of the so-called condimental foods:

Articles.	Lbs.
Linseed oil-cake	25
Flax-seed	10
Molasses	20
Corn meal	40

Ground tumeric root.....	1 1-2
Ginger.....	0 1-8
Carraway seed.....	0 1-8
Powdered gentian	0 1-2
Cream of tartar	0 1-8
Sulphur	1
Common Salt.....	1
Coriander seed.....	0 5-8
Total 100	

Boil the flax-seed in ten gallons of water until it forms a thin mucilage; then stir in the tumeric, ginger, carraway, gentian, cream of tartar, sulphur, common salt and coriander; now add the molasses, then the corn meal and ground oil-cake, stirring it well together. If it is desired to keep it long it may be dried in a hot-air chamber or oven at about steam heat, after which it will require grinding for convenient use; but the materials may be ground together in their natural state if manufactured for commercial purposes.

The domestic animals, no less than man, require a variety of food to make healthful and nutritious diet. Watch a horse or cow feeding in pastures with various grasses. It is rare that one alone will be eaten unless it is far better than the others. There will be a bite here and another there, making altogether a more palatable mouthful than could either be alone. In the stables this choice is not given, as the hay is generally bought for its uniformity, while a mixture, which really makes the best hay, is considered inferior. But even in the stable some variety is now regarded as necessary by the best horsemen. Winter feed is mostly too dry. It is wonderfully benefited by adding a few roots.

But be careful to change foods gradually. If a horse has been accustomed to oats, a sudden change to a full meal of corn will almost always sicken him. Even if the nature of the food is not changed, but its quantity is to be increased or diminished, do this gradually.

Food should be of a more laxative nature when the horse is to stand for some days.

Delicate feeders must be tempted to take their rations, and such should never be fed too strongly at one time. A little linseed boiled to a jelly and mixed with the corn is seductive.

Hay damped and salted will tempt others. Tick-beans, a double handful, are a relish in weakly subjects; pale malt for the convalescent or indisposed; damp bran and oats are engaging for others. Some breeders give carrots and tares in small quantities.

As to the times for feeding, we have already seen why the horse should be fed frequently. Three meals a day are the least number permissible, and many hold four to be better. To feed four times in the day diminishes the interval of fasting, and gives the horse no chance to get ravenous. The hours, of course, depend on the horse's work, and no general rule can be laid down. In English stables the custom is: 6 A. M. Water and feed with a little hay. 7 A. M. Feed with grain. 12 M. Feed with grain. 5.30 P. M. Water and hay. 6.30 P. M. Feed with grain.

The heaviest feed should be at night. Then the bulk of the hay should be given, but see that it is not enough to make a greedy horse lose any of his sleep. It is both inhumane and dangerous to give an extra allowance in the morning to a horse that has a hard day's work before him. That practice may result in a stomach-blout. The horse starts out feeling full and oppressed; he soon grows dull and listless, and fails to respond to the whip; he sweats profusely, tries to lie down; his head is carried forward and downward; or if he is checked up he is heavy on the reins, stumbles or blunders forward, and often falls. The pain and distress are constant, and the end is often fatal.

Better, then, "brace your horse up", if need be, by increasing his supper somewhat the night before. If he is to travel all day, and it is likely to be hard to find a place to bait him, take along a nose-bag. Were that appliance, too, used on the farm more than it is, farmers would have healthier horses.

One of the most common errors of feeding, and one Professor Michener says produces more digestive disorders than any other, is to feed too soon after a hard day's work. This must never be done. If a horse is completely jaded, Michener says it will be found beneficial to give him an alcoholic stimulant when he goes into the stable. A small quantity of hay may then be given him, but his grain should be withheld for an

hour or two. If he is but ordinarily tired, let him stand until he is cool and comfortable before giving him the grain.

On the other hand, Feek, the trainer — and his experience gives his words weight — declares that though he formerly used cherry wine, brandy, etc., as a stimulant to give a horse between heats, he discarded all of these years ago because their after effect is so bad. They have the same effect on a horse as on a man — first stimulating, then depressing. Whenever any stimulant is necessary, Feek uses a homœopathic preparation, a few drops on the tongue, which he says has helped him to win many a long and hard race.

The best nourishment he knows of for a horse between heats n case one is needed, say, after a horse has gone two or three hard heats and has become heated, is given by a quart or two of clean oats. Dampen them, put them In a sieve and spread them out, so the horse cannot get a large mouthful at once. This should be repeated after each heat if the race lengthens out to five or six heats. Feek says he has used oatmeal gruel and it is good for those horses that will eat it, but his experience is that very few horses like it and any horse will eat oats. "We all know that when a man is tired a few mouthfuls in the stomach will build him up wonderfully, and it is the same with a horse."

But it does not follow that because a little food under such circumstances is a good thing, much will be better. On the contrary, violent exercise immediately after eating any considerable amount, ruins horses and causes distress in all animals that are put to it. And though every man of reflection knows that violent exercise immediately after eating causes a pain in his own stomach, yet many will give horses the most solid food just before beginning the labors of the day.

It is best to have fixed hours for feeding, and whatever they may be, adhere to them as far as possible. The horse has a remarkable faculty for telling time, particularly meal time, and to delay makes him restless. Regularity of feeding is as valuable a thing to a horse as it is to a man. Neither will long have perfect digestion if irregularity in meals is frequent.

CHAPTER VI.

WATERING.

Water is the most important food a horse takes. It is a food just as much as hay or grain is. It is by far the largest constituent of a horses body, it is wasted and consumed like the other elements, and like them it must be replaced.

Water is the one food that all animals share in common. Note particularly that it is the one food that horses and men take under like conditions. Treat the horse in watering, then, as you would treat yourself.

Impure water poisons you: it will poison the horse. Ice-water threatens your health and even your life: it may injure your horse or kill him. You drink frequently and in small quantities: let your horse do the same.

When you are heated, you take a few swallows and then if you have self control, forbear: your horse has less intelligence and self control than you have; therefore after letting him have a few swallows, make him forbear.

The surest thing to make you sweat freely during a hot day is to drink freely during the morning: if you fill your horse before he goes to work, he will sweat freely.

And so we might go on comparing watering horses to watering men, laying down the same rules under almost all the conditions, but not quite all. In one physiological feature we have seen that the horse is unique, — he has an exceptionally small stomach. This spoils the completeness of our equation by making it preferable with the horse, to water before eating rather than after. We have seen that long after a horse ends his meal there is undigested food in his stomach. Give him water then and it is liable to drive this on into the intestines, resulting not only in waste of food, but also in indigestion and worse evils, such as flatulant or spasmodic colic or fatal enteritis. It has been found that water passes through the stomach

very quickly, so that if given before food it gets out of the way of the food. But if given after the food, besides pushing that ahead faster than it would naturally go, more of the water is detained in the stomach than should be, diluting the gastric juice and giving another cause for indigestion.

To this theory has been applied the test of experiment. A horse was fed about four quarts of whole oats and immediately after given water to drink. Soon after the horse was killed and cut open. Scarcely one quart of oats was found swimming in the water in the stomach, the remaining three quarts having been forced from the stomach into the intestines by the water. Another horse was given water first and then about four quarts of oats. Fifteen minutes after feeding, this horse was killed and cut open. The entire quantity of oats was found in the stomach and they had already become attacked by the digestion.

Nevertheless, this question of watering before or after eating, is not yet settled. The weight of opinion, to be sure, has of late years been in favor of before eating, and the arguments on that side seem the more rational. Yet trials made recently by Professor Sanborn of the Utah Station lead him to the conclusion that horses should be watered before and after eating. He found that horses watered before eating grain retained their weight better than when watered after feeding grain. Horses watered before feeding had the better appetite or ate the most. Horses watered after feeding grain, in ratio to the food eaten, seemed to digest it as well as those watered before feeding. In a prior trial there was a small apparent advantage in favor of feeding after watering.

An idea prevails among horsemen that horses should never be watered oftener than three times a day. That idea is wrong and in its application is brutal. It has been well said that feeding a horse principally on grain and driving him five hours without water is like giving a man salt mackerel for dinner and not allowing him to drink before supper time — very unsatisfactory for the man. If you know anything about the care of horses and have any sympathy for them you will water them as often as they want to drink — once an hour if need be. By doing this you will not only be merciful to your animals

but you will be a benefactor to yourself, as they will do more work, they will look better and live longer. Learn from the experience of street car companies, whose employees water their horses every hour, and sometimes oftener, when they are at work.

In a state of nature the horse drinks no more than he needs and no more than is good for him. It might be concluded that if while in the service of man he had access to water at all times, he would likewise regulate his drinking rightly, and so he would, were it not for the fact suggested above, that his power of self control is not great enough to keep him from drinking from excess when he is heated. This is the main danger from keeping a trough of water in the stable where the horse can always get at it, — a practice that has many commendable features and should be adopted when possible, for the danger referred to can be easly obviated by turning off the water or covering over the trough after the horse has had a few sips from it in coming in from a hard day's work or a fast spin. Such a trough, however, should be fed by a constantly running stream, or be emptied three times a day, and it must be kept clean. Horses detest stale and filthy water, and will long suffer the tortures of thirst before they will drink it.

They would, indeed, refuse all impure and poisonous water if their senses of smell and taste were equal to detecting the noxious elements. But though these senses are extremely delicate, they can no more tell than man can what is safe water and what isn't. The scientific investigations of these later years have taught us that some of the waters pleasantest to the taste are most dangerous to health and life. The sweetest of well-water is often the most deadly.

We have not learned how to detect the poison without the chemist's aid, but we have learned where it lurks. We know shallow wells and ponds close to barn-yards, manure-heaps, cess-pools, and any rotting vegetable matter, are almost sure to contain the germs of disease, causing diarrhœa, dysentery, and other diseases of stock, in many instances resulting in death. Therefore the safe way is to fill the barnyard trough with running water brought from a distance, not to water the horse in stagnant pools, and to be as careful of what he drinks as you are

of what you drink. If you will remember that extreme thirst would induce you to drink pretty bad water, and that if you did not use your judgment you would often drink bad water that looks, smells and tastes good, you will see that it is not safe to let your horse drink anything you can make him drink. Give him rather only what you know he should drink.

Cool water is good for both man and beast. Ice-cold water is dangerous. It is neither necessary nor wise to coddle a horse to the extent of heating everything he drinks, nor even of warming ordinarily cool water by adding some hot, but it is desirable to have the yard trough where the sun will strike it in the winter morning, and one ought not to bring the bucket too quickly from the well. Let it stand till the chill is off.

The horse needs more water in hot weather than in cold more when he is working than when slehedi i.

Professor Michener says it is a popular fallacy that if a horse is warm he should not be allowed to drink. The claim that the first swallow of water "founders" the animal or produces colic, is erroneous. No matter how warm a horse may be, it is always entirely safe to allow him from six to ten swallows of water. If this is given on his going into the stable, he should be given at once a pound or two of hay and allowed to rest an hour before feeding. If water be then offered him, it will in many cases be refused, or at least he will drink but sparingly. The danger is not in the "first swallow," but in the excessive quantity he will take if not restrained. A recent writer has gone so far as to maintain that it is just at this time, when an animal is warm in all its parts with an active circulation, that it is best able to resist the chilling effect of a draught of cold water. The stomach then being empty, the fluid passes into the bowels and is rapidly absorbed. It is held by the same writer that the most dangerous time to give a horse a full draught of cold water is after he has cooled down from fatiguing work and has partaken of a meal; the comparatively small stomach is replete with energy, the circulation weak, the extremities are cold, the whole system is languid, and not in a state calculated to resist the chill. There is at least a grain of truth in this argument, but until the doctors have agreed, it will be wiser to take the middle and give water cautiously to a horse when he is heated.

Many people object to hard water as causing harshness in the coat, and soft water is doubtless preferable. Yet it is pointed out that no part of the country produces finer horses than the limestone states of Vermont and Kentucky. Where rainwater is used, it should be kept in clean and well-ventilated cisterns.

Marvin points out that everyone who has had any experience in horse-keeping, well knows a change in water is generally resented by the horse, and therefore the best results in training will follow the use of not only pure water but the same water all the time if possible. "I have observed that a horse does the best with his home water. He acquires a taste for it, and is quick to detect the taste in the different water that he is offered away from home. It may seem the same to the trainer, may be chemically the same, but the horse will detect the difference. This only illustrates one of the thousand little influences that may interfere with the trainer's work."

CHAPTER VII.

Feeding Stallions.

Horses in the stud, like any other horses, should be fed with an eye to their work. This does not demand exceptional feeding so much as intelligent feeding. In other words, the peculiar work of the stallion demands more than ordinary care on the part of those in charge of him. It is neither necessary nor desirable to vary much his rations during the breeding season from those given to him at other times, or from those given to the other horses in the stable, but as it is peculiarly essential that he should be both well and strong, the effect of his diet must be more carefully watched. At such a time the whole object of feeding should be to give strength and vitality. So the food should be of the muscle-making rather than the fattening variety. Protein is wanted rather than carbohydrates.

Therefore as a rule feed oats, and not corn; bran plentifully, oil-meal rarely, if at all. The stallion should have plenty of hay. Avoid over-feeding, which will make him plethoric and sluggish. Never give him more than he will eat up clean with a relish. Give him grass or some green food when it can be had; otherwise use carrots with an unsparing hand. Horses, like men, enjoy an occasional alteration of diet, and in moderation it is conducive to health: thus, a little sound dry corn now and then in time of service or hard training is a good thing; a bundle or so of nicely harvested sheaf oats, as a substitute for hay; a few clean blades of corn fodder, and once or twice a week — oftener is too relaxing — a scalded mash with a handful of oil meal in it is beneficial in every way.

Professor Stewart thinks that grain, especially when fed alone, should always be fed dry, so as to cause a greater flow of saliva in its mastication, and as a stallion in full service is always fed liberally with grain, it is not safe nor economical to feed it without mixing with a portion of cut hay.

Taboo the idea that feeding some drug or nostrum will increase the ability of a horse to get foals. Anything that adds to his health, strength and vigor will increase his virility or sexual power, simply because the sexual organs will share the general tone of the system, while, on the contrary, whatever tends to impair the health or lessen the general vigor of the system, will weaken the sexual organs. The only medicines to be given are those that may be necessary to cure indigestion, for no stallion with his digestion out of order will be a sure foal-getter. What can be accomplished by care in this matter is shown by the experience of George S. Hall, of Frederickton, O. He says that when he bought Mohawk, Jr., the horse's digestive organs were in bad condition, and he was subject to spasmodic colic. "I first fed him on ground oats," says Mr. Hall, "but soon found something else was needed. I mixed one pint of wheat flour, once a day, in one gallon of ground oats; this helped the cause but still he scoured too much. I increased the pint of flour to twice a day —could see that it continued to help, but didn't stop the scouring entirely, so I put one pint of the flour in one gallon of oats three times a day. This method stopped the scours for about three weeks, when he was as bad as ever.

"I concluded he wanted something to make digestion easier, so I put one tablespoonful of flaxseed meal in every feed. There appeared to be too much gas on his stomach; to remedy that I tried feeding one teaspoonful of saleratus every evening. I mixed one gallon of fine ground oats with one pint of wheat flour, one heaping tablespoonful of flaxseed meal, and one teaspoonful of saleratus; these I mixed with one pint of boiling water. I fed him the same in the morning, except I kept out the saleratus, and added one tablespoonful of salt. At noon I fed him the ground oats, flaxseed and flour. I fed him clover hay; it is softer and more easily digested.

"He improved every day, and is now the surest stallion in Ohio. He had 109 patrons last season and got 80 colts. He has had 125 patrons this season, and I am confident nearly 100 are in foal. He is fat and remarkably vigorous. His digestive organs have been all right ever since I began feeding the ingredients named. I venture to say there is not another stallion

in the world 25 years old that has had 125 patrons this year and got 90 per cent. of them in foal."

Trainer Mike Bowerman tells as follows how he treats Wilton, 2.49¼: "His season, for the last two years, has begun in February. We limit him to 50 mares, and never serve any mare after August. On the first day of September Wilton's shoes are taken off, he is turned into the paddock and runs out about six hours every day — three in the morning and three in the evening. His feed is cut down to six quarts of oats and bran, with plenty of clean timothy hay each day, until Feb. 1. Then we increase it to nine quarts. We still continue to let him run in the lot until April 1, then begin to jog him from six to seven miles each day, with a little more feed. We serve one mare a day only; we never blanket him in the stable. We have a stall 20x20, light and airy for him. I can say further that he gets 45 out of 50 mares in foal with this treatment."

CHAPTER VIII.

Feeding Brood Mares.

When a mare is to be bred, it is wisest to make no change whatever in her food or surroundings. The breeding season comes at just the time of the year when it is natural to make changes, and disregard of their influence doubtless causes many instances of failure in foal-getting. To this fact may be traced the prevalence of the notion that green clover tends to prevent conception, the truth probably being that the clover does the mischief not through any inherent peculiarity of its own, but as any green food just substituted for the dry winter rations would do. If the mare has been running on clover for any length of time, there is no need of taking her from it when she is to be bred. Indeed that would be more likely to make trouble.

While in foal the mare should be fed like the stallion in the stud, on the muscle-making and not the fattening foods. Many say she should have no corn whatever in any shape, but during the winter a little now and then to keep her warm seldom does harm. At the approach of foaling time it should be abandoned altogether, as its heating tendencies would then be objectionable and it might cause excessive fever. Plenty of moist food should be fed, roots of some sort, carrots, turnips, beets or potatoes, grass when in season. Some of the wisest breeders regard it the proper time for mares to bring forth their young when grass is to be had in abundance, for no food so fitly prepares them for the act.

The pregnant animal having to form blood for herself and fœtus, therefore requires more food than one not in that condition.

All foods that tend to produce indigestion are to be carefully guarded against. Such are rank grass and rapid growing grass, over-ripe, fibrous hay or straw, any food that has been injured and rendered musty, and food that is smutty or ergotised.

Water should never be given the mare until the chill is first taken off. It is dangerous to give a pregnant mare a large drink of cold or ice water: any food or water likely to cause any disturbance in the digestive or other organs is to be shunned. Among other things oil-cake is said to be dangerous at this time.

When foaling time is at hand, be particularly careful that the food is not in the least smutty or mouldy, and that only the best of grain or hay be fed. Give her plenty of pure, fresh drinking water, and of salt. A few days before and after foaling feed very light for fear of scouring the colt. Then gradually increase the mare's food to about all she will eat up clean. Remembering that protein is the most important constituent of milk, feed the mare on oats, bran, good clean shorts, carrots, etc., and as soon as grass comes turn mare and colt out in the same paddock by themselves nights. Barley and the same bulk of fine wheat bran mixed together will make a very good food for brood mares for the summer, but it should be fed mixed with moistened cut hay.

Great care should be taken not to heat the blood of the mare while suckling a foal. Remember, too, that the recent exhaustive investigations of milk have demonstrated that it has a great influence on whatever animal consumes it, whether babe, calf or colt. It is generally conceded that the best way to administer medicine is through the mother, and likewise that poisons can be thus effectively administered. Therefore while the colt is sucking, you are feeding both mother and offspring with the food eaten by the mare, and as that which her mature constitution can stand may be fatal to the delicate foal, you must not content yourself with noticing the effect of the food on the parent only. Acid or fermented food of any kind, for instance, may not safely be fed to mares that are giving milk. Colts have often been known to die because apples have been fed to the mothers.

CHAPTER IX.

COLT FEEDING.

No horse food topic is more important than that of colt feeding, none is more discussed, and on none are there more diverse opinions and practices. Yet if we apply to it the same reasoning we use in feeding babes, the subject does not seem very complicated or abstruse after all. For instance, take the matter of weaning. We know it is better for both babe and mother that she should nurse the child. It is the same with the mare and colt. We know further that many mothers cannot give their babies milk enough, and that the natural food must be supplemented or replaced by other food, and that the best supplement or substitute is other milk, notably that of the cow. But cow's milk is not in all respects like human milk, nor is it like mare's milk. Therefore when it is to take the place of either, it is better prepared to resemble more nearly the food it replaces. In the case of colts this is done by skimming the cow's milk, for mare's milk contains no cream. It often happens that babies are fed artificially from the start, but this seldom occurs with colts. They are rarely weaned before a month old, and the normal time for weaning is five or six months after foaling. Sometimes before weaning takes place the mare's milk is supplemented by cow's milk, but seldom satisfactorily. If the mare does not give milk enough, the general opinion is in favor of weaning at once and substituting cow's. If, however, cow's milk is to be added to the colt's diet before weaning, it is wise at the outset to dilute it by adding two parts of water to one of milk, and to this should be added a little sugar. Gradually change the proportions for a month till no water at all is added.

To be sure, the use of cow's milk for colts either before or after weaning has had many critics, but the weight of opinion now is in favor of it as a food both safe and economical. The great trotting-stallion and sire George Wilkes was raised on

cow's milk. Belle Hamlin had all she wanted of it from the time she was weaned until grass came next spring. "Aurelius" argues strongly in favor of its use, and says he is satisfied from his own experience that every stock farm should have a number of good milking-cows as a part of its outfit. This milk should be set in creamers, so that the milk of the morning may be skimmed at evening, and *vice versa*. The skim milk should be warmed to be lukewarm before it is given. The cream that is skimmed off is of no value whatever to a growing colt, but on the contrary is a detriment. Besides, it may be churned, or sold in quart cans at a price that will go far to pay for the expense involved in the keeping of cows. Smith, Powell & Lamb, of Syracuse, have a centrifugal separator, and after separating the cream give the milk still warm from the cows. Dudley Miller of Oswego, a well posted writer on horses, agrees with Smith, Powell & Lamb in the opinion that it would pay a horse breeder to have a herd of cows for that purpose, and feed the skim milk, even if he threw the cream away. But, as the cream may pay the whole expense, it will be seen at a glance that this most excellent food may be obtained at practically no cost at all.

In a recent colt-feeding experiment at the Iowa Station it was found that "ten pounds of separated milk had about the same feeding value as one pound of the best grain mixture, and considering the fact that the first period covered two of our severest winter months (January and February), and the second occupied a time of milder temperature, it is probable that the milk had even higher feeding value than the results indicate in this case. The results of utilizing separated milk for feeding colts may be regarded as highly satisfactory. Those who have had experience in the care of imported stock of this age soon after reaching this country, after the hardship incident to a rough sea voyage and the changes met in passing from one continent to another, are aware how difficult it is to make a satisfactory improvement under these conditions. In this case every animal responded promptly and made uninterrupted progress. That the satisfactory results obtained were to a considerable extent due to the milk fed during the winter is not unlikely."

It is probable that the objections raised to feeding cows' milk have been chiefly due to feeding the cream. Mr. Belmont gave the whole milk of his rich Jerseys to his running foals and they did not develop satisfactorily. Had he skimmed it first, the result might have been different. Where the deep setting system prevails and the skim milk is kept sweet, it is surely worth a trial, but nothing that has soured should ever be fed to a colt.

In the Iowa test a change was made from whole milk to separated, and it is worth noticing that the amount had to be reduced for a day or two to prevent scouring, a precaution that should always be taken in the use of separated milk.

It is now common to begin giving solid food to colts when they are two or three months old — in fact as early as they can be induced to take it. This is in addition to the mare's milk or cow's milk, according as the weaning is late or early. The usual way of making a start is to put the mare's food low where the foal can get at it; instinct or the spirit of imitation will lead him to take a bite. Oats and bran are the usual foods, some breeders adding corn meal until the colt is weaned. But the corn is to be used sparingly at all stages of the colt's growth, and likewise any of the fattening foods. It is bone and muscle that the colt needs, and the nitrogenous foods are what should be given to him.

Flaxseed jelly, used judiciously, will cause a foal to grow rapidly, materially helping to keep the digestive organs in a healthy condition, and giving a fine development to the whole form. It may be made by boiling flaxseed twenty minutes in from six to eight times its bulk of water, forming a jelly. Two tablespoonfuls of it may be mixed with a handful of oats and a handful of bran, or may be stirred into a quart of warm skim-milk. Begin by giving it once a day, and after a week or ten days, twice a day, 11 A. M. and 4 P. M. being as good times as any. After a colt has learned to eat flaxseed jelly, he is usually fond of it, but it may be necessary to teach him first to take the oats and bran alone.

The use of such an adjunct to the mother's food as this is particularly desirable if the mare is put to work. At such a time a reasonable amount of reasonable work will not result in serious injury to the colt, but if the flaxseed jelly is not given, he

may not grow as rapidly as he would if the dam were doing very little work. While the mare is in the field, there is usually no necessity of drawing any milk from her, but when taken to the barn she should be cooled off before allowing the foal to suck.

From weaning time on, the question of feeding grain without stint or even liberally is a debatable one. Opponents of the practice characterize it as a "forcing process" and refer to it as "hot-house growth," while its advocates claim there is no such thing as forcing the growth of a colt unnaturally. They say that with colts as with children the appetite is insatiable, and that if exercise enough is provided, there is no harm in giving all that can be eaten. When Chimes was a yearling he got 15 quarts of oats daily, besides plenty of grass and hay, and he ate his oats clean. According to Mr. Williams, Axtellas a two year old was fed in proportion even more liberally. Dr. J. W. Day, Dr. Thomas S. Flood, and other successful colt handlers testify their belief that there is no such thing as "forcing colts." A. J. Feek says, in "Every Man His Own Trainer," in his opinion there is more injury done weanling foals by not feeding than by over-feeding; they should be fed what good hay they can eat and from four to six quarts of oats a day.

H. D. McKinney, a well-known breeder of Janesville, Wis., reports that he has found it advisable in raising his trotting colts to feed them liberally and have them looking well to the purchaser. He gets them to eating grain as early as possible. In the pasture he has an enclosure 16 feet square into which the youngsters can go, and he keeps a box of oats and bran and some salt where they can get at it at all times. The little fellows soon begin to nibble and before they are four months old they can eat a good deal. After being weaned he feeds them at night all they will eat of steamed barley and bran. In the morning they get oats and in the middle of the day carrots. If the pasture is short in the spring he gives them the benefit of a grain ration; he does not let them shrink. By this system the next fall he has mature horses. Then he breaks them and lets them alone awhile, afterwards testing them for speed. He believes in always feeding liberally. He gives them all they will eat of barley and bran.

Another Western breeder says he feeds small rations five times a day for six weeks after weaning and he always has water where the colts can get it. Sometimes he finds a colt a little stubborn about drinking and occasionally in such a case he puts cow's milk in the water, but ordinarily after being shut up for twenty-four hours the colt will get thirsty and drink. At the end of six weeks he reduces the number of feeding times to four, and when the colt gets to thriving well he drops down to three. The feed he uses depends much on what has been raised on the farm that year. He goes more by his balance sheet than he does by a balanced ration. He uses whatever he can raise or buy cheap. He feeds crushed oats, bran, oil-cake, and silage from which the cobs have been removed, and gives turnips for variety.

At the convention where these beliefs and practices were given, another speaker said he would feed colts all they could eat of oats until they were turned out on grass. They would not fall back after being turned out, and by this system of generous feeding he had been able to raise two-year-olds as big as three or four-year-olds. Another has found that colts thus fed would fall away when turned on grass and lose all they had gained. He did not use grain with his colts, but kept them looking well on cornstalks. He had bought colts that had been fed oats from the first, but they did not do well for him. Another also had experienced the same trouble; the colts did not hold their flesh when turned on grass. Still another was also of the opinion that colts ought not to be fed heavily.

John M. Stahl, writing in the National Stockman, said: "A mixture of equal parts by measure of oats, wheat bran, and shelled corn I find is the best grain for colts; and corn fodder may make one-third of the rough feed, the other two-thirds being clover hay cut in good season and nicely cured. Colts should be liberally fed, but it is a mistake to feed them largely of grain; yet I would give them a little larger proportion of grain than the work horses during the winter. It pays to push colts, providing the pushing through the food box and manger be so adjusted that the animal will not suffer from indigestion.

Walter J. Bennett, in a communication to the New England Homestead, declares it strange farmers do not see that the first

three years make the framework of the colt. "Whether that framework be large or small depends on two things,—the breed and the feed. If the breed is large, the colt when reared will have the large frame, but if food of sufficient quantity and right quality is withheld, nature at once begins to shrink the frame to suit the feed. Hence to withhold food, in either quantity or quality, is to undo all that has been done in the way of breeding. If, on the other hand, food has been supplied sufficient to carry out nature's idea, she goes on with it and executes, so to speak, the original plan, and enlarges and improves on it. The weanling colt should have four quarts of oats every day from fall till May. The yearling should have as much at least, and the two-year old more, if it is desired to make heavy weights and produce a horse that will sell, and all this in addition to all the hay and grass it wants to eat. This is just as important in producing roadsters or drafts. After the frame is made and it is desired to keep horses on the cheap plan and let them rough it, that can be done with safety. The frame made, they can live and prosper on hay, but if the colt is treated thus, it is at the expense of future usefulness."

These varying opinions show that the question is by no means settled. Some points, however, are clear. It is evidently a matter, primarily, of comparative economy. Health is a secondary consideration, or rather it is not much affected one way or another. It is a problem of growth, and whether it pays to feed liberally for the sake of early maturity and better appearance. Without doubt, it is poor economy to feed no grain whatever, but the proportion of grain to the rest of the diet is an economical question that is to be answered according to circumstances. The New England farmer, for intance, whose main crop is hay, will hardly profit much by exchanging all of it for Western oats to feed to his colts, when he can keep them in fair condition on hay, grass, a few apples, potatoes and the like, with some skim milk for the weanlings. In the grain regions of the West, on the other hand, the natural and economical colt food would be oats and bran,

The actual results of the two plans of feeding are shown by experiment conducted by Henry C. Wallace of Iowa, tried on four colts, foaled in May, 1888, out of low grade draft mares

and out of imported percherons. They were allowed plenty of oats till November, when they were weaned. After weaning two of them were turned into a field of 160 acres, containing second growth clover, corn-stalks, oat stubble, etc. They stayed in this field with a number of other horses until next spring, receiving no grain and no hay, except at times when the snow was too deep to enable them to reach other feed. The only shelter was that afforded by the two straw stacks. In April, 1889, these two colts were put in the stable and fed a little grain and hay for two or three weeks. Early in May they were turned out on wild pasture, staying there until fall, when they were again turned in the clover and stalk-field, and received the same treatment as was given during the previous winter. In April, 1890, they were fed a little grain and hay as before. In May they were turned into wild pasture and received a small amount of hay. Early in November they were weighed, and the team weighed 2,725 pounds.

The two other colts were treated somewhat differently. After weaning, the feed of oats was continued, the colts being stabled at night and receiving oats and tame hay night and morning. Late in December a small amount of corn was added to the daily feed. During the day they ran in a blue grass and wild-grass pasture. In November the grain ration was again given and continued through the winter as before, the team being turned into pasture early in May. They ran in the blue grass pasture until November, 1890, when they were weighed. The team weighed 3,050, being then thirty months old, the same age as the other team when it was weighed. The team fed again ate altogether, not counting feed before weaning, between 128 and 130 bushels of oats and 35 bushels of corn, the feed bill amounting to about $30. The other team had about 25 bushels of corn and oats, worth between $4.50 and $5. The weight alone was not all the difference made by the feed. While all the colts kept in nice smooth flesh all the time, there was a marked difference in the development of the two teams irrespective of weight. The team fed grain broadened out proportionately at all points and showed that symmetrical development so pleasing to the eye of the stockman in whatever animal it may be found. While the colts that "rough it" were not by any

means stunted, yet in looking at them one felt that there was something lacking. They kept in good flesh but there was more middle than is usually liked in a horse and too much taper at the ends — too much leg.

The conclusion of the whole matter may be summed up with the advice, "Feed as much grain as you can afford." Mr. Wallace's grain bll for his best fed pair was only $35,—surely not ruinous,—but that is a good deal different from what A. T. Maxim figured it would cost a New England farmer to raise a pair of grain-fed colts, and as Mr. Maxim was a New England farmer himself, and a brainy one too, his judgment and expeience on this point are worth noting. He supposed two mares are bred to a well-bred stallion at a service fee of $25 for each The owner, presumed to be a Maine farmer, will make the mares work enough to pay their keep, so the cost of the two foals at weaning time may be reckoned at $50. Then if the owner feeds them after the approved method, which is to keep them growing to their greatest capacity and looking smooth and nice all the time, Mr. Maxim figured it will take eight quarts of oats a day for each one for the first year to do this, or about 150 bushels for the year at a cost of about $60. After the first year it may not take as much grain to keep them in first-class shape. But the cash cost of the grain, enough to keep them up to the standard condition for the next three years, cannot be estimated at less than $50 a year. And for most New England farmers this means paying out that amount of cash, as but few of them raise their own grain, so that the two colts at four years of age will have cost in money paid out $260; and if at that age they are sold for $400, the breeder is left $140 as a recompense for the hay and grass that the colts have consumed during the four years of their existence, and also for the time and care that has been bestowed on them. It may be said that colts brought up in that way will sell for more than $200 apiece. True some of them will, but then again others will not sell for more than $150.

If the cost is as high in New England as Mr. Maxim thus estimated, it is clear that heavy grain-feeding may be allowable for the owner of a single colt, or for the owner of a large breeding establishment with capital behind it; but yet be out of the

question for the average farmer raising a few horses for market.

It turns out, then, to be in the long run more a matter of capital than of economy. And right here it will be well to state that it costs a little more, pound for pound, to produce a good horse than a good steer. Any horse that is worth raising will bring at least ten cents a pound, and the colts Mr. Maxim argued about he supposed will sell for 20 cents a pound. The steer sells for two or three cents. E. W. Stewart gives an account of feeding three colts whose gain was in round numbers two pounds each daily, which was as economically made as that of steers. Boussingault, of France, fed several colts on weighed rations. Three weighing 1,106 pounds, ate 19.8 pounds of hay and 7 pounds of oats. This was in the equivalent of hay 2.6 per cent. of live weight daily, and gave a growth of 1.2 pounds daily, as good as an equal amount of hay would make on steers. Prof. J. W. Sanborn, however, has made some tests that led him to think the horse will not make as effective use of coarse foods as will the steer. These foods cost something more a pound of digestible matter than does hay, so that it is probable horse flesh costs slightly more than steer flesh, yet not enough more to cut any figure when the relative values of the growths are considered.

Whenever capital permits, then, feed grain to the colts. Oats are the favorite variety, but they are not to be used alone. There is no single colt-food any more than there is any single boy-food. Variety is even more important to growing than to mature horses, and it is never unimportant. It is believed, indeed, that a mixture of other grains is preferable to oats alone. That would seem to be indicated by the results of tests at the Maine Experiment Station, one in 1890, when oats were compared with a mixture of peas and wheat middlings, the other in 1891, when the comparason was with gluten meal, linseed meal, and middlings.

The outcome of the experiment in 1890 was, that oats produced less growth than an equal weight of a mixture of peas and middlings, the relation of growth being as 100 to 111. The fact that in this experiment peas were used as a part of the grain ration, a food that in the market is comparatively costly,

seemed to be a good reason for repeating the experiment with commercial foods that are more common, bear a less price, and are comparatively nitrogenous in character.

In the second experiment, which was made in the spring of 1891, two colts were used. No. 1 was a grade Percheron filly eleven months old, and No. 2 was a grade Percheron gelding eleven months old.

They were fed through two perioes on the following rations:

Period 1	Colt 1	10 lbs. hay 6 lbs. grain mixture
	Colt 2	10 lbs. hay 5 lbs. grain mixture
Period 2	Colt 1	10 lbs. hay 7 lbs. oats
	Colt 2	10 lbs. hay 6 lbs. oats

The grain mixture consisted of middlings, gluten meal and linseed meal compounded in the ratio of 60, 35 and 15. The average daily cost of the ration in Period 1 was about 12 cents, and in Period 2 about 14 cents, a difference of two cents a day for each animal.

The feeding began March 12, and the animals were first weighed March 17 and 18. Period 1 continued 43 days, and Period 2, 41 days.

The colts were tied in stalls and were given free exercise in a large yard during all pleasant weather. So far as could be determined, no unfavorable conditions entered the experiment.

The results are stated as follows:

	Colt No. 1	Colt No. 2
Weight of colts at end of Period 1	776 lbs.	652 lbs.
Weight of colts at beg'ng of Period 1	711 lbs.	602 lbs.
Gain in weight in 43 days	65 lbs.	50 lbs.
Daily gain on mixed grains	1.51 lbs.	1.16 lbs.
Weight of colts at end of Period 2	794 lbs.	690 lbs.
Weight of colts at beg'ng of Period 2	776 lbs.	652 lbs.
Gain in weight in 41 days	18 lbs.	38 lbs.
Daily gain on oats	.43 lbs.	.93 lbs.

These figures, however, do not prove that oats themselves are poor food so much as they prove it to be unwise to let the colts have for grain oats only. It will take other tests, and thorough ones too, with a grain mixture containing oats against one without oats, to convince most breeders that oats are not desirable as a part of the ration.

One of the oat mixtures highly commended consists of equal parts of oats and wheat bran, with about one-third their weight of corn.

Professor Henry suggests that if clover hay and oat straw are available, the following ration, (based on 1,000 lbs. weight of animal, and to be reduced according to size,) might be tried to advantage: 5 lbs. corn; 5 lbs. oats; 2 lbs. oil-meal; 10 lbs. clover hay; 10 lbs. straw. Corn stover may be substituted in part for the clover hay and straw.

Another writer says: "There is a prevailing opinion that clover hay is not fit to feed a horse at all. While I would not feed a grown road or track horse clover, I would feed no other when the same animal is young. If any who read this are sceptical, let them test it and see. Feed one colt timothy, another clover, or feed the same one each kind of hay at different times. Then throw out the manure where the rain can fall on it and as it washes away the digested portion, you will be surprised to see how completely the clover is digested and how entirely undigested is the timothy."

Another writer advises the following combination for colts seven months old or more: 4 lbs. cut clover hay; 1 lb. ground oats; 3 lbs. fine wheat bran; ¼ lb. linseed meal. Let the cut clover hay be slightly moistened, so that the ground feed will adhere to it; mix it all together and give in two feeds, morning and evening, giving the colts the run of the yard in pleasant weather. This writer believes the most important food for the growth and even development of colts is clover, hay or wheat bran. "Clover hay can usually be obtained as cheaply as timothy, and in many places at less cost. Good clover hay contains double the muscle-forming matter of timothy. Wheat bran is comparatively rich in muscle-forming matter, and its ash is rich in phosophate of lime to grow good solid bones."

There is, nevertheless, a great difference of opinion in regard

to the colt feeding value of wheat bran. Some have an idea that it has a tendency to produce colic. Others claim that it is a fruitful cause of worms. Most Northern breeders, however, regard it a profitable food in winter. While supplying the material for making bone, it also aids in keeping the bowels from becoming constipated, a matter that should be kept constantly in mind. If bran or oil-meal is not used to avoid the risk of stoppage, some moist food should be supplied, and this is indeed a good thing under almost any circumstances. Sweet apples are almost as good as grass for colts. Carrots and other roots are a great aid, and even potatoes are of much benefit. Sugar both prevents stoppage and improves the appearance of the colt. The way it is used is to dissolve the sugar in water and pour it on the chaff or cut hay, taking care that the food is well mixed, and in a day or two the colt will be found licking the sides of the mangers long after the last morsel of chaff has been eaten.

Diarrhœa is as dangerous as constipation, and the two often bear the relation of cause and effect, but more commonly in the first few months of the colt's life. Prevent or relieve constipation, and you remove one fertile source of diarrhœa in foals. Another cause not rare is the eating of hay, straw, etc., when the foal has not yet the necessary teeth for masticating such food, and the stomach and bowels are not enough developed for digestion. In foals that have died of diarrhœa large accumulations of unchewed hay are sometimes found wadded in the stomach, while in other cases the discharges are freely mixed with broken, undigested straws, which act as a serious irritation. The eating by the foal of hay, straw, and rubbish should be prevented by placing him in a clean pasture, where such material is not available, or if he is kept in the stable or barnyard, by muzzling and thus confining him strictly to a moderate allowance of his mother's milk.

This milk, though, is itself a common cause of diarrhœa. Sometimes the foal takes too much of it, which can be prevented by partly milking the mare at the right times. Sometimes allowing the foal free access to his mother after he has been kept from her till very hungry, brings on the disease. More often it is caused by milk that is unhealthy, either from the ill-health,

improper feeding, or over-heating of the dam. Milk is a secretion that is affected in a remarkable degree by the health of the mother. Food and water exercise a material influence on the quality of the fluid, often acting in a way that is not understood, causing changes neither the chemist nor the microscopist can define.

Some of the experiments carried on some years ago in France led to the conclusion that certain grains given to cows produced milk which was unfit for infants, and the final result of the inquiry was to show that the child was not merely the most sensitive test for milk derived from cows fed on brewer's grains, but was in fact the only test. The most careful analysis did not reveal any ingredient that could be referred to as the cause of the indigestible character of the fluid.

Therefore if a foal suffers from diarrhœa and no apparent cause exists, try changing the mare's food, even if she appears in perfect health.

There is some difficulty in treating cases of indigestion in very young animals, which readily succumb to continuous pain. Sedative enemas are safe and effective in cases of colic, as they relieve pain and afford time for other remedies to act. A dose of castor oil (2 to 6 ounces according to age) may be given at once, to be followed by an enema of warm water, containing two drachms to one-half ounce of laudanum, or, if no means of giving an enema are at hand, one or two ounces of ordinary chalk mixture may be given. If the pain continues, flannels wrung out of hot water may be applied to the abdomen until the pain is relieved.

All through the period of colthood the amount of food should be carefully looked to, as any food in excess of the amount digested is not only wasted but also is an injury, promoting indigestion, colic, and worms.

A good magnifying glass will by an examination of the droppings, show if the grain is all assimulated or not. You can keep the colt in good health and fine condition with a little care, and not be crowding him with grain and then condition powders to try to counteract the over feeding.

After he has been broken, never be afraid to give a colt a horse's ration if you make him do a horse's work.

Marvin, who made such a success at Palo Alto with Sunol and other fast ones, says in his book on "Training the Trotter": "As we are now working our colt the reader may properly be reminded that it is important to see that the youngster is kept strong and stout. A good diet at this stage is, besides the usual hay, ground oats for the morning meal, and at night a dish of bran steamed, the right proportion being about three parts of oats to one of barley. Give the colts all they will eat up clean. A colt cannot get too fat before he is two years old. Between his growth and his work all he can eat will be assimilated. The rule is that colts go back in condition after weaning. This is not as it should be, for a colt that is properly fed and cared for will improve after weaning. The fact that his growth is arrested shows that after weaning he has insufficient or unsuitable food, and every breeder should be watchful at this period, for a set-back in the first year is never made up for. Feed him well and especially if you are working the colt see that he is getting plenty of good food. You will not hurt him by giving him too much at this age, for he will not eat too much."

Says A. J. Feek, speaking of how to develop a two-year-old: "As you increase the work increase the feed; give soft feed once a day—at night—and plenty of good timothy hay, except on the morning of the day you expect to speed him. That morning it would be advisable not to fill his stomach with hay, —wait till after he has had his work. As soon as grass makes its appearance, give him a bite every day, letting him eat ten or fifteen minutes toward night after his work, as many times grass will make a horse puff and blow if he has it before he is speeded. Still it is acknowledged that Dr. Grass is many times the best veterinary we can employ."

CHAPTER X.

Feeding Sick Horses.

When a horse is sick, he needs the food that will nourish him most and at the same time require the least exertion. Moreover, it must be food that will encourage his appetite, or at any rate not repel it. In health he is dainty, and in sickness he is fastidious. Therefore be then more careful than ever that the food is fresh, sweet-smelling, and wholesome.

Bran is by all odds the most favorite food for the invalid horse. It acts as a laxative, is frequently tempting to the appetite, and is easy of digestion. There is no part of general treatment more universal than offering this as a change of food. If a horse is very weary, and his powers of digestion are weakened in consequence, induce him to take a warm bran mash, which comfortably distends the stomach, and satisfies any craving for food, thereby enabling him readily to lie down and rest his enfeebled system, until repose restores its wonted vigor. Does he show slight symptoms of cold or fever, a warm bran mash is a convenient plan of steaming, and consequently soothing the irritable mucous membranes of the air passages; it is a substitute for the more stimulating diet he is accustomed to, and gently promotes the activity of the digestive apparatus. If he is incapacitated by lameness, a lower diet than that he gets when in full work is judicious, and bran is selected. If it is necessary to administer purgative medicine, a bran mash or two renders the bowels more susceptible to its action, and a smaller portion of the drug is therefore required to produce the desired effect, there being, at the same time, less risk of painful spasms accompanying its operation. Bran mashes may be given hot or cold — cold they are perhaps quite as grateful to the horse; but the nibbling of the hot mash in catarrhal affections is particularly beneficial, from the necessary inhalations of the steam arising therefrom.

As in sickness the horse, like man, is weak, save him the work of grinding hard oats or dry hay. Crushed oats and bran mixed half and half, make a ration easily swallowed, nutritious, and usually acceptable. Oatmeal gruel is one of the best of foods at such a time. It should not be forced on the invalid, but a pail of it should be slung in his box, out of which he will soon begin to drink if water is denied him. It is more often badly than well made, being too thin or not boiled long enough. To make it right a pound of meal should be put in a gallon of water, and the mixture be stirred steadily till it boils.

When oats are offered and refused, many convalescent horses can be coaxed into eating if one pint of oats be mixed with one pint of barley and both steamed until the barley bursts. Then add a handful of wheat bran and feed slightly warm.

Linseed is useful. It is nutritious, and, from its oleaginous nature, soothing to the frequently irritable mucous membrane of the alimentary canal, and hence is to be particularly recommended in the treatment of sore throats; nor is its bland effect local only, its more general influence being particularly observable in affections of the kidneys. It may be given either boiled, forming, when cool, a gelatinous mass, and being mixed in that state with bran, or the liquid after boiling may be offered as a drink.

It must be remembered that all food must be taken by the horse as he desires it. In sickness more than at any other time one realizes the force of the old adage that you may lead a horse to water, but you can't make him drink. If he will not drink nor eat when he is sick, if the most tempting viands have no effect on him, there is nothing to do but wait his pleasure — or rather his need. When he has no appetite, the conclusion is patent that his stomach is not in the fit condition to digest anything, and it is then worse than useless to try to force anything into it.

Hay softened by scalding will often be taken with a relish when refused before. Hay tea will sometimes create a desire for food. It is made by pouring water over good hay in a large basket, and allowing it to stand until cool, then pouring off the liquid. Corn on the cob is often eaten when everything else is refused. Bread may be tried, also apples. Roots are

extremely useful at such times, being both tempting and beneficial. The quantity given should be small, one medium-sized carrot cut lengthways in slender slivers; one small yellow turnip cut very fine in dice shaped pieces; three medium potatoes cut dice shape; and, if it can be obtained, one or two heads of endive. When such unusual articles of food are offered, the groom should be cautious not to wash the roots, but to rub off any dust that may adhere to the skin; endive may be washed and shaken reasonably dry.

If the animal can be persuaded to drink milk, that will support him for days. Some horses will drink it, others will refuse it. Three or four gallons of sweet milk may be given during the day, in which may be stirred three or four fresh eggs to each gallon of milk.

Bottled beer or bottled porter in cases of great weakness have produced most satisfactory results. The beer or porter should be slightly warmed and a pint in one drink given at short intervals. After the third pint has been swallowed a perceptible gain in strength ought to be manifest; five, or at the most, six pints, given within four hours, should save a sinking horse, that is, when exhaustion is the adverse condition.

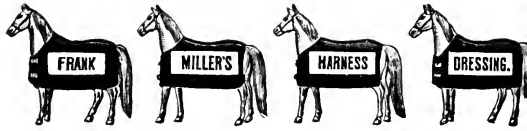
Never give a sick horse cold water.

In cases of constipation, if the case is not complicated with colicky symptoms, a change to light, sloppy diet, linseed gruel or tea, with plenty of exercise, is all that is required. Remember that in adult horses this trouble is usually due to long feeding on dry, innutritious food, scanty water supply or lack of exercise, and removal of cause will remove the effect. If something else has brought it on, consult a veterinarian. Likewise with diarrhœa, if it is due to faulty food or water, a change suffices. Its external causes, so to speak, are mouldy or musty food, stagnant water, being kept on low, marshy pastures, exposure during cold nights, or low, damp stables — in any of which cases it is easy to discern and remove the trouble. As with constipation, if other causes appear to be at work, get skilled advice.

Feek says, speaking of a fast three-year old in training: "If his bowels get loose, a few handfuls of wheat every day would check them, or a few slices of stale bread from your table are

soothing and have a tendency to regulate them. Many horses have a natural looseness of the bowels, especially if they go out into a crowd wnere there is any excitement. If you give medicine to check the bowels, it is dangerous. You will also be liable to check his speed several seconds, as I have seen occur in a number of cases. You will remember that it is sometimes dangerous in the human family also to check a diarrhœa too soon, as it causes a worse and sometimes fatal sickness. The fact is, keep as near nature as possible under all circumstances and you will succeed if success is possible."

For horses afflicted with heaves, or broken wind, the diet should be confined to the best of food and the smallest quantity. A little hay once a day is enough. The animal should invariably be watered before feeding; never directly after a meal. It is a good plan to dampen the food slightly to lay the dust. Do not work the animal immediately after a meal. Exertion, when the stomach is full, invariably aggravates the symptons. Turning on pasture gives relief. Carrots, potatoes, or turnips, chopped and mixed with oats or corn, are a good diet.



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