

Optimal management of equine pastures

on the three most common soil types in the Netherlands.

Author	Britt Breunis
Programme	International Equine Business Management
University	Aeres University of Applied Science
Date	28 – 5 – 2020
Place of publication	Dronten
Thesis coach	Toine van Westing

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Preface

Before you lies the thesis on “the optimal management of equine pastures on the three most common soil types in the Netherlands.” The research described in this research will be used as a basis for writing a guide on the management of equine pastures. It has been written as part of my graduation year of the study ‘International Equine Business Management’ at the Aeres University of Applied Science in Dronten. I was engaged in writing this thesis from January to July 2020.

I would like to use this opportunity to thank my supervisor Toine van Westing for all the provided information and guidance throughout writing this report. I would like to thank my friend Wilma as well, for giving advice and supporting me throughout the writing process. Finally, I hereby thank my classmates and dear friends Brechtje Hendriks, Kristie van Straaten, Lisa Lootens, Daisy van ‘t Wout and Kiki Hoogervorst for providing me with feedback and advice during the writing process and all others that have been engaged in this research, by means of filling out the enquiry or otherwise.

10 – 5 – 2020

Britt Breunis

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Summary

This thesis covers the topic of '*Optimal management of equine pastures*'. From the equine sector, a request was made for more knowledge on the topic of pasture management. The main problem with gaining information on this topic is not the lack of existing knowledge, but the knowledge being spread over a vast amount of sources and these sources contradicting each other.

The purpose of this thesis is discovering which knowledge is already known and which knowledge is desired, in order to write a practical guide on equine pasture management for the equine sector. This was done through the following main-question: "what is the optimal management of equine pastures on the three most common soil types in the Netherlands?" This question was divided into three subjects: the existing knowledge and need for knowledge on the topics of pasture management, soil and vegetation.

Literature offers an immense amount of information, however the necessary information is often not available in one place. Additionally, sources also contradict each other quite often. The knowledge among the respondents in this research turned out to be limited, especially compared to literature. The respondents were generally aware of the big picture, but the reasoning behind certain actions and deeper knowledge were lacking.

The request for new knowledge was mainly on the topic of vegetation, the operative soil and on management in personal circumstances. Therefore, information on soil, management practises and especially vegetation in relation to soil types should be included in the guide. By offering one source with correct information, the demand for new knowledge should be easier fulfilled.

Samenvatting

Deze scriptie omvat het onderwerp '*optimaal management van paardenweides.*' Vanuit de hippische sector kwam het verzoek om nieuwe kennis over het onderwerp weidemanagement. Het probleem met het verkrijgen van nieuwe informatie over dit onderwerp is niet het gebrek aan bestaande kennis, maar de verspreiding van deze kennis over een omvangrijke hoeveelheid aan bronnen en de tegenspraak tussen deze bronnen.

Het doel van deze scriptie is ontdekken welke kennis reeds bekend is en welke kennis gewenst is, om zo tot een praktische handleiding over management van paardenweides te komen voor de hippische sector. Dit werd middels de volgende hoofdvraag gedaan: "wat is het optimale management van paardenweides op de drie meest voorkomende bodemsoorten in Nederland?" Deze vraag is onderverdeeld in drie onderwerpen: de bestaande kennis en vraag naar kennis met betrekking tot weidemanagement, -bodemsoort en -vegetatie.

De literatuur biedt een immense hoeveelheid aan informatie, echter is de nodige informatie vaak niet beschikbaar op één plek. Daarnaast spreken verschillende bronnen elkaar vaak tegen. De kennis van de respondenten in dit onderzoek bleek beperkt, met name wanneer deze met de literatuur vergeleken wordt. De respondenten waren zich over het algemeen bewust van de grote lijnen, maar de redenering achter bepaalde acties en achterliggende kennis ontbraken.

De vraag voor nieuwe kennis was veelal rondom het onderwerp vegetatie, de bodemsoort waarop de respondenten operatief zijn en management onder persoonlijke omstandigheden. Om deze reden zouden informatie over bodemsoorten, management praktijken en met name vegetatie in relatie tot bodemsoorten moeten worden omvat in de handleiding. Door het aanbieden van één bron met correcte informatie zou de vraag naar nieuwe kennis makkelijker voldaan moeten worden.

I. Introduction

This thesis covers the topic of management of equine pastures on the three most common soil types in the Netherlands. The enquiry for knowledge on this topic has arisen from the equine sector. More specifically, various people within the equine sector – in different layers of the sector – have voiced their request for this knowledge, particularly knowledge that can be easily applied at their own stables. Among these various layers are people that keep their horses at their own homes, people that own a livery stable and people who own professional stables.

The research that will be conducted in this report will not be based upon what is known and what is unknown in a universal fashion, but rather on what is known and what is unknown within the equine sector. It is commonly known that there is a lack of knowledge in the equine sector, especially when it is compared to the cattle sector. A large portion of the knowledge that is required for this report is already known within sectors such as the cattle sector, however not yet applied within the equine sector.

The subjects that will be addressed in the introduction all have a function in the management of the pasture. Starting with the three most common soil types in the Netherlands (sand, clay and peatlands), that each require a different approach in management as they influence the land in different ways. This includes the vegetation that grows on these soils and the influence of the soils themselves on horses and pastures. This subject is followed by grasses and plants suitable for equine pastures, with the main focus on vegetation that is consumable by horses and beneficial to their health. After this comes undesirable vegetation for pastures, which could negatively impact the horses' wellbeing. In order to maintain a good pasture, revitalisation of the pasture is equally important. This item is followed by the subject of fertilisation, which is necessary to keep the soil, vegetation and horses healthy. Consecutively is the importance of various nutrients, divided into main and trace elements, which are essential in sustaining the health of the soil, vegetation and the horses.

I.1 Sand, clay and peatlands

The Netherlands has a number of distinct geographic soil regions (Jongmans et al., 2013). The country is below sea level for nearly 50 percent of its land. Over 90 percent of the soil contains groundwater levels from 1.40 meters up to the top soil in wintertime, therefore artificial drainage is often required. In the Dutch rural areas sandy soils (43%), marina clays (24%), organic soils (14%) and fluvial clays and loams (8%) dominate. Only a small part in the south of the country consists of loess grounds (1.4%) (Hartemink & Sonneveld, 2013). To simplify: the soil type map from the University of Wageningen (2006) exhibits that the three most common soil types in the Netherlands are: sand, clay (fluvial and maritime) and peatland. Soils are made up of solids (~50%) and pore space (~50%). The solids consist of minerals (45%) and organic matter (5%) and the pore space consists of air (25%) and water (25%). The nature and relative proportions of previous components differ, dependent on the location of the soil in the landscape and on the parental material in the region (Voroney, 2019).

In NEN-EN-ISO 14688-1:2019, clay is classified as '*natural soil with a composition based on the masspercentages lutum, silt and sand*' and contains a lutum fraction of > 0 and $< 2 \mu\text{m}$ (Van Der Meulen, De Lang, Maljers, Dubelaar & Westerhoff, 2003). 'Clay however, can also be used as a general term for *'fine mineral soil constituents.'*

The lutum in clay soils is compiled of silicon and aluminium containing minerals. Due to the shape and composition of this soil, the soil particles excel at retaining water and nutrients. Clay is often calcareous, especially near the sea. Any soil containing more than 8 percent of lutum is considered

clay; the more lutum the ground contains, the heavier the clay will be (Provincie Gelderland, De Marke, Wageningen University & Research, & Royal HaskoningDHV, n.d.).

Sand soil has been classified under NEN 5104 based on a minimum proportion of grains in the sand fraction and a maximum percentage of gravel (<30%), silt, lutum and organic material; for further classification see appendix one. A sand fraction has a grain size between $\geq 0,063$ and < 2 mm (Van Der Meulen et al., 2003). A sand soil should contain less than 8 percent lutum and consist of more than 50 percent sand. Characteristic for this soil is its great permeability, a benefit of which is less humidity and this allows the ground to still be well cultivatable in the autumn. A disadvantage of this soil is the quick disappearance of moisture and nutrients to deeper grounds, reducing the fertility of the soil and resulting in inferior crop yields. Additionally, a higher amount of nitrogen leaches into the groundwater, which forms a threat to freshwater resources (Provincie Gelderland, De Marke, Wageningen University & Research, & Royal HaskoningDHV, n.d.).

Peatlands, or mires [peatland where active forming of peat takes place (Craft, 2016)], are formed by the natural accumulation of partially decayed biomass (Stracher, Prakash & Sokol, 2012). The definition of peatland, according to Joosten and Clarke (2002): “a peatland is an area with or without vegetation with a naturally accumulated peat layer at the surface” (p. 24).

To be classified as peat soil, the soil needs to have a proportion of organic material with a minimum of 15 percent (sandy peat) or a minimum of 30 percent (clayey peat) (Van Der Meulen et al., 2003, p. 77-78). The natural openness of peatlands makes the soil great grazing grounds, which is especially seen often in northern countries (Joosten & Clarke, 2002). Figure 1.1 displays the occurrence of sand, clay and peatlands in the Netherlands.

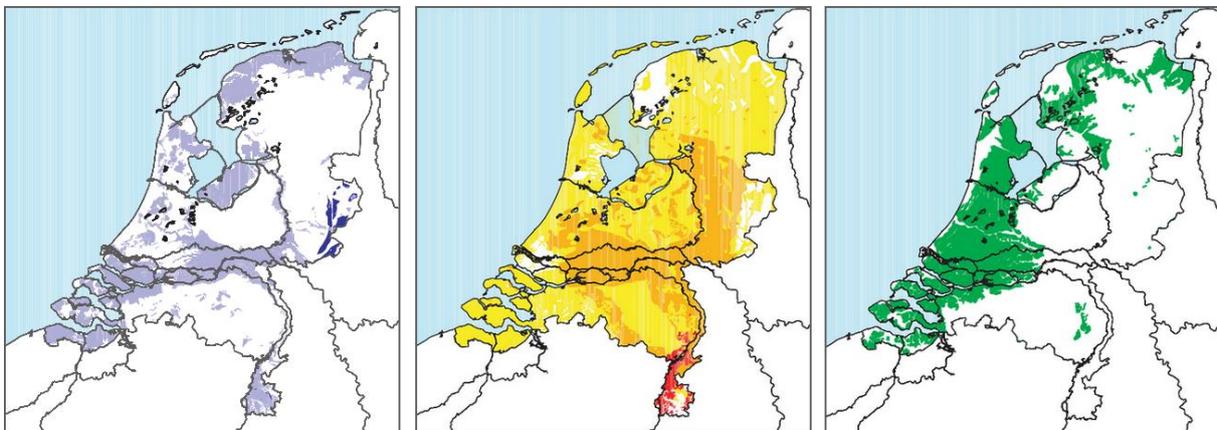


Figure 1.1 Occurrence of clay (left), sand (middle; yellow: fine sand; orange: coarse sand; red: coarse sand and gravel) and peatlands (right) in the Netherlands (Van Der Meulen, 2003).

The classification and designation of peatland is determined by the content of organic matter, lutum, and silt + sand in accordance with NEN 5104. The classification and designation of the soil types sand and clay are determined by the content of lutum, silt and sand in accordance with NEN 5104. The specific differences between sand, clay and peatland as depicted in the soil sciences, are illustrated in annex one: classification and designation of soil types (Rijkswaterstaat, 2019). Briefly summarised: peatland contains 15 – 100% organic matter, 0 – 70% lutum and anywhere between 0 – 100% sand. Any soil that contains less than 15 % organic material is either sand or clay, varying from weak or strong silty clay or sand, to weak or strong sandy clay or loam (Van Der Meulen et al., 2003).

NEN 5104 has been replaced by various reports up to now, of which NEN-EN-ISO 14688-2:2018 is the latest version. The content however remains the same.

The difference in moisture in the soil, as well as the difference in fertility, has a big influence on the usability of ground for horse pastures. The moisture in clay and peatlands, especially in the autumn and winter, could lead to diseases such as mud fever and thrush. Additionally, intensive use of clay pastures in wet periods causes relief on the ground, which will not automatically go away once the clay ground starts drying up and harden in the summer. This in turn often causes injuries to horses. Precipitation on sand soil often disappears quickly into the ground, which makes the soil less fertile (Voroney, 2019).

The soil on the surface is enriched with organic material, accounting for 1 to 10 percent of the entire soil mass. The definite amount of organic material in the soil depends on farm practices, soil cultivation and cropping systems. This material is built up out of residue from plants, fauna and microbes in diverse states of decomposition, which could be anywhere from litter to humus. Grass that grows on this soil ensures input of organic matter and the waste that is generated afterwards is consumed and disintegrated by organisms in the soil (Voroney, 2019).

I.II Grasses and plants suitable for equine pastures

A good equine pasture needs different plants for consumption, varying in nutritional value, amount of sugar and stalkiness, for instance. Grass differentiates itself from other agricultural crops by its vast amount of species. Each type has specific characteristics, which makes it more or less suitable for certain soil types, climates or exploitations. Most of the grasses will bolt without having to be sown again. Young grass that is rich with leaves is characterised by a very high nutritional value, since it does not contain many cell walls, but does contain a lot of sugars and protein. Older grass is richer in stalks and contains more fibres, which is desired for horses. Depending on the type of grass a maximum growth will take place from July till August and will diminish after September. The grasses form new roots after the winter period, which means it will depend on oxygen and nutrients in the soil. Additionally, fertilisation of the grass is most important during this period. Many grasses naturally exist in the Netherlands, of which some are suitable for equine feed. Amongst the suitable grasses are: English ryegrass (mixed), meadow fescue, red fescue, Kentucky bluegrass, meadow foxtail, cocksfoot and timothy grass (Department Landbouw en Visserij, 2014).

Before being able to understand why certain plants are suitable for horses or not, it is important to have a basic understanding of plant biology. The anatomy of the plant concerns the shoot, stem, blade, sheath, collar, nodes, tiller and stolon above ground. At ground level is the crown and below the ground are the roots and rhizomes. The anatomy of a grass plant is displayed in figure 1.2.

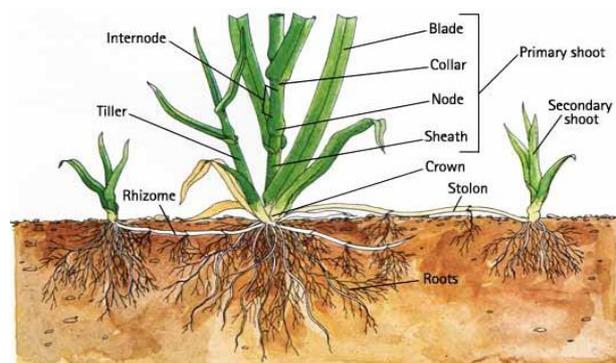


Figure 1.2. Grass plant anatomy (GrassMasters, n.d.).

Plant physiology refers to processes occurring within the plant, which account for its being alive and its productiveness. A living plant only requires a few simple environmental materials to stay alive, which are water, oxygen, carbon dioxide and numerous minerals. The plant uses light energy to incorporate more complicated substances from these simple materials. Among these complicated substances are carbohydrates, that in turn incorporate other complicated substances such as protein and lipids. These simple materials as well as the complicated substances need to be transferred within the plant, to parts where they are necessary. The plant's cells and organs are produced by utilisation of these materials, from which growth and development arises. The plant's control systems provide the plant with an ordered way of growth and development (Lopez & Barclay, 2017).

Many of the meadows in the Netherlands, now used as horse pastures, have previously been used for cattle. These fields were sown with grasses for the optimal cow diet, which would lead to the highest amount of milk or meat. The set up for an optimal cattle field however, does not work for horses, due to the difference in the gastrointestinal tract of the horse. A horse naturally requires to digest energy poor and fibre rich feed. A cow on the other hand needs grasses with the highest possible nutritional value. These fields are often sown with English ryegrass, which is rich in protein and sugar. The risk on catching laminitis, equine exertional rhabdomyolysis (Monday morning disease) or insulin resistance becomes greater due to excessive sugar intake (Dansen, 2017).

English ryegrass, also known as perennial ryegrass, is suited for pasture grazing, provided it is not the only grass in the pasture. It is highly palatable and has a high yield potential. Depending on the environmental conditions, it may live for two to four years. It is not very drought-resistant and does not tolerate high temperatures well (University of Kentucky, 2016).

Meadow fescue is a perennial grass that has a good resistance to cold and humid weather. Its slow growth and rooting make it easily overgrown by English ryegrass, when the grassland is used extensively. It also delivers an average productivity and it sensitive to drought (Encyclopedia pratensis, n.d.).

Red fescue grass is typically used in mixtures destined for golf fields and firm (recreational) sods. This type of grass has a high tolerance for salt and requires little to average fertilising and water. It also easily restores itself after grazing or cutting. Due to the fine stolons and deep roots it is very drought resistant (Bals, 2009).

Timothy-grass is very winterproof, also highly luscious for horses and rich in fibres. It is often used in horse grass blends. The shallow roots allow the plant to be easily overgrown by other plants. Provided the pasture is not intensively grazed, this plant can be used very well (USDA, 2011).

Kentucky bluegrass is a perennial grass with shallow roots (USDA, 2004). Its stolons allow the grass to have a positive effect in the forming of the sod, as well as making it drought resistant (Bals & Boer, 2009). The grass grows best in cool and humid environments (USDA, 2004).

Meadow foxtail grows in sunny places and is winterproof. The stolons of this grass type are short, as they root only where they grow. The amount of fructan in this grass type is generally low (Ecopedia, n.d.).

The cocksfoot grass is deep-rooted and usually decays within a year (Instituut voor Natuur- en Bosonderzoek, 2007). This grass continuously grows young leaves and is able to withstand intensive grazing (Göhl, 1982). It can be used for pasture grazing, as well as for cutting. The main benefit of cocksfoot is the higher production in forage in the summer, in contrast with other forage grasses (USDA, 2010).

The following plants are desirable in equine pastures, however not in high proportions, as they have a low digestibility and a high amount of energy. They will grant extra nutrients, especially minerals and sometimes proteins, that otherwise might need to be supplemented with concentrated feed. They may also have a positive effect on the structure of the diet and contribute to a better digestion.

Red, White and Crimson clover strongly improve the quality of the sod: aiding in improving the structure, organisms and fertility of the soil. Protein levels are more consistent in clover than in grass, as consequence of the nitrogen fixation that happens within the plants. This results in the pasture requiring less nitrogen fertilisation (De Wit & Rietberg, 2015). Red clover cannot endure intensive grazing and poor drainage, in contrast to the white clover. However, it can tolerate shade quite well

and is resistant to drought (University of Kentucky, 2016). White clover is winter hardy and drought-resistant. It may however overgrow other plants, due to its stolons that quickly spread above ground (University of Kentucky, 2016). Crimson clover is found to be highly palatable for horses (McCann & Hoveland, 1991) and grows well in many soil conditions (King, 1999).

Alfalfa is a perennial flowering plant, often cultivated as roughage. It shares the same family as clover (Fabaceae, generally known as legume, pea or bean family) and also its ability to retain nitrogen in the soil. The roots of alfalfa run deep and improve the soil structure, which is also beneficial for water management (Wervel, 2008). This plant easily overgrows weeds and can be cut for roughage 3 or 4 times annually (PAVO, 2017).

I.III Undesirable grass types and plants in equine pastures

Next to the grass types that are beneficial for horses, there are naturally grass types that should be avoided. Certain monocots (also referred to as weeds), which are flowering plants of which the seeds typically include just one embryonic leaf (Encyclopaedia Britannica, n.d.), could contain fewer nutrients or could even be toxic. These weeds take nutrients away from desired types during their growth and can even overgrow them and start dominating the sod.

Having undesired weeds could indicate certain problems in relation to the management of the pasture. For instance the annual meadow grass. This grass is not toxic, but does not have any nutritional value, though it does absorb nutrients that could otherwise be absorbed by desired plants. It grows quite fast and therefore could overgrow good types, which are less dominant or low-yielding (Mitich, 1998). Nettles as a fresh plant is undesirable as feed, as they leave a burning and irritating feeling. For grazing pastures this plant is not desired, however it is a fine plant in cutting pastures (Ferguson, 2016).

Other plants that should be avoided are ragwort, buttercups and red sorrel. These vary in toxicity and horses will not be able to detect and avoid them once they have been processed to dry feed.

Ragwort is toxic for horses, but when it grows in the pastures they will eat around it. Once dried it becomes more dangerous, because they cannot recognise the smell of the plant anymore (Macdonald & Russo, 1989). This plant exists in extremely nutritionally deficient soils, so preventing it from growing can be done by keeping the soil healthy and rich in minerals through fertilisation (Van de Ven, 2007).

Buttercups occur regularly in equine pastures, although horses usually graze around them as they taste unpleasant. They are mildly toxic to horses and when the flowers are dried, the toxins nearly fully disappear, which makes hay that contains a low amount of dried buttercups safe. The plant grows well on wet soils and seldom occurs in light and well-drained soils (Kentucky Equine Research, 2013).

Red sorrel is a perennial plant with over 200 types. Due to oxalic acid in the leaves, horses usually avoid eating this plant. However, by eating large amounts of red sorrel symptoms of toxicity may occur (Quaghebeur, 2019).

Undesirable vegetation that generally does not grow in pastures, but might appear in the vicinity, are common yew, buxus and oak trees. Buxus is often decoratively planted on equine farms. It can be toxic after ingesting 750 grams or more. Horses usually avoid this plant because of its intense bitterness, but they have more difficulty with distinguishing broken branches (Van Manen, n.d.). Common yew is extremely poisonous, as only 0,5 to 2 grams per kilogram of bodyweight can have lethal consequences. Parts of this plant can be relocated by the wind, so this plant should be avoided

in the vicinity of equine pastures altogether (Piskač, Stříbrný, Rakovcová & Malý, 2015). Lastly, the acorns from the oak are also toxic, especially in their green phase, mainly from spring to midsummer (Deprez, 2017).

I.IV Grassland revitalisation

Revitalisation of the grassland is necessary when an inferior botanical composition has been established. This can happen, for instance, due to frost damage, erosion, poor grassland management or intensive grazing. Poor grassland management results in reduced productivity, because desired grasses are overgrown by undesired or inferior grasses. Horses graze very close to the top soil, causing some grasses to disappear and inferior grasses to stay. This often happens in places where the sod has been trampled, such as around the drinking places and at the field's entrance. Horses also tend to defecate in the same places and do not eat around these places, which makes less of the field available for grazing. Benefits of revitalisation are a healthier soil, more production of plants and lower worm contamination.

The best periods to sow the grassland is in early spring and early autumn. The temperature and humidity in these periods ensure an optimal germination and growth of the grass. The soil temperature needs to be at least 8 °C and it is best to sow before precipitation (Barenbrug, n.d.).

A vast amount of grass seed mixes for horse pastures have been brought to the Dutch market already, which combine the best qualities of different grass types. Eight of these grass seed mixtures are displayed in table 1.1. The *festulolium* mentioned in this table is a hybrid mix of either meadow or tall fescue with either perennial or Italian rye (Mapleseed, n.d.).

Table 1.1. A selection of grass seed mixtures available on the Dutch market.

%	English Rye	Kentucky Bluegrass	Timothy	Red fescue	Meadow fescue	Cocksfoot	Rye	Tall fescue	Festulolium	Red clover	White clover	Crimson clover	Herbs
1	60	12	15	10									3
2	50	20	20	10									
3	10	15	30	10	15			10					
4			35	25	25	15							
5			20		20	5	15	5	15	10	3	7	
6			25	15	22		17		15	4	2		
7			25	15	15	15	14	10		4	2		
8	50	20	20	10									

1. Pavo GrassSeed, 2. Vitahorse GrassBalance, 3. VitaHorse Low Fructane Mix, 4. Bio-Ron graszaad mengsel 1, 5. Bio-Ron gras/klaver mengsel 2, 6. Bio-Ron graszaad mengsel 3, 7. Bio-Ron graszaad mengsel 4 and 8. Horse Star Paardenweide.

I.V Fertilisation

Grass will only grow optimally if enough nutrients are available to be absorbed by the plants' roots. By fertilising, the amount of nutrients in the soil will be elevated. The aim of fertilising is not only to enhance the grass production, but also maintaining the quality – nutritional value – of the grass. Fertilisers also deliver elements that will be ingested by horses and contribute to their health (Barenbrug, n.d.).

The optimal fertilisation depends on the pasture's utilisation. When the pasture is merely used for grazing, only a few nutrients are depleted, so only a little fertilising is necessary. Ample fertilisation is necessary when the field has been used for hay winning in the spring. Therefore, fertilisation needs to be tailored to the nutrient requirement of the soil (Department Landbouw en Visserij, 2014).

I.VI Importance of various nutrients

Plants in development require 17 fundamental elements to grow, which are divided in three groups. The first one contains three macronutrients that are retrieved from water, air or both: carbon (C), hydrogen (H) and oxygen (O). The nutrients absorbed from the soil are divided into macronutrients and micronutrients, outlined in table 1.2, along with the average content and range of the nutrient, based on the dry weight of the plant. The split between the two groups is established by the amount of the nutrients necessary for the plant to grow decently (Mahler, 2004).

I.IV.I Macronutrients

Nitrogen (N) is required in large for decent growth. Usually, a plant contains 1.5% nitrogen, but this may vary from 0.5% to 5.0%. N is mobile in the plant, giving it the ability to move from old to new tissue. N is a component of amino acids, which are the building blocks for protein. Yellowing of the plant indicates a lack of protein. An excess of nitrogen allows plants to become too protein-rich. N naturally occurs in organic matter in the soil (Mahler, 2004). Protein is required by horses for maintenance, reproduction, lactation, work and growth (Westendorf, 2004).

Phosphorus (P) makes up 0.2% in a plant on average, but this can range from 0.1 to 0.5%. P is mobile within the plant and goes where it is needed. A phosphorus deficiency is not commonly visible, but can be found through a soil test. P is vital for adenosine diphosphate (ADP), adenosine monophosphate (AMP) and basal metabolism (Mahler, 2004). In horses, P is needed for the formation of bones and teeth. Excesses of ingested P are excreted in the horse's manure (University of Kentucky, 2018).

Potassium (K) usually makes up 1.0% of a plant on average, ranging from 0.5% to 5.0%. P is necessary in plants for managing the inner water and energy supply, as well as forming and transporting carbohydrates. A deficiency of P shows if yellow or brown spots appear in the leaves (Mahler, 2004). Horses require P for the contraction and relaxation of the muscles. An excess of P is filtered out by the kidneys in healthy horses and excretes through urine (Kentucky Equine Research, 2017). Usually, horses digest enough P from forage. However, when the equine diet does not consist a proper amount of forage or if the horse sweats excessively, a P deficiency can occur, which may cause critical problems (Kentucky Equine Research, 2015).

Sulphur (S) makes up circa 0.1% of a plant, but this may range from 0.05% to 0.5%. S is another component of certain amino acids, which form protein. It is also required to form protoplasts (cells that do not or only partly contain a cell wall) and enzymes. S is only adequately mobile in the plant. A deficiency of S is seen by new plant tissue colouring yellow (Mahler, 2004). Horses need sulphur for the production of protein, quality of the hooves, healthy joints and building ligaments and tendons (Life Data Labs Inc., n.d.).

Calcium (Ca) typically comprises 0.5% of a plant, but may be as high as 5%. It is used in the plant for division, elongation and structure of the cells. Ca is not mobile within plants, so a deficiency is shown

Table 1.2. Plant content of 14 soil-derived essential nutrients

Nutrient	Symbol	Average	Range
.....%			
Nitrogen	N	1.5	0.5 – 5.0
Phosphorus	P	0.2	0.1 – 0.5
Potassium	K	1.0	0.5 – 5.0
Sulphur	S	0.1	0.05 – 0.5
Calcium	Ca	0.5	0.5 – 5.0
Magnesium	Mg	0.2	0.1 – 1.0
.....ppm.....			
Boron	B	20	2 – 100
Chlorine	Cl	100	80 – 10.000
Copper	Cu	6	2 – 20
Iron	Fe	100	50 – 1.000
Manganese	Mn	50	20 – 200
Molybdenum	Mo	0.1	0.05 – 10
Nickel	Ni	<0.0001	-

Adapted from Mahler (2004).

at the growing tips (Mahler, 2004). Ca is essential for healthy bones and teeth, but also for nerve and muscle functions in horses (Kentucky Equine Research, 2012).

Magnesium (Mg) is generally extant for 0.2% in plants, but this may range from 0.1% to 1% (Mahler, 2004). Mg is essential for developing chlorophyll, which colours the leaves green. The colouring of the leaves is essential in the photosynthesis process (Roca, Chen & Pérez-Gálvez, 2016). Lacks of magnesium leads to discolouration of the vegetation (Mahler, 2004). Mg is an essential mineral for horses, playing parts in various bodily functions. It is one of the crucial minerals in the bones and involved in more than 300 enzyme reactions. Along with Ca, Mg is also crucial in nerve transmissions and muscle contraction (Kentucky Equine Research, 2011).

I.IV.II Micronutrients

Micronutrients appear in plants in rather low concentrations, frequently only a few parts per million (ppm) of the total weight of the plant. Nevertheless, deficiencies will still be harmful.

Boron (B) comprises circa 20 ppm in plants. The conversion of sugars, cell development and regulation of growth is promoted by boron. B is immobile within plants, which means deficiencies will show in the growing tips of plants. Overirrigation or excessive precipitation may cause leaching or boron (Mahler, 2004). B is a vital mineral in the horse's bone and joint health. It helps reduce inflammation and increase mental alertness. The horse's kidneys filter out excesses and B is excreted through the urine (Holmes, 2019).

Chlorine (Cl) covers circa 100 ppm in plants and is necessary for the process of photosynthesis. Cl is very mobile within the plant. A Cl deficiency is unlikely to happen, but if it does it will show through chlorosis and necrosis of the leaves (Mahler, 2004). Cl helps regulate the acid balance in extracellular fluids in horses and is a vital component of gall, which digests fat in the large intestine. Cl also helps form hydrochloric acid, a substance required for digestion (Understanding Horse Nutrition, n.d.).

Copper (Cu) makes up circa 6 ppm in the plant, but may range from 2 to 20 ppm. Cu is an part of cytochromes in the plant (a protein) and required to activate enzymes. The element is immobile, so deficiencies first appear in young plant tissue. Cu deficiencies in the soil most likely happen on soils containing more than 8% organic matter (Mahler, 2004). Cu is needed in a horse's physiology for enzymes to function optimally. Particular processes requiring Cu are production of energy, iron metabolism, formation of connective tissue, functioning of the central nervous system and production of melanin (Thunes, 2019).

Iron (Fe) is necessary for plants to produce chlorophyll. A deficiency in iron can be seen by yellowing of the younger leaves. Plants typically contain 100 ppm of Fe, but the content may range from 50 to 1.000 ppm (Mahler, 2004). Fe is vital in the production of red blood cells in horses. An excess of Fe may result in insulin resistance (Richards & Nielsen, 2018).

Manganese (Mn) has a concentration of circa 50 ppm in plants, but may range from 20 to 200 ppm. Mn is required for photosynthesis and enzyme activation in plants. It is immobile within the plant, so deficiencies show in the youngest plant tissue first (Mahler, 2004). For horses, Mn is important for the formation of bones, activating enzymes and use of energy (Kentucky Equine Research, 2013).

Molybdenum (Mo) takes up 0.1 ppm in plants on average, ranging from 0.05 to 10 ppm. Being immobile in plants, deficiencies of Mo show in the younger tissue. Mo is needed for plants to utilise N. In legumes, Mo is required for nitrogen fixation (Mahler, 2004). Horses require Mo to make enzymes which help form building blocks of DNA and RNA (Liburt, 2017).

Nickel (Ni) occurs in plants for less than 1 part per billion. This small amount is however an important mineral for iron metabolism in plants (Mahler, 2004). In humans and animals, Ni has an essential function in the metabolism (Groppel, Kronemann & Grün, 1984).

Zinc (Zn) makes up circa 20 ppm in plants, ranging from 10 to 100 ppm. Zn is needed by plants to break down protein and activate enzymes. It is hardly mobile in plants, so deficiency will show in young plant tissue first (Mahler, 2004). In horses, Zn plays a part in more than 100 various enzymes. Many of these participate in the metabolism of protein and carbohydrates. An excess of Zn results in a decrease of Cu absorption (Liburt, 2018).

I.VII Fencing

A good fence should meet the following standards: horses need to remain in the pasture, the fence has to be safe for horses, and the fence should be sustainable and weatherproof. The ability of pastures to fit in the landscape is becoming more and more important. For this reason, it is advisable to choose for wooden poles and brown wiring as fencing. A benefit of wooden poles is that they do not leach chemicals and do not contaminate the soil or the groundwater.

I.VIII Purpose of the research

As can be concluded from previous paragraphs on soil, vegetation, revitalisation, fertilisation, nutrients, and fencing, most of the information necessary for writing a guide on pasture management exists. However, more often than not, the needed information is not available in one document. This has become clearly evident through the amount of references used for this report only. Many of these reports that do contain the right information are full of other information that is not applicable on equine pastures. The information gathered in this report forms the basis for writing a guide on pasture management.

Next to this, what was uncertain in this matter is the knowledge that horse and land owners do and do not have, as well as the information they would like to receive on the subject of pasture management. Research has been conducted on this matter, prior to establishing the guide. This was necessary in order to make the guide as applicable as possible to the people in the sector that have stated their request for knowledge on the matter.

I.IX Research questions

The purpose of this research was to find an answer to the question: “what is the optimal management of equine pastures on the three most common soil types in the Netherlands?” with the purpose of providing a practical guide on equine pasture management to the sector. The answer to this question has been found through answering the following sub-questions:

- I. Which knowledge and need for knowledge do horse and land owners have concerning the management of their grazing pastures?
- II. Which knowledge and need for knowledge do horse and land owners have concerning pasture soil?
- III. Which knowledge and need for knowledge do horse and land owners have concerning vegetation in equine pastures?

II. Material and methods

The objective of this research was to provide a guide for horse and pasture owners on how to optimally manage their pastures, in which the horses' optimal welfare is the highest priority. By conducting the research it has become clear which information exactly is required on the three different topics by the public. This information will be used in order to write an applicable guide.

All three sub-questions aided this purpose and have been answered through qualitative research. An enquiry has taken place, in which three subjects are divided: knowledge and the demand for knowledge on pasture soil, pasture vegetation and management of pastures. The aim of this research was to find out which knowledge horse and land owners already have and which knowledge they would like to acquire. After the research has been conducted, it is now known which information is the most important for the guide. The enquiry consisted of an in-depth interview, held with a ten people. The questions for this enquiry can be found in annex II. At least three inquiries have been held on the three different soil types to ensure diversity.

It was intended to have face-to-face interviews with at least ten people and at the same time write down the answers on the form. Due to COVID-19, it was not possible to meet with people, so the enquiries were sent over e-mail to ten people who then filled it out and sent their answers back. Another consequence of the COVID-19 pandemic has been a slight delay in this research. This delay, as well as not being able to hold face to face interviews, has led to the answers being less elaborate than initially intended. Nonetheless, the answers given were by far sufficient to work with.

From May 26 to July 1 2020, people have been approached to be interviewed. The people that agreed upon this request have sent in their answers anonymously before July 1, 2020. The results have afterwards been compared to one another and the information that has come from them can be found in chapter three: results.

The answers from the interviews have been thoroughly studied and compared with each other. The questions and answers have been divided into several sub-groups: general information on the respondents, knowledge on pasture management, knowledge on pasture soil, knowledge on pasture vegetation, features of a good equine pasture, findability and origin of information on pasture management, soil and vegetation and finally which information is desired in relation to pasture management, soil and vegetation.

The general information about the respondents has been processed and put in an overview table, for which the first four numberless questions have been used. For the information on the sub-group "knowledge on pasture management" the answers from questions 1 and 4 from the enquiry have been combined, as there was often a lot of overlap between the answers. In sub-group "knowledge on pasture soil" answers from question 2 have been processed. "Knowledge on pasture vegetation" has been answered through question 3 and on occasion question 5, as some respondents gave more information on their knowledge of vegetation in this question. The sub-group "features of a good equine pasture" has been solely processed with information from question 5, where the respondents wrote what they considered a good equine pasture should consist of. Questions 6 to 12 have accounted for the information on "findability and origin of information on pasture management, soil and vegetation" and have been processed by means of counting the answers and calculating the amount of times certain sources were named. Finally, the last question from the enquiry also makes up the last sub-group on which information is desired in relation to pasture management, soil and vegetation by means of a free guide.

In order to write subchapters 3.2 to 3.6, important terms that were mentioned by the respondents have been noted and were further counted by how many of the other respondents had also mentioned this pasture-related term. By counting the amount of times these terms were mentioned, it became clearer on which topics the most knowledge is, where it was gained before and where it will be gained in the future, and where the desire for more knowledge lies.

III. Results

The following data describes the age, profession and backgrounds of the respondents. Out of ten respondents, four are below the age of 30, four are aged between 30 and 50 and the remaining two are above the age of 50. The connection between all of the respondents is their ownership of horses. Eight out of ten respondents own a livery yard or sports stable in which they tend to their own and other people's horses. The remaining two respondents are professional riders. Only one of the respondents is not in possession of their own land. Three of the respondents have their horses located on sand soil, three on peatland soil and four on clay soil. An overview of the differences in profession, age, ownership of horses and land and the soil type on which the respondents are operative can be seen in table 3.1. As the respondents wish to remain anonymous, they have been named from A to J.

Table 3.1. Overview of data on ten people interviewed on their profession, age, ownership of horses and land and the soil on which they are operative.

	Profession	Age	Horse owner	Land owner	Soil
A	Livery yard and sports stable owner	47	Yes	Yes	Peatlands
B	Livery yard owner	42	Yes	Yes	Peatlands
C	Student, livery yard owner	21	Yes	Yes	Peatlands
D	Livery yard owner	38	Yes	Yes	Sand
E	Livery yard owner	22	Yes	Yes	Sand
F	Professional rider	20	Yes	No	Sand
G	Professional rider	25	Yes	Yes	Clay
H	Sports stable owner	52	Yes	Yes	Clay
I	Livery yard owner	45	Yes	Yes	Clay
J	Sports stable owner	64	Yes	Yes	Clay

III.I Knowledge on pasture management

Regarding pasture management, certain terms related to managing equine pastures were put in a list and the amount of times they have been mentioned has been counted (with a maximum score of 1 per responder). The results can be seen in table 3.2. This table includes the knowledge about the management of equine pastures, as well as what the people carry out or wish to carry out in their own practice.

Table 3.2. Terms related to equine pasture and the amount of people that mentioned them, out of ten respondents.

Term	Amount	Term	Amount
Sowing	2	Soil sample	4
Re-sowing	4	Nutrients in the soil (for vegetation)	4
Cutting before the season	6	Nutrients in the vegetation (for horses)	2
Cutting during season	7	Variety in vegetation	9
Weeds removal	7	Move horses between pastures	7
Manure removal / dragging	6	Move horses between pastures (worms)	2
Manure removal for worms	2	Putting sheep or cows on the pastures	2
Sod trampling (grass)	5	Safe fencing	1
Sod smoothness	3	Shelter / shade	2
Special attention to where the sod is trampled	2	Water the grass	1
		Fertilising	9

As has been asked what people think is important about managing their pastures, it becomes clear that a variety in vegetation is essential to most people. The reason for having a variety in vegetation however is not always known: they just know variety is good. Only two people stated the reason for this is to ensure nutritional value for the horses and four people stated the horses like to have different tastes.

Nine out of ten respondents know the lands have to be fertilised, however it was only mentioned once when fertilisation needs to take place and just four respondents take soil samples before fertilisation, as to know what exactly they need to fertilise with or to check the soil health.

The removal of weeds in the pasture is mentioned by seven of the respondents. One person has declared to know about a few weeds that are dangerous to horses, the others have mentioned to be aware that weeds in general are not beneficial and need to be taken out. The weeds that were mentioned by this person are: buttercups, ragwort and nettles.

Cutting the grass before the season is done by six respondents. Three of these have stated to do so, solely to use this first cut for their own hay. Another has stated that they believe horses like shorter grass better than very tall grass. Two respondents mentioned the first cut contains too much sugar and protein, which is not beneficial for their horses to eat. Seven out of the ten respondents cut their pastures during the season as well. The main reason for this was allowing the inferior grass to grow again and removing plants that are not eaten (as much).

It has been mentioned seven times that horses should be moved between pastures during the season. Two people reasoned they did this to prevent worm contamination, the other five argued it was to allow the grass some rest and time to regrow. It has not been specifically mentioned to do this in relation to the vegetation being able to take up new nutrients.

The replacement of horses in the pasture with sheep or cows has been mentioned twice. One respondent argued the sheep will eat the vegetation and weeds that the horses leave and the other mentioned to do this as a prevention to worm contamination. Neither of them mentioned any possible complications by doing so.

Two people have mentioned sowing their fields at the start of the season, as well as re-sowing of the pasture, which has been mentioned four times, to fill up the places where the sod has been trampled. There was no reasoning behind why exactly the trampled places need to be re-sown, other than that there just is not any grass growing there. Five respondents mentioned trampling of the sod, of which two have especially named where the sod is often trampled or open, near water or feeding places and near the entrance of the pasture, as this is where horses spend a lot of their time. The smoothness of the sod has been mentioned three times, which has been found important to prevent injuries to the horses.

Six times respondents mentioned removal or dragging of manure is important, preferably a few times per week. Two respondents added they do so specifically to prevent worm contamination. It has not been mentioned by any of the respondents to do so as a natural fertiliser for the vegetation or any other reason.

As it is a part of the pasture, safe fences have been mentioned once. The necessity of horses being able to shelter, albeit an actual building or a natural option, has been mentioned two times, of which the shelter should be specifically to grant the horses a place in the shade. Only one person, located on a sand soil, mentioned having to water the pastures during the summer twice daily.

III.II Knowledge on pasture soil

In general, the answers people gave on their knowledge on pasture soil were quite shallow. Five of the respondents filled in that “different plants grow (better) on different soils.” Two times it was mentioned that clay soil is very wet and muddy, which is thought to be inconvenient, and once it has been added that horses can get stuck in this muddy soil and become injured. It was also mentioned four times that the nutrients in the soil are important for grass growth, however not further specified. The specific nutrients that are necessary have not been mentioned at all. These four respondents have also added that taking soil samples is important to know if the soil is lacking in certain nutrients. Two people have stated to find peatlands unsuitable as pasture land, as they believe grass does not grow well on this soil type. The third respondent operative on peatlands contradicted this, saying they think the grass does grow very well on the soil and they need very little fertilising. Three respondents have said to be aware that different soils have different needs, but only related to moisture: once it has been said that sand soil is too dry in the summer and the pasture needs extra watering and three times that clay gets too wet.

III.III Knowledge on pasture vegetation

The main subject people stated about their knowledge of vegetation was that a pasture needs to have different grasses and herbs in it. This was stated by nine out of ten respondents, where four reasoned it was important because the horses like different tastes, one stated it was important for a variation in the horse’s diet and the remaining four did not know the reason behind the importance. One respondent added that is important to know which grasses and herbs are in the field, but they did not know why it was important.

Three people mentioned the importance of the vegetation being stalky, where one gave as reason that the horses then need to chew longer, which is beneficial to them. Another seven respondents stated it is important to remove weeds from the pasture. One of these said it was important because of the toxicity, another named three specific plants that needed to be removed and the remaining respondents left out a reason. Other than grasses, herbs and weeds in general, there was no mention of any other vegetation. The subject of nutrients in the vegetation was mentioned twice. Both people stated that the vegetation should not contain too much protein and sugar and one of these added that the nutrients should be the right amount. Besides protein and sugar, no other nutrients were mentioned.

III.IV Features of a good equine pasture

According to the respondents, a good equine pasture is considered one that consists of a great variety in vegetation, which has been mentioned nine out of ten times. It was mentioned seven times that the pasture should contain enough grass for the horses. The possibility for the horses to find shelter, especially from the sun, has been found of importance to two of the respondents. Three respondents deemed a good pasture to be free of open sod and one considered safe fencing of equal importance. A variety of other important features of a good pasture have been mentioned, which are displayed in table 3.3, along with the amount of respondents that mentioned them.

Table 3.3. Features that make a good equine pasture and the amount of respondents that mentioned their importance.

Feature	Amount	Feature	Amount
Variation in vegetation	9	Enough space for the horses	2
Enough grass	7	Even ground	1
Possibility for shelter	2	Stalky vegetation	1
No open sod	3	Sugar and protein content	2
Safe fencing	1		

III.V Findability and origin of information on pasture management, soil and vegetation

In the enquiry, questions were asked about the ease with which information was found on the topics of management, soil and vegetation, on a scale from 1 to 10: 1 being very difficult and 10 being very easy. The following averages have been calculated:

- The ease with which information on pasture management is found 7.1
- The ease with which information on pasture soil is found 6.8
- The ease with which information on pasture vegetation is found 6.2

An additional question has been asked to find out of the respondents think the information that has been found was enough to be applicable. This question was also scored on a scale from 1 to 10: 1 being far too little, 10 being plentiful and has led to the following average:

- The rate with which information was deemed enough (to be applicable) 6.5

The amount of correspondence of the information that has been looked up by the respondents has been answered as follows: three out of ten people found the information to be corresponding and the remaining seven have answered the question with “sometimes.”

The knowledge was gained through the following channels (multiple answers possible):

- Education 2 times
- Experience 7 times
- Internet 5 times
- Professionals 7 times

New information is being looked up through the following channels (multiple answers possible):

- Internet 9 times
- Professionals 8 times

No other channels of having gained or finding new information has been mentioned by any of the respondents. One person, who gained and searched information only by means of the internet, gave additional comments on the findability of information. They thought the information is findable, but not nearly accessible enough. The information is spread and they would appreciate it if the information would be in one place and more compact. Another two respondents commented that the information could be better, more applicable, more information in general and in one place.

III.VI Desired information on pasture management, soil and vegetation

On the question “which information would you still like to acquire by means of a free guide on pasture management on pasture management, soil in relation to horses and vegetation for horses?” most of the answers were related to vegetation. Three respondents specifically expressed their request for knowledge on which vegetation grows best on each soil type. Four other respondents desired more information on vegetation in general and another desires tips on the vegetation in their pasture specifically. One other respondent requested more knowledge about weeds. One respondent added desiring to have more information on the nutritional value of useable vegetation in the pastures as well.

Four respondents answered they would like to know specifically what the best management practises are on a specific soil. One of these four added they would like to be able to fill in questions on the amount of horses, time the horses are in the pasture and other information, to which an

elaborate plan rolls out. Another of these four would like to know what exactly they need to do every month: when to sow, when to fertilise, when to put the horses in the field or not.

From the answers on this question it appears that people are mainly interested in information that specifically applies to their own pastures. The right vegetation for the horses in relation to the right vegetation for the soil type appears to be the number one demand. Furthermore, management tips on the operative soil are desired. Finally, some have stated that the information they find, mainly on the internet, is not applicable or elaborate enough to their specific needs.

IV. Discussion of results

The objective of this research was to assess the knowledge and demand for knowledge of various people within the equine sector on the topic management of equine pastures. To be able to evaluate the existing knowledge and the request for new knowledge, the topic has been divided into three subjects: pasture management, pasture soil and pasture vegetation. Literary research has assisted in the writing of chapter one and has supported in forming a basic understanding of fundamental information on each of the three topics.

The qualitative research that has been executed consisted of ten enquiries. It was originally intended to hold these enquiries in an interview-form, where the questions would be verbally asked and answered. Sadly, the outbreak of the COVID-19 virus affected this intention and thus the method had to be adjusted. It is therefore that the enquiries were held over media channels, rather than in person. The enquiries were sent to the ten people who had agreed to answer the questions and the answers were written down and sent back. This setback has had a slightly negative impact on the research for two reasons: the answers received are relatively short, compared to what was expected and this method has lend no opportunity to dig deeper on the answers, as would be the case in a verbal enquiry. Nonetheless, all enquiries were by far sufficiently filled out to still execute the research and in a few cases the respondents were later contacted to elaborate their answers further, in order to get a more complete image of their answers. Hence, all three research questions have been answered fully and so it is fair to say that the method used in this research has been successful nonetheless.

One of the benefits of face-to-face interviews would have been the opportunity to dig deeper on the different topics. This would have led to not having to combine the answers in some cases, as the drifting off to another topic could have been steered back. Another opportunity in digging deeper would be the possibility to ask what the respondent's management specifically looks like, on a daily, weekly, monthly and yearly basis for example, if the original answer was not very elaborate. The questions could have been started broader and then narrowed along the interview, to collect as much information as possible, including things the respondents did not think of at first.

Compared to the existing literature, the knowledge of the respondents on all three topics seems quite shallow. This may have two reasons: either they did not think of it at the moment of filling out the enquiry or they genuinely did not have the knowledge. However, the respondents had been requested to be as thorough and elaborate as possible in their answering, to which they all agreed. For this reason, it is expected that the shallow-seeming answers are truly the knowledge they possessed at the moment of filling out the enquiry.

One of the most important findings in this research is that the information from various channels does not always correspond with each other, even within the same channel. This makes it a lot more difficult for people to know what is right and what is not. This is especially the case when both the internet and professionals are consulted. Furthermore, the required information is often not available in one place, causing people to be forced to consult multiple sources and so they become more prone to finding contradicting information.

IV.1 Pasture management

Knowledge on pasture management

The most important managing factor for the respondents is having a variety of vegetation in the pasture. The reason for having a great variety, a balanced and nutritional equine diet, is however not commonly known. The second most important managing factor is the fertilisation of the pasture. People know that it has to be done, but the specifics are lacking: when does fertilisation have to take place and which fertilisation should be used are not among common knowledge. Seven of the respondents stated to know that weeds generally are not desired in a pasture and need to be taken out. However, only one respondent knew of possible dangers that weeds could bring.

Six respondents cut their pastures before the season, of which only two reasoned to do so in relation to the protein and sugar content of the grass. Other reasons, such as worm contamination, prohibiting weeds and other inferior plants to overgrow desired vegetation and risks of illnesses such as laminitis have not been mentioned. Seven of the respondents mentioned cutting their pastures during the season, though none mentioned this to specifically relate to the grass being able to take up nutrients to grow. The main reason for cutting during the season was allowing all the grass to grow equally again and to remove plants that are not eaten (especially where the horses have left manure and so bushes originate).

The moving of the horses between pastures is done by seven of the ten respondents, though none reasoned to do this so the plants are able to take up new nutrients. Growth is mentioned however, but merely by letting the grass rest. Also replacing the horses by cows or sheep has been mentioned twice, once in relation to worms and once in relation to the vegetation. There were no mentions of the dangers of these replacements, for example the spread of the common liver fluke, which is often found in cattle.

Sowing and re-sowing of the field is only done by a four respondents, however none of them reasoned they did this to ensure the variety of vegetation in their field, which many of them deemed an essential part of a good pasture. Also, it was not reasoned why the open spaces in the pasture need to be re-sown, though an open sod has multiple disadvantages, other than three mentions of the sod needing to be smooth to prevent injuries. Half of the respondents did mention the trampling of the grass and open sod in places the horses often are.

The dragging or removal of manure is also done by six of the respondents, where two reasoned to do so to specifically prevent worm contamination. It did not seem to be commonly known however, as well as removing the manure to prevent bushes, to ensure that weeds or other low-nutritional vegetation do not overgrow the good vegetation or as a natural fertiliser for the pasture.

One respondent mentioned to find safe fencing important. It was not mentioned what fence fencing exactly encompasses or that the fencing should be fitting in the landscape. The possibility for horses to shelter from certain weather conditions was also scarcely mentioned.

There seems to be a general understanding of how a pasture should be managed well, but a lot of necessary information on this topic, and several smaller subjects within the topic, seems unfamiliar compared to the literature presented in chapter I. This sub-question has quite some overlap with the other two questions, partially since the topics soil and vegetation make up part of the management, and possibly partially because the definition of "management" is lacking. As per the Oxford Learner's Dictionary, management is defined as: "*the act or skill of dealing with people or situations in a successful way*" (2020) and should hence have been answered only with practices of successfully

dealing with the pasture. It would have been wise to have included this definition in the enquiry for clarification on the question.

Demand for knowledge on pasture management

The findability of information on pasture management was scored with a 7.1. New information on this topic will mainly be encountered through the internet or through professional sources. The knowledge that is requested on this topic is generally: more specific knowledge about exact personal circumstances. This either includes information on what to do at a certain moment in time or a time-specific management schedule.

IV.II Pasture soil

Knowledge on pasture soil

The knowledge of the respondents on pasture soil was remarkably brief compared to the information available in literature. It was rudimentary known that different plants grow (better) on different soils, but the justification is lacking. The same thing can be said for the soil nutrients: some knew they are important, but none reasoned why or which nutrients are in fact important.

Two people stated to find peatlands unsuitable as pasture land, as they believed grass does not grow well enough on this soil. This is contradicted by Joosten and Clarke (2002), who claim that peatlands make great grazing grounds for their openness and the utilisation of peatlands as pasture land is even very frequent in Northern countries. There might of course be other reasons involved why the grass does not grow well on these pastures, for example lack of certain nutrients or simply the wrong vegetation for this soil. The third respondent who is located on peatland soil also contradicted this, stating they believe the grass grows very well on this soil and little fertilising is required.

The knowledge the respondents stated to have on soil was only on the soil they were operative on themselves. None of the respondents specifically stated to have any knowledge on another soil, other than related to moisture in the soil.

Demand for knowledge on pasture soil

The findability of information on pasture soil was scored with a 6.8. New information on this topic will mainly be encountered through the internet or through professional sources. The demand for new knowledge on this topic is specific to the soil on which the respondents are operative. Five respondents stated they require more information on how to specifically manage the pasture on their soil type. In addition to this requests were made for more information on vegetation in relation to soil type, specifically which vegetation does and does not grow well on certain soil types.

IV.III Pasture vegetation

Knowledge on pasture vegetation

In comparison to the information on pasture vegetation available in literature, the knowledge from the respondents is mediocre. Nine out of ten people declared variety in vegetation to be good feature of a pasture. However, none of the respondents was able to specify which plants should specifically be included or avoided. Four of these nine did give no reasoning for variation at all.

None of the respondents stated to know that some weeds are not dangerous, but rather overgrowing the desired plants, or which weeds were dangerous and why. Only one person mentioned three specific types of weeds they knew needed to be removed.

As for nutrients, which are essential for plants to grow, only sugar and protein were mentioned twice, in the context of an excess not being beneficial for horses. Related to managing the pasture, fertilisation should be measured to the nutrition demand of the soil. Those nutrients which are lacking in the soil are also lacking in the plants, all with their own consequences.

Demand for knowledge on pasture vegetation

The findability of information on pasture management was scored with a 6.2. New information on this topic will mainly be encountered through the internet or through professional sources. There is a clear demand for knowledge on vegetation, specifically elaborated by the respondents, as well as based on the lack of knowledge on this topic. The demand for information on vegetation is related to the demand for information on soil: which plants grow (well) on which soil seems to be the main request from the respondents. In addition, a request has been made for more information on weeds.

V. Conclusion and recommendations

The purpose of this thesis is finding an answer to the question “what is the optimal management of equine pastures on the three most common soil types in the Netherlands?” with an additional purpose of providing a practical guide on equine pasture management to the equine sector. The following sub-questions have supported in finding the answer:

- I. Which knowledge and need for knowledge do horse and land owners have concerning pasture soil?
- II. Which knowledge and need for knowledge do horse and land owners have concerning vegetation in equine pastures?
- III. Which knowledge and need for knowledge do horse and land owners have concerning the management of their grazing pastures?

In order to write a practical and above all an applicable guide, it was important to find out which information is already known to the public and which information they would like to obtain. An enquiry had been sent out and answered by ten people, to which the specifics can either be found in chapter III Results or Annex II Enquiry of horse and land owners.

This chapter describes what the current knowledge and the demand for new knowledge exactly includes on the topics of pasture management, pasture vegetation and pasture soil. Since the topics are closely related to one another, as one cannot exist without the other, some overlap between the topics has occurred.

V.I Pasture management

Most of the people interviewed for this research know it is important to have a variety in the pasture vegetation. It is however not known among them which vegetation specifically is beneficial or detrimental for the pasture, the soil and the horses. Therefore, a request has been made for more information on pasture vegetation. Another management feature that is commonly known is the requirement of fertilising the pasture. It was not commonly known how and when fertilisation exactly needs to be executed.

The benefits of cutting the pastures, before and during the season, is less generally known. Six respondents cut their pastures before and during the season, but the reasoning behind this action is overall lacking. Sowing and re-sowing the pastures before the season starts is also done by a few respondents and again, the argument behind this action is generally missing. The necessity of removing or dragging manure is also quite common knowledge, as stated by six of the respondents, to prevent worm contamination, which was mentioned by two respondents. Other reasons for dragging or removing manure were not mentioned. The last component of pasture management mentioned by the respondents is safe fencing, which was mentioned by only one respondent. No mentions were made about fences having to fit into the landscape, nor the pasture altogether.

The request for new knowledge on the topic of pasture management is mainly more specific knowledge about exact personal circumstances. This would either be in the form of information on what to do at certain moments in time or a time-specific management schedule.

V.I Pasture soil

In comparison with the information on soil in general, as well as soil specifically related to equine pastures, the knowledge among the respondents was noticeably brief. The principle that different plants grow (better) on different soils was known amongst the respondents, but the details were

unfamiliar. Correspondingly, this can also be said about the knowledge on soil nutrients: some knew of their importance, but again the details were absent.

As to the specific soils discussed in this research, two people deemed peatlands unsuitable as pasture land and they reasoned grass does not grow well on this soil. This belief is contradicted by Joosten and Clarke (2002) who state peatlands can make great grazing grounds and by another respondent who deemed their peat soil great for grass growth. A few others mentioned clay to be very wet soil and sand to be dry. Nothing further on the topic of soil was stated by the respondents.

The requested information on soil is specific to the soil on which the respondents are operative. Five of the respondents requested more information on management practices specifically on their soil.

V.III Pasture vegetation

The knowledge of the respondents on vegetation was mediocre compared with the information on pasture vegetation available in literature. Most of the respondents declared a variety in vegetation to be good, but not one of them was able to specify which vegetation was good or not.

As for the nutrients that plants require to grow, it was only mentioned twice that the vegetation should not contain too much sugar and protein for the horses. None of the other nutrients, which are not only essential for plants, but also for the horses, were mentioned.

As has been mentioned in chapter *V.I Pasture management*, a request has been made by the respondents on more information on pasture vegetation, especially on which vegetation works well on their operative soil.

V.IV General conclusion

It can be concluded that the demand for new knowledge on all three subjects is quite brief and specified: the respondents require information that is applicable on their own pastures, especially knowledge on vegetation and some knowledge on management of the pastures.

A lack of knowledge has been established however, as the respondents' knowledge has been compared to literature. This lack of knowledge has not been a specific request for new knowledge by the respondents, but has arisen from the comparison. The people that have been interviewed did not seem aware of this lack of knowledge and there where there is no awareness, demands cannot be made.

V.V Recommendations

As there is an unawareness of the lack of knowledge among the respondents, it would be advisable to include the topics on which there seemed to be very little to no information in the guide on pasture management. These topics include:

- Basic information on the pasture soils sand, clay and peatlands and management tips
- Suitable vegetation for equine pastures, including specifics on which soil types they dwell well and on which they are not suitable
- Undesirable vegetation for equine pastures
- Fertilisation and soil samples
- The importance of various nutrients, for the vegetation as well as the horses

As the main demand from the respondents has been on vegetation, specifically related to soil type, this should make up the greatest part of the guide. An overview of available grass seed mixes on the Dutch market could be included in addition to general information on vegetation.

One of the most important findings in this research is that the information from various channels does not always correspond with each other, even within the same channel. This makes it a lot more difficult for people to know what is right and what is not. Furthermore, the required information is often not available in one place, causing people to be forced to consult multiple sources. Therefore it is advised to put the right information in one place, written in a concise and clear manner.

As this research only dealt with the most important parts of establishing and maintaining a good equine pasture, further research should be conducted on other topics that are of importance, for instance establishing and maintaining roughage pastures, the size of a pasture in relation to the maximum amount of horses and the least amount of time they should be turned out daily. In addition, the soil types in this research were generalised to the three most common types in the Netherlands: sand, clay and peatlands. However, this fully excludes the soil type loess and also does not include more specific soil types, for example the difference between fluvial and marina clay. For future studies it would be wise to look into the specific differences between all soil types occurrent in the Netherlands, to make information even more specifically applicable as well.

For further research it is recommended to question a larger group of people, in order to find out more precisely which information is requested or necessary. Since the respondents have mainly shown interest in more information applicable to their own personal circumstances, it would be useful to find out how to generalise these personal circumstances. That way, the information that can be given in the guide can still apply to a large group of people, as well as it being applicable.

By putting correct information in one document, it would be easier to fulfil in the demand for new knowledge. As was calculated in chapter III.V, the respondents still found it quite easy to find information overall, but it could be a lot better still. Compared to literature, there is a lot of information unbeknown among the public. The information is definitely out there, though spread over a lot of different sources. The creation of a document in which all this information is gathered would make it easier for people to find and in the end contribute to the welfare of the horses. For this reason, the topics listed at the beginning of this sub-chapter should definitely be included in the final guide on optimal pasture management.

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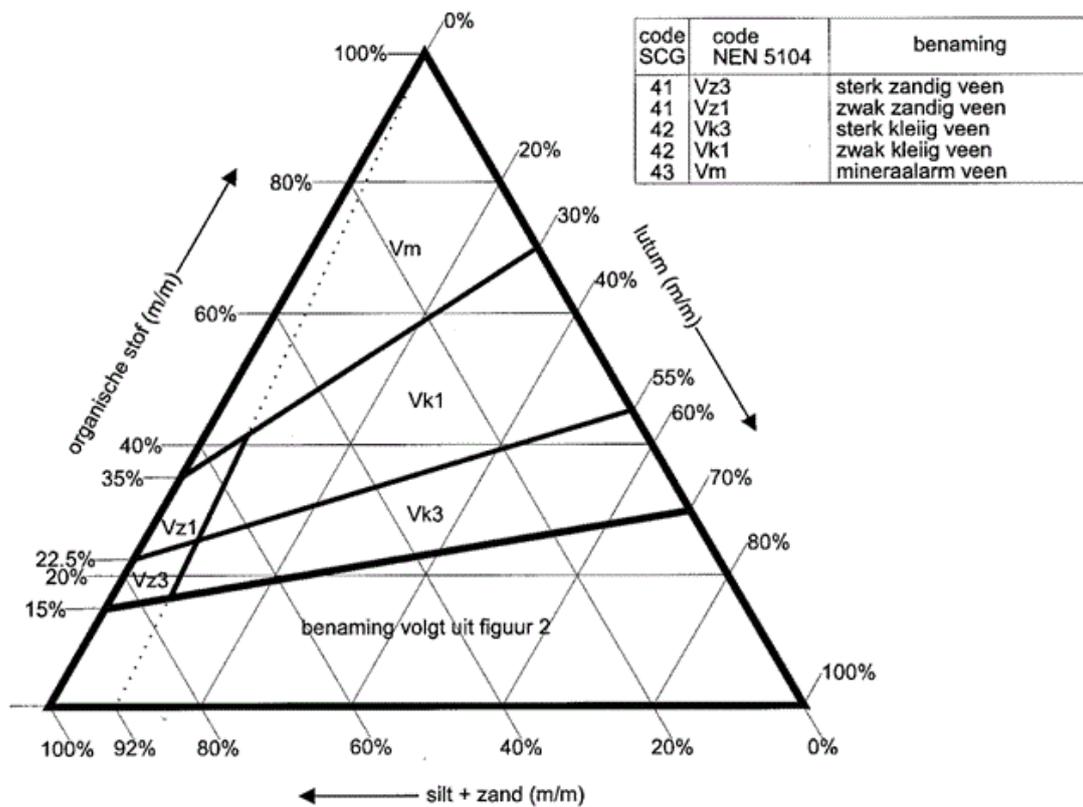
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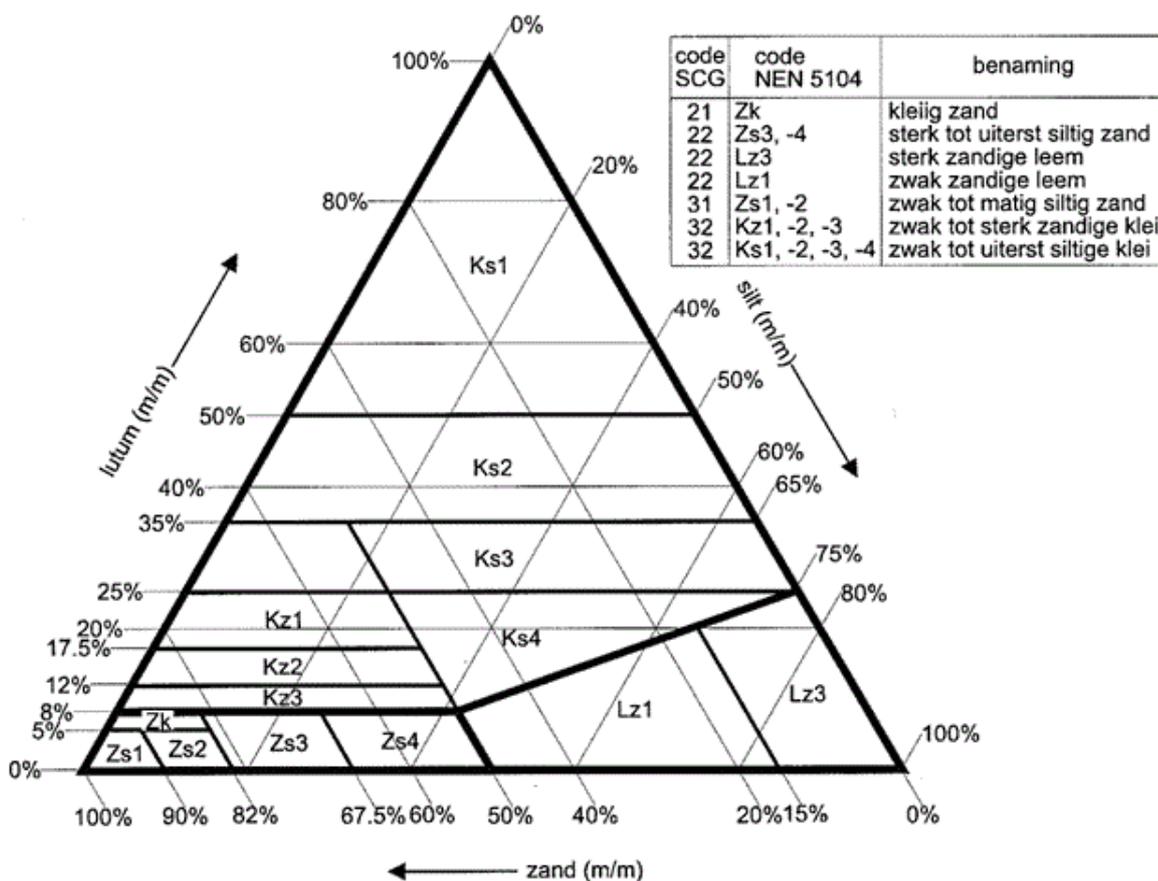
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Annex I Classification and designation of soil types



Figuur 1: Indeling en benaming van grondsoorten naar de gehalten aan organische stof, lutum en silt + zand conform NEN 5104



Figuur 2: Indeling en benaming van grondsoorten naar de gehalten aan lutum, silt en zand conform NEN 5104

Annex II Enquiry horse and land owners

Name (*optional*):

Age:

Profession:

Relation with horses:

If known: on which soil are your horses located or do you intend to be operative?

If unknown: what is the location, so the soil type can be investigated?

- I. What do you know about pasture management?
- II. What do you know about soil in relation to equine pastures?
- III. What do you know about vegetation in equine pastures?
- IV. How do you manage and utilise your equine pastures (or would in the future)?
- V. What do you consider to be a good equine pasture?
- VI. Where have you gained information about pasture management, vegetation for equine pastures and soil in relation to equine pastures?
- VII. Where do or would you look for information on pasture management, soil in relation to equine pastures and vegetation for equine pastures?
- VIII. Is the information you need on equine pasture management easy to find?
Rate the simplicity from 1 – 10: 1 being very difficult, 10 being very easy.
- IX. Is the information you need on vegetation for equine pastures easy to find?
Rate the simplicity from 1 – 10: 1 being very difficult, 10 being very easy.
- X. Is the information you need on soil in relation to equine pastures easy to find?
Rate the simplicity from 1 – 10: 1 being very difficult, 10 being very easy.
- XI. Is the information you find enough (to be applicable)?
Rate the information from 1 – 10: 1 being far too little, 10 being plentiful.
- XII. Does the information you look up match with other sources?
- XIII. Which information would you still like to acquire by means of a free guide on pasture management on pasture management, soil in relation to horses and vegetation for horses?