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## Nutrition and Feeding of Donkeys

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### Introduction

The donkey is a herbivore. This means that it eats plants as food. The food provides the energy, protein, minerals and vitamins which the donkey needs for maintenance, for work, for growth, and when appropriate for pregnancy and lactation. Many people assume that donkeys can survive by fending for themselves on grazing and do not need any special feeding. However, the food demands of donkeys can vary over the year, depending if they are doing a lot of work, or if they are pregnant or have a foal to feed. The feed quality of grazing varies through the year too as the grasses develop from young easily digested plants to the mature plants after flowering, which contain more fibre and are less digestible. To make sure a donkey is well fed it is necessary to know something about its feed requirements and then how best to meet these requirements from the feeds that are available.

There are many reasons to feed a donkey well. Good feeding keeps a donkey in good body condition. This makes it less prone to harness and saddle sores when working. Good nutrition can reduce the occurrence of disease, reduce the effects of disease on the donkey and help increase the rate of recovery from a disease. Young animals need good feeding to reach their potential for growth. Good feeding can help donkeys live longer. Good feeding of a female donkey helps it produce and rear a healthy foal to provide replacements or income from sales. A thin donkey is prone to disease, and harness sores, works slowly and does not reproduce.

A great deal of scientific research has gone into measuring and predicting the nutrient requirements of horses in competition and in racing and more recently in their use for pleasure. The energy, protein, mineral and vitamin requirements have been determined. The average nutrient composition of feeds commonly given to horses is available in tables of feed composition. Ways in which to formulate rations to meet requirements using common feeds are explained in all good books on equine nutrition. The reader wanting these details is referred to the list of further reading at the end of this chapter. There is much less information on donkeys than there is on horses.

This chapter aims to give some basic background to the nutrition of the donkey and some simple practical advice for feeding donkeys. It is for use by field workers with no access to nutrition laboratories, but who know what work the animals are doing, whether they are to be used for breeding, and what they are fed on.

### Feeding Strategy of the Donkey

To feed a donkey well does not require a large amount of money or feed, it is easier to feed a working donkey well than for example a working ox. The donkey is smaller and so needs less actual feed than most cattle. However, the way in which the donkey processes the food and what it gets from it are different from an ox. It is important to remember this when feeding donkeys - they are not just small oxen. Their feeding strategy is different.

Donkeys and horses are non-ruminant herbivores, unlike cattle, which are ruminant herbivores. The non-ruminant herbivores digest the fibre part of the diet in the hind-part of the digestive tract. The ruminant herbivores (cattle and buffalo) digest it in the fore-part of the digestive tract (the rumen). This means that the products of this fibre digestion are less available to the non-ruminant herbivores than to the ruminants. To get round this, the feeding strategy of non-ruminant herbivores is to have a greater throughput of food, but extract fewer nutrients from it than the ruminant herbivores do. This is why for their size donkeys will eat more roughage per unit of live weight than cattle, but a lower proportion of the dry matter they eat will be digested. Cattle will consume dry matter equivalent to about 2% of their live weight per day, whereas on the same roughage donkeys will consume dry matter equivalent to 2 - 2.5% of their live weight per day, and larger horses will eat food dry matter equivalent to 2.5 - 3% of their live weight per day. This assumes that they are given the time to eat it. Compared to the horse, the donkey is better at digesting roughage feeds and so will tend to digest a greater proportion of the dry matter than the horse given the same roughage diet. This difference is hardly noticeable with

very digestible "good quality" roughages such as lucerne, but can be as much as 3 - 4% better digestibility with "poor quality" feeds such as barley straw or maize (corn) stover.

The reasons why donkeys are better than ponies at digesting poor quality roughages are not known. Some people have suggested the proportions of the micro-organisms in the hind-gut are different, with those in the donkey being better at cellulose digestion. Some scientific evidence is available to support this. Other people suggest it is the proportionately larger digestive tract in relation to live weight in the donkey. In the past it was suggested that the fact that donkeys seem to "do better" than ponies, was because donkeys had lower requirements for food than horses per unit live weight (as much as 25% in some reports). Comparative studies of energy and protein requirements of donkeys and ponies have not shown any differences of this magnitude. Therefore it seems likely, in the absence of other evidence, that at least part of the reason why donkeys do better than horses on the same feed is their greater ability to digest roughage feeds. This is advantageous when a fixed amount of food is fed, where horses cannot take advantage of their generally higher voluntary intakes of roughage.

*The donkey usually has a greater voluntary food intake per unit live weight than the ox and is better at digesting fibrous diets than the horse.*

## **The Digestive Tract**

The anatomy of the digestive system of the donkey is similar to that of the horse (Figure 1). It consists of the mouth (lips and teeth), the esophagus, the stomach, the small intestine, the large intestine (cecum and colon) and the rectum.

### **The Mouth**

The lips of the donkey are sensitive and mobile. They can position grass and forage for biting and select what is taken into the mouth. As a consequence the donkey rarely eats wire, plastic and other unpalatable substances when feeding on rubbish dumps or rough grazing on roadsides. The teeth are the key components in processing the feed. Unlike ruminants the donkey cannot ruminate. It does not regurgitate food to give it a second chew. This means that it only has one chance to break the food up into small pieces before they are swallowed to reach the digestive processes in the stomach. A donkey when feeding bites off the grass or roughage then chews it many times while it is lubricated with saliva to aid breakdown and start digestion. The more fibrous and drier the food the more saliva is added from the salivary glands in the mouth. One kilogram of hay may need as much as 6000 - 8500 chews before it is all eaten. Choking is rare in a donkey and usually happens only if a greedy, rapid eater is fed pelleted ground feed, such as grass meal, which is dry, but easy to take into the mouth. It is rarely a problem for tropical working donkeys on longer roughage feeds or grazing.

### **Teeth**

The young donkey has a set of deciduous teeth, which are replaced between the ages of 2.5 to 4 years old with a set of permanent teeth. The dental formula of the permanent teeth is:

$2 \times (\text{incisors } 3; \text{ canines } 1 \text{ [males]; premolars } 3 \text{ (4); molars } 3) \text{ Total} = 40$   
 $2 \times (\text{incisors } 3; \text{ canines } 1 \text{ [males]; premolars } 3 \text{ (4); molars } 3)$

The first premolars called wolf teeth are usually present in the upper jaw of only 30% of females and 65% of male donkeys and are of no practical value. In horses they are often removed in a riding animal if they interfere with the use of the bit.

The incisors are the teeth used for cutting. The premolars and molars are used for chewing and grinding the food at the back of the mouth. The incisors and cheek teeth grow continuously throughout life, so if a tooth is lost the animal may develop problems from the absence of a wearing surface for the tooth opposite it (above, or below) in the mouth. The molars grind over each other laterally as well as vertically during the jaw movements in the chewing processes. These can wear unevenly and become sharp at the edges. Often donkeys are in poor condition because their teeth have become uneven and these have caused mouth sores and pain when eating or chewing. Watch the donkey eating to check this. If its teeth are causing problems it will eat reluctantly, drop food from its mouth when eating (quidding), eat with the front teeth then bolt its food, or hold food in its mouth when the mouth is opened. Uneven, sharp teeth are easily corrected. They can be filed using a tooth rasp.

*The teeth of a donkey are so important to maximize food intake and breakdown of the food for digestion that it is important to look after them.*

### **Tooth rasping tips**

- Use a Houseman gag if possible to keep the mouth open
- Do not keep the donkey's mouth open too long at a time
- Use the correct rasp files for top, bottom, back and front cheek teeth

- Make sure the rasp files are in good condition and are not worn
- You may have to rasp the teeth more than once if they are in poor shape

### **Stomach**

After chewing and swallowing the food goes down the esophagus to the stomach where some of the digestion takes place. Muscle contractions of the stomach will help further breakdown the food and ensure mixing with the gastric juices. These juices contain hydrochloric acid, which helps begin protein digestion. Some microbial fermentation of the food takes place in the esophageal end of the stomach, where the saliva buffers the acid, but it is not a large amount. The capacity of the stomach for food is relatively small about 8 - 9 liters for the adult donkey. Food usually passes out of the stomach 1 - 2 hours after feeding, but the stomach is rarely empty and food may remain there for up to three hours. The short period of time means that donkeys should be fed "little and often", which in reality means 3 - 4 times a day for a working animal, to make best use of the feeds given. Infrequent feeding can also increase the chances of digestive upsets leading to colic.

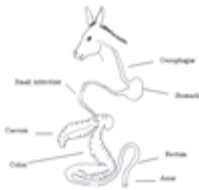


Figure 1. The digestive system of the donkey. - To view this image in full size go to the IVIS website at [www.ivis.org](http://www.ivis.org) . -

### **Small Intestine**

From the stomach the partly digested food goes into the small intestine. This is the major site of digestion of the food. The food mixes with enzymes from the pancreas (which act on proteins, carbohydrates and fats), and from the intestinal glands (which act on proteins and carbohydrates) and with bile. Bile is produced in the liver and goes into the small intestine via the bile duct. It helps in digestion of fats. Donkeys do not have a gall bladder to store bile. Digestion of the non-fibrous part of the diet continues and is completed along the length of the small intestine. Absorption of the end-products of the digestion occurs as the digesting mass is moved along the intestine by muscle contractions of the walls of the intestine, called peristalsis. The end-products of digestion are monosaccharides such as glucose, fructose and galactose from carbohydrates, amino-acids from protein digestion, and fatty acids from fat digestion. Water, vitamins and minerals are also absorbed in the small intestine. The digesta becomes more solid as it moves towards the large intestine.

### **The Large Intestine**

This consists of the cecum and colon, where the last stages of digestion take place. The cecum is a closed sac, linked to the colon, and the colon links the small intestine to the rectum. It has about twice the capacity of the cecum. The colon and cecum provided a good environment for the large population of micro-organisms which carry out the fermentation of the undigested food remaining and the unabsorbed nutrients. Some of the bacteria and protozoa, which make up the micro-organisms found in the cecum and colon of the donkey, are similar to those found in the rumen of cattle and buffalo, but most are different. The micro-organisms can digest the fibrous part of the food, the cellulose, hemicellulose and lignified parts of the plant material. The donkey has no enzymes of its own to do this, and so particularly on fibrous diets the micro-organisms play a vital part in releasing nutrients for further digestion and absorption from the gut. The micro-organisms grow and multiply using the available amino-acids in the gut. They also synthesize all the B vitamins and vitamin K<sub>2</sub> needed by the donkey. The end-products of the microbial fermentation of fibre and energy in the large intestine are the volatile fatty acids - acetate, propionate and butyrate (similar to the products of the ruminal fermentation that occurs in the ruminants).

The type of food fed determines the types and proportions of the micro-organisms in the hind-gut. It can take up to two weeks for the micro-organisms to adapt to a change in diet, and so it is very important not to change a diet too quickly. Sudden changes in diet can result in colic, diarrhea or laminitis. It is better to change a diet gradually, so as not to upset the micro-organisms and hence upset the donkey. A common time for problems in some countries is at the start of the wet season when new grass suddenly becomes available and people switch their donkeys from a crop residue based diet to a grazing regimen.

Digestion and absorption continue along the colon while the food is travelling along its length. Large quantities of water and electrolytes are absorbed.

### **The Rectum**

The food residues pass into the rectum from the large intestine in the form of feces which are expelled through the anus along with much of the methane gas produced as a by-product of microbial fermentation, and some of the microbes themselves.

One way in which a young donkey obtains the cellulose digesting micro-organisms after birth is by eating grass soiled by the feces of other donkeys. Some animals will eat the actual feces. In older animals this is considered a vice, as it is

sometimes seen in housed donkeys that are "bored". However, it can also sometimes be seen in donkeys that are hungry and kept in a confined area where there is little grazing available.

*To make the best use of the food given, the donkey should be fed 3 - 4 times a day, especially when it is working.*

## **Nutrient Requirements and Provision**

The nutrients required by all animals are water, energy, protein, minerals and vitamins.

### **Water**

Water is often overlooked when thinking about nutrient needs. Also many working equids suffer from varying degrees of dehydration, because they do not receive enough water in the working day. Donkeys evolved in a desert environment, which means that they usually require less water per unit of live weight than most other large mammals, except of course the camel. The amount of water a donkey needs does depend on the food it is eating, the work it is doing, its physiological state and the ambient temperature, in which it is living and working. The more dry matter an animal eats the more water it needs. For every kg of dry matter eaten a donkey in cool conditions and doing no work needs about 2.5 quids of water. When working a donkey uses a lot of energy in muscle contraction. The by-product of this process is heat. The donkey loses the extra heat, to maintain its body temperature while working, by sweating and in extreme conditions by panting to keep cool. These activities use up body water. Hence a working donkey needs more water than an idle donkey, sometimes 5 to 6 times as much. A lactating donkey needs more water than one that is not producing milk, about twice as much. As the environmental temperature increases over 30°C the water requirement goes up 3 - 4 times as the donkey sweats to cool down. All these factors added together mean that the water requirement of a specific donkey on a specific day can vary from 5 to 35 liters per day.

### **Provision of Water**

The best advice that can be given on how to meet water requirements is - offer water to the donkey at every opportunity and at least 4 times a day, more if it is working in the heat. Contrary to popular belief a donkey, and a horse, does not suffer from water toxicity. Both species can drink large amounts of water in one go without suffering any ill effects. A donkey deprived of water is very good at drinking to its requirements. In a study in Zimbabwe donkeys drinking only every 48 hours, drank the same amount over a three-week period as donkeys allowed to drink as much as they wanted daily. Working donkeys can also be watered during work in the day with no harm. In any short rest periods it is important to make sure the donkey is in the shade and to offer it water. It may not drink straight away so let the donkey spend some time at the trough or with the water bucket (at least 5 minutes) to see if it will drink. When it starts drinking it may pause in drinking and look about, make sure it is allowed to continue until it has finished and turns away of its own accord.

*Offer water at every opportunity especially to working donkeys*

### **Energy**

Requirements of a donkey for energy are usually described as the amount of digestible energy that the donkey needs. This means the amount of energy that it needs in a form it can digest. Feeds all contain energy, but the amount that a donkey can digest depends on the nature of the food. For example it can digest about 85% of the energy present in maize grain, but only 35% of the energy present in maize stover. This is because maize stover is much more fibrous than maize grain, and so less of the food energy is available and more goes out in the feces. Hence energy requirements of equids are usually given as the amount of digestible energy needed. This overcomes the problem that all feeds have different digestibilities. The digestible energy needs of a 150 kg donkey are about 20 MJ per day for maintenance. This does not mean much unless it can be related to actual amounts of feed that are needed to meet requirements (this is dealt with later on).

All animals use energy for muscle contraction and so when a donkey is working its energy requirement will increase:  
Energy requirements for work = the energy cost for walking + the energy cost for carrying a load + the energy cost for pulling a load + energy cost of moving uphill against gravity.

The greatest proportion of the energy used in work is that used for walking. The additional energy used in carrying a load or pulling it or moving uphill, in addition to that used in walking, is relatively small. In difficult terrain in which the donkey uses more energy per meter walked than it does on firm level ground, it will travel at a slower speed and travel less in the day. If pulling or carrying heavy loads, which require more extra energy, the donkey will travel at a slower speed than if lightly laden and again travel less in the working day. This means that the extra daily energy required for work can be estimated reasonably accurately by determining the distance travelled when working, rather than worrying about type of work, or load, or terrain.

An average sized donkey (150 kg) will need about 60% extra energy in going 10 km, 100% extra in going 20 km and about

140% extra energy if it travels 30 km doing work, either pulling a cart over a hard road on the level or carrying a load on its back.

If distances are difficult to estimate, the hours spent working can be used to help estimate energy requirements. A donkey working for 4 hours a day will usually need about another 50% more energy than if it had not been working. Working for 6 hours a day can mean a doubling in energy requirement and for 8 hours an increase in energy requirement on a working day to 2.5 times that needed for maintenance on a non-working day. This also takes into account some short rest periods during the working day i.e., it assumes the donkey does not spend the whole time moving in the working day.

Donkeys in the last three months of pregnancy need about 10% more energy each day than when non-pregnant, while a lactating donkey mare in the first 3 months of lactation will need about 120% more energy than when not lactating and idle. The amount needed will decrease to about an extra 50% energy over idle requirements in the later parts of lactation as milk yield decreases.

Growing donkeys have a similar requirement for energy as an adult donkey, but being small they have a lower food intake. Hence their energy needs should be provided in a more concentrated form than that available in roughage alone.

### **Provision of Energy**

Energy is available to the donkey in several different forms. It is supplied in the food as carbohydrate, fat or protein. It is also available from the body reserves of glycogen in the muscles and liver or from fat in the adipose tissue throughout the body. Providing energy from food protein is wasteful. Many working donkeys are in lean condition and so have few body reserves to call on. The main supply of energy to a working animal is therefore the carbohydrate and fat in the diet.

Carbohydrate is in two forms:

- simple carbohydrates, which are broken down to glucose which is absorbed from the small intestine into the bloodstream and
- complex carbohydrates found in fibrous plant material, which are fermented by the micro-organisms in the large intestine to produce volatile fatty acids absorbed through the gut wall into the bloodstream.

Concentrate feeds contain carbohydrates mainly in the simple form whereas roughages are high in fibre, the complex carbohydrates. Concentrate feed usually provides the donkey with the more readily accessible form of energy, which can be readily digested and absorbed in the small intestine. A donkey fed mainly on the complex carbohydrates in roughage relies mainly on the micro-organisms in the large intestine to produce the energy giving substrates in a form it can use. Donkeys and horses cannot be fed on concentrates alone. They must have some fibre in the diet to stimulate muscle contractions in the digestive tract, and to dilute the more readily fermentable simple carbohydrates. This reduces chances of colic or other digestive problems, which can occur when equids are fed high levels of concentrate feed.

If the daily energy requirement of a working donkey doubles then in theory on a working day the donkey will have to eat at least twice as much as it needs for maintenance, or lose weight. The working donkey on poor to moderate quality roughage does not increase its voluntary food intake in response to work. In some cases food intake may even decrease as a working donkey has less time in the day for feeding. Therefore to meet the extra energy requirements on a working day the donkey needs to be given a better quality ration. This is one with more digestible energy than that found in most of the roughages, such as crop residues and standing hay, which are commonly available for working donkeys. Failure to improve the concentration of energy in the working donkey's ration will result in the donkey losing weight while working. Some weight loss can be acceptable in a working donkey doing only seasonal work. It has the opportunity to gain weight in the off season, but weight loss is not acceptable in a donkey that is working every day of the year, or one which starts work in a lean condition.

*The extra energy needed by a working donkey is best provided by concentrates (mainly the simple carbohydrates) to give a supply of energy in a more readily digestible, and available form than that found in roughage (mainly complex carbohydrates).*

### **Protein**

Requirements for protein for the adult donkey are relatively small and are mainly needed to meet the protein requirements of the micro-organisms in the large intestine, vital for the breakdown of fibre in the diet. Work does not increase the protein requirements of a donkey in any significant amount. Any increase in protein requirement in work, usually due to tissue repair after injury, is likely to be met by the protein contained in the additional feed being given to meet the extra energy needs of the working donkey. Growing and pregnant donkeys that are laying down body tissue and lactating donkeys that are producing protein in milk require more protein in their diet than other donkeys.

The requirements of a pregnant mare for protein increase in the last 3 months of pregnancy when fetal growth is greatest.

This is the time when the developing fetus occupies increasingly more space in the abdominal cavity, reducing the donkey mare's capacity to eat bulky roughage diets. In order to meet the extra needs for energy and protein at this time it is necessary to increase the amount of concentrate in the ration and reduce the roughage.

### **Provision of Protein**

Proteins consist of long chains of amino acids. There are 25 important amino acids of which 10 are essential amino acids in the diet. They are essential because they cannot be synthesized by the donkey, or the micro-organisms in the hind-gut, in sufficient amounts to meet the donkey's requirements. There is no system for digesting microbial protein in the large intestine, so the donkey really depends on the protein it eats to supply the amino acids it needs. Plants can synthesize all the amino acids a donkey needs. A young growing donkey has a high requirement for lysine. This is the amino acid most likely to be deficient and inhibit growth if the young donkey is fed only on roughage. Amino acids which are eaten in excess of requirements cannot be stored, but are metabolized to supply energy, or converted to body reserves of fat and glycogen. Thus it is wasteful to feed excessive amounts of protein. This situation rarely occurs in the working tropical donkey as good dietary protein sources are generally expensive and are therefore used carefully by most owners who can afford them.

The amount of protein in a feed for livestock is usually expressed as the amount or percentage of crude protein in the food dry matter. This is actually the nitrogen in the food dry matter multiplied by 6.25. This is based on the fact that most proteins contain 16% nitrogen i.e.,  $100/16 = 6.25$  units of protein for every unit of nitrogen. It is easy to measure the nitrogen content of a food, much harder to measure the amino acid content. The protein quality of a feed depends on the type of amino acids present as well as the amount of protein in it. Feeds with similar nitrogen contents can have the same crude protein content, but the proportion of essential amino acids and therefore the quality of the feed may be different. The higher the proportion of essential amino acids, the better is the quality of the protein.

In ruminants much of the dietary protein is broken down in the rumen into simple nitrogenous compounds and used by the micro-organisms to grow and produce microbial protein. Therefore some of the extra nitrogen to promote microbial growth and hence aid fermentation of the complex carbohydrates can be provided in the diet as urea. In the donkey this can have fatal consequences, as the urea would be absorbed directly into the bloodstream through the stomach wall and small intestine, before reaching the micro-organisms in the large intestine, where it could be of use. This means that feeding urea can cause urea toxicity in the blood, which can quickly kill the donkey. Therefore all the protein needs of the donkey and the nitrogenous needs of the micro-organisms in its large intestine have to be supplied from protein in the diet. The donkey's diet should never be supplemented by feed or fertilizer-grade urea or by ruminant concentrate feeds containing urea.

The best quality proteins, those that contain the greatest proportion of essential amino acids in the protein, are the animal proteins such as fishmeal. The best of the plant proteins in this respect is soya. The legumes are the roughages which contain the greatest amounts of protein. As grasses and cereal plants mature so the protein content of the stem and leaves decreases, hence protein content and therefore protein quality of hay decreases the later the crop is harvested in the growing season. The mature cereal straws and stovers contain very low amounts of protein.

As with the energy in a feed, it is important to know how much of the protein in the feed is available to the donkey i.e., how much of it can be digested in the gut and how much just passes straight through into the stoves. Mature cut or standing bush hay may only be 45% digestible whereas a freshly cut berseem may be 75 - 80% digestible. For early-lactating mares and growing foals, the donkeys that have the highest requirements for good quality protein (and for the essential amino acids), it is worth investing in some protein rich concentrates. The animal proteins (fishmeal or milk protein) are best to optimize growth of the young foal, but are rarely obtainable or affordable for people keeping working donkeys. The alternatives are those plants available locally which contain the highest levels of protein.

*The donkey cannot store protein in the body, so the daily protein needs have to come from protein in the diet. Urea must not be used as a supplement for a donkey*

### **Minerals and Vitamins and their Provision**

The minerals are inorganic elements, which have a range of functions in the metabolic processes and activities in the body. The major minerals are calcium, phosphorus, and magnesium (important in the structure of the body and skeleton) sodium, potassium, and chloride (important in the acid/base balance and fluid regulation), sulphur (needed in metabolic processes). The trace minerals (which are needed in minute amounts in the donkey's body) are iron, manganese, zinc, copper, iodine, selenium and cobalt. All can be provided from the diet. The requirements for calcium, phosphorus and magnesium are greatest in the growing animal. The working animal needs to maintain its fluid balance through the replacement of the sodium lost in sweat. It is important therefore to ensure that a working donkey is given a handful of salt in its feed each day, or that it is provided with rock salt or a salt lick when it is resting.

The vitamins are organic substances essential for the correct operation of physiological functions. They are needed in very small amounts. The vitamins are of two types. The fat-soluble vitamins are A, D<sub>2</sub>, D<sub>3</sub>, E and K and the water-soluble vitamins are vitamin C and the B-group of vitamins. The B vitamins and K<sub>2</sub> are synthesized by the micro-organisms in the large intestine so it is less important to provide them in the diet, and vitamin C can be produced by the donkey in sufficient amounts to meet requirements. Fresh green leafy legumes and grasses are good sources of the vitamins, so it is advisable to feed these in small amounts regularly to the donkey. Mineral and vitamin supplements are available which can be added to rations where donkeys have no access to fresh green plant material.

*Fresh green fodder is a good source of vitamins and salt is an important supplement especially for working animals.*

### **Measurement of the Digestibility of Feeds**

Digestibility of a feed is assessed by measuring the extent to which the dry matter, organic matter, protein or fibre components of the feed are digested. The digestibility of dry matter can be determined by measuring the amount of dry matter eaten over a given period (usually no less than 7 days) and the amount of dry matter given out in the feces at the same time. This means confining the donkeys in individual stalls for the period and weighing the feed they eat and the feces they excrete. Samples of each day's feed intake and feces collected are dried to a constant weight (until all the water has gone) to determine the dry matter content in each. From these values, the total dry matter eaten and the total excreted is calculated. The dry matter digestibility of the feed expressed as a percentage is then:

Digestibility of feed (%) =

$$\frac{\text{Weight of dry matter in the food} - \text{weight of dry matter in the feces} \times 100}{\text{Weight of dry matter in the food}}$$

This method does not require any sophisticated laboratory, just the means to dry the feed and feces and an accurate weighing scale. Drying is usually started in the sun and finished in an oven at about 60°C for a day.

The digestibility of any of the other nutrients such as organic matter (dry matter - ash content), protein or fibre (neutral detergent fibre and acid detergent fibre) can be determined by measuring the total present in the food and feces dry matter and substituting the values in the formula above. A nutrition laboratory is needed with facilities to be able to determine the protein, fibre and ash in order to determine these components of a feed. There are tables of feed composition that can be studied to see the average values for the digestibilities of many of the feedstuffs. However, less information is available for equids than for ruminants.

### **Foods Available**

Most donkeys are fed on roughages for most of their life, supplemented with grazing of natural grassland, roadsides, bush and scrubland if they are kept in the rural areas. Many working donkeys are found in urban and peri-urban areas of the world where opportunities for grazing are few and people feed their animals entirely on purchased feeds. In these situations the day's earnings often dictate what quality of roughage feed the donkey is given. However, unless the roughage is of top quality (fresh legumes or legume hay) a working, pregnant, lactating or growing donkey, needs to receive some supplementary feeding in addition to roughage if it is to maintain condition and health and be productive.

### **Roughages**

Roughages range in quality from good (fresh and conserved legumes) to poor (stovers and straw from the sorghum, millet and rice production). It is important to be able to recognize good roughage from poor roughage. The obvious points to look for are the state of the roughage. It should be free from dust and moulds, smell sweet and be free from any rubbish (unpalatable and poisonous weeds, plastic, wire and other litter). The next step is to assess the type of roughage in terms of feeding value. For digestible protein this is relatively easy: the legume roughages are usually high in protein content, grass and standing hays medium to low in protein content and the crop residue straws and stover low in protein. The younger the grass, the higher the protein content. As all plants mature the content of digestible protein falls as the plants become more fibrous. Similarly as the amount of fibre (complex carbohydrates) increases, so the digestible energy content of the roughage decreases. The tropical grasses grow and reach maturity (seed) more rapidly than the temperate grasses. They are more fibrous than the temperate grasses and can have very low protein contents when mature. The temperate grasses generally have higher protein contents than tropical grasses.

Scientists have developed a simple scoring system to determine the energy value of a roughage for a ruminant based on appearance. This is for use by people in the field. It is meant as a guideline when looking at grass and pasture, legumes, hays and crop residues. The higher the score the better the feeding value of the roughage (Table 1). It is a useful system to

adopt for roughage assessment when feeding the donkey. It is based on:

- *General appearance* - is the roughage free from mould, dust, rubbish? Does it smell good and sweet?
- *Leaf to stem ratio* - is it very fibrous with a lot of stems or young and leafy?
- *Color* - is it young, green and fresh cut or old, yellow dry and cut late?

Score each of these three characteristics from 1 to 5 according to the descriptions in Table 1, and then add them up. Use these scores to interpret data in both Table 3 and Table 4.

<b>Table 1. Scoring system for assessing the quality of a roughage in relation to digestible energy content (D.G. Smith and P.J. Thorne, personal communication)</b>					
<b>Characteristic</b>	<b>Score</b>				
	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
<b>General Appearance</b>	Very Poor	Poor	Moderate	Good	Very Good
<b>Leaf to Stem Ratio (age of plant)</b>	Mainly stems	Stems > Leaf	Leaf = Stem	Leaf > Stems	Very leafy
<b>Color</b>	Yellow	Yellow > Green	Green > Yellow	Green	Very Green

As a guide when feeding donkeys:

Roughages with a score under 6 are poor with little energy value, while those over 12 will have high levels of digestible energy and so be good for feeding working, lactating or growing donkeys. A freshly cut green berseem with a lot of leaf would score 12 - 13, whereas chopped barley straw with some leaf left may score less than 6 and stover stems with few leaves left may score 3.

### **Energy Rich Concentrates**

The cereal grains are good sources of energy, but they need to be crushed, or rolled or cracked so that the carbohydrates and proteins within the grain can be best digested. Oats can be fed untreated, but crushing improves digestion. The grain of barley is in a hard hull so needs rolling to break the case. Sorghum and wheat are small and so are best cracked or rolled before feeding otherwise they can pass through the donkey without being digested. Maize grain can be fed in any form but as it is hard it is best cracked especially for animals with poor teeth.

Cereals are best fed as a mixture of at least two types rather than one cereal type alone in a concentrate ration. Molasses is a source of readily digestible carbohydrate that can increase the palatability of dry feeds, whilst providing some energy. The main problem with molasses is storage in hot weather as it can ferment and go bad, particularly low grade molasses, which has the highest water content. Oil is a good source of energy and is being increasingly used in competition horse and racehorse diets. Vegetable oils (soybean, rapeseed, corn, palm, sunflower or safflower oil) and fish oils can be used in small quantities. A cup a day in the feed as an additional energy source is good for working donkeys, but it should be introduced gradually into the diet over 10 - 14 days. The oil should be added just before feeding. The problem especially with vegetable oils, which contain a lot of polyunsaturated fats, is storage in hot weather, as these oils can go rancid quickly. For this reason they are best purchased in small amounts rather than in bulk.

*Cereals are a good source of energy for a donkey*

### **Protein Rich Concentrates**

Cereals if fed with poor quality roughage can give a diet low in protein. Pregnant, lactating and growing animals need protein rich feedstuffs to complement especially poor quality roughages. The oil seed cakes soya bean cake and cotton seed cake are some of the best protein sources for donkeys. Sunflower cake can also be fed. Groundnuts can contain a mould toxin to which equids are sensitive, so the cake is best avoided. Gram (*Dolichos biflorus*), sometimes called "field" or "horse" gram is another good protein source, which is available in many tropical countries for donkeys and can be fed without cooking. It is best cracked or ground. Faba, horse or broad beans (*Vicia fabia*) are legumes which contain approximately 25% crude protein. They can be fed raw. Many of the other beans, namely from the *Phaseolus* species (mung, navy, kidney, lima beans) need cooking to remove toxins before they are fed to equids, and so are less useful.

Fodder legumes, such as lucerne and berseem contain higher levels of protein than the grasses whether fresh or conserved.



*Oil seed cakes and legumes are good sources of protein for donkeys*

### **Other Concentrates Fed to Donkeys**

Wheat bran can be expensive for the nutrients it provides - some energy and more protein. It is deficient in calcium and high in organic phosphorus, so can exacerbate bone abnormalities due to calcium: phosphorous imbalances especially in growing animals. It is best avoided unless there is no alternative.

### **Food Storage**

Some nutrients in roughages, cereals and protein supplements deteriorate during storage. Most people have to store food for their donkeys, if only for short periods. Rules for feed storage are much the same as for storage of human food!

The food should be stored somewhere cool, and where the temperature does not fluctuate a lot, ideally where there is good air flow, ventilation and low humidity. Feeds should not be stored in direct sunlight or in damp conditions and should be kept away from rain, water, rodents, insects and birds.

*Store feed well to reduce spoilage and save money especially when feed has been purchased*

### **Why do nutritionists usually talk about dry matter intake and not actual intake of fresh food?**

This is because the amount of water in food varies. A kg of fresh grass can have 80% of its weight as water, whereas a kg of cereal grain only contains 15% water. This means that an animal eating a kg of grass will only get 200 g of the other nutrients it needs, however, if it eats a kg of cereal grain it will get 850 g of the other nutrients it needs. In deciding how much food to give a donkey is it better to estimate the dry matter content of the food and, knowing how much dry matter a donkey can eat, then work out how much "fresh feed" to offer. The important thing to remember when feeding fresh green food is that it contains a lot more water than the other feeds. If it is the only source of food the donkey is getting, you need to feed more of it than if the donkey is eating conserved roughage or concentrates.

### **Food Intake**

When planning how to feed a donkey, we can estimate that a donkey is able to eat each day, when given roughage, an amount of dry matter equivalent to 2% per day of its live weight. This assumes that generally it receives roughage of moderate quality. The actual amount of dry matter that a donkey will eat in a day depends on many factors. Some of the important ones are given in Table 2. These are worth remembering especially if you find the donkey is thin. It may be that it is simply not getting enough dry matter to eat.

#### Type of Food

Young plants can be eaten faster than mature ones, but contain less dry matter in a kg. One kg of ground or pelleted feed takes less time to eat than 1 kg of roughage, even if this is chopped. One kg of concentrates or legume hay takes less time to eat than 1 kg of crop residues.

#### Time Allowed for Eating

In natural conditions a donkey would spend 14 - 16 hours a day in feeding. It is important that donkeys kept on grazing land have time to eat. Work in particular takes the donkey away from feeding. The more work it does the less time there is for feeding, but the more food is needed to meet the increased energy requirement. A working donkey therefore needs more concentrated feeds than one that is not working. Donkeys are more susceptible to the time available for eating than cattle. Cattle increase rate of eating if they have been working, donkeys do not, since the initial chewing is more important in processing the food in the donkey than in the ox (a ruminant).

#### Amount on Offer

When feeding roughage, the more the donkey is offered the more able it is to select the more palatable parts of the roughage. The dry matter digestibility of straw given to a donkey ad libitum can be up to 7% higher compared to the digestibility measured when the same feed is offered in limited amount.

#### Water Available

The donkey, if dehydrated, will reduce its food intake and eventually stop eating, therefore ideally it needs as much water as it can drink in the day. A donkey watered every 48 hours will decrease average daily dry matter intake of an average quality roughage by 50% compared to a donkey with access to water when it wants in the day.

#### Health

A sick donkey usually reduces its intake. Donkeys with high parasite burdens sometimes increase their intake, but will tend to lose weight, despite doing so.

Donkeys with sharp or unevenly worn teeth will eat slowly and have a lower than average food intake in a day. Rasing the teeth will help.

#### Physiological State

Donkeys in late pregnancy will have less abdominal space available for feed, due to the labium and will tend to reduce intake of roughage. Increasing concentrate intake can compensate for this.

#### Ambient Temperature and Humidity

As ambient temperature or humidity increase so intake of roughage decreases. One way the donkey regulates its body temperature is by reducing the metabolic heat produced during feeding. Rate of passage of digesta through the intestine can also slow down when the donkey is hot, further reducing food intake.

<b>Table 2. Factors affecting the amount of food a donkey will eat in a day</b>
<b>Food Type:</b> Nature of feed Quality of feed
<b>Management:</b> Time allowed for eating Amount on offer Water available Health Internal parasite burden State of the teeth Reproductive state
<b>Environment:</b> Ambient temperature and humidity

### **Guidelines to Feeding Donkeys for Different Activities**

These are guidelines, since the exact amounts and proportions will be affected by how much production is expected from the donkey, its body condition and the food available. A thin donkey has few body reserves of energy, whereas a donkey in good condition does have something in reserve for a short period.

Table 1 shows how to assess the feeding value of roughage in terms of poor, moderate and good.

#### **Maintenance**

A donkey can eat enough to meet its maintenance energy requirements from a moderate quality roughage diet of hay or a mixture of straw and green fodder (such as lucerne) in proportion of 3:1 or from moderate quality grazing, if the animal is allowed ad libitum access to the food source in the day. It will then eat about 2.5 kg of dry matter in a day per 100 kg live weight. A donkey allowed access to grazing at will, will spend about 60% of the day in feeding.

#### **Work**

Work reduces the time available for eating therefore we can assume the donkey will only be able to eat about 2 kg of dry matter in a day per 100 kg live weight. Therefore the donkey needs its energy in a more concentrated form than when it is not working. On moderate roughage it will need about half its dry matter intake as energy rich concentrates if working 4 hours a day and 60% if working for 8 hours a day. On poor quality roughage it will need more concentrates. If working 4 hours a day it will need about 60% of its dry matter intake as energy rich concentrates and if working 8 hours a day about 70% of its dry matter intake as energy rich concentrates.

#### **Growth**

Energy needs of young donkeys can be met by a diet of 2:1 concentrate to roughage after weaning for the first year of life. This assumes dry matter intake at 1.5 kg per 100 kg live weight when the donkey is small increasing to 2 kg per day when it reaches about 100 kg live weight.

#### **Pregnancy and Lactation**

Pregnant donkeys given a ration with a ratio of 1:1 moderate quality roughage to protein rich concentrate, will eat about 2 kg dry matter per 100 kg live weight, which can meet their protein requirements for late pregnancy. Donkey milk is not as rich in protein as cow's milk, however, protein requirements increase especially in early lactation. After the foal is born the amount of protein and readily digestible energy in the mare's ration needs to increase. A ration of proportionately 40% moderate quality roughage to 60% mixture of energy rich and protein rich concentrate would provide sufficient nutrients for the first three months of lactation. This allows the donkey to meet requirements for lactation for both energy and protein and give the foal a good start in life. After 3 months the protein and energy requirements of the mare decrease and a ration

of 1:1 moderate quality roughage to concentrate will meet requirements. At weaning concentrate can be removed from the mare's ration if she is not working. When only poor roughage, such as a cereal crop residue, is available, it is necessary to increase the proportion of concentrates in the ration.

<b>Table 3. Daily rations for adult donkeys, assuming the roughage they receive is of poor quality (score 4 - 6 on the scale given in Table 1)</b>					
<b>State</b>	<b>Live Weight (kg)</b>	<b>Total Dry Matter Intake (kg)</b>	<b>Amount of Roughage (kg)</b>	<b>Amount of Concentrates (kg)</b>	<b>Remarks</b>
<b>Mature idle</b>	100	2.5	2.25	0.25	Need to supplement poor roughage with some concentrate
	200	5	4.5	0.5	
<b>Work 4 hr/day</b>	100	2	0.8	1.2	Need to supplement with energy rich concentrates Much less time for feeding in the day when working 8 hr than when idle or only working 4 hr
	200	4	1.6	2.4	
<b>Work 8 hr/day</b>	100	2	0.6	1.4	
	200	4	1.2	2.8	
<b>Last 3 months of pregnancy</b>	100	1.5	0.5	1.0	Needs protein rich concentrates rather than energy rich. Less space in abdomen for roughage
	200	3	1.0	2.0	
<b>First 3 months of lactation</b>	100	2	0.6	1.4	Needs mixture of protein and energy rich concentrates, and increased water requirement
	200	4	1.2	2.8	
<b>&gt; 3 months of lactation</b>	100	2	0.8	1.2	
	200	4	1.6	2.4	

<b>Table 4. Daily rations for adult donkeys, assuming the roughage they receive is of moderate quality (score 7 - 10 on the scale given in Table 1)</b>					
<b>State</b>	<b>Live Weight (kg)</b>	<b>Total Dry Matter Intake (kg)</b>	<b>Amount of Roughage (kg)</b>	<b>Amount of Concentrates (kg)</b>	<b>Remarks</b>
<b>Mature idle</b>	100	2.5	2.5	0	No need to supplement moderate roughage for idle donkey, if given time to eat
	200	5	5	0	
<b>Work 4 hr/day</b>	100	2	1.0	1.0	Need to supplement with energy rich concentrates Much less time for feeding in the day when working 8 hr than when idle or only working 4 hr
	200	4	2.0	2.0	
<b>Work 8 hr/day</b>	100	2	0.8	1.2	
	200	4	1.6	2.4	
<b>Last 3 months of pregnancy</b>	100	1.5	0.75	0.75	Need protein rich concentrates. Less space in abdomen for food
	200	3	1.5	1.5	
<b>First 3 months of lactation</b>	100	2	0.8	1.2	Needs mixture of protein and energy rich concentrates, increased water requirement
	200	4	1.6	2.4	
<b>+ 3 months of lactation</b>	100	2	1.0	1.0	
	200	4	2.0	2.0	

The ultimate check on whether the amount of food is sufficient for the donkey is to monitor its body condition (Table 5) and adjust the ration accordingly. If the working donkey is losing weight it needs more energy in the ration or less work or both. Increase the energy concentration by improving the roughage quality (Table 1), or increase the proportion of concentrates to roughage. Make sure enough water is available to meet requirements.

If the pregnant or lactating donkey is getting thin (Table 5), it needs more energy and protein and less bulk. Reduce the dry roughage offered, and increase the proportion of concentrates to roughage, offer more green roughage if available, especially to the lactating donkey. Make sure water intake meets requirement.

*Feed enough to maintain weight especially of a working donkey*

#### **Estimation of the live weight of a donkey**

Donkey owners rarely have access to a weighing machine large enough to weight their donkey regularly. An alternative method is to use a tape measure to measure the girth of the animal around its body over the heart, just behind the forelegs. For a working donkey the conversion formula is:

$$\text{Live weight (kg)} = \text{heart girth (cm)}^2 \cdot 2.65 / 2188$$

This gives a reasonable prediction of the weight of the animals, but it is not always so easy to detect the relative changes in weight that occur from week to week in an animal.

#### **Estimation of Body Condition of a Donkey**

The easiest method of assessing whether a donkey is receiving enough food is to look at the amount of "condition it is in and then give it a score depending on where it fits between very thin and very fat. People in temperate and tropical countries have developed different scoring systems for donkeys, but provided one stays with a particular system, then it is possible to assess the changes in weight that occur within an animal reasonably well over time.

To use the scoring system given in Table 5 first walk round the donkey, stand back and look at it. Consider whether it is:

- Lean - (1 - 3) the frame/bones are obvious.
- Moderate (4 - 6) the frame and covering are balanced.
- Fat (7 - 9) the frame is not as obvious as the covering.

Having decided which condition category the donkey fits in then look at and feel it more closely to see if you can further sub-divide it into the more specific categories under L, M and F in Table 5. It is rare to see a working donkey with a body condition score of 8 or 9.

#### **Practical Tips on Feeding Donkeys**

- Buy the best quality feed affordable, store it well.
  - Check and if necessary have the teeth rasped and worm a donkey regularly so it can make the best use of the food it is given.
  - Feed after watering, not before. If it is dehydrated the donkey will not eat well or stop eating all together.
  - Offer the food in a trough not from the ground to reduce spoilage and wastage.
  - Feed individually, not in a group to reduce bullying and make sure each donkey gets its own ration.
  - Allow time for eating. Always feed the donkey in the shade when it is relaxed. Feed the daily ration in 3 - 4 meals in the day. The donkey cannot eat its daily allowance all at once in one large meal.
  - Feed some of the roughage as green feed when it is available. Because it is low in dry matter (it can be 80% water) it is best to feed it in addition to dry roughage and let the donkey choose. One kg a day (about 200 g dry matter) is adequate.
  - If the roughage is poor quality offer more of it so the donkey can select the more nutritious parts, offer the remainder to your cattle, goats or sheep, or use as bedding and then compost.
  - Feed a mixture of two to three types of concentrate food rather than one type only.
  - Feed a handful of salt a day to a working donkey, mixed into its feed.
  - Allow donkeys to graze as often as possible, but do not rely on grazing only unless it is a good pasture. Good pastures are rare where working donkeys are found.
  - Chop roughage and crush/crack the cereals, barley, wheat, maize, to improve digestion and intake. Soaking is an alternative if crushing is not possible before feeding barley and wheat, but only soak it for 12 hours at most before feeding.
  - If the donkey is working feed concentrates in the day, roughage at night when the animals have more time to eat.
-

Table 5. Body condition scoring for working donkeys		
Score	Condition	Features
1	L -	Markedly emaciated; bone structure easily seen over body; little muscle present; animal weak, lethargic.
2	L	Animal emaciated; individual spinous processes, ribs, tuber coxae, tuber ishii and scapular spine all prominent; some muscle development; neck thin, prominent withers, shoulders sharply angular.
3	L +	Vertebral column prominent and individual vertebral spines are pointed to the touch; little fat, but superspinous musculature over spinous processes apparent. Ribs, tuber ischii and tuber coxae prominent; loin area and rump concave; little muscle or fat covering over withers and shoulders.
4	M -	Vertebral column visible; tuber ischii palpable but not visible, tuber coxae rounded by visible; rump flat rather than concave; ribs palpable but not obvious; withers, shoulders, neck with some muscle and fat cover; scapular are less clearly defined.
5	M	Superspinous muscles developed and readily apparent; can palpate vertebral column; tuber coxae rounded; rump rounded, convex; tuber ischii not visible; some fat palpable in pectoral region and at base of neck; can palpate ribs, but not visible.
6	M +	Cannot palpate spinous processes easily; back becoming flat, well covered; rump convex and well muscled; some fat palpable on neck, base of neck and pectoral region; neck filled into shoulder; tuber coxae just visible. Animal smooth and well covered.
7	F -	Animal smooth and well covered; back flat cannot palpate spinous processes; tuber coxae just visible; fat on neck and pectoral region beginning to expand over ribs; flank filling, neck thickening.
8	F	Animal appears well covered with body rounded with fat and bones not discernible; flanks broad; broad flat back.
9	F +	Bones buried in fat; back broad or flat, in some cases crease down back; large accumulations of fat on neck, over pectoral area and ribs; flank filled with fat.

### Conclusions

The final test of a ration is to try feeding it to some donkeys and see if it is palatable, maintains weight and keeps the animals healthy. Feed a range of feedstuffs - if possible a mixture of dry forage, green forage and some concentrate - and then you can rarely go wrong. Feed the young donkey on the best possible feeds available, good quality roughage and high protein, energy concentrates. It is good investment for the future.

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