**Resting guides to be translated to dutch:**

**Vitamin C**

Vitamin C is a biological antioxidant, but it also has other important functions in the organism.

Horses (like many other animals) seem to be able to derive vitamin C from glucose. The Vitamin C requirements of the horse are not defined as well as the other vitamins that are included in PC-Horse. Although the horse normally produces adequate amounts of vitamin C, it is customary to add the vitamin to concentrates and vitamin- and mineral mixes.

**Biotin**

Biotin plays a part in many metabolic reactions in the body, including the metabolism of fatty acids and amino acids, and during the production of glucose. Biotin is also important for normal cell replication.

Biotin is found in many feeds and feed components. Examples of biotin content are: Alfalfa hay 0.2 mg/kg DM, Oats 0.1 to 0.4 mg/kg DM, Barley 0.13 to 0.17 mg/kg DM.

Biotin is one of the water soluble B-vitamins. For a horse, the exact requirement for biotin is not yet determined. Therefore, PC-Horse cannot warn of deficiency or of surplus of biotin in the ration. Normally, sufficient biotin to cover the horses' needs is produced by the microbes in the intestinal tract. Biotin is reported to have a positive effect on normal hoof growth and in the repair of damaged hooves. For such conditions, typical recommendations say that relatively large amounts of biotin (10-30 mg/day) must be provided for periods of 7-9 months.

Many animal feeds and mineral- and vitamin mixtures have added biotin. There are also special supplements with particularly high levels of biotin on the market.

**Too little Clor (Cl)**

 Chloride deficiency may occur, commonly in combination with sodium deficiency, during hard exercise and in hot environments, where sweating is extensive. Otherwise forages will contain sufficient chloride to balance bodily losses.

**Solutions**: Provide salt licks and extra salt whenever sweating is extensive

**Too much Chloride.**

Not an actual condition.

**Potassium**

Normal forage (grass, hay, silage) is rich in potassium. Even though the potassium requirements of horses are known, we have chosen not to include potassium requirements in PC-Horse, because the roughage in the ration will, under normal practical conditions, provide a large excess of potassium. During extreme physical activity (endurance riding and other high intensity competitions) it is recommended to use electrolyte (mineral) mixes with potassium to replace sweat losses. Molasses from sugar cane is also a good source of potassium.

In plant cells potassium (K+) is found together with various organic anions (ions with negative electrical charge). A dietary surplus of potassium must be excreted with urine and feces, and is accompanied by anions, such as bicarbonate or chloride. A high excretion of bicarbonate leads to an alkaline urine, which is typical for herbivore animals (plant eaters). The potassium content of the feed is part of the cation-anion balance (DCAB) which PC-Horse calculates for a feed or a complete ration.

**Too little Sulfur (S)**

Sulfur is a chemical element. In the body, sulfur is part of the amino acids cysteine and methionine. These amino acids are referred to as sulfur-containing amino acids, and they are represented in practically all proteins that makes up the body. Sulfur is among others also part of the B-vitamins thiamine (vitamin B1) and biotin, the natural anticoagulant heparin, and chondroitin sulfate, an important constituent of cartilage in all joint surfaces.

Horses cover their requirements for sulfur through intake of organic, sulfur-containing feed molecules, mainly the amino acids methionine and cysteine.

When the ration has sufficient amounts of protein, preferably from several sources, sulfur deficiency will not occur.

**Too little fat**

The most common rations for horses contain little fat. Amongst forages such as hay and haylage, the fat content is usually 10-15 grams of digestible fat per kg of dry material. In barley the content of fat is approximately 20 grams and in oats 50 grams per kg.

Fat in the form of vegetable oils can be an important energy supplement for the horse, particularly for horses that have problems with the regulation of their blood sugar (glucose) levels, and whose ration therefore should be one with minimal amounts of cereals. Fat is therefore recommended for horses that have a history of laminitis or have problems with "tying up" symptoms and muscle degeneration.

**Too much fat**

The horse digests fat well, when consumed in moderate quantities. If we give vegetable oil in the ration, we expect that it is unproblematic to give up to 0.10 kg per 100 kg of body weight. This means that we could give 0.5 litres per day to a horse of 500 kg. The oil should be divided into at least two meals. The horse is not particularly fond of vegetable oil. You will therefore have to mix the oil with feeds that the horse will eat readily, such as grain or concentrates.

Fat is rich in energy, and usually contains around three times as much energy as conventional feed mixtures. This means that 0.3 kg of oil has about the same energy value as 1 kg of concentrates.

**Fibre**

The horse is a grass-eating (herbivore) animal and its digestive system is adapted to rations consisting mainly of roughage, i.e. grasses and herbs, either fresh or as hay or haylage. Roughages are rich in fibre and the horse needs this fibre for both energy and as a structural component which ensures proper functioning of the digestive system. In simple terms, we can divide the horse's digestive system into two parts. In the stomach and small intestine, which comes first, we find enzymes that digest starch, sugars, proteins and fat. Further along, in the caecum and colon, a rich population of microbes (i.e. protozoa, bacteria and yeast) helps to break down the fibre component into short-chain fatty acids that can be absorbed and utilized for energy. In horses on forage-rich diets, a significant part of the energy needs are met by the acids produced from fibre. Although the cellulose in the fibre-fraction is composed of glucose molecules, microbial digestion transfers the glucose to short (volatile) fatty acids – which subsequently are absorbed. As a consequence, the products of fibre digestion do not affect the horse's blood sugar concentration and insulin secretion.

Fibre-rich diets require a long time for chewing. They keep the horse occupied and increase the time needed to consume a meal. This is important for the horse's comfort and well-being, and leads to increased saliva production, which in turn helps reduce the risk of gastric ulcers.

A horse ration must contain a certain amount of roughage and in PC-Horse we place that requirement at 1.5 kg per 100 kg body weight. When using haylage, with its higher water content, it is necessary to adjust the amount fed to reach the requirement for roughage dry matter. This is done easily through the formula:

hay (in kg x 85)  
----------------------------------------------- = kg of haylage  
dry matter content, % in haylage

Example: A horse weighing 500 kg has a requirement of 7.5 kg hay per day. How much haylage with 60% dry matter must be given in order to be equivalent to 7.5 kg of hay:

7.5 kg hay x 85  
-------------------- = 10.6 kg haylage  
60

The fibre content of forages will vary widely between plant species, and also from one stage of botanical development to another. When plants are harvested early in their growth, the fibre content is not high, but the nutritional value of the fibre is at its highest. A later harvest will have a higher fibre content, but at the same time increased amounts of lignin will cause a decrease in the nutritional value of the fibre. We must therefore consider carefully what are the forage qualities that will suit different types of horses the best.

In PC-Horse, we calculate the amount of fibre in the ration based on an analysis of the crude fibre content. In regular hay or haylage there is about 300 grams of crude fibre per kg dry matter (DM). It will be somewhat lower for early cuts and higher for the late cuts.

PC-Horse sets the lower limit for crude fibre in the daily ration to 3 grams per kg body weight daily, and the horse should preferably receive more than this. This minimum limit is roughly equivalent to the amount of forage mentioned earlier.

There are several methods available for the analysis of fibre in roughages. All recommendations given in PC-Horse are based on crude fibre analysis, and this is the only method that should be used when including analysis of fibre in the program. If selecting NDF (non-detergent fibre), a fibre analysis which is commonly used for cattle, you will get twice as high numbers as when using the crude fibre analysis.

**Starch**

If you have been warned about too much starch in a meal, you should distribute the concentrates and grains in the ration throughout the planned meals, and introduce more meals if necessary. You can also try to replace some of the concentrates with roughage (hay, haylage, beet pulp) of good quality. You can read below more about starch and how this feed component is digested.

**Starch in the horse's ration**  
Starch is a carbohydrate found in plant seeds and roots, such as grains or potatoes, and is an energy reserve for the plant. For comparison, animals use fat as their energy reserve. Starch is the most energy-rich part of the grain. The content of starch in oats and barley is about 500 g per kg (50% of the weight), and there is slightly more starch in barley than in oats.

**Digestion of starch in the horse**  
We want as much as possible of the starch to be digested and absorbed in the small intestine. Starch which is not digested in the small intestine will be passed on into the caecum, which is very large in the horse. Here, starch may create imbalances in the microbial flora and lead to a fall in pH and a reduced digestion of fibre.

The chemical and physical structure of starch varies between grain species. The starch in oats is more easily digested than starch from barley and maize. This has practical significance for the horse because the horse can digest more oat starch in the small intestine than starches from other cereal species. When barley and maize are treated with pressure and heat, as is common in the commercial production of feed mixtures, the starch becomes more easily digestible, and behaves more like oat starch in the digestive tract.  
Glucose is produced when starch is cleaved by several enzymes in the small intestine, and is then absorbed into the blood. A meal of cereals will in just a few hours give the horse elevated blood glucose (blood sugar) concentrations. Blood levels of glucose are regulated by the hormone insulin. Increased secretion of insulin takes place after a meal, and the hormone promotes the storage of glucose in the form of glycogen in liver and muscles. Glycogen is an important energy store for the horse, and is mobilized quickly when needed, for example during strenuous exercise and competitions.

Horses are sensitive to variations in blood sugar. Some horses, especially ponies, may have trouble regulating blood sugar (a form of insulin resistance). Some horses may also become excited if the blood sugar concentration rises quickly (heating). It is therefore important, when planning feeding, to consider the amount of starch each horse will receive at every meal.

**Recommendation**  
Because of its properties, starch is both an important source of energy in the horse's ration, and also a feed component that can cause adverse reactions in the digestive system. As mentioned earlier, we do not want too much undigested starch to arrive at the caecum. At the same time, we do not want the starch to be too easy to digest, since this will give rise to excessive increases in blood glucose levels. It is therefore important to have a good grasp of how a starch-rich ration affects your horse, and how you can achieve a digestion profile for the starch that balances the two effects mentioned above. With PC-Horse you have the means to ensure that the amount of starch contained in each meal is within the recommended limits.

In normal healthy horses, we recommend that a single meal should not contain more than 1,5 grams of starch per kg body weight. This means that a horse weighing 500 kg should not get more than about 750 grams of starch per meal. Since cereals and grain mixtures contain 400-500 grams of starch per kg, you should not give more than about 1,5 kg of grain or concentrate mix per meal. If your horse has a high energy requirement and receives a high proportion of grains and concentrates in its diet, we recommend increasing the number of meals per day, or changing the distribution of feed between meals if you become aware that the amount of starch per meal is too high.

In PC-Horse, you can distribute the horse's overall ration over individual meals. You will then be given a clear warning when the amount of starch in one or more of your meals exceeds the recommended limits. For horses that have trouble regulating blood sugar, or easily develop symptoms of "tying up", it will be beneficial to provide less starch per meal than the recommended 1,5 g/kg body weight. As an alternative you can feed vegetable oil (see below), thus reducing the amount of grain or concentrate mix in the ration, without depriving the horse of too much energy.

**Sugar**

Sugars in feeds are analyzed using several methods. The most common is referred to as “total sugar”, and measures simple sugars such as glucose, fructose and sucrose.

In regular hay, the sugar content is about 100 grams per kg, but with a considerable variation. In haylage, part of the original sugar is broken down during fermentation, and the sugar content is usually lower. In grains and concentrates, the sugar content is low (the normal sugar content of oats and barley is only about 18 to 20 grams per kg.). Rations containing added molasses will, however, have a higher content of sugar.  
  
The amount of sugar found in hay and haylage seldom causes problems in horses. The uptake of roughage is spread over many hours of the day. Sugar absorption is therefore taking place over an extended period of time in the small intestine, and does not lead to large fluctuations in blood glucose concentrations.

Horses that have problems with blood sugar regulation or are insulin resistant may still benefit from forage that is low in sugar.

**Fructanes**

Fructanes are complex molecules (polysaccharides) which grasses store as an energy source. The horse lacks enzymes to digest fructanes in the small intestine, and these carbohydrates will therefore not be digested in the same way as starch and simple sugars. Fructanes are instead transported to the caecum, where they are broken down by microbes. If the ration contains large quantities of fructanes, it can cause, in the same way as too much starch, an imbalance in microbial fermentation and adverse conditions in the caecum. In the case of some horses, this may lead to laminitis. It is therefore important that horses are introduced gradually to a lush, rich pasture.

The level of fructanes in grasses varies with weather conditions and grass species. In cold periods, the fructane content can be higher than in warm periods. On hot sunny summer days, there is little to worry about. In the early summer and autumn, during periods of cold nights and mornings the fructane content of the grass can be very high. It is therefore wise to give extra attention to the horse's reactions to grazing in cool periods, especially early and late in the grazing season.

Since the fructane content of grasses varies so much, specific analyses of fructanes are not commonly used. However, since there are significant differences in the amount of fructanes amongst grass species and varieties, those who grow their own horse feeds also have the option to seed grasses selected for their moderate fructane content.