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COMPUTING HORSE NUTRITION: HOW TO PROPERLY CONDUCT AN EQUINE NUTRITION EVALUATION

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Introduction

Feed manufacturers and horse owners place a great deal of emphasis on the nutrient content of the feeds and supplements that they produce or feed to their horses. Often, extremely rigid values are used for certain nutrients. For instance, horse owners will insist that they feed a 14% protein concentrate to their yearlings; 13% protein would be considered completely inadequate and 15% protein would be excessive. These preconceived ideas about the correct nutrient concentration for different classes of horses are more a product of tradition and misinformation than science. In fact, the concentration of a specific nutrient in a grain mix or supplement is only relevant when it is viewed in the context of a total ration. Therefore, it is important that we have a system to accurately evaluate the complete ration of the horse. Unfortunately, this is not as simple as it may first appear. Nutrition evaluations are based on a number of assumptions and estimates that may or may not be correct. This paper will outline the steps that should be followed when conducting a nutrition evaluation for horses. It will attempt to point out the weaknesses that are an unavoidable part of conducting such an evaluation and it will introduce a new computer software program that will make the evaluation process less tedious and more accurate.

The protocol

Every nutrition evaluation should follow the same series of steps. Omitting any of these steps can lead to serious errors in an evaluation. The obvious place to start with any nutrition evaluation is by classifying the type of horse that we are feeding. Different classes of horses have different nutrient requirements and they will eat different amounts of forage and grain.

Horses can be classed into the following broad categories:

Table 1. CLASSES OF HORSES

Growing horses	*Broodmares*	*Adult Horses*
Suckling foals	barren	idle
Weanlings	early pregnant	light work
Yearlings	late pregnant	moderate work
Long yearlings	early lactation	heavy work
Two year old	late lactation	geriatric

Within each class of horse, it is also important to know the horse's current body weight, its age and mature body weight if it is growing, and its rate of body weight gain or loss. Obviously, for a growing horse weight change will be as growth, but for adult horses weight changes will also have a large influence on nutrient requirements. For example, an adult horse that is too thin may need to gain weight to reach a desirable body condition. This extra weight gain will require additional dietary calories which will increase the horse's total daily energy requirement.

Nutrient requirements

Ration evaluations are intended to compare a horse's daily nutrient intake to a set of requirements to see how well the feeding program meets the horse's nutrient needs. This seems a pretty straight-forward accounting exercise, but what nutrient requirements should we use? The National Research Council (NRC) publishes a set of requirements for horses as it does for other species of livestock, so many nutritionists chose to use these numbers to evaluate a ration. Unfortunately, the NRC figures fall short in a number of respects. For the most part, NRC values represent *minimum* requirements for most nutrients. These are the levels of intake that are required to prevent frank deficiency symptoms. There is no allowance included as a safety margin to take into account factors which may increase the requirement for a nutrient. Different sources of nutrients may have different bioavailabilities and there may be other substances within a ration that interfere with the digestibility or utilization of the nutrient.

Digestible energy and protein are two NRC requirements that fairly accurately describe the needs of horses maintained under practical management conditions. These two requirements were for the most part developed from direct measurements of growth response and energy balance in a number of different experiments. Other requirements such as calcium and phosphorus were developed using more theoretical calculations involving estimates of endogenous losses and digestibility. Still others

were based on values developed for other species or from single experiments that were far from conclusive. For most of the vitamins and minerals, we use values ranging from 1.25 times NRC to values as high as 3.0 times NRC. These more liberal requirements are based on KER's own research and experience in the field. All of these nutrient requirements are far from absolute and they will continue to evolve as more data become available. For now, though, we feel that our requirements adequately reflect what is needed by the horse under a wide range of conditions.

Types of evaluations

There are two ways that you can approach a ration evaluation. One way is to evaluate a current ration for nutrient adequacy by tallying up what is currently being fed and comparing that to the horse's requirements. This is actually more difficult that it may first appear since most horsemen don't actually know exactly what their horses are eating. There are a number of checks that can be used to more accurately estimate feed intakes and we will review those later. A second type of evaluation is one in which a ration is being developed for a horse. These types of evaluations are also tricky since the various feeds and levels of intakes selected must be practical and safe for the horse in question.

Both types of evaluations depend on the concept of *energy balance* to match feeds intake to requirements. Calculating energy balance allows a primary overall evaluation of how well a ration meets the horse's needs. Only after we are satisfied that the horse is in a reasonable state of energy balance will we proceed with the rest of the evaluation.

Energy is the key

The first step for every evaluation is to calculate the energy requirement of the horse. We currently use units of *Digestible Energy (DE)* to describe dietary energy requirements. DE requirements can be expressed as kilocalories (kcal) or megacalories (Mcal), where 1 Mcal equals 1000 kcal. Joules are another unit of measure used to describe DE. To convert calories to Joules, simply multiply by 4.18. Therefore, 1 kcal = 4.18 kJ and 1 Mcal = 4.18 MJ. Digestible energy is actually a fairly crude method of describing the energy content of feed, since it is calculated by subtracting the energy lost in the manure from the gross energy (GE) content of the feed. There are large differences in how efficiently the digested energy is utilized from different feedstuffs, so DE requirements can only be viewed as ball park estimates that must be refined depending on the type of diet being fed. For example, a horse will require more DE to meet its energy requirement if it is eating an all forage diet than if it is eating a ration high in grain or added fat. More accurate systems of energy evaluation

utilizing net energy (NE) have been developed, but have not been placed into widespread use because of a lack of information about NE requirements for various classes of horses and NE contents of different feedstuffs.

Table 2. ENERGY REQUIREMENTS FOR DIFFERENT CLASSES OF HORSE

Class of horse	*Equation*	*Body weight (ADG)*	*DE (Mcal/day)*
Weanling	1.4 + (0.0136 x BW[1]) + (4.54 x ADG [2])	500 (1.75)	16.1
Yearling	1.4 + (0.0136 x BW) + (7.27 x ADG)	725 (1.25)	20.4
2 yr old	1.4 + (0.136 x BW) + (9.1 x ADG)	1000 (0.50)	19.6
Maintenance	1.4 + (0.0136 x BW)	1100	16.4
Early pregnant[3]	(maintenance DE)	1100	16.4
Late pregnant[4]	(maintenance DE) x 1.2	1100	19.7
Early lactation[5]	(maintenance DE) + (0.04 BW x 0.36)	1100	32.2
Late lactation[6]	(maintenance DE) + (0.03 BW x 0.36)	1100	28.3
Light work	(maintenance DE) x 1.25	1100	20.5
Moderate work	(maintenance DE) x 1.50	1100	24.6
Heavy work	(maintenance DE) x 2.00	1100	32.8

[1] BW = body weight (lb)
[2] ADG = average daily gain (lb/day)
[3]early pregnant = 1st 8 months of pregnancy
[4] late pregnant = last 3 months of pregnancy
[5]early lactation = 1st 3 months of lactation
[6] late lactation = 2nd 3 months of lactation

Table 2 lists the DE requirements for various classes of horses. The maintenance DE requirement for horses is DE (Mcal/day) = 1.4 + 0.03 x body weight (Kg). Requirements for other classes of horses will depend on age, growth rate, reproductive status or work intensity. We will evaluate each of these classes later. For now, let's evaluate the mature, idle horse. An average 500 kg (1100 lb horse) horse requires 16.4 Mcal DE/day. Remember, this is an average figure and there will be great variation among individuals, but it gives us a place to start.

Once the energy requirement is established, a ration must be designed. A horse's ration must contain an adequate quantity of forage to maintain proper gut function. This amount, both in absolute terms and as a percentage of the total diet, will change depending on the age and physiological status of the horse. Table 3 provides guidelines for forage and grain intake in various classes of horse.

From this table we can see that a mature horse at maintenance needs to consume at least 1% of its body weight and 50% of its total ration as forage. How much digestible energy does this amount of forage provide? The answer depends on the type of forage selected. The next step in performing a ration evaluation is estimating the energy content of different feedstuffs. For grains and feeds, values from the literature are generally used. Table 4 lists some common equine feedstuffs and their estimated DE contents. It should be emphasized that these energy values are only estimates since very few actual DE determinations have been made on individual feed ingredients, and those that have been made have used mathematical formulas to calculate the energy content of individual grains. Only the DE content of forages can be determined directly.

If our 1100 kg horse were eating a midbloom timothy hay with a DE content of 0.80 Mcal/lb, then an intake of 1% BW (11 lbs) would provide only 8.8 Mcal of DE. This is far short of the horse's DE requirement (16.4 Mcal/day) and at this level of forage intake, supplemental grain would be required. With this minimal forage intake, the horse would require about 5.5 lbs of a concentrate containing 1.35 Mcal/lb. It is much more likely that a horse of this type would eat 2% of BW/day as hay. This level of hay intake (22 lbs) would provide 17.6 Mcal DE, a level that is fairly close to the horse's requirement, considering the relatively low efficiency with which DE is used from forage. But what about the mature horse that is maintaining its weight and condition (i.e. zero energy balance) just fine on 5 lbs of timothy hay per day and bluegrass pasture? The horse must be consuming around 16-17 Mcal of DE/day to maintain a constant body condition and only 4 Mcal are coming from the hay. Therefore, it must be eating enough pasture per day to provide an additional 12-13 Mcal DE. If bluegrass pasture contains about 1.0 Mcal DE/lb of DM, then the horse must be consuming 12 or 13 lbs of pasture dry matter per day. As you can see from this example, a horse can meet its DE requirements from a number of different sources. The ration most appropriate for an individual will depend on a number of factors related to management and forage availability. How well any of these rations meets the rest of the horse's nutrient requirements will be determined later in the evaluation, but for now we must quantify levels of intake for each feedstuff.

Table 3. EXPECTED FEED CONSUMPTION BY HORSES

	% of body weight		*% of diet*	
Horse	*forage*	*concentrate*	*forage*	*concentrate*
Maintenance	1.0-2.0	0-1.0	50-100	0-50
Pregnant mare	1.0-2.0	0.3-1.0	50-85	15-50
Lactating mare (early)	1.0-2.5	0.5-2.0	33-85	15-66
Lactating mare (late)	1.0-2.0	0.5-1.5	40-80	20-60
Weanling	0.5-1.8	1.0-3.0	30-65	35-70
Yearling	1.0-2.5	0.5-2.0	33-80	20-66
Performance horse	1.0-2.0	0.5-2.0	33-80	20-66

The above example also assumed that the horse was in energy equilibrium or zero energy balance. In other words, energy intake exactly equalled energy expended so the horse neither gained nor lost weight. This is the goal when feeding a mature, idle horse, but often a horse will get fat while eating nothing but pasture. To calculate how much extra DE the horse is consuming over its maintenance requirement, follow these steps:

1) weigh the horse repeated over several weeks at the same time per day
2) calculate average daily weight gain
3) 1 lb of fat deposition requires about 7.5 extra Mcal of DE

A horse that is on pasture gaining 1.5 lbs per day (make sure it's fat deposition and not gut fill) must be consuming about 11 lbs of pasture dry matter more than is required to maintain constant body weight since most pasture contains about 1.0 Mcal DE/lb of dry matter. Adult horses can easily eat 2.5% (27.5 lbs) of their body weight per day as pasture dry matter, so it's easy to see how an 1100 lb horse can get fat on pasture alone! This level of pasture intake provides 27.5 Mcal DE/day, which is 11 Mcal over the maintenance requirement. This extra DE would produce 1.5 lbs of fat deposition per day, and in three months on this type pasture, your horse has gained 135 lbs of weight.

Table 4. DE CONTENT (MCAL/LB) OF COMMON EQUINE FEEDSTUFFS

Hays		*Pasture*		*Grains and supplements*	
As fed	*DE (Mcal/lb)*	*Dry basis*	*DE (Mcal/lb)*	*As fed*	*DE (Mcal/lb)*
Timothy (early bloom)	0.83	Alfalfa	1.34	Barley	1.49
Timothy (midbloom)	0.80	Bahiagrass	0.92	Beet pulp	1.06
Timothy (late bloom)	0.78	Bermudagrass	1.08	Corn	1.54
Alfalfa (early bloom)	1.02	Bluegrass	0.95	Molasses	1.20
Alfalfa (mid bloom)	0.94	Clover	1.14	Oats	1.30
Alfalfa (late bloom)	0.89	Fescue	1.01	Soybean meal	1.43
Bermuda grass	0.85	Orchard grass	1.04	Sweet feed	1.35-1.40
Bluegrass	0.72	Pangola grass	0.89	Vegetable oil	4.08

This same weight gain would result from 8 lbs grain per day fed along with 20 lbs of midbloom timothy hay. Many mature horses are fed this way and the horse will often gain 100 lbs before the owner notices that it is getting fat. In this situation, a ration evaluation would signal that this excess weight gain may be taking place. If so, the energy balance of the horse needs to be assessed. For more information about monitoring energy balance, see the article "*What does your horse weigh?*" in section 5 of this book.

Calculating pasture intake

The amount of pasture eaten by any class of horse can be calculated by subtracting the DE intake from all other feedstuffs from the horse's daily energy requirement. Dividing this number by the pasture's calculated energy density yields daily dry matter intake. For example, a yearling that weighs 725 lbs with an average daily gain of 1.25 lbs/day should require 20.4 Mcal DE/day. If that yearling is eating 8 lbs of sweet feed (10.8 Mcal DE) and 4 lbs of mature alfalfa hay (3.6 Mcal DE), then it must be consuming around 6 Mcal of DE from pasture. Most grass pastures contain about 1 Mcal DE/lb, so this yearling must consume about 6 lbs of pasture dry matter per day. These intakes can then be used to evaluate the adequacy of the ration for other nutrients in addition to energy.

This method of calculating pasture energy intake works well provided that two assumptions are correct:

1) The horse is really consuming the intakes of the other feedstuffs
2) You have chosen the correct energy requirement

Often times, using the method described above for estimating pasture intake yields a negative number. If this occurs, then either the DE intake of the other feeds was too high or the calculated energy consumption was too low. Sometimes, horse owners report higher intakes for feeds than are actually eaten. This is particularly true for forage were hay is rarely weighed and large quantities are often wasted. Grain intake can also be overestimated since that coffee can that is used to measure grain doesn't hold nearly as much grain as coffee! Other times, the hay and grain intake may be correct, but the horse may be consuming more energy than calculated. This can happen if the horse is expending extra energy because of activity or to keep warm in cold weather or it may be that a young horse is growing faster than assumed. For example, a yearling needs about 5 lbs of additional grain (7.3 Mcal DE) per lb of gain. If average daily gain is higher than assumed, then the horse may eating significantly more DE than calculated.

Evaluating nutrient adequacy

After nutrient requirements are established and intakes estimated, the various feedstuffs should be sampled and analyzed for other nutrients. The accuracy of the entire nutrition evaluation depends on the use of proper methodology for sampling feedstuffs. The feeds should be thoroughly mixed and a representative sample taken. This is not difficult for pelleted feeds since each pellet is fairly uniform in composition. For textured feeds and home mixes, however, sampling is more critical. If an odd nutrient value is encountered, look to sampling error as a likely cause.

Sampling forages presents a challenge, especially when sampling pasture. A hay core can be used to get a representative hay sample for analysis. Pasture analysis is more difficult. The first question that must be addressed is whether the entire pasture should be systematically sampled or if only those areas heavily grazed should be sampled. Since horses tend to be "spot" grazers, it is probably best to sample the areas heavily grazed rather than the entire pasture.

When expressing feed intakes and nutrient composition, we use "air dry" values for hay and grain and "100 % dry matter" values for pasture. This is because hay and grain intakes are actually measured "as fed" and pasture intakes tend to be estimated. The moisture content of the pasture is not relevant to our evaluation and only confuses how to calculate intake.

WEANLINGS

Let's evaluate the ration of a 6 month old weanling. This is a March foal born in Kentucky, so the current evaluation would be in September. This particular foal is eating 8 lbs of a commercial concentrate containing 16% protein and 1.45 Mcal DE/lb. It weighs 550 lbs and is gaining an average of 1.87 lbs/day. Therefore, it would have a daily DE requirement of 17.4 Mcal (see table 2). The 8 lbs of grain provides 11.6 Mcal DE, leaving about 6 Mcal of DE needed from forage.

If this weanling were maintained on pasture without hay supplementation, then it would probably consume around 6 lbs of pasture dry matter. Table 5 contains a tabular evaluation of this feeding program. The top portion of this table contains the nutrient composition of the ration. Notice that the concentrate intake is expressed on an "as fed" basis while the lower portion provides the *daily* nutrient intake for DE, protein, lysine and a number of macro and micro minerals. In addition to the concentrate and pasture, it is assumed that this weanling will voluntarily consume about 30 grams (~ 1 ounce) of free choice salt per day.

Table 5. NUTRITION EVALUATION OF A 6 MONTH OLD WEANLING* EATING PASTURE PLUS A 16% PROTEIN GRAIN MIX. NOTICE THAT THIS TYPE OF RATION PROVIDES MORE PROTEIN THAN NECESSARY

Nutrient Composition	*Fall pasture*	*Grain ESF 1*	*Salt*	*Total nutrient*	*Supplied by ration*	*Required nutrients*
Intake (lbs/day)	6.01	8.00	0.11	14.11		
Intake (kgs/day)	2.73	3.64	0.05	6.42		
Dry matter %	100.00	89.00	100.00	93.77		
Protein %	16.00	16.00		15.88		
Lysine %	0.56	0.72		0.65		
DE (mcal/kg)	2.20	3.10		2.69		
Calcium %	0.55	0.95		0.77		
Phosphorus %	0.30	0.75		0.55		
Magnesium %	0.20	0.38		0.30		
Sodium %	0.01	0.25	40.00	0.46		
Potassium %	1.70	0.68		1.11		
Zinc (ppm)	35.00	125.00		85.72		
Manganese (ppm)	70.00	125.00		100.62		
Copper (ppm)	12.00	45.00		30.61		
Selenium (ppm)	0.10	0.50		0.33		
Iodine (ppm)	0.05	0.40		0.25		
Cobalt (ppm)	0.10	0.20		0.16		
Daily intakes						
Dry matter (kgs/day)	2.73	3.24	0.05		6.02	6.25
Protein (kg/day)	436.80	581.60	0.00		1018.40	783.00
Lysine (g/day)	15.29	26.17			41.46	36.54
DE (Mcal DE/day)	6.01	11.27	0.00		17.27	17.40
Calcium (g/day)	15.02	34.53	0.00		49.55	44.25
Phosphorus (g/day)	8.19	27.26	0.00		35.45	29.50
Magnesium (g/day)	5.46	13.81	0.00		19.27	11.06
Sodium (g/day)	0.27	9.09	20.00		29.36	18.75
Potassium (g/day)	46.41	24.72	0.00		71.13	62.50
Zinc (mg/day)	95.55	454.38	0.00		549.93	500.00
Manganese (mg/day)	191.10	454.38	0.00		645.48	500.00
Cooper (mg/day)	32.76	163.58	0.00		196.34	150.00
Selenium (mg/day)	0.27	1.82	0.00		2.09	1.88
Iodine (mg/day)	0.14	1.45	0.00		1.59	1.25
Cobalt (mg/day)	0.27	0.73	0.00		1.00	0.94

* Class weanling 550.00 Body wt. (lbs); 250.00 Body wt (kgs); 500.00 Mature wt. (kgs); 0.85 ADG (kg/day); 1.87ADG (lbs/day); 6.00 Age (months)

This evaluation can also be presented graphically as in figure 1. This type of presentation expresses intakes of each nutrient as a percent of required supplied, thus eliminating the various units of measure that are confusing to the horse owner. In

addition, a graphic presentation of this type shows the relative contribution that each ingredient makes to the overall nutrient intake of a ration.

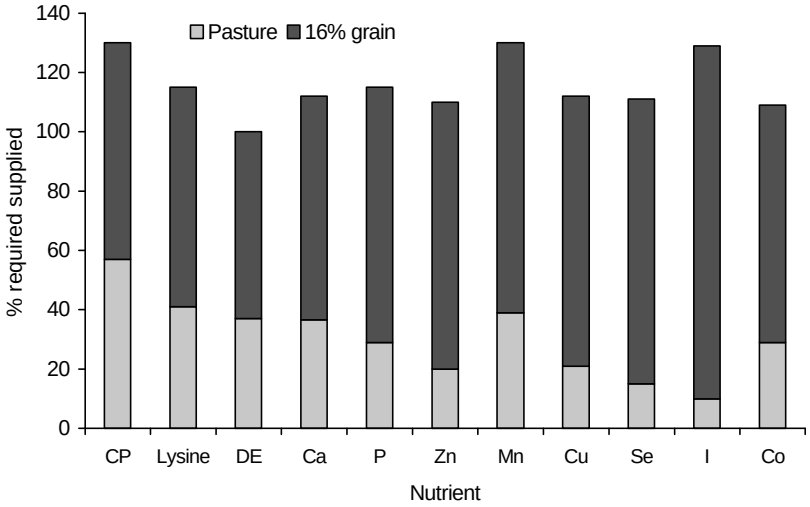

Figure 1 Weanling eating pasture plus a 16% protein grain concentrate

From this evaluation, it is apparent that a 16% protein concentrate is unnecessary to meet the weanling's protein requirement since the forage portion of the ration (pasture) is high in protein.

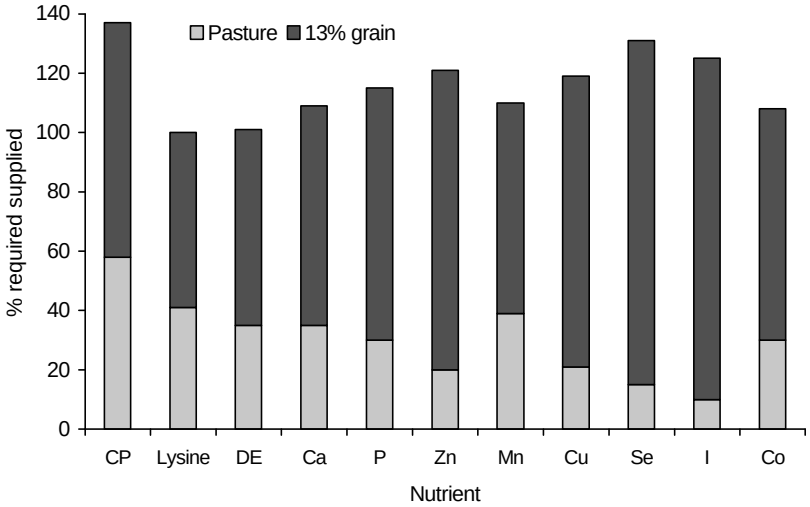

Figure 2 Weanling eating pasture plus a 13% concentrate

Table 6. NUTRITION EVALUATION OF A 6 MONTH OLD WEANLING* EATING PASTURE PLUS A 13% CONCENTRATE.

Nutrient Composition	*Fall pasture*	*Grain ESF 1*	*Salt*	*Total nutrient*	*Supplied by ration*	*Required nutrients*
Intake (lbs/day)	6.01	8.01	0.11	14.12		
Intake (kgs/day)	2.73	3.64	0.05	6.42		
Dry matter %	100.00	89.20	100.00	93.88		
Protein %	16.00	13.00		14.17		
Lysine %	0.56	0.59		0.57		
DE (mcal/kg)	2.20	3.17		2.73		
Calcium %	0.55	0.90		0.74		
Phosphorus %	0.30	0.70		0.52		
Magnesium %	0.20	0.30		0.26		
Sodium %	0.01	0.20	40.00	0.43		
Potassium %	1.70	0.40		0.95		
Zinc (ppm)	35.00	140.00		94.26		
Manganese (ppm)	70.00	100.00		86.46		
Copper (ppm)	12.00	40.00		27.78		
Selenium (ppm)	0.10	0.60		0.38		
Iodine (ppm)	0.05	0.40		0.25		
Cobalt (ppm)	0.10	0.20		0.16		
Daily intakes						
Dry matter (kgs/day)	2.73	3.25	0.05		6.03	6.25
Protein (kg/day)	436.80	473.20	0.00		910.00	783.00
Lysine (g/day)	15.29	21.29			36.58	36.54
DE (Mcal DE/day)	6.01	11.54	0.00		17.54	17.40
Calcium (g/day)	15.02	32.76	0.00		47.78	44.25
Phosphorus (g/day)	8.19	25.48	0.00		33.67	29.50
Magnesium (g/day)	5.46	10.92	0.00		16.38	11.06
Sodium (g/day)	0.27	7.28	20.00		27.55	18.75
Potassium (g/day)	46.41	14.56	0.00		60.97	62.50
Zinc (mg/day)	95.55	509.60	0.00		605.15	500.00
Manganese (mg/day)	191.10	364.00	0.00		555.10	500.00
Copper (mg/day)	32.76	145.60	0.00		178.36	150.00
Selenium (mg/day)	0.27	2.18	0.00		2.46	1.88
Iodine (mg/day)	0.14	1.46	0.00		1.59	1.25
Cobalt (mg/day)	0.27	0.73	0.00		1.00	0.94

* Class weanling 550.00 Body wt. (lbs); 250.00 Body wt (kgs); 500.00 Mature wt. (kgs); 0.85 ADG (kg/day); 1.87ADG (lbs/day); 6.00 Age (months)

In this instance, a 13% protein grain mix will meet the weanling's protein requirements. If this type of mix is adequately fortified with other nutrients, then it is perfectly fine for weanlings grazing high quality pasture such as the type found in Central Kentucky. Table 6 and figure 2 illustrate this type of ration.

If this weanling had been raised on poorer quality pasture or fed only grass hay, then the 16% protein grain mix with higher levels of supplemental mineral would have been required. Table 7 and figure 3 show this type of ration where the foal is consuming the same quantity of concentrate along with orchardgrass hay. With this type of ration, protein may be marginal and lysine may actually be deficient. Also, calcium intake may be lower than optimal. In this instance, the text book "16%" for weanlings is probably justified.

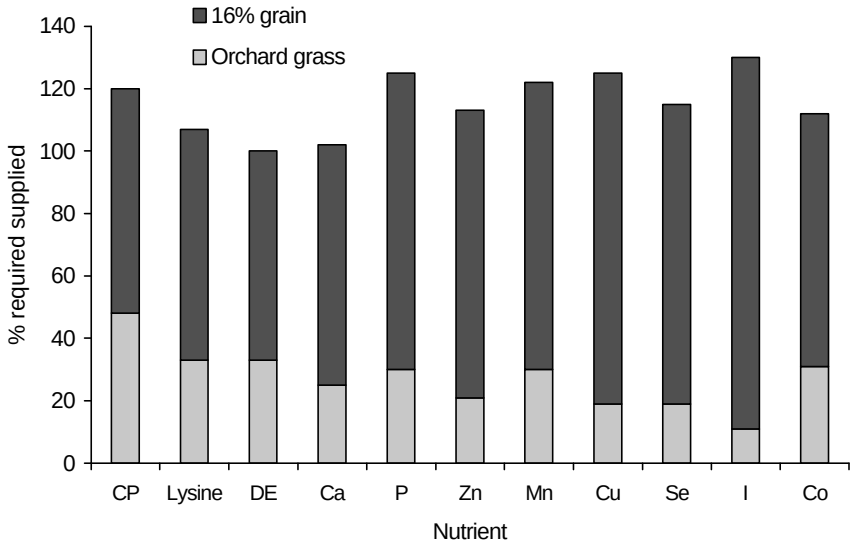

Figure 3 Weanling eating a 16% protein concentrate plus orchardgrass hay.

Evaluation software

Conducting an equine nutrition evaluation by hand calculation can be a tedious process. Therefore, Kentucky Equine Research has developed a software program to simplify the process. This program, called MicroSteed™, will automatically calculate nutrient requirements for each class of horse using either KER equations or those developed by the NRC. It also contains a large data base of feed ingredients from various geographic region around the world including many commercial concentrates and supplements. This program is written for use in a Windows environment in a very user friendly format. It will automatically create stacked bar graphs such as the ones illustrated in figures 1-3. In addition, help screens contain useful information about typical horse weights and growth rates.

Table 7. NUTRITION EVALUATION OF A 6 MONTH OLD WEANLING* EATING ORCHARDGRASS HAY PLUS A 16% PROTEIN CONCENTRATE.

Nutrient Composition	*Fall pasture*	*Grain ESF 1*	*Salt*	*Total nutrient*	*Supplied by ration*	*Required nutrients*
Intake (lbs/day)	7.04	8.01	0.11	15.16		
Intake (kgs/day)	3.20	3.64	0.05	6.89		
Dry matter %	89.10	89.00	100.00	89.13		
Protein %	11.40	16.00		13.75		
Lysine %	0.40	0.72		0.57		
DE (mcal/kg)	1.94	3.10		2.54		
Calcium %	0.34	0.95		0.66		
Phosphorus %	0.30	0.75		0.54		
Magnesium %	0.10	0.38		0.25		
Sodium %	0.01	0.25	40.00	0.43		
Potassium %	2.59	0.68		1.56		
Zinc (ppm)	36.00	125.00		82.76		
Manganese (ppm)	50.00	125.00		89.26		
Copper (ppm)	8.00	45.00		27.49		
Selenium (ppm)	0.11	0.50		0.31		
Iodine (ppm)	0.05	0.40		0.23		
Cobalt (ppm)	0.10	0.20		0.15		
Daily intakes						
Dry matter (kgs/day)	2.85	3.24	0.05		6.14	6.25
Protein (kg/day)	364.80	582.40	0.00		947.20	783.00
Lysine (g/day)	12.77	26.21			38.98	36.54
DE (Mcal DE/day)	6.21	11.28	0.00		17.49	17.40
Calcium (g/day)	10.88	34.58	0.00		45.46	44.25
Phosphorus (g/day)	9.60	27.30	0.00		36.90	29.50
Magnesium (g/day)	3.20	13.83	0.00		17.03	11.06
Sodium (g/day)	0.32	9.10	20.00		29.42	18.75
Potasium (g/day)	82.88	24.75	0.00		107.63	62.50
Zinc (mg/day)	115.20	455.00	0.00		570.20	500.00
Manganese (mg/day)	160.00	455.00	0.00		615.00	500.00
Copper (mg/day)	25.60	163.80	0.00		189.40	150.00
Selenium (mg/day)	0.34	1.82	0.00		2.16	1.88
Iodine (mg/day)	0.16	1.46	0.00		1.62	1.25
Copper (mg/day)	0.32	0.73	0.00		1.05	0.94

* Class weanling 550.00 Body wt. (lbs); 250.00 Body wt (kgs); 500.00 Mature wt. (kgs); 0.85 ADG (kg/day); 1.87ADG (lbs/day); 6.00 Age (months)

MicroSteed™ makes equine nutrition evaluation much simpler and more descriptive. However, it will produce accurate results only if the rules outlined in this paper are followed. Feed intakes that match energy status must be used and feedstuffs must be properly sampled and accurately analyzed. With these safeguards, a great deal can be learned from conducting thorough equine nutrition evaluations.