

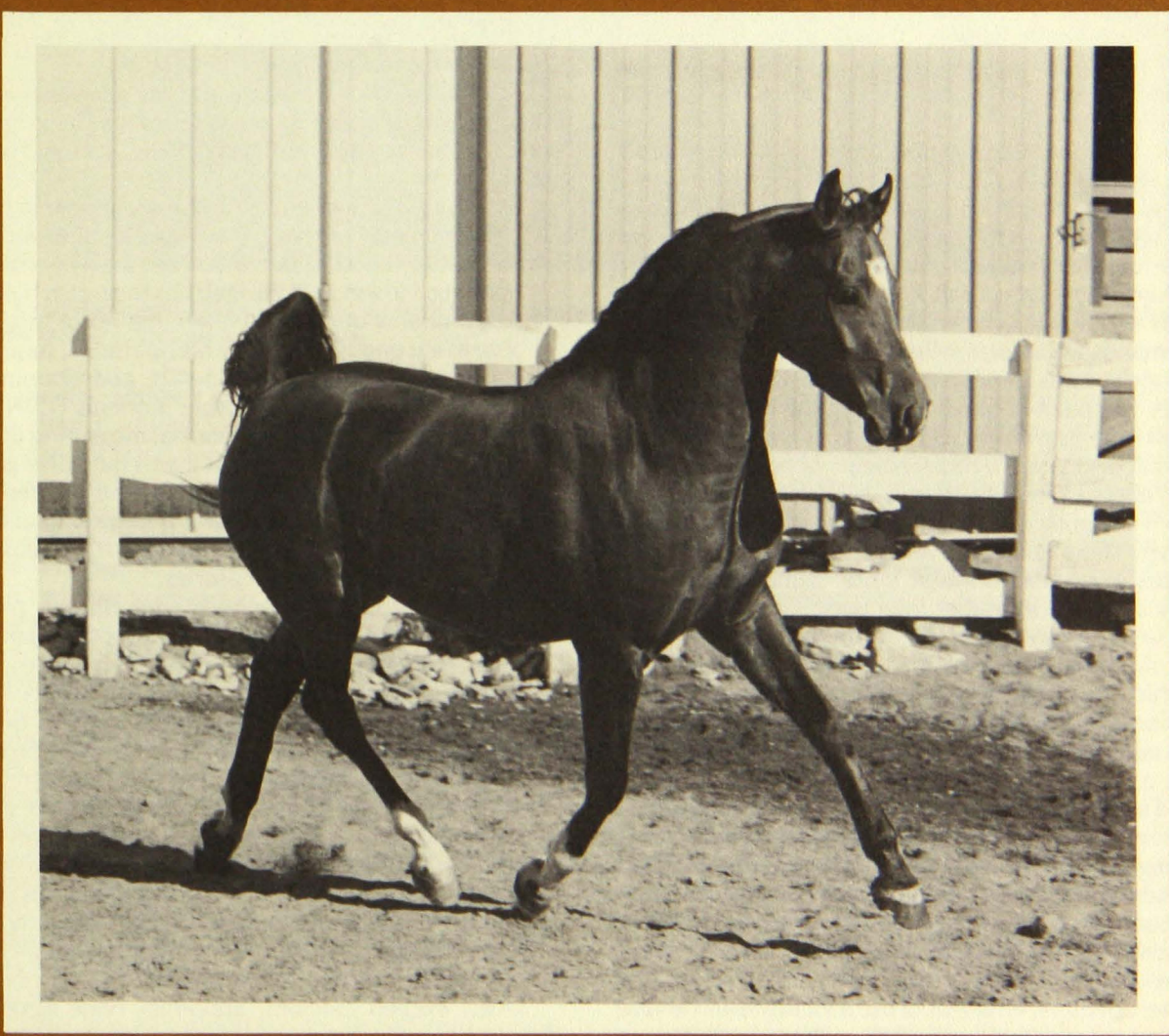
MN 2000
EB 348
Rev 77
C2 Blmt

EXTENSION BULLETIN 348
REVISED 1977
AGRICULTURAL EXTENSION SERVICE
UNIVERSITY OF MINNESOTA

UNIVERSITY OF MINNESOTA
DOCUMENTS
FEB 3 1978
ST. PAUL CAMPUS LIBRARIES

HORSE NUTRITION AND FEEDING

R. M. JORDAN



This archival publication may not reflect current scientific knowledge or recommendations.
Current information available from University of Minnesota Extension: <http://www.extension.umn.edu>.

HORSE NUTRITION AND FEEDING

R. M. JORDAN

Horse breeders are always concerned about the amount and kind of feed to give their horses. Many variables can affect a horse's nutritional needs: 1) temperament and disposition, 2) present condition, 3) age, 4) body type and weight, 5) production stage (how many hours a day the horse is ridden, pregnant horse, or lactating horse), and 6) climatic conditions.

Knowledge about the nutritional requirements of horses is not as comprehensive as it is for cattle or swine. Some recommendations that are available are based on research obtained with cattle, light horses, and draft horses. For example, the nutritional requirements of a light horse may be different from those of a draft horse due to differences in disposition and temperament and particularly to the peak energy demands on a horse when he is ridden at fast gaits.

Fortunately, considerable research on the nutrition of light horses has been conducted during the last five years. Results will help determine such things as the energy, protein, mineral, and vitamin requirements of horses; whether horses can absorb and utilize bacterially-synthesized amino acids and B vitamins or whether they must be provided in the diet; why some horses are allergic to certain feeds; and what makes some horses sweat more, if indeed they do, when they are fed corn rather than oats.

A horse's digestive tract differs considerably from a cow's. In the cow, much of the digestion occurs in the rumen, which is a large fermentation vat in the forepart of the digestion tract. Synthesis of the B vitamins and amino acids also takes place in the rumen. The horse, on the other hand, has a relatively small, simple stomach and a large cecum and colon located between the small and large intestines. In the horse, synthesis occurs in the cecum and colon.

To a degree, the cecum and colon serve the same purpose for the horse that the rumen does for the cow. However, the cecum's location toward the end of the digestive tract probably reduces its contribution to the horse's overall digestive efficiency.

Whether adequate synthesis of the B vitamins and amino acids occur in the cecum and whether these nutrients are absorbed and utilized by the horse in sufficient quantity to assure optimum production (weight gain, work, and speed) have not been entirely resolved. However, most authorities

believe the horse benefits greatly from the products of digestion that occur in the cecum and colon including B vitamins, amino acids, and particularly fatty acids. Therefore, if given good feeds, a horse will usually obtain an adequate supply of B vitamins and essential amino acids.

To feed your horse adequately, you must understand the horse's nutritional needs and the nutritional composition and contribution of various feeds. Here are some terms you should know:

Dry matter—Most grains and hays contain 88-90 percent dry matter. If a horse receives insufficient dry matter, he may become bored and chew on his stall and eat bedding. However, if the feed has too much bulk (excessive amounts of fiber or water), the horse might not be able to eat enough to satisfy his nutritional requirements (carbohydrates, protein, minerals, and vitamins).

Energy value—Total digestible nutrients (TDN) and digestible energy (DE) are means of measuring the energy value of a feed. TDN is what keeps the horse going and puts the fat on his back. Most often, energy is the element lacking in horse rations. Grains and good quality roughages are the usual sources of energy. Digestible energy (DE) is measured in kilocalories.

Protein—Protein is necessary for all life processes. Horses need a quantity of protein; but the quality is also important, particularly for young horses. Legume hays, pasture, soybean meal, linseed meal, and commercial protein supplements are the usual sources of protein. Legumes and soybean meal both provide protein that contains a good balance of the essential amino acids.

Minerals—Salt, calcium, and phosphorus are the major minerals required by horses. Salt requirements increase with perspiration, and the loss may amount to one to two ounces of salt a day. Calcium and phosphorus should be provided in a ratio of one to one. The quantity of phosphorus should not exceed the quantity of calcium. According to Cornell University data, when phosphorus levels exceed calcium, abnormal bone development and hormone imbalance occur. However, research at the University of Minnesota indicates calcium levels may exceed phosphorus levels by as much as four to six times with no apparent harm. Required trace minerals



This mare is obviously well-fed and in sufficient flesh to adequately nurse her foal. For rapid development, the foal should be creep-fed a palatable and nutritious grain mixture.

are normally supplied in adequate amounts in a good horse ration. Commercial mineral blocks or a mixture of equal parts of trace-mineralized salt and bone meal or dicalcium phosphate are the usual sources of supplemental minerals. Mixing salt with bone meal, (which alone is unpalatable) will assure adequate intake.

Vitamins—Vitamins A and D are both fat-soluble. Vitamin A must be supplied in the ration, but exposure to sunlight will usually supply adequate vitamin D. Feed that ordinarily contains vitamin A can have the vitamin A destroyed by oxidation. For instance, year-old hay has lost most of its vitamin A value. The various B vitamins are usually present in adequate amounts in good quality forage. Furthermore, synthesis in the horse's cecum provides adequate quantities of these vitamins under most circumstances.

Under certain circumstances, though, it is possible for a horse to suffer from B vitamin deficiency (usually thiamine). In addition, weanlings definitely need a diet that provides a good balance of amino acids in sufficient quantity if maximum growth is to be attained. Lysine is the amino acid that is most limiting.

Knowledge about nutrition has expanded considerably since the days of draft and cavalry horses. But some people still harbor misconceptions about feeding horses. For example, many horse owners believe that timothy hay and oats

are essential components of a horse ration and that legume hay (alfalfa or clover) and corn or barley shouldn't be used. However, ample evidence indicates that legume hay is excellent for horses and many successful horse trainers prefer corn or barley as grains. Just as false is the notion that all commercial feeds are poor investments. Commercial feeds may actually provide nutrients like trace minerals, vitamins, and protein supplements in a less expensive form than the individual horse owner can provide.

Visual Evaluation of Feeds

Hays

Color—Green feed is normally higher in all vitamins, particularly vitamin A (as carotene) and riboflavin. The green color indicates the hay has not been rained on excessively, is less apt to contain mold, and is more palatable.

Type—Legume hays like alfalfa and clover are normally higher in proteins, vitamin A, and minerals (especially calcium) than are grass hays. They should be preferred over grass hays.

Leaf to stem ratio—A high leaf to stem ratio makes a feed more nutritious and palatable. Such feed has greater value per ton. Nutrients are concentrated in the leaves—stems are low in digestibility.

Date of cutting—Age at cutting is a good indicator of feed value. As a hay matures, it declines appreciably in protein and phosphorus, increases in fiber, and decreases in digestibility.

Mold—Hay that “smokes” when a bale is opened is moldy. If fed it may cause heaves. Abortion, colic, and even death have been attributed to moldy hay. Often visual evidence of these toxic molds is not obvious. All types of hay can mold, though normally it’s a greater problem with legumes.

Grains

Bushel weight—Oats weighing 26 pounds per bushel have more fiber, less energy, and therefore less feed value than heavy oats weighing 34-40 pounds per bushel.

Color and smell—Grains should be clean and bright-colored. A dull gray appearance indicates that grains have been rained on and may be musty or have mold and bacterial growth on them.

Foreign material—Portions of cob, weed seeds, dirt, stones, etc. greatly detract from the value of grains, and reduce feed value.

Kinds of grain—The energy value of grains varies widely. Corn is considerably higher in energy value than oats, but oats are higher in protein and minerals. Oats are more bulky than corn and thus a safer feed.

Moisture content—Corn and sorghums, in particular, may contain excessive moisture and thus be subject to mold and spoilage. Excess moisture adds weight but no feed value.

Table 1 indicates the relative amounts of major nutrients that various feeds contain. Obviously, some deviations from the average values occur. In general, remember that grains contain 70-80 percent TDN and hays about 50 percent TDN. Legumes are considerably higher in protein than are grass hays. Hays are richer sources of calcium and most trace minerals than are grains, but grains are richer sources of phosphorus. Furthermore, grains, except for corn, contribute almost no vitamin A value to a horse ration.

Nutritional Needs of the Horse

Every horse owner should understand a horse’s needs and what affects those needs. The four basic nutrient groups

Table 1. Composition of Typical Horse Feeds¹

Feedstuffs	Typical	Energy		Based on 90% dry matter content					Vitamin A Equivalent I.U./lb. ³
	Dry Matter Content % ²	TDN %	DE MCal/lb.	Total %	Digestible %	Fiber %	Calcium %	Phosphorus %	
Grains									
Oats	88	68.0	1.40	11.9	7.3	11.2	.10	.34	—
Corn	88	81.0	1.62	9.0	4.6	2.1	.02	.31	500
Barley	88	75.0	1.50	11.7	7.2	5.0	.08	.41	—
Wheat	90	79.2	1.58	12.9	8.5	2.7	.05	.37	—
Rye	90	76.5	1.53	12.1	9.5	2.0	.06	.34	—
Sorghum	90	76.5	1.53	11.2	6.8	2.0	.04	.32	—
By-products									
Beet pulp	90	64.8	1.30	9.0	4.0	18.8	.68	.10	—
Beet molasses	77	80.1	1.60	7.8	3.8	—	.16	.03	—
Cane molasses	75	64.8	1.30	3.9	0.0	—	.89	.08	—
Wheat bran	90	58.5	1.17	16.2	11.6	10.1	.14	1.18	—
Protein supplements									
Soybean meal	90	75.0	1.44	46.4	40.2	6.0	.32	.68	—
Linseed meal	90	68.4	1.37	34.7	29.2	8.9	.40	.82	—
Brewers grains	90	59.4	1.17	25.3	20.2	14.7	.26	.49	—
Cottonseed meal	90	67.5	1.35	40.3	34.2	11.8	.15	1.18	—
Roughages									
Hay-alfalfa	88	51.3	1.02	15.4	9.9	27.8	1.20	.20	7,500
timothy	88	49.0	.98	7.5	3.7	29.8	.36	.17	4,000
bromegrass	88	49.0	.98	10.6	4.4	30.4	.35	.18	3,000
orchard grass	88	49.0	.98	8.6	4.8	31.0	.40	.22	7,500
canary grass	88	49.0	.98	9.4	5.3	31.7	.30	.22	7,500
alsike clover	88	51.0	1.02	13.2	7.6	26.5	1.20	.22	25,000
red clover	88	51.0	1.02	12.8	7.3	26.5	1.30	.20	8,000
Alfalfa-brome haylage	46	50.0	1.00	14.0	4.1	31.0	.54	.18	18,000
Corn silage	40	63.0	1.26	7.3	2.2	22.0	.24	.18	—
Corn stover	88	50.0	1.00	5.2	1.0	33.4	.44	.08	—

¹Values are from NRC feed composition tables.

²For most feeds, the “as fed basis” will provide nutrients similar to those presented here. To convert the exceptions—high moisture feeds, silage, haylage, molasses, etc.—to an “as fed basis,” divide the values given by 90% and then multiply that answer by the dry matter content, i.e., corn silage 7.3% ÷ 90% protein × 8.1% × 40% dry matter = 3.2% protein on an “as-fed basis.”

³Values calculated on basis of 1 mg. carotene equal to 400 I.U. of Vitamin A.

—carbohydrates, protein, minerals, and vitamins—are all required in varying amounts by horses for maintenance (horse at rest), work (riding), pregnancy, lactation, and growth.

The best source of horse nutrition information is the National Research Council. Their recommended requirements are the studied judgments of a committee of respected horse nutritionists. The recommendations in this bulletin are based on information provided through the National Research Council.

Horsemen use several guidelines to determine how much feed and what kind of feed their horses need. It may be so many flakes of hay or scoops of grain per horse; it may be a particular ratio of hay to grain, or it may be a percent of a certain nutrient in the grain ration. For vitamins, horsemen figure so many units per horse daily or so many units per pound of grain. Minerals are provided as a percent of the total diet or grain mix, and energy is provided as pounds of total digestible nutrients (TDN) or calories per head daily. When horsemen think of protein, it's so many pounds per head daily or a percent of the grain ration.

While the horseman may think in terms of units per pound or percentages, the horse has a specific daily requirement for a given amount of a nutrient. While 30 pounds of feed that contain .3 percent calcium may provide an adequate intake of calcium, 15 pounds of a high grain ration containing .3 percent calcium would provide only half enough. Therefore, saying a horse requires .3 percent calcium or 10 percent protein in its ration doesn't tell you much. It's the amount fed times the concentration of the nutrient that determines whether a specific daily requirement will be provided.

Table 2 shows the concentration of energy (TDN), or proportion of grain to hay to feed. It also indicates the percent of protein and minerals or units of vitamin A to include in rations that should be fed horses and ponies at various stages of production.

The first requirement for all nutrients is that they maintain the horse. If a horse is to work, reproduce, and suckle young, additional feed, or more logically, greater concentration of nutrients beyond the maintenance requirements must be provided (Table 2). The stage of production (lactation, work, etc.) determines what nutrient(s) must be increased and to what degree. For example, riding a horse 2-3 hours a day (light work) increases the animal's need for energy about 30 percent over maintenance, and 4-5 hours of normal riding increases energy needs 65-70 percent. Even more striking, when ridden hard (for polo, jumping, etc.) a horse may use as much energy in 1 hour as he requires for 24 hours of maintenance and six times more than for light work. However, protein requirements do not increase significantly with exercise. A mare during the last quarter of her pregnancy needs about 20 percent more protein than she requires for maintenance, but her energy requirement increases only slightly.

Without exception, all these examples call for greater nutrient concentrations in the diet as shown in Table 2. Don't attempt to memorize all the figures but do remember the major points such as: work doesn't increase protein needs; lactation is a critical time for all nutrients, etc.

To determine the specific amount of a nutrient your 1100 pound horse needs and how to provide it, use the ration concentration data from Table 2 and the amount of daily feed from Table 3 to arrive at the specific daily amounts

Table 2. Nutrient Concentration in Diets for Horses and Ponies^a

	Dig. energy mcal/lb	Total digestible nutrients %	Diet Proportions		Protein			Phos- phorus %	Vitamin A activity I.U./lb
			Concen- trate %	Roughage %	Crude %	Digest- ible %	Calcium %		
Maintenance	1.0	50	0	100	8.5	3.7	.30	.20	725
Gestation	1.1	55	25	75	10.0	5.9	.45	.30	1365
Lactation									
1st 3 months	1.2	60	50	50	12.5	9.4	.45	.30	1135
Lactation	1.1	55	25	75	11.0	6.2	.40	.25	1000
Creep Feed	1.4	70	100	0	20	14.9	.85	.60	—
Foal, 3 months	1.3	65	75	25	20	14.9	.85	.60	680
Wean, 6 months	1.25	62.5	60	40	14.5	9.6	.60	.45	725
Yrlg, 12 months	1.20	60	50	50	12.0	6.8	.50	.35	910
Yrlg, 18 months	1.15	57.5	40	60	10.5	5.6	.40	.30	910
2 yr.									
Light training	1.20	60	50	50	10.0	5.3	.40	.30	910
Mature working horses^b									
Light work	1.1	55	25	75	8.5	3.7	.30	.20	725
Moderate work	1.2	60	50	50	8.5	3.7	.30	.20	725
Intense work	1.25	62.5	60	40	8.5	3.7	.30	.20	725

^aDiets containing 90% dry matter.

^bLight work—western pleasure, equitation
Moderate work—ranch work, barrel racing, jumping
Intense work—racing, polo, hunting.

Table 3. Daily Feed and Nutrient Requirements of 1100 Pound Horse at Various Production Stages.

	Wt. lb.	Daily gain, lb.	Daily feed, lb.	Ratio		Dig. energy Mcal	TDN lb.	Protein, lb.		Cal-cium, g.	Phos-phorus, g.	Vit. A 1000 I.U.
				Conc.: %	Roughage %			Crude	Dig.			
Maintenance	1100	0	16.4	0	100	16.4	8.2	1.4	.64	23	14	12.5
Last 90 days gestation	1200	1.2	16.8	25	75	18.4	9.2	1.6	.86	34	23	25.0
Lactation												
1st 3 mo.												
33 lb. milk	1100	0	23.9	50	50	28.3	14.1	3.0	1.8	50	34	27.5
Lactation												
3 mo. to weaning												
22 lb. milk	1100	0	22.3	25	75	24.3	12.2	1.9	1.4	41	27	22.5
Suckling foal,												
3 mo.	340	2.6	10.4	75	25	13.7	6.8	1.9	1.4	33	20	6.2
Requirements above milk						6.9	3.4	.9	.7	18	13	0
Weanling, 6 months	506	1.8	12.2	60	40	15.6	7.8	1.7	1.1	34	25	9.2
Yearling												
12 months	715	1.2	14.2	50	50	16.8	8.4	1.7	1.0	31	22	13.0
Long yearling												
18 months	880	.8	15.1	40	60	17.2	8.6	1.6	.8	28	19	16.0
Two year old	990	.3	14.5	30	70	16.6	8.3	1.4	.7	25	17	18.0

of nutrients required. Table 3 is an excellent guide, but horse feeding still involves some art. Individual horses vary considerably and should be fed accordingly. To accommodate for deviation, horsemen may have to provide 10-15 percent more nutrients than the amounts given in Table 3.

Tables of this type have been worked out for horses of various weights. For brevity's sake, only the nutrient requirement for a 1100 pound horse is presented. Table 3 shows that the energy requirement of a 1100 pound mare during the last quarter of gestation amounts to only 1 pound more TDN (2 pounds of good hay equivalent) than the amount required to maintain a non-pregnant mare of the same weight. Proper nutrition for horses is especially vital during lactation and early growth. Note that the amount of protein needed during lactation is twice that required for maintenance (3.0 pounds vs. 1.4 pounds), and that considerably more TDN is required for lactation than for pregnancy (14.1 pounds vs. 9.2 pounds). Calcium and phosphorus needs also are more critical for lactation and growth. Vitamin A requirements during the last quarter of pregnancy are twice those needed for maintenance or for light work, and calcium and phosphorus requirements are likewise increased during lactation.

You may be dismayed at the number of values given on the tables, but if you are concerned with a 1100 pound horse during only one stage of production, the figures should not be overwhelming. If all horsemen consistently fed corn and timothy always of the same quality, we would utilize very simple tables. Because the kind and quality of feeds used vary tremendously, and a given-size horse is expected to perform a specific task and therefore has a definite nutrient requirement, we need tables to provide information about those requirements and what feeds will best supply them.

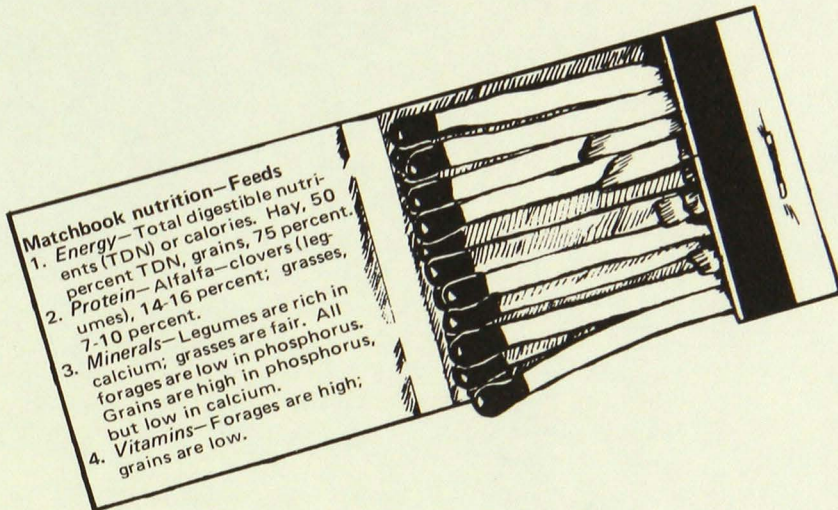
Some Specifics

1. Attaining a working knowledge of the composition of two or three typical horse feeds and what your own

specific horse requires is not difficult. All it requires is an attitude of wanting to know.

- Alfalfa, either as high quality hay or pellets, will alleviate protein, calcium, vitamin A, trace minerals and B vitamin shortages in most types of horse rations.
- No specific mention of the requirements for B vitamins, vitamins C, D and E or specific trace minerals has been made. There are two reasons for this: 1) Under normal circumstances the occurrence of deficiencies of B vitamins, vitamins C, D and E and the trace minerals have not been well documented; and 2) We do not know what the requirements are for those nutrients. This is not to say that horses don't have requirements for those nutrients. But it does imply that good rations normally meet those requirements and that many horses receive supplementations of one kind or another in excess of what they need. There is no short circuit scheme of performing nutrition miracles.
- Trace mineralized salt contains no calcium, and phosphorus and dicalcium phosphorus is not a source of selenium, manganese or other trace minerals. A horse has a natural craving for salt but has neither a particular appetite or natural instinct to seek out sources of calcium or phosphorus. Therefore, the way to supplement horses with calcium or phosphorus (limestone and dicalcium phosphate are rich but unpalatable sources) is to mix trace mineralized salt with limestone or dicalcium phosphate. If the ration is deficient or an inappropriate calcium phosphorus ratio exists, in the summer mix 75 percent salt and in the winter 60 percent salt with the proper source of calcium or phosphorus.
- Aside from adequate nutrition, we know of no nutrient or supplement that will a) make the hoof grow faster and stronger; b) cure a curb, spavin, ringbone, etc; c) increase conception in mares or libido in stallions; d) increase intelligence; e) prevent colic; or f) cure heaves, sleeping sickness and EIA. In short, don't be stampeded into buying magic from a bottle or a can.

6. Complicated grain mixes are not necessarily superior to very simple mixes such as whole oats and pelleted soy-bean meal.
7. Horses with widely different nutrient needs should be fed separately and fed different rations.
8. The quality of the forage is a major determiner of what level of nutrients should be in the grain ration.



RULES OF 10

How to feed the horse—Daily maintenance requirements for 1,100-pound horse

1. 10 pounds TDN
2. 10 percent protein
3. 10 parts forage: 1 part grain
4. 10,000 IU Vitamin A
5. $\frac{1}{10}$ as much Vitamin D as A
6. Wager 10:1 supplemental B vitamins not needed

This horse has been fed to show; the animal has a shiny coat, spirit, animation, and the desire to perform.



How to Formulate a Horse Ration

Formulating an adequate ration for your horse is simple if you remember several things: what the horse requires, what kind of feed will fill those requirements economically, what feeds are palatable and will satisfy the horse yet not encourage wood chewing, tail biting, cribbing, etc., and how much of a given feed the horse can eat. In addition, it will involve a bit of arithmetic.

Step 1. Learn to Calculate

The most common feeding problem confronting horse people is figuring what percent of a given nutrient is in a mixed ration. Referring to tables will show how much protein, TDN or calcium is in corn or oats but is not specific for a mixed feed of unequal parts of corn, oats and soybean meal, for example.

In order to figure the nutrient content of a mixed grain ration, simply multiply the pounds of each of the feedstuffs in the mixture (corn, oats, soybean meal, etc.) by the percent of the nutrient (TDN, protein, calcium, etc.) that each feed contains. Total the amounts obtained and divide by the pounds of feed in the mixture. This procedure provides a weighted average. The common error is to add up the protein content of the corn, oats and soybean meal and divide by three. However, if corn and oats constitute 90 percent of the mixture, they naturally have a greater effect on the average composition than soybean meal which made up but 10 percent of the mixture, in this example.

An example of the correct procedure for determining average nutrient content of mixed rations is shown below.

Weight of ingredient	Content, %		Amount Provided ¹ (lb.)	
	TDN	Protein	TDN	Protein
150 lb. corn	81	9	121.5	13.5
250 lb. oats	68	11.9	170.0	29.8
50 lb. soybean meal	75	46.4	37.5	23.2
1 lb. salt	0	0	0	0
Totals 451 lb.			329.0	66.5

¹150 lb. corn x 81% TDN = 121.5 lb. TDN

$\frac{329.0 \text{ lb. TDN}}{451 \text{ lb. feed}} = 72.9\% \text{ TDN}$

$\frac{66.5 \text{ lb. protein}}{451 \text{ lb. feed}} = 14.7\% \text{ protein}$

Step 2. Fitting the Feed to Your Horse's Requirements

The next step toward providing your horse's nutrient needs is to relate or compare what is provided in the feed with what the horse needs. When doing this, consider such factors as the horse's capacity and willingness to eat a given feed, feed costs and ease of feeding.

1. Since forage normally constitutes the major ingredient in the horse's daily ration, compare the nutrient content of the forage (Table 1) with the nutrient requirements of your horse (Table 2). Until you do that, you don't have any idea to what extent you must supplement the ration. It's possible that the forage

you have will provide all the nutrients the horse needs.

To illustrate the various points to be made in this bulletin, let's assume that our hay is timothy that was cut at mid bloom and that we are formulating a ration for a 12 month old yearling that when mature will weigh 1100 pounds.

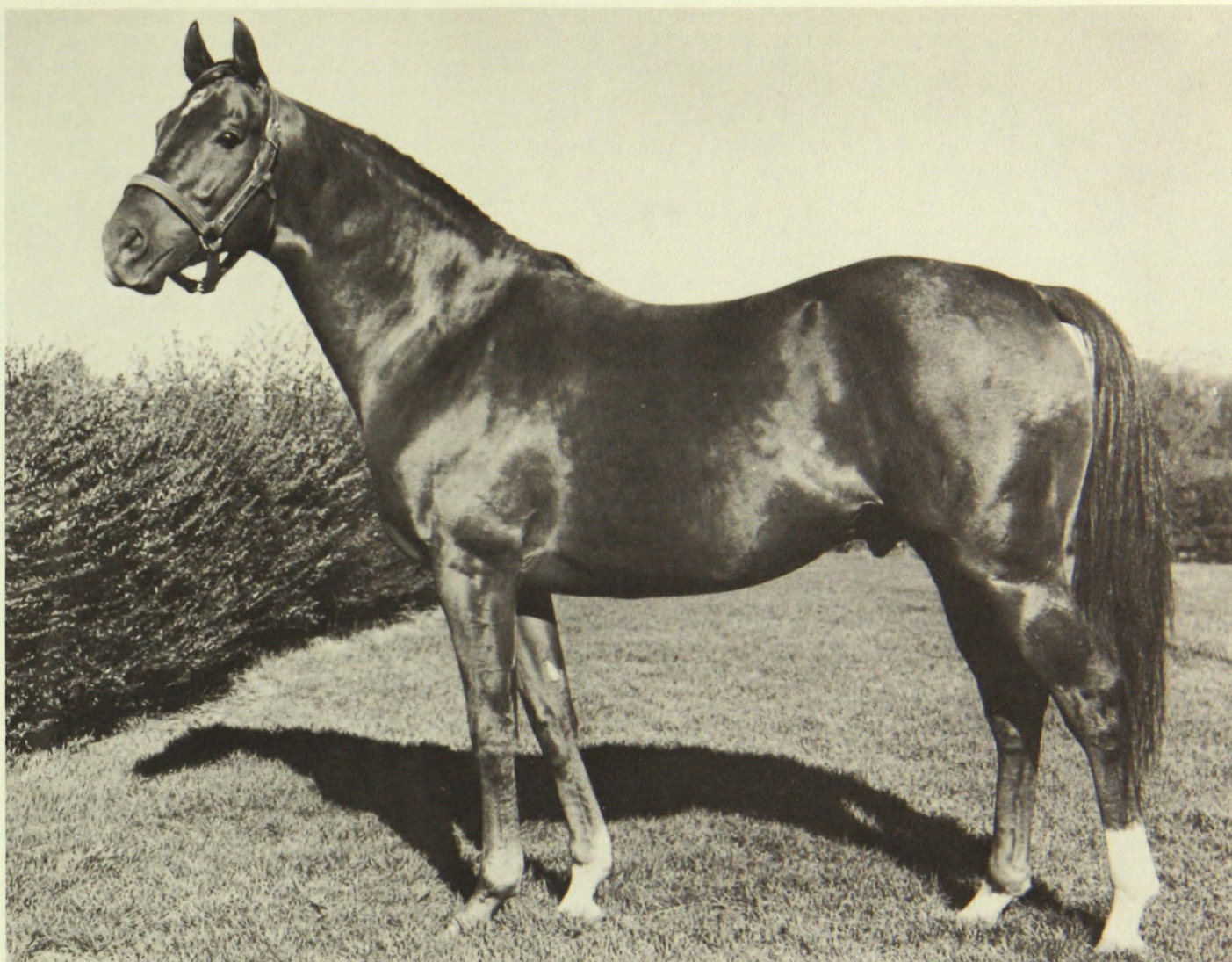
2. Write down the composition of the timothy hay (from Table 1) and the nutrient concentration in the ration necessary to meet the yearling's requirements based on what he would consume per day (Table 2), as follows:

	TDN %	PROTEIN %	CA %	P %	VIT. A., I.U./lb.
Timothy supplies	49	7.5	.36	.17	4,000
Horse requires	60	12.0	.50	.35	910

3. Compare the nutrient composition of timothy hay with what the ration for a yearling should contain. You should conclude that:
 - a. Timothy hay is too bulky (lacks concentration of energy). A yearling simply can't eat enough to meet his needs.
 - b. Timothy is inadequate in protein, calcium and phosphorus.
 - c. Timothy hay provides an adequate concentration of vitamin A.
 - d. To correct the nutrient shortcomings of timothy hay, the grain supplement must be sufficiently rich in these nutrients to compensate for the inadequacies of the hay.

Step 3. Correcting the Nutrient Shortcomings of Timothy Hay

1. The energy shortage of timothy should receive the first consideration. Table 3 suggests a yearling should be fed 14.2 pounds of a ration consisting of equal parts of hay and grain. Such a mixture contains 60 percent TDN (Table 2) and 14.2 pounds would provide 8.5 pounds of TDN which is about the daily TDN requirement for a yearling (Table 3). If you felt your particular yearling needed more total feed per day with no increase in TDN intake you might change the hay:grain ratio from 1:1 to 2 parts hay and 1 part grain. Fifteen pounds of that ration containing about 57 percent TDN would also provide the yearling's daily TDN requirement of 8.5 pounds.
2. Our next concern is protein. Remember a yearling's ration should contain 12 percent protein. However, a ration consisting of one part timothy hay (7.5 percent protein) and one part grain (corn-oats equal parts) with 10.5 percent protein results in an average protein content in the ration of only 9 percent (7.5 percent plus 10.5 percent = 18 ÷ 2 percent). Thus, the ration is still deficient in protein.
3. What protein content should be in the grain ration to correct the deficiency, 14, 17, 20 or 25 percent? Rather than guess, simply determine the difference in protein between what is desired (12 percent) and what is in the



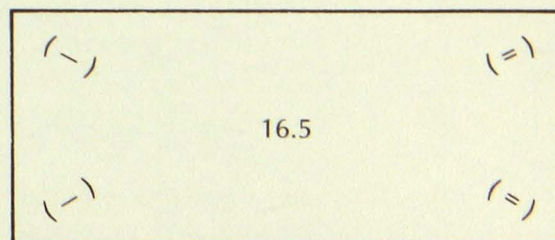
During the breeding season, a grain ration containing 12-14 percent protein (possibly fortified with vitamins A and D) should be fed in sufficient amounts to keep a stud like this in strong, vigorous condition.

hay (7.5 percent). In this case, that is 4.5 percent. This 4.5 percent additional protein added to the desired level, 12 percent, equals 16.5 percent protein that the grain mix should contain. Thus, 16.5 percent protein in the grain plus the 7.5 percent in the hay = 24 percent ÷ 2 parts of the ration = 12 percent protein in the total ration. So far we are right on!

4. How does one determine what proportion of feedstuffs to use to end up with 16.5 percent protein rather than 26.5 percent? Let's choose soybean meal (SBM) as a rich source of protein to mix with the corn and oats grain mix. To determine the amount of SBM to add, employ the square method as shown. Enter in the middle what percent you are seeking (16.5 percent). At each left hand corner write in the percent of protein in the SBM (46.4 percent) and in the corn-oats mix (10.4 percent). Then determine the difference between each of the values and 16.5. Those differences are the proportions of each feedstuff necessary to result in a total mix that will contain 16.5 percent protein.

SBM 46.4% protein

6.1 parts SBM



Corn-oats 10.4% protein

29.9 parts corn-oats
36.0 Total parts

To convert parts to percent, divide each component's part by the total number of parts, i.e.—

$$\frac{6.1}{36.0} = 16.9\% \text{ SBM} \qquad \frac{29.9}{36.0} = 83.1\% \text{ corn-oats}$$

5. While 14.2 pounds of a ration consisting of 7.1 pounds of timothy and 7.1 pounds of grain (16.5 percent protein) met the TDN and protein needs, we have no assurance that it contains enough mineral or in the correct calcium:phosphorus ratio to meet the daily requirements of a yearling (Table 3). We calculate the amount of calcium and phosphorus supplied by our ration as follows:

Calcium; 7.1 lb. timothy \times .36% calcium = .026 lb. \times 454 grams = 11.8 grams calcium. Since the 7.1 lb. of grain mix consists of 83.1% corn and oats, and 16.9% soybean meal, multiply those figures by 7.1 pounds to determine the number of pounds each of the mixture constitutes. Thus, 5.9 lb. corn and oats mix \times .06% calcium (corn has .02% and oats .10%, Ca, average .06%) = .0035 lb. \times 454 grams = 1.6 grams calcium, and 1.2 lb. SBM \times .32% calcium = .0038 lb. \times 454 = 1.7 g. calcium. Total calcium = 11.8 g. from hay + 3.3 g. from grain = 15.1 g.

Phosphorus: 7.1 lb. timothy \times .17% phosphorus = .012 lb. \times 454 grams = 5.4 grams phosphorus. 5.9 lb. corn-oats mix \times .325% phosphorus = .019 lb. \times 454 grams = 8.6 grams P. 1.2 lb. SBM \times .68% P = .008 lb. \times 454 grams = 3.6 grams phosphorus. Total phosphorus = 17.6 grams.

6. After constructing a table, based on the yearling's requirements (Table 3) and the nutrients provided by the 14.2 pounds of ration, it is obvious that inadequate calcium and phosphorus are provided and that the Ca:P ratio is wrong.

Feed, lb.	Energy	Protein	Vitamin A		
	TDN lb.	Total lb.	Ca g	P g	1000's I.U.
Requirement for a 715 pound yearling					
14.2	8.4	1.7	31	22	13.0
Amount Provided					
Timothy	7.1	3.5	.59	11.8	5.4
Grain	7.1	5.0	1.10	3.3	12.2
Total		8.5	1.69	15.1	17.6

7. Correct the calcium and phosphorus shortage as follows:
- Subtract the calcium supplied from the requirement (31 g. - 15.1 = 15.9 g. Supplemental calcium needed).
 - Decide what calcium source to use. Since we need both calcium and phosphorus, dicalcium phosphate is the mineral source of choice. However, the major need is for calcium. Therefore, if we mix equal parts of dicalcium phosphate (24.0 percent calcium) and limestone (34 percent calcium), we can make a satisfactory mix to add to the grain that contains 29 percent calcium.

- How much of the mineral mix must the yearling consume daily in order to obtain 15.9 grams calcium? (15.9 grams Ca needed \div 29.0% Ca in the mix = 54.8 g. limestone-dical mix will provide 15.9 grams calcium.

- What about phosphorus? Since dical contains 18.0 percent phosphorus and limestone contains none, the mixture contains 9 percent. Thus, 54.8 grams limestone-dical provide 4.9 grams phosphorus which adequately corrects the phosphorus shortage in the hay-grain ration.

8. It is one thing to know how much mineral a horse must eat to receive adequate calcium and quite another to know what percent mineral to add to the grain. Our task is to convert 54.8 grams mineral in each 7.1 pounds of grain to a percentage figure. First, convert all weights to metric (7.1 pounds \div 2.2 pounds = 3.25 Kg. feed). Convert 54.8 grams to .0548 Kg. and .0548 Kg. of mineral divided by 3.25 Kg. feed equals 1.69 percent dical-limestone added to the grain would assure adequate intake of mineral.

If your hay had been half alfalfa, adequate calcium would have been provided, and providing a salt-dical mix free-choice would also help alleviate the mineral shortage. But the fact remains that we can't assume that hay and grain always provide adequate nutrition for horses. To provide the best rations we must do more than merely guess at what is or is not provided.

Pasturing Horses

Pasture forage has virtually the same nutrient composition on a 90 per cent dry matter basis as hay (Table 1). Two differences exist — grass doesn't contain 90 percent dry matter, usually only 20 to 35 percent dry matter and grazing permits a horse to eat only the most palatable, and usually the most nutritious part of the plant.

Can a horse, grazing a good pasture, consume enough to meet its nutrient requirements for:

Maintenance — Yes. In fact, mature horses can get fat on grass and yearlings and two year olds will make appreciable weight gains.

Gestation — Yes. Grass is usually a laxative feed that's high in protein and vitamins. Pasture provides an ideal environment for foaling mares.

Lactation — Many mares will actually gain weight while lactating. However, as the season advances the amount and quality of forage commences to decline. Under those circumstances, the mare will lose weight while her foal will gain, but at a slower rate. If the lactating mare is to be rebred, a loss in body weight may result in lack of estrus and/or ovulation. For big, active and heavy milking mares (Thoroughbreds, American Saddlebreds, etc.) 4 to 8 pounds of grain per head daily may be fed to maintain weight until the mare has conceived.

Work — Whether pasture will meet the requirements for work depends on the quality of pasture and how much the horse is ridden. Riding increases the energy requirements, over maintenance, by 35 to 200 percent, depending on how long and at what speed the horse is ridden. Feeding 2 to 6 pounds of grain per day will maintain weight and stamina better than only pasture.



Hackney crossbred mare being maintained in a fleshy condition on nothing but a fertilized brome grass pasture, salt and minerals.

What's the best pasture forage? Orchardgrass is the best followed by brome grass. These species provide good forage early in the season, form a good sod, and are very palatable and nutritious. Timothy and blue grass don't produce as much forage and become dormant and unpalatable earlier in the summer. Reed canary grass is a heavy producer and is palatable early in the season. However, by July it becomes high in alkaloids and becomes exceedingly unpalatable.

Legumes, alfalfa and clovers would contribute nitrogen to the grasses, lengthen the growing season, and increase the protein and mineral content. However, if grazed continuously, or grazed in the fall, they will be killed out in about one year.

R. M. Jordan is a professor, Department of Animal Science, and extension animal husbandman.

Issued in furtherance of cooperative extension work in agriculture and home economics, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Roland H. Abraham, Director of Agricultural Extension Service, University of Minnesota, St. Paul, Minnesota 55108. We offer our programs and facilities to all persons without regard to race, creed, color, sex, or national origin.