

## **A formula for energy expenditure**

Everybody knows that endurance/distance horses burn up a lot of calories during conditioning and competition, but until fairly recently, energy requirements were only very roughly estimated by the National Research Council. Specifically, horses in light work were estimated to require 125% of their maintenance energy requirements; horses at medium work were estimated as requiring 150% of maintenance and horses at hard work requiring 200% of their maintenance energy requirements.

There are several obvious and unavoidable problems with this method---firstly, individual horses vary greatly, as do the environments they are kept in. Cold weather, parasites, age, body weight and many other factors can all affect feed efficiency and thus the energy requirement. Secondly, individual opinions of what constitutes "hard work" can vary greatly---what a show or pleasure rider may consider an intense work schedule would probably be considered an easy week by many competitive endurance riders.

Several years ago, a much more specific formula was published by Pagan and Hintz in the Proceedings of the Equine Nutrition and Physiology Society. Both Drs. Pagan and Hintz are widely respected physiologists and Dr. Hintz is one of those responsible for compiling and editing the National Research Council's book Nutrient Requirements for Horses. Although the data that resulted in this formula was collected on the flat, it still provides the most accurate field method of estimating energy expenditure during exercise to date.

It's interesting to calculate the calories required for an average horse to cover 50 miles---a 900 lb horse carrying a 165 lb rider and covering 50 miles in 6 hours actual riding time burns up 18.3 megacals (Mcal). The same horse carrying a 210 lb rider and covering the same fifty miles in four hours would burn 26 Mcals. A 1000-lb thoroughbred carrying 112 pounds and running a mile in two minutes would burn 4.6 Mcals in just two minutes, which is pretty impressive considering he's providing the majority of that energy in the form of glucose (endurance horses get the majority of their energy requirements from stores of body fat, which is in greater supply.)

Since feed efficiency is only around 60% efficient for a typical ration (that means that only 60% of the calories ingested actually get utilized in energy production, the rest are burned in metabolism or lost as heat, etc), that means that you would have to feed the above two example endurance horses 30.5 and 43.4 Mcals, respectively, to make up the energy burned during that 50-mile ride. If you were feeding corn grain to replace those calories, you'd have to provide 18.8 or an incredible 26.74 pounds in addition to the horse's normal maintenance requirements---which for an average 900 pound horse, would be an additional 13.4 Mcals. Of course, you wouldn't try to replace those expended calories in a single meal, but use this information to plan a sensible and consistent nutritional program in order to maintain good body condition throughout the ride season.

The engineers and math whizzes can take this formula and run with it. For the rest of us, below are directions on how to actually get useable numbers to help make intelligent choices in a feeding and management program.

The formula is:  $Y = e^{3.20 + .0065x}$ ; where x is the speed in meters/minute, and Y equals the calories expended per kg per minute.

Here's how to actually get an answer if you're not a math genius---you will need a calculator that does logarithms, natural logs, etc, just the cheap kind they give out at the gas station won't do it.

First you need to calculate the average speed ("x") you're traveling at. It's okay if you change speed a lot, the formula still works. Figure out how many miles you traveled and how long it took you to get there. Convert the miles to meters by multiplying miles times 1609.35 (the number of meters in a mile). Fifty miles is 80,467.5 meters. Divide this number by how many minutes you took getting there. This will give you your average speed in meters per minute. For example, if you took six hours to travel fifty miles then  $x = 80,467.5 \text{ divided by } 360 = 223.54 \text{ meters/min.}$

Multiply x by .0065 and add 3.20. For example, 223.54 times .0065, plus 3.2 equals 4.65. If you have a memory function on the calculator, put this number into the memory, or at least write it down.

Find on the calculator the inverse function for the natural log. The primary function on the calculator button will say "LN", and the inverse/2nd function will have an "e" with an "x" superscript. Take the number you just calculated above (in the example, the 4.65), push the 2nd function key, and then the LN key to get the inverse function. In the above example, the result would be 104.89. This number is the number of calories your horse is burning PER minute, PER kilogram of weight getting moved down the trail. This is "Y". Put this number into memory or write it down.

To calculate the total expenditure of energy, you need to know how many total kilograms of weight your horse is having to move down the trail. Take your horse's weight in pounds and add the number of pounds he's carrying in rider and tack weight. For example, a 900 pound horse carrying 165 pounds of rider and tack totals 1065 pounds. Divide this number by 2.2 to convert to kilograms. 1065 pounds equals 484 kilograms.

Take the number of kilograms and multiply it by the Y number you calculated above, and then calculate THAT number by the minutes you were riding. In the on-going example, if you took six hours to do a 50 mile ride, you rode for 360 minutes. So the total expenditure of calories was 18,650,000 calories.

To convert this number into something less cumbersome, divide this number by 1,000,000 (one million) to give you megacals (Mcal), or by 1000 to give kilocalories (Kcals), the unit most people are thinking of when they think "calories", as in "that piece of cake is 500 calories". Horses rations are most commonly calculated in Mcals.

Divide the number of Mcals by .60. For example, 18.65 Mcal divided by .60 equals 31.08 Mcals. This is the number of extra calories you would have to actually feed just to replace the calories burned during this ride, IF you wanted to maintain weight---remember, the horse has already supplied the energy he needed from fat stores, as well as a small amount from what he ate during

the ride. Hopefully, if you're competing, then you are already feeding more than just a flake of hay. Just to give a general idea, you would have to feed 20 pounds of corn to supply the 18.65 Mcals, or about 15 cups of vegetable oil, or 23 pounds of oats. So if you're competing a lot, you might use this formula to give you just a general idea of how many extra calories you need to be providing in the daily ration (obviously, you would spread the extra calories over a number of days, and make sure the horse keeps exercising, so you don't run into digestive upset and/or azoturia problems). If you don't provide enough calories, the horse isn't going to drop dead or his ears fall off, he's just going to lose weight throughout the season, which IS eventually going to affect his performance.

This formula when applied to distance horses is probably going to provide only a reasonable estimate of energy expenditure. The exact number would vary depending on factors like terrain, temperature, the skill of the rider and individual factors like temperament, keeping qualities, type of feed provided and feed efficiency factors. An exact measurement would be highly impractical in the field, and impractical as well, as conditions are going to change from day to day. But for those riders that like knowing the details of what's going on with their horse (or are possibly looking for an explanation of why Lightning is losing weight despite what would seem to be an adequate ration), this formula might be something interesting for you to keep around.

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