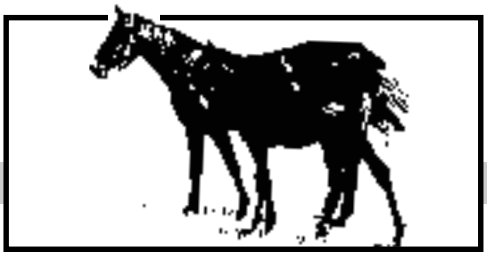
Virginia Cooperative Extension

REPRINTED 2000



Animal and Poultry Sciences

PUBLICATION 406-473

Nutrient Requirements and Balancing Rations for Horses

*L. A. Lawrence**

Nutritional requirements of horses are composed of two factors - maintenance needs and activity needs. These requirements are additive and both must be satisfied if the animal is to maintain its body weight and condition or degree of fitness.

Deficiency or over abundance of some nutrients can also limit horse performance or production. Balancing the diet of a horse begins with meeting maintenance requirements.

MAINTENANCE

The maintenance requirements of a horse are dependent upon its 1) size (body weight, BW), 2) environment, and 3) individual digestive and metabolic efficiency. Maintenance needs include a voluntary exercise factor essential to the animal's well being. Daily requirements, as proposed by the NRC (1989) in the Nutrient Requirements for Horses, for horses with mature weights of 880, 1100, and 1320 lb are shown in Tables 1, 2, 3, and 4, respectively. Requirements increase in direct proportion to BW.

Individual variation among horses, which may be large, must be considered in applying requirement information to any individual horse. Unlike other livestock, horses have never been selected for feed efficiency or uniformity.

The NRC (1989) has made nutrient requirement calculations for horses easy for those with access to a microcomputer. A computer program calculates the requirements with information based on the age, weight, and activity of the horse. Nutrient Requirements of Horses, including the computer program, can be ordered from National Academy Press, 2101 Constitution Ave., NW, Washington, DC, 20418.

1. Energy

Energy requirements of horses are typically measured in Megacalories (Mcal) of digestible energy. Weight change of the animal is the easiest way to evaluate the adequacy of energy intake. Condition scores (see appendix) or weight tapes can be used to determine the body composition and/or weight of the horse. This should be part of routine horse care. Adjusting energy intake 10 to 15% above or below the requirement should result in weight gain or loss. Table 5 can be used to estimate relative intake of forage and concentrate (grain) based on a percentage of body weight. Table 5 indicates that in most situations horses at maintenance will meet energy requirements with forage alone. In fact, forage is the basis of diets for all horses. The relative feeding values of several hays are based on assigning a value of 100 to timothy hay and comparing others to it: timothy -100, alfalfa - 133, orchardgrass - 105, and legume-grass mixtures have values ranging from 115 to 120. Basically, this means the average alfalfa hay has 33% more digestible energy than the typical timothy hay. Digestible energy (DE) is determined by a digestion trial. It is the difference in the energy found in the feed and the energy lost in the feces.

2. Protein

The protein requirement for maintenance is quite low and is generally met by the protein in good quality forage and grain. No protein supplementation is usually needed unless the forage protein levels are less than 8-9%. Excess protein, above the horse's requirement, is an unnecessary expense and is broken down and used for energy but may also be detrimental to athletic performance. For example, German research with endurance horses has shown a negative effect on fluid balance when high protein diets were fed.

*Extension Animal Scientist, Horses, Virginia Tech

3. Minerals

Since sodium levels are below requirements in most feedstuffs, a source of salt should be available to all animals. Free-choice salt containing trace minerals is usually recommended. Exercising horses should consume 1 to 2 ounces of salt per day.

Quality forages will usually provide adequate calcium (Ca) and phosphorus (P) for maintenance. To be safe, forage analysis is good insurance. Calcium and phosphorus ratios are important for horses. Ca:P ratios of 1.5:1 or 2:1 in the total diet are recommended for most classes of horses and should never be below 1:1. The NRC (1989) states that if P is adequate Ca:P ratios can be as high as 5:1 for mature horses. Recent research suggests Ca:P ratios should not be above 2.5 for growing horses. Alfalfa hay can have ratios of up to 15:1. Therefore, horses fed alfalfa or other legume hays may need P supplementation to maintain a proper Ca:P ratio. Grass hay can be low in Ca and P. Supplementation of grass hay diets should be done with equal Ca:P or with more Ca than P. Diets can be balanced by including proper supplementation in the grain portion of the diet. Grains are high in P and low in Ca so they must be appropriately supplemented as needed. Offering a free-choice mineral containing Ca and P may help meet requirements, but horses cannot be counted on to consume needed quantities of supplements. Using oats or other grains to "cut" or add to commercial diets is not recommended because it may alter Ca:P ratios and dilute minerals and vitamins. There are feeds designed to be mixed with oats, and these are more appropriate choices. Trace mineral requirements are usually met by feeding good quality hay and free-choice trace mineral salt. However, there are some deficiencies in Virginia forages that require close attention. Selenium and copper are generally deficient and adequate supplementation is necessary (Table 6).

4. Vitamins

The vitamin needs for maintenance of mature horses will usually be satisfied by high quality fresh forages. Horses receiving hay for extended periods should receive supplemental vitamin A and E. Vitamin A activity is lost in hay during storage and vitamin E values vary considerably among forages. Vitamin D is provided by exposure of horses to sunlight and by sun-cured hays. The B complex vitamins are synthesized in the horse's digestive tract and supplements are not needed for horses consuming maintenance diets. For more information on vitamins, see Table 6.

ACTIVITY

1. Reproduction

During the first eight months of gestation, the nutrient requirements of mares are only slightly above maintenance. Approximately 60% of the weight of the foal is accumulated during the last three months of gestation. Failure to provide adequate levels of nutrients during late gestation will result in reduced foal size and loss of the mare's body tissue. To insure rebreeding, the mare should gain 0.3 to 0.8 lb per day of weight during the last three months of gestation.

Milk production dramatically increases the requirements for many nutrients. The increases in the mare's requirements are directly related to the amount of milk produced and milk production is related to body weight of the mare. The mare produces about 3% of her body weight in milk during the first three months of lactation and 2% during the period from 4 to 6 months. Energy requirements for lactating mares are twice the maintenance requirement. Protein, Ca, and P requirements increase proportionately to the energy requirements during this time of high productivity.

2. Growth

The NRC (1989) recognizes (Table 4) two levels of growth for foals. The requirements reflect increases in almost all nutrients for rapid growth and moderate growth rates. A foal receiving adequate energy and protein may need additional Ca and P for proper bone development. Adequate trace minerals for growth must also be available in the diet. Nutrient balance is very important in growing horses. A crude protein/energy ratio of 50 g/Mcal DE and 45 g/Mcal DE for weanlings and yearlings is an important consideration for growing horses. Lysine is the first limiting amino acid for horses and is required at 0.65% of the diet for weanlings and 0.5% for yearlings. Lysine requirements are best met with a high quality protein oil meal such as soybean meal. Commercial diets balanced for growth are good investments for foals, weanlings, and yearlings.

3. Work

The influence of exercise on the nutritional requirements of the horse is dependent upon the intensity of the work, its duration, and the size of the horse. Exercise increases the energy expenditure of the horse, but it has little effect on other nutrients with the exception of water and electrolytes (sodium, potassium, chloride, and calcium) if excessive sweating occurs.

Table 3 contains the formulas for calculating energy requirements for horses doing light work (Western and English pleasure, bridle path hack, equitation), moderate work (ranch work, roping, cutting, barrel racing, jumping, etc.), and intense work (race training, polo, etc.). Daily work of 1 hour or more at a moderate level usually raises the energy requirement above what can be supplied by forage alone. Water and electrolytes are lost in perspiration. The electrolytes are important for muscle function and fluid balance. Intense work places stress on horses, and vitamin supplementation is probably effective in performance horses. Electrolytes should be mixed in water and offered to the horse; however, clean, fresh water should also always be available to a horse that has been properly cooled down.

FEEDING HORSES

Horses evolved as grazers and do best when fed high forage diets. Bulky feeds must be included in the diet to maintain digestive tract function. Roughage requirements can be met by feeding at least 1% of the horse's body weight as forage. In some situations, diets containing only forage may be undesirable and use of concentrates is necessary. Grains have 50-60% more digestible energy than forage and can decrease the bulk in the diet. Vegetable oils and animal fats have 2.25 times the amount of energy per pound than grains. They also can be used in horse diets. However, they may affect energy metabolism and body composition. Fat should not be added at more than 10-15%, by weight, of the total diet and additional vitamin E should be supplemented to horses fed fat.

Formulation of concentrate mixtures depends on the animal's requirements and the portion of the requirements provided by the forage. To determine the portion of the requirement met by hay or pasture, a forage nutrient analysis should be performed by a testing laboratory. Your local county Extension office can recommend a forage testing laboratory. Table 5 shows recommended concentrate to roughage ratios for different classes of horses, Table 7 contains the nutrient contents for the total diet, and Table 8 provides recommended concentrate allowances to be fed with forages. Concentrates fed with alfalfa can be lower in protein, energy, and Ca than those fed with grasses. However, P should be adequate to meet Ca:P ratios. When trying to balance Ca:P, it is important that laboratory analysis for these minerals be used to insure proper supplementation. Calcium and P nutrition requires careful consideration. Calcium availability is 50-75% and P availability is from 25-35% in typical forages. Remember never to get the P higher than the Ca.

Commercially-prepared concentrates are usually balanced for a particular class of horse. Lactating mares, growing horses, and the horse that is working or training hard need to be fed carefully balanced diets. It may be advantageous to use commercial diets for these classes of horses. Commercial diets should be purchased to meet the protein requirements of the particular class of horse being fed. If alfalfa is being fed, choose a supplement balanced to be fed with alfalfa. If grass is being fed, choose a supplement balanced to be fed with grass hay. The crude fiber (CF) content of a grain mix should range between 7-12%; generally, the higher the CF, the lower the energy.

Consistency is a key to good feeding practices. Change individual feeds in the diet slowly over a period of a week. When feeding horses, remember that individual variation is large and the "eye of the master" plays an important role in providing adequate energy.

Feeding Rules

1. Feed at least twice a day.
2. Be consistent in the amount and type of feed. If you must change, change only by 1/4 of the amount being fed per day.
3. Make sure the horse has salt.
4. Provide a good source of water kept at about 40 degrees F.
5. Control parasites.
6. Check the teeth to see if they need floating (filing off the sharp edges).
7. Regularly monitor the condition (weight) of the horse.
8. Provide regular exercise.
9. Don't allow the hot horse free access to water.
10. Observe the horse every day for general health (temperature, pulse, and respiration, etc.).

Adapted from NRC (1989) and E. A. Ott, Dietary Nutrient Allowances for Horses. 1984 Feedstuffs, Vol. 56, No. 30, P. 72.

Table 1. Daily Nutrient Requirements for Mature Horses

Animal	Weight	DE[a] (Mcal)	Crude Protein (g)	Lysine (g)	Calcium (g)	Phosphorus (g)
Mature Horses	880	13.4	536	19	16	11
Maintenance	1100	16.4	656	23	20	14
(First 8 mo preg.)	1320	19.4	776	27	24	17
Stallions	880	16.8	670	23	20	15
(breeding season)	1100	20.5	820	29	25	18
	1320	24.3	970	34	30	21
Pregnant Mares	880	14.9	654	23	28	21
9 mo	1100	18.2	801	28	35	26
	1320	21.5	947	33	41	31
10 mo	880	15.1	666	23	29	22
	1100	18.5	815	29	35	27
	1320	21.9	965	34	42	32
11 mo	880	16.1	708	25	31	23
	1100	19.7	866	30	37	28
	1320	23.3	1,024	36	44	34
Lactating Mares	880	22.9	1,141	40	45	29
Foaling to 3 mo	1100	28.3	1,427	50	56	36
	1320	33.7	1,711	60	67	43
3 mo to	880	19.7	839	29	29	18
weaning	1100	24.3	1,048	37	36	22
	1320	28.9	1,258	44	43	27

[a] *Digestible Energy*

Table 2. Daily Nutrient Requirements for Working Horses

Animal	Weight	DE[a] (Mcal)	Crude Protein (g)	Lysine (g)	Calcium (g)	Phosphorus (g)
Working Horses						
Light work[a]	880	16.8	670	23	20	15
	1100	20.5	820	29	25	18
	1320	24.3	970	34	30	21
Moderate work[b]	880	20.1	804	28	25	17
	1100	24.6	984	34	30	21
	1320	29.1	1,164	41	36	25
Intense work[c]	880	26.8	1,072	38	33	23
	1100	32.8	1,312	46	40	29
	1320	38.8	1,552	54	47	34

[a] *Examples are horses used in Western and English pleasure, bridle path hack,equitation, etc.*

[b] *Examples are horses used in ranch work, roping, cutting, jumping, etc.*

[c] *Examples are race training, polo, etc.*

Table 3. Energy Requirements of Horses for Work

Activity	
Light work[a]	DE = 1.25 (maintenance DE)
Moderate work[b]	DE = 1.50 (maintenance DE)
Intense work[c]	DE = 2.00 (maintenance DE)

[a,b,c]*From Table 1*

Table 4. Daily Nutrient Requirements for Growing Horses

Animal	Weight (lb)	Daily Gain (lb)	DE[a] (Mcal)	Crude Protein (g)	Lysine (g)	Calcium (g)	Phosphorus (g)
GrowingHorses							
Weanling, 4 mo	319[a]	1.87	13.5	675	28	33	18
	385[b]	1.87	14.4	720	30	34	19
	440[c]	2.20	16.5	825	35	40	22
Weanling, 6 mo							
Moderate growth	396	1.21	12.9	643	27	25	14
	473	1.43	15.0	750	32	29	16
	539	1.65	17.0	850	36	34	19
Rapid growth	396	1.54	14.5	725	30	30	16
	473	1.87	17.2	860	36	36	20
	539	2.09	19.2	960	40	40	22
Yearling, 12 mo							
Moderate growth	583	0.88	15.6	700	30	23	13
	715	1.10	18.9	851	36	29	16
	825	1.43	22.7	1,023	43	36	20
Rapid growth	583	1.10	17.1	770	33	27	15
	715	1.43	21.3	956	40	34	19
	825	1.76	25.1	1,127	48	41	22
Long yearling, 18 mo							
Not in training	726	0.55	15.9	716	30	21	12
	880	0.77	19.8	893	38	27	15
	1045	0.99	23.9	1,077	45	33	18
In training	726	0.55	21.6	970	41	29	16
	880	0.77	26.5	1,195	50	36	20
	1045	0.99	32.0	1,429	60	44	24
Two year old, 24 mo							
Not in training	803	0.33	15.3	650	26	19	11
	990	0.44	18.8	800	32	24	13
	1188	0.66	23.5	998	40	31	17
In training	803	0.33	21.5	913	37	27	15
	990	0.44	26.3	1,117	45	34	19
	1188	0.66	32.3	1,372	55	43	24

[a]*Expected mature wt. 880 lb*

[b]*Expected mature wt. 1100 lb*

[c]*Expected mature wt. 1320 lb*

Table 5. Expected Feed Consumption by Horses (% body weight)[a]

	Forage	Concentrate	Total
Mature Horses			
Maintenance	1.5-2.0	0-0.5	1.5-2.0
Mares, late gestation	1.0-1.5	0.5-1.0	1.5-2.0
Mares, early lactation	1.0-2.0	1.0-2.0	2.0-3.0
Mares, late lactation	1.0-2.0	0.5-1.5	2.0-2.5
Working Horses			
Light work	1.0-2.0	0.5-1.0	1.5-2.5
Moderate work	1.0-2.0	0.75-1.5	1.75-2.5
Intense work	0.75-1.5	1.0-2.0	2.0-3.0
Young Horses			
Nursing foal, 3 mo	0	1.0-2.0	2.5-3.5
Weanling foal, 6 mo	0.5-1.0	1.5-3.0	2.0-3.5
Yearling foal, 12 mo	1.0-1.5	1.0-2.0	2.0-3.0
Long yearling, 18 mo	1.0-1.5	1.0-1.5	2.0-2.5
Two year old	1.0-1.5	1.0-1.5	1.75-2.5

[a] *Air-dry feed (about 90% DM)*

Table 6. Other Minerals and Vitamins for Horses and Ponies (Dry Matter Basis)

	Adequate Concentrations in Total Rations				
	Maintenance	Pregnant & Lactating Mares	Growing Horses	Working Horses	Maximum Tolerance Levels
Minerals					
Magnesium (%)	0.09	0.11	0.08	0.09	
Potassium (%)	0.30	0.42	0.30	0.43	
Sodium (%)	0.10	0.10	0.10	0.30	3[a]
Sulfur (%)	0.15	0.15	0.15	0.15	1.25
Iron (mg/kg)	40	50	50	40	1,000
Manganese (mg/kg)	40	40	40	40	1,000
Copper (mg/kg)	10	10	10	10	800
Zinc (mg/kg)	40	40	40	40	500
Selenium (mg/kg)	0.1	0.1	0.1	0.1	2.0
Iodine (mg/kg)	0.1	0.1	0.1	0.1	5.0
Cobalt (mg/kg)	0.1	0.1 0.1	0.1	10	
Vitamins					
Vitamin A (IU/kg)	2,000	3,000	2,000	2,000	16,000
Vitamin D (IU/kg)[b]	300	600	800	300	2,200
Vitamin E (IU/kg)	50	80	80	80	1,000
Vitamin K (mg/kg)	[c]				
Thiamin (mg/kg)	3	3	3	5	3,000
Riboflavin (mg/kg)	2	2	2	2	

[a] *As sodium chloride.*

[b] *Recommendations for horses not exposed to sunlight or to artificial light with an emission spectrum of 280-315 nm.*

[c] *Blank space indicates that data are insufficient to determine a requirement or maximum tolerable level.*

Table 7. Nutrient Concentrations in Total Diets for Horses (Dry Matter Basis)

	Digestible Energy (Mcal/kg)	Protein (%)	Lysine (%)	Calcium (%)	Phosphorus (%)
MATURE HORSES					
Maintenance	2.00	8.0	0.28	0.24	0.17
Stallions	2.40	9.6	0.34	0.29	0.21
Pregnant mares					
9 mo	2.25	10.0	0.35	0.43	0.32
10 mo	2.25	10.0	0.35	0.43	0.32
11 mo	2.40	10.6	0.37	0.45	0.34
Lactating mares					
Foaling to 3 mo	2.60	13.2	0.46	0.52	0.34
3 mo to weaning	2.45	11.0	0.37	0.36	0.22
Working horses					
Light work[a]	2.45	9.8	0.35	0.30	0.22
Moderate work[b]	2.65	10.4	0.37	0.31	0.23
Intense work[c]	2.85	11.4	0.40	0.35	0.25
GROWING HORSES					
Weanling, 4 mo	2.90	14.5	0.60	0.68	0.38
Weanling, 6 mo					
Moderate growth	2.90	14.5	0.61	0.56	0.31
Rapid growth	2.90	14.5	0.61	0.61	0.34
Yearling, 12 mo					
Moderate growth	2.80	12.6	0.53	0.43	0.24
Rapid growth	2.80	12.6	0.53	0.45	0.25
Long yearling, 18 mo					
Not in training	2.50	11.3	0.48	0.34	0.19
In training	2.65	12.0	0.50	0.36	0.20
Two year old, 24 mo					
Not in training	2.45	10.4	0.42	0.31	0.17
In training	2.65	11.3	0.45	0.34	0.20

[a]*Examples are horses used in Western and English pleasure, bridle path hack, equitation, etc.*

[b]*Examples are horses used in ranch work, roping, cutting, jumping, etc.*

[c]*Examples are race training, polo, etc.*

Table 8. Recommended Nutrient Allowances for Concentrates (As-Fed Basis)

	Concentrate allowances[a]			
	DE	Crude Protein[c]	Calcium	Phosphorus
	Mcal/kg	(%)	(%)	(%)
MatureHorses				
Maintenance	3.0	10.0 - 12.0	0.40	0.30
Mare, late gest.	3.0	12.0 - 14.0	0.50	0.40
Mare, early lact.	3.0	12.0 - 14.0	0.65	0.45
Mare, late lact.	3.0	12.0 - 14.0	0.65	0.45
Working Horses				
Light	3.0	10.0	0.40	0.30
Moderate	3.0	10.0	0.40	0.30
Intense	3.0	10.0	0.40	0.30
Young Horses				
Creep feed	3.1	15.0 - 16.0	0.95	0.65
Foal 3 mo[b]	3.1	15.0 - 16.0	0.95	0.65
Weanling 6 mo	3.1	15.0 - 16.0	0.95	0.65
Yearling 12 mo	3.0	12.0 - 14.0	0.65	0.45
Long yearling 18 mo	3.0	12.0 - 13.0	0.50	0.40
2 year-old	3.0	10.0 - 12.0	0.45	0.35

[a]*Formulated to be fed with average quality grass hay. If higher quality roughages are fed, the nutrient content of the concentrate can be reduced.*

[b]*Without milk.*

[c]*Greater crude protein allowance suggested to be fed with grass hays, lower crude protein suggested to be fed with legume hays.*

Table 9. Example Nutrient Contents of Typical Feedstuffs for Horses.

Animal	Dry Matter %	Digestible Energy (Mcal)	Crude Protein %	Lysine %	Calcium %	Phosphorus %
Alfalfa hay Early-bloom	90.5	2.24	18.0	0.81	1.28	0.09
Alfalfa hay Mid-bloom	91.0	2.07	17.0	0.80	1.24	0.22
Alfalfa hay Late full-bloom	90.0	1.97	15.5	0.79	1.08	0.22
Brome, smooth hay Mid-bloom	87.6	1.87	12.6	[a]	0.25	0.25
Brome, smooth hay Mature	92.6	1.57	5.6	[a]	0.26	0.22
Orchardgrass hay Early-bloom	89.1	1.94	12.8	[a]	0.24	0.3
Orchardgrass hay Late bloom	90.6	1.72	7.6	[a]	0.24	0.27
Timothy hay Early-bloom	89.9	1.83	9.6	[a]	0.45	0.25
Timothy hay Mid-bloom	88.9	1.77	8.6	[a]	0.43	0.20
Timothy hay Late bloom	88.3	1.59	6.9	[a]	0.34	0.13
Barley, grain, Pacific coast	88.6	3.17	9.7	0.27	0.05	0.34
Corn, grain	88.0	3.38	9.1	0.25	0.05	0.27
Oats, grain, Pacific coast	90.9	2.91	9.1	0.33	0.10	0.31
Soybean meal, 44% protein	89.1	3.14	44.5	2.87	0.40	0.71

[a]*Blank space indicates that data are insufficient to determine a requirement or maximum tolerable level.*

Table 10. Calcium, phosphorus and magnesium contents of mineral supplements.

	Calcium %	Phosphorus %	Magnesium %
Bone meal, steamed	32.3	13.3	0.6
Calcium carbonate	36.7	0.5	0.3
Dicalcium phosphate	23.7	18.8	—
Limestone, ground	36.1	—	2.1
Monosodium phosphate	—	25.8	—
Monodicalcium phosphate	16.8	22.1	0.5
Phosphate, defluorinated	31.7	13.7	0.3
Sodium tripolyphosphate	—	25.1	—

Balancing Rations for Horses

Steps to take in order to balance a ration

1. Evaluate the weight and condition of the horse to be fed. Determine the horse's weight by using a scale or using an equine weight tape. Horses should be in moderate condition. The best way to evaluate this is by feeling along the ribs. You should not be able to see the ribs, but you should be able to feel them just under the skin with some fat filled in between the ribs.

2. Determine the class of the horse, i.e. working hunter, pleasure horse, race horse, lactating mare.

3. Using the weight and class of the horse, locate its nutrient requirements in Tables 1 through 4.

4. Using Table 5, approximate the amount of forage and concentrate or grain needed by the horse.

5. Determine the forage to be used, then calculate the nutrients provided by the forage using Table 9.

6. Subtract the nutrients provided by the forage from the requirements. The difference is what must be provided by the concentrate.

7. Select the appropriate concentrate and feed adequate quantities to meet energy and/or protein needs.

8. Balance calcium and phosphorus and provide a trace-mineralized salt at .5 to 1% of the diet or free-choice. Provide vitamin supplements as needed (see text).

EXAMPLE OF ONE METHOD OF BALANCING HORSE RATIONS

1. *Determine weight and condition:*

   The horse is mature in moderate condition and weighs 1100 pounds.

2. *Determine the class:*

   The horse is in the performance class, doing moderate work, eventing or ranch work.

3. *Locate the horse's nutrient requirements:*

   Find the daily nutrient requirements in Table 2. Using the Ration Calculation Form, fill in the requirements from the table.

4. *Determine the amount of forage and concentrate or grain needed to feed the horse.*

   Table 5 indicates that the horse needs between 1.0-2.0% of its body weight in forage and between 0.75-1.5% of its weight in grain. Total intake of feed will be between 1.75 and 2.5% of the horse's body weight and 1.5% of the weight should be fed in forage. To calculate 1.5% of the horse's body weight, using ratio and proportion, set up the formula and solve for x:

   $\frac{1.5 \text{ lb}}{100 \text{ lb}} = \frac{X \text{ lb}}{1100 \text{ lb}}$

   $\approx (100) =$ (1.5) 1100 cross multiply

   $X = \frac{1650}{100}$ divide by 100

   $X =$ 16.5 lb forage

   This establishes that if 1.5 lb is 1.5% of 100 lb, then 16.5 X lbs of forage is 1.5% of 1100 lbs of body weight

5. *Determine the forage to be used and its nutrients:*

   A decision is made to use sun-cured alfalfa hay at the mid-bloom stage of maturity. Mid bloom is the stage in which half the plants are in bloom. Using Table 9, find the percentages of nutrients contained in the feedstuff. To make the calculation easier, convert pounds to kilograms at this point. The conversion unit is 1 kg = 2.2 lb.

   Again, ratio and proportion can be used to set up a formula to convert 16.5 lb to kg.

   $X = \frac{16.5}{2.2}$ divide by 2.2

   $X =$ 7.5 kg of alfalfa hay

   Next, set up formulas to calculate percentage of nutrients supplied by 7.5 kg of alfalfa.

   Digestible Energy of Alfalfa is = 2.07 Mcal/kg

   (2.07 Mcal/kg) x 7.5 kg = 15.52 Mcal

Crude Protein = 17% = 17 kg crude protein/100 kg alfalfa

$\frac{17 \text{ kg}}{100 \text{ kg}} = \frac{X \text{ kg}}{7.5 \text{ kg}}$

X (100) = 17 (7.5) Cross multiply

X = $\frac{127.5}{100}$ divide by 100

X = 1.27 kg crude protein/7.5 kg alfalfa

Conversion of kilograms to grams

1 kg = 1000 g

1.27 kg (1000) = 1270 g crude protein/7.5 kg alfalfa

Lysine, calcium and phosphorus are calculated similar to crude protein.

6. *Determine what nutrients must be supplied by the concentrate:*

That will be the difference between the nutrients provided by the forage and the nutrition requirements. In this example, the difference will be 9.1 Mcal of energy and 3 g of phosphorus.

7. *Select an appropriate concentrate and determine the amount needed .*

Use either a concentrate mixed by a commercial company or a cereal grain such as oats, corn, barley, or a combination. If a commercial product is used, select one that is designed to be fed with alfalfa hay to bring Ca:P ratios in line, thus insuring that proper balance of minerals and vitamins.

Oats will be used for this example. The Digestible energy of oats is 2.91 Mcal/kg. To calculate the amount of oats needed each day, set up the following formula:

9.1 Mcal of Digestible energy is needed.

$\frac{2.91 \text{ Mcal}}{1 \text{ kg}} = \frac{9.1 \text{ Mcal}}{X \text{ kg}}$

X 2.91 = 9.1 (1)

X = $\frac{9.1}{2.91}$

X = 3.13 kg oats

Convert kg to lb

$\frac{1 \text{ kg}}{2.21 \text{ lb}} = \frac{3.13 \text{ kg}}{X \text{ lb}}$

X (1) = 3.13 (2.2)

X = 6.89

X = 7 lb of oats/day

8. Balance calcium and phosphorus, and provide a trace-mineralized salt at .5 to 1% of the diet or free-choice plus vitamin supplements as needed (see text).

   Calculate additional nutrients supplied by the oats. Evaluate the Ca and P balance. Both Ca and P requirements are met in this ration. This ratio is considered to be in the safe range for mature horses, but to illustrate how to bring the ratio closer to 2:1, a phosphorus supplement will be added. Using Table 10, choose a supplement that supplies P without Ca. Monosodium phosphate is 25.8% P with no calcium. Calculate how much P is needed to provide a 2:1 ratio.

   $\frac{103 \text{ g Ca}}{2}$ = 51.5 g P needed

   52.1 g P needed to get 2:1 ratio

   $\frac{28}{}$ g P supplied by diet

   23.5 g needed to supplement diet

   Monosodium phosphate

   $\frac{25.8 \text{ g P}}{100 \text{ g P}} = \frac{23.5 \text{ g P}}{\text{X g Monosodium P}}$

   X (25.8) = 23.5 (100)

   $X = \frac{2350}{25.8}$

   X = 91 g Monosodium P

   91 g sodium phosphate

   Convert to ounces (1g = 28.3 oz)

   $\frac{1 \text{ oz}}{28.3 \text{ g}} = \frac{\text{X oz}}{91 \text{ g}}$

   X (28.3) = 91

   X = 3 oz of monosodium phosphate per day

This will provide a 2:1 Ca:P ratio. If a trace-mineral salt mix containing selenium is available and a vitamin supplement is provided, the horse should be receiving a balanced diet.

This example illustrates only one method of balancing rations. There are other methods that can be used for more complex formulations, including computer generated least-cost rations. However, the principles used in this example will be applicable in many situations. Using the text and tables of this publication, many of the typical rations fed to horses can be balanced.

Ration Calculation Form

Farm _____

Animal Type Mature 1100 lb Working Horse

Season Early Spring

	Amount/day		Dig. Energy	Crude Protein	Lysine	Ca	P
	kg	lb	Mcal	g	g	g	g
Requirements			24.6	984	34	30	21
Provided by forage (type) Alfalfa	7.5						
Needed in grain ration							

Grain Ration Ingredients	Amount/day kg	lb					
Oats	3.1 kg	7	9.1	285	10	3	10
Salt	56 g						
Vit-Min Premix	56 g						
Mono Phos	2.8 g	0.09	0.02				23.5
Total for ration	10.7	23.7	24.6	1560	70	103	51.5

Condition

Condition	Neck	Withers	Loin	Tailhead, Pins & Hooks	Ribs	Shoulder
1 Poor	Bone structure easily noticeable. Animal extremely emaciated, no fatty tissue can be felt.	Bone structure easily noticeable.	Prominent spinous processes.	Tailhead and hooks and pins project prominently.	Ribs project prominently.	Noticeable bone structure on shoulder.
2 Very Thin	Neck faintly discernible. Animal emaciated.	Withers faintly discernible.	Slight fat covering over base of spinous processes. Transverse processes of lumbar vertebrae feel rounded. Spinous processes are prominent.	Tailhead and hooks and pins are prominent.	Ribs prominent.	Shoulder faintly discernible.
3 Thin	Neck accentuated.	Withers accentuated.	Fat built up about halfway on spinous processes. Transverse processes cannot be left.	Tailhead prominent, but individual vertebrae cannot be visually identified. Hook bones appear rounded, but easily discernible. Spinous proccesses easily discernible. Pin bones not distinguishable.	Slight fat cover over ribs. Ribs easily discernible.	Shoulder accentuated.
4 Moderately Thin	Neck not obviously thin.	Withers not obviously thin.	Spinous process (ridge) along back.	Tailhead prominence depends on conformation, fat can be felt around it. Hook bones not discernible.	Faint outline of ribs discernible.	Shoulder not obviously thin.
5 Moderate	Neck blends smoothly into body.	Withers appear rounded over spinous processes.	Back is level.	Fat around tailhead beginning to feel spongy.	Ribs cannot be visually distinguished but can be easily felt.	Shoulder blends smoothly into body.
6 Moderate to Fleshy	Fat beginning to be deposited.	Fat beginning to be deposited.	May have slight crease down back.	Fat around tailhead feels soft.	Fat over ribs feels spongy.	Fat beginning to be deposited.
7 Fleshy	Fat deposited along neck.	Fat deposited along withers.	May have crease down back.	Fat around tailhead feels soft.	Individual ribs can be felt, but noticeable filling between ribs with fat.	Fat deposited behind shoulders.
8 Fat	Noticeable thickening of neck. Fat deposited along inner buttocks.	Area along withers filled with fat. Fat deposited along inner buttoocks.	Crease down back.	Fat around tailhead very soft.	Difficult to palpate ribs.	Area behind shoulder filled in flush.
9 Extremely Fat	Bulging fat.	Bulging fat.	Obvious crease down back.	Bulging fat around tailhead. Fat along inner buttocks may rub together. Flank filled in flush.	Patchy fat appearing over ribs.	Bulging fat.

Source: Henneke et al. 1983

Figure 1. Condition Score System