No feed, no eggs

Scoping study on feed supply for boosting the poultry sector in Kinshasa, DRC

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This report describes the results of a scoping study to increase the local feed supply for the Eggs for Congo project that develops a poultry value chain near Kinshasa in the DRC. Given the climatic circumstances in the Kinshasa area, maize and soybean production can potentially increase considerably compared to the current production levels. An important challenge is to improve the low soil fertility and to improve the availability and access to production inputs including knowledge required to increase crop productivity.

Keywords: chicken, maize, soybean, feed production, poultry

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Photo cover: E.L.M. de Jonge

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Summary

The feed needs explained

The EFC project can be divided into two stages: production of pullets until 4-6 weeks and raising of the hens for laying and the cockerels for meat.

The maize and soybean quantities in this report were calculated for the first stage, managed by the EFC project.

Feed ingredients for the second stage were not included in this study. The 4-6 weeks old pullets will be sold to smallholder farmers and are assumed to partly free-roam and scavenge their own feed. If pullets are sold to (larger) farmers which keep them in a more controlled environment, additional grains and concentrate will be needed.

Consumption of poultry meat and eggs in metropolitan Kinshasa is low and depends largely on low-quality overseas imports. A main bottleneck to local poultry production is a shortage of affordable local feed ingredients, like maize and soybean.

A Dutch-Congolese cluster of private companies started an impact project[1], Eggs for Congo (EFC), that will develop a poultry value chain near Kinshasa. The cluster follows the African Poultry Multiplication Initiative model. This report summarizes opportunities and challenges to increase local and affordable feed ingredient production for the EFC project.

The climatic circumstances in the EFC project area allow for a considerable improvement in maize and soybean yields. However, the soils are less suitable for supporting high crop yields, as they are slightly acidic, very sandy, weathered and poor in nutrients and organic matter. Liming and adding organic matter, together with an adequate fertilization scheme and smart crop rotations, will be needed to improve the soil fertility and increase crop yields. Organic matter should be considered an important resource.

Stimulating the local poultry sector *by boosting crop productivity* will support the local food supply: bringing knowledge and inputs to increase the overall low crop yields in the area helps to alleviate hunger.

Many topics still need to be investigated, such as the local availability, needed quantities and costs of agricultural inputs, organic matter, manure and suitable cover crops, crop rotations and cropping calendars. The sector is also missing knowledge and expertise, and at the hardware side agricultural machinery, as well as storage and drying equipment.

Setting up a local soybean oil industry can support the increase of soybean yields, caused by higher investment and more focus on effective cropping practices. The remaining soybean cake can be sold cheaply as chicken feed, providing multiple benefits for the poultry sector.

Maize productivity improvements contributing to lower product prices, will not benefit only the EFC farms but also smallholder chicken farmers, farmers that cultivate maize only for own (livestock) consumption, and maize consumers. Farmers selling maize might not want to see prices drop, but as local production is yet almost negligible, the benefits of more knowledge and higher yields are likely to counter this disadvantage. Last but not least, more research is needed on how to attract smallholder farmers and women to the EFC project.

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[1] The Eggs for Congo project is supported by the Netherlands Enterprise Agency (RVO).

1 Introduction

The Democratic Republic of Congo (DRC) is the second largest country in Africa by area with a population of over 100 million inhabitants. Its capital Kinshasa has an estimated population of 15 to 20 million and is among the three largest cities of Africa together with Lagos in Nigeria and Cairo in Egypt.

While the DRC shows one of the highest population growth rates in sub–Saharan Africa (3.2% per year) poverty rates are also high, almost 70% of the population lives from US$ 2.15 or less per day indicating the widespread malnutrition and hunger[2]. Inadequate consumption of nutritious foods has a large impact on the health of DRC's population. FAO proposes increasing the consumption of nutrient dense (including animal-based) foods for better health in sub-Saharan Africa. Eggs and poultry meat are a good source of animal protein (FAO, 2023), but the availability of local poultry products is extremely low in the DRC. Eggs availability is 0.2 g/day/capita. That is low even for Sub Saharan Africa standards (1.4 g/day/capita)[3].

Current consumption of poultry meat and eggs in metropolitan Kinshasa depends largely on cheap and low-quality overseas imports (FAOSTAT)[4]. To replace imports by local production, 3,200 poultry farms are needed in the Kinshasa region, which may create more than 30,000 jobs (Ndambi & Vernooij, 2018). One of the bottlenecks to start local poultry production is a shortage of affordable local feed ingredients, such as maize and soybean.

A Dutch-Congolese consortium started early 2023 an impact cluster project to develop a poultry value chain near Kinshasa with support of the Netherlands Enterprise Agency (RVO), based on the concepts of the African Poultry Multiplication Initiative. The Congolese partner in the cluster, Eggs for Congo sarl[5] (EFC), will transform their layer farm (built in Kinshasa in 2020) to a parent stock farm and will build a hatchery there. This development was recently strengthened by the purchase by EFC of a parent stock farm and a hatchery in Congo-Brazzaville.

The project used double-objective chickens of the Sasso breed (Hendrix Genetics) bred for subtropical climate conditions, with an acceptable egg production by the hens, while the males still produce sufficient meat. The breed has been adapted to African circumstances and can partly scavenge their own feed after 4-6 weeks, making them very suitable for backyard farming or suboptimal circumstances.

The hatcheries will ship day-old chicks to so-called mother unit farms which will raise them to four weeks-old chicks that can be sold to small farmers who can sell the birds after 12 weeks for meat or keep the hens for table egg production. They can sell the eggs and eventually the spent hens for meat.

This scoping study conducted by Wageningen Plant Research focuses on the possibilities to boost the local feed supply. Adequate feed ingredients are essential in the first stages of the chicken rearing and will increase the production in the later stages. As the situation is at present, there is grounded concern that there will not be enough feed ingredients from the DRC at affordable prices available to supply the parent stock and mother units. Current yields of potential grains like maize, sorghum, cowpea and soybean are all extremely low; on average less than 1 t/ha in the DRC (FAOSTAT)[6]. Detailed information is needed on the yield potential and how to increase current low crop yields in the region.

One of the concerns is that the production of feed ingredients (maize, soybean) goes at the expense of direct food availability as most feed crops are also used as a staple food for human consumption. Food security is already low in the DRC, so it is important to ensure that feed production does not inhibit local food

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[2] https://data.worldbank.org/country/congo-dem-rep?view=chart [visited June 23, 2023].

[3] https://www.foodsystemsdashboard.org/ [visited November 30, 2022].

[4] https://www.fao.org/faostat/en/#data/FBS [visited June 23, 2023].

[5] https://sosoyasika.cd (visited June 23, 2023].

[6] https://www.fao.org/faostat/en/#data/QCL [visited June 23, 2023].

production. At the same time, affordable poultry products (meat and eggs) should help increase the consumption of nutrient dense foods, which is recommended to reduce malnutrition (FAO, 2023).

In this report we want to point out that increasing overall crop productivity does not only benefit animal feed ingredient production, but also food availability for direct human consumption.

1.1 Objective of study

The main objective of this study is to assess whether and how enough local feed grains can be produced to support the Eggs for Congo project, without hampering human food production. The study aims to identify possibilities to increase and improve feed raw material production.

The study identifies current opportunities and bottlenecks in feed production around Kinshasa that can be used as input for the formulation of a feed supply improvement program.

1.2 Feed model for the Eggs for Congo project

Figure 1 illustrates a simplified model of the feed supply for the Dutch-Congolese Congo Kinshasa Poultry Partners. The 4-5 weeks chicks raised by the mother units will be sold to small farmers who can fatten the cockerels until 12 weeks for meat and keep the hens for table egg production. They can sell the laying hens for meat as well.

The parent stock and the mother units need to be supplied with maize, soybean and concentrates of which the concentrates will be imported by EFC for the time being. It is expected that small farmers will predominantly let the chickens roam freely while giving them limited amounts of grains as feed supplement.

To produce enough feed ingredients (not all ingredients but just bulk raw materials), various inputs are needed ranging from fertile land, seeds, nutrients, lime and the knowledge and capacity to produce crops. In addition to the main products (eggs, animals), the parent stock farm, mother units and small farmers will produce chicken manure. The manure should be considered and treated as a valuable source of nutrients and organic matter to produce the feed ingredients.

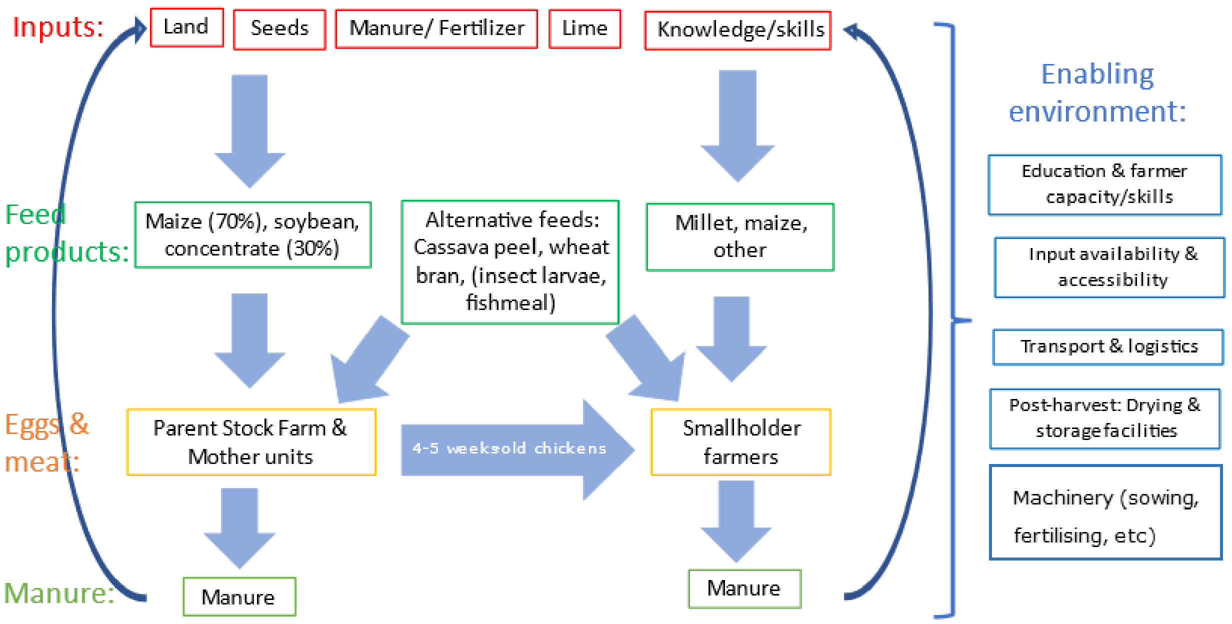

Figure 1 *Simplified feed model of the Eggs for Congo project.*

1.3 Study area

The stock farm of the Eggs for Congo project is located east of Kinshasa (**Figure 2**). Because of logistics and transport costs, the feed ingredient supply area is limited to an area covered by a radius of about 800 km around Kinshasa, roughly covering the provinces of Kinshasa, Kongo-Central, Kwango, Kwilu, Mai-Ndombe and Equateur, Kasai, Tsuapa and small parts of Sankuru and Kasai-Central (**Figure 2**).

Figure 2 *Map of the DRC with a small red circle indicating Kinshasa province where the stock farm of the Eggs for Congo project is located, and a large circle roughly indicating the study area, which is the targeted feed ingredient supply area (less than 800 km from Kinshasa).*

Although this area is large (roughly 514,000 km² or 5.14 million hectares), a part of it is covered by tropical rainforest, especially in the North and East of the study area (**Figure 3**). Considering DRC's commitment to the Paris agreement, reducing deforestation is one of the country's main objectives in its fight against climate change (DRC, 2021). Therefore, large parts of the targeted area are not available for agricultural production.

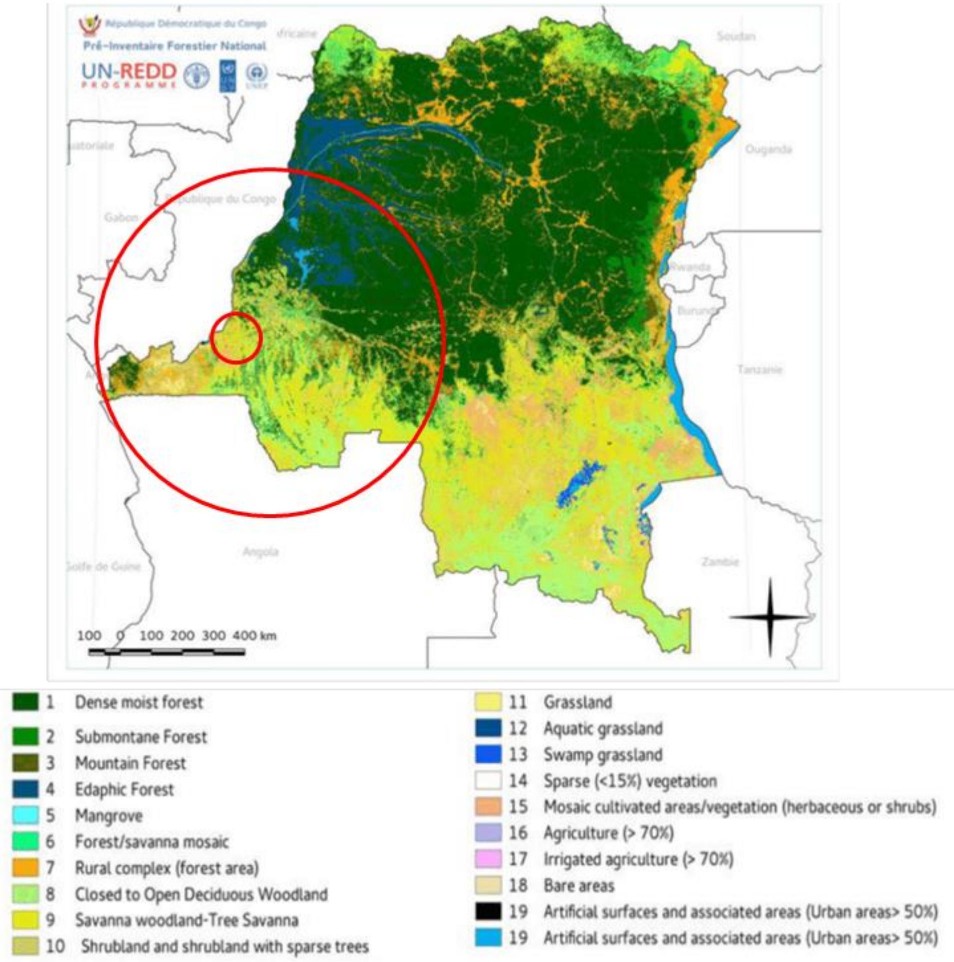

Figure 3 *Land cover in the DRC. The small red circle indicates Kinshasa province where the stock farm of the Eggs for Congo project is located, and a large circle roughly indicates the study area, which is the targeted feed ingredient supply area. Source: Djomo, Adrien & Congo, Ministry, 2017.*

1.4 Methodology

For this study, various information- and data sources have been reviewed. An important element was the Eggs for Congo (EFC) kickoff seminar in Kinshasa in March 2023. The first author of this report participated and presented the aim of this scoping study. The event allowed to meet the EFC project partners and learn more about the plans of EFC and the feed ingredient requirements for the project. After the presentation there were interesting engagements with local stakeholders, knowledge about agriculture in the DRC was exchanged. The kickoff meeting in Kinshasa included a field visit to the EFC farm and a visit to a field research station of Loyola University of Kinshasa, which provided contextual insights in food and feed ingredient production and the level of agricultural research. During the field visit, we took three soil samples from fields that were designated to be used for growing maize and soybean.

After return to the Netherlands, the soil samples were analyzed by the Eurofins lab in Wageningen, and the results are described in this report together with the results of another soil sample taken by the EFC project from another location in the study area in 2022. Although these four samples are insufficient to characterize the soil characteristics of the entire study area, they give an indication of the soil fertility problems to overcome.

We used spatial soil databases with information on soil properties of the study area to interpret the results of the soil samples and to qualitatively extrapolate these findings to rest of the study area. The soil property maps give insight in the spatial variation and distribution of typical soil fertility indicators in the study area.

In addition, a literature review was done on soils and crop production (potentials) in the western part of the DRC. However, much of the available literature is related to eastern DRC, where soils are more fertile because of their volcanic origin and climate conditions are more favorable because of the higher altitudes. Less publications were available on agricultural experiments and production potentials in the western DRC. Therefore, we also looked into the production potentials of maize and soybean in north-eastern Brazil, which is within the same climate zone as western DRC and at the same latitude.

1.5 Outline of the report

The report starts with the characterization of the agronomic- and climatic circumstances in the area (Chapter 2). Based on experiences with similar climate and soil (northern Brazil), we explore what yields can be expected on short- and long term under the given soil- and climatic circumstances of the study area in Chapter 3. Chapter 4 highlights the ambitions of the Eggs for Congo EFC project and productivity scenarios to meet these ambitions. In Chapter 5, we discuss what steps need to be taken to reach such yields. We will conclude with an overview of important topics to consider and further investigate for boosting maize- and soybean production in Chapter 6.

Figure 4 *Week-old Sasso chicks in the Eggs for Congo farm, Kinshasa.*

2 Biophysical characteristics of the feed ingredient supply area

2.1 Climatic conditions

According to the Köppen-Geiger climate classification, the largest part of the feed ingredient supply area is classified as Tropical Savanna (Aw) with the driest winter month receiving less than 60 mm precipitation (Kottek et al, 2006). Total rainfall was 1507 mm per year (period 2000-2020). Average precipitation was 1524 mm/year in the last decade (2010-2020) and 1471 mm/year the period 1990-2000 suggesting that climate change results in wetter conditions.

The area is very close to the equator, which means that the temperature is quite stable throughout the year, and hardly ever drops below 18°C, while daily maximum temperatures are around 25°C year-round.

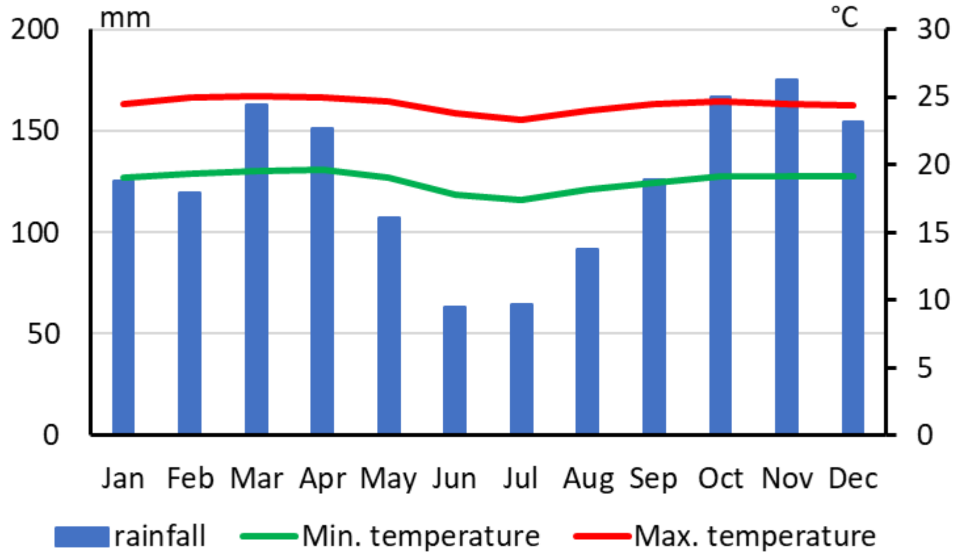

Figure 5 *Long-term average monthly temperature (min-max) and precipitation in the DRC. Source: Harris et al. (2020)*[7]*.*

These temperatures allow for two or more cropping seasons per year if sufficient water is available. Only during the dry season (June-August) rainfall may become a limiting factor depending on the soil water holding capacity of prevailing soils and capillary rise of groundwater. On the other hand, the humid conditions during the other months will be a challenge for post-harvest processing and may require specific drying and storage facilities.

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[7] https://crudata.uea.ac.uk/cru/data/hrg/#legacy: version CRU CY v.4.06 [visited June 23, 2023].

2.2 Soil characteristics from samples

During the field visit in March 2023, three soil samples were taken. A fourth sample had been taken by the EFC consortium earlier in 2022. All samples were analysed in Wageningen at Eurofins laboratory. The samples were taken at several locations where EFC is planning to grow maize and soybean: one was taken by the EFC team at the EFC parent stock farm (N'Sele) in 2022. In March 2023, one sample was taken at the Loyola university 'Mongata' farm and two samples were taken from both sides of a field that EFC targeted for cultivating maize and soybean in the future (fields named 'plot Mongata').

Table 1 shows the most important soil fertility indicators of the four samples: Soil structure/composition, Soil organic carbon content (SOC), pH and Cation Exchange Capacity (CEC). These indicators help to identify crop growth limiting factors and the potential efficiencies of used inputs, as the uptake efficiency of inputs by plants is related to various soil characteristics (Van Ittersum & Rabbinge, 1997).

Table 1 *Major soil fertility indicators of soil samples taken in 2022 and 2023 (see text)[8]. The original analysis sheets are in Annex 2-5.*

Soil property	**EFC farm 2022 (N'Sele)**	**Loyola farm Mongata (CERED-ULC)**	**Plot Mongata river side**	**Plot Mongata N1 side**
pH	5.6	5.3	4.4	5.6
Soil Organic Carbon (%)	0.7	1.0	1.1	1.0
Clay (%)	2	1	3	1
Loam (%)	4	1	15	1
Sand (%)	93	96	80	97
CEC (cmol+/kg)	<1.1	<1.1	<1.1	1.9

Observations at **Table 1**:

1) **Structure**: the soils are mostly sandy. All samples contained at least 80% sand, with three samples containing over 90% sand.

Sandy soils have a coarse texture due to larger soil particles. Therefore, these soils have more difficulty retaining water and nutrients than loam- and clay soils. Sandy soils tend to be low in nutrients. It is important to dose nutrients well on a sandy soil to minimize leaching losses.
Due to the coarse structure, sandy soils erode easily when no vegetation cover is present. Sandy soils are also more prone to being acidic, as chemical reactions and weathering take place more easily than on clay soils and soils rich in organic matter, due to their particle size and low CEC.
Sandy soils naturally have a low carbon content[9], often less than 1%. Increasing the organic carbon content of sandy soils will improve water- and nutrient retention, but is challenging, especially under the wet tropical conditions of the DRC which favour organic matter decomposition year-round.

2) **Soil Organic Carbon (SOC)**: the highest SOC content found in the soil samples is 1.1%. The other three samples had a lower-than-average SOC content, as most agricultural soils have a SOC of 1-6% (Lost and Hartemink, 2019).

SOC contributes greatly to chemical soil fertility, soil structure and water retention capacity. Therefore, it is an important soil quality and fertility indicator. As SOC is easier to measure, more and better data is available on SOC than on SOM[10].

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[8] Sampling locations are (EFC farm: 15.603239, -4.241; Loyola: 16.2836, -4.527897; fields named Plot Mongata: 16.249822, -4.463547).

[9] 1% Soil organic matter (SOM) is approximately 0.58% soil organic carbon (SOC).

[10] See footnote 9.

SOC values below 1% are relatively low, as agricultural soil generally has an average 1-6%. The low values are likely due to the sandy soils and the warm climate, both conditions limit the build-up of SOC (Lost and Hartemink, 2019).

3) **pH**: the pH of the soils is between 4.4 and 5.6. Considering that the optimal pH for maize and soybean is between 5.8 and 7, these soil samples are slightly too acidic.

Acidification of soil is a natural process with major consequences for plant growth. When soils become acidic, particularly when the pH drops below 4.5, it becomes difficult to produce most food crops. As soil pH declines, the availability of plant nutrients decreases due to chemical soil reactions that make nutrients unavailable (like P) to plants (paragraph 0). These reactions also release other ions, that are otherwise fixed, to the soil solution for plant root uptake. Aluminium and other elements like manganese become soluble and can be taken up by plants but are toxic to plants in high concentrations. The major effects of soil acidification for plants are the aluminium becoming soluble and the loss of cation nutrients from the soil. Aluminium toxicity at low pH levels is the major limiting factor in plant growth in acid, weathered tropical soils. Favourable crop responses to liming appear to be primarily due to aluminium deactivation (Harter, 2002). These problems are common in humid tropical regions that have been highly weathered, like in the DRC (Harter, 2002).

4) **Cation Exchange Capacity (CEC)**: the CEC is lower than 1.1 cmol+/kg soil in three samples and around 1.9 cmol+/kg in the fourth sample. This is very low and indicates that the soils can hardly retain any plant nutrients.

The CEC of the soil indicates how easily cations (positively charged ions) are exchanged between the soil and water or plant roots.

Clay minerals and organic matter tend to be negatively charged. Clay and organic matter attract (adsorb) positively charged ions (cations) with their negative charge. This process causes the cations (which are often nutrients) to stay within the soil root zone instead of rinsing out. Adsorbed cations can exchange with other cations in the soil solution, this is what the term “cation exchange” comes from. When plant roots take up cations, more cations that were adsorbed to clay or organic matter particles become available in the soil solution.

Cation exchange capacity (CEC) is the total of the negative charges within the soil that adsorb plant nutrient cations such as calcium (Ca2+), magnesium (Mg2+) and potassium (K+). The CEC describes the soil’s capacity to release nutrient cations to the soil solution for plant uptake.

Sandy soils have a limited capacity to exchange cations because sand itself has no electrical charge. This means sandy soils have a very low CEC, but this can be improved by adding organic matter. Organic matter has a high CEC, even higher than clay, which makes it a good addition to improve soil fertility.

The CEC is strongly related to the pH of the soil. A low soil pH is associated with a low effective CEC; negatively charged particles in the soil are taken up by soluble H+ and Al^3+ ions, which causes nutrients to leach instead of being available to plants in the soil solution. The CEC can be improved by raising the pH and by adding organic matter. Adding organic matter can be done with green manure crops, leaving crop stubbles on the land, rotating cereal and tuber crops, and by adding mulch, compost or organic manure.

2.3 Soil characteristics from spatial analysis

In addition, a spatial analysis was done based on the *SoilGrids* database[11] to gain insight in the variations in soil fertility in the entire study area. The same soil fertility indicators pH, soil structure, soil organic carbon and the CEC were used. We compared the results to the soil samples taken during the field visit.

2.3.1 Soil structure

The soils in the feed ingredient supply area are quite sandy, with low percentages of loam and even lower percentages of clay (**Figure 6**). According to **Figure 6** the soil samples are from an area with predominant sandy loamy soils, which have sand contents ranging from roughly 45 to 85%. The analysed soil samples were much sandier, one sample had a sand percentage of 80%, but three samples contained over 90% sand (**Table 1**).

The deviation between the soil map information and soil samples may be related to spatial heterogeneity and/or inaccuracy of the data available in the soil map. Especially in countries with little soil data information, like the DRC, soil maps may contain considerable inaccuracies because of data interpolations over large areas with no soil data. In general, the soil map suggests quite sandy conditions in western DRC consistent with the soil samples.

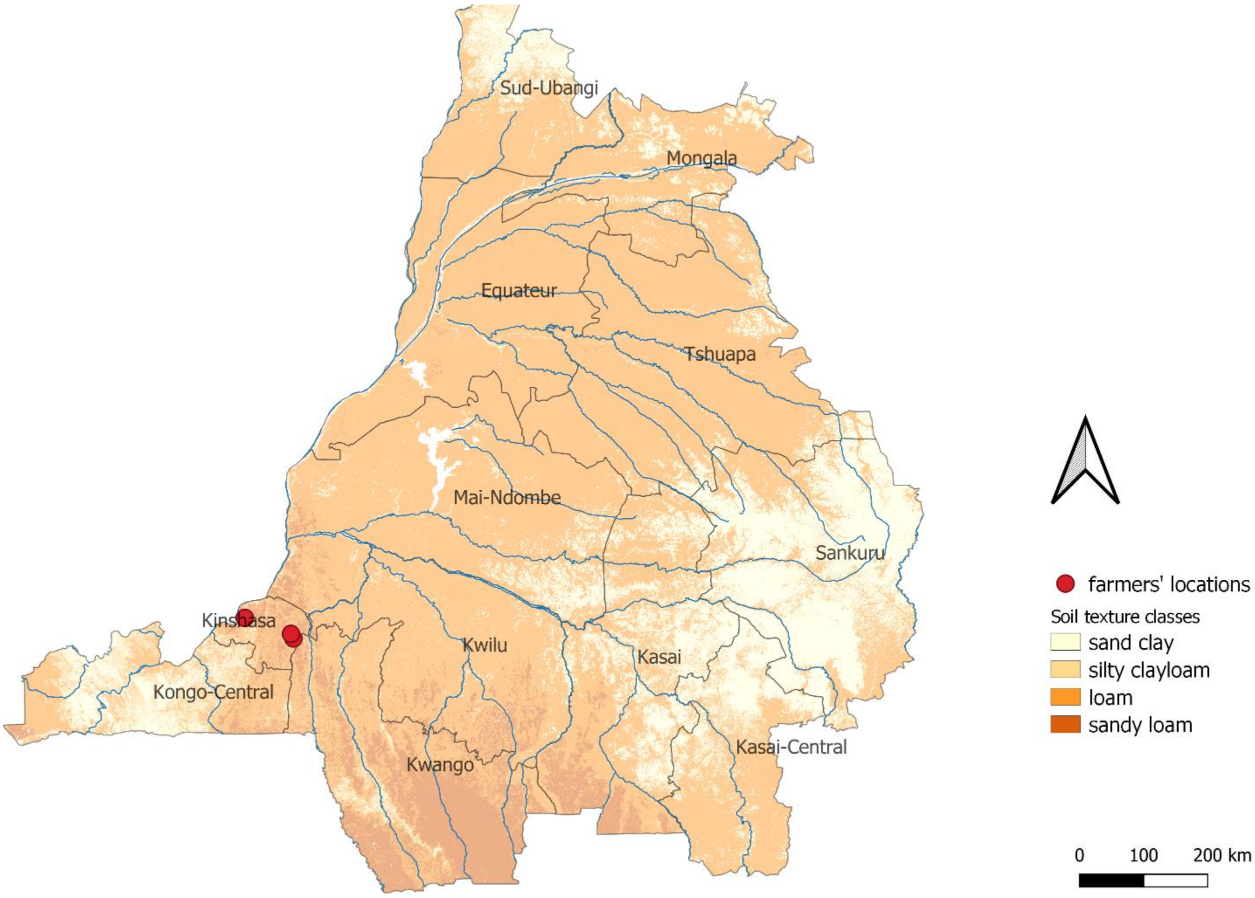

Figure 6 *Soil texture classes in the study area of the DRC. Source: ISRIC* [12]*.*

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[11] https://data.isric.org/geonetwork/srv/eng/catalog.search#/metadata/2a7d2fb8-e0db-4a4b-9661-4809865aaccf [visited June 25, 2023].

[12] https://data.isric.org/geonetwork/srv/eng/catalog.search#/metadata/2a7d2fb8-e0db-4a4b-9661-4809865aaccf [visited June 25, 2023].

2.3.2 Soil Organic Carbon

Figure 7 shows the percentage of SOC of the study area. The range in the legend is from >0.6 to max. 7.6% SOC. Many locations have a SOC percentage between 0 and 1.1, which corresponds well with the values found in the soil samples (**Table 1**).

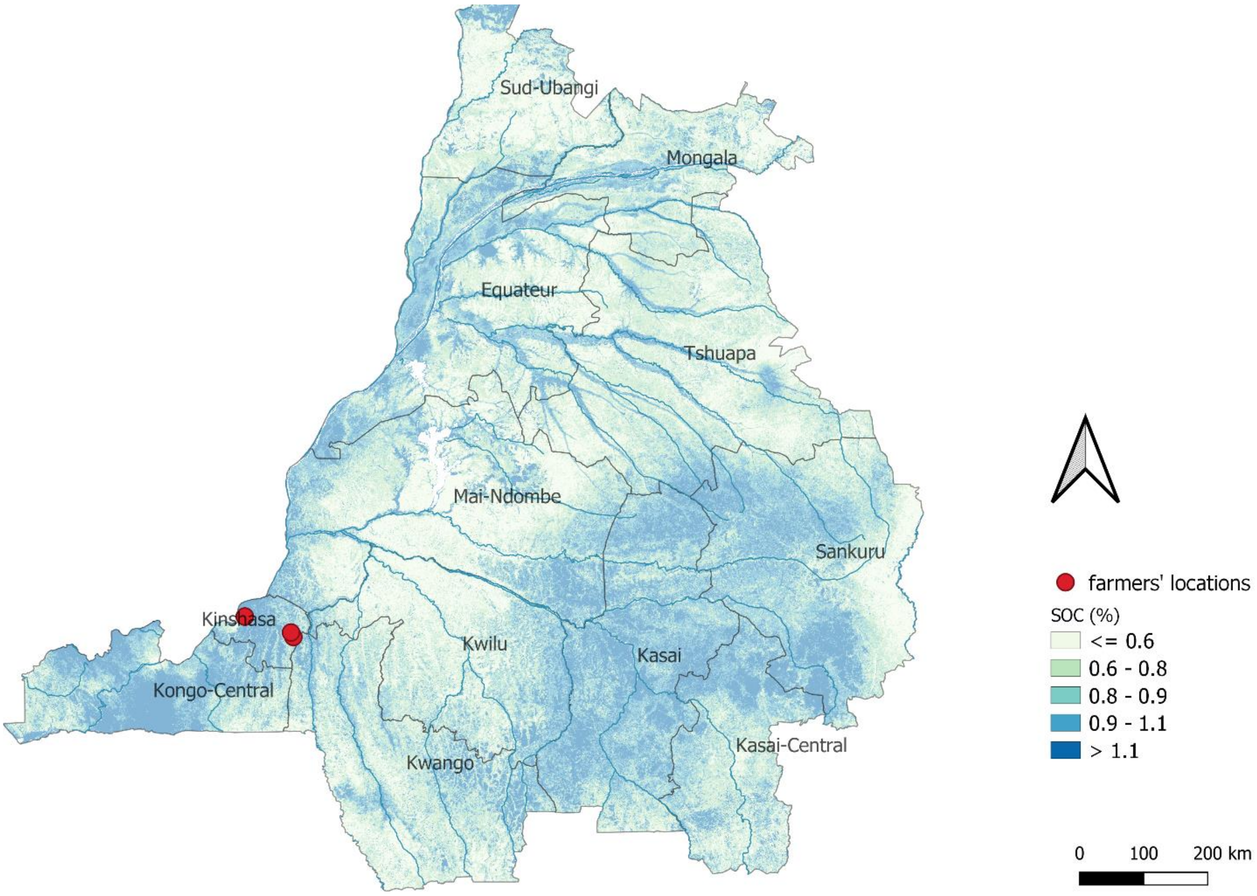

Figure 7 *Soil Organic Carbon content in the study area of the DRC, Numbers in legend should be divided by ten, scale between colours is in quantiles. Source: ISRIC* [13].

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[13] https://data.isric.org/geonetwork/srv/eng/catalog.search#/metadata/9a66a37e-8a4e-463b-b83a-fd49049c323a [visited June 25, 2023].

2.3.3 Soil pH

The soil pH values vary between <4.8 (very acidic) to just around 6 in the study area (**Figure 8**). Soils around Kinshasa have a pH ≈ 5.5, which corresponds with the pH observed in three of the four soil samples (**Table 1**). Soils in the northern part of the area are more acidic, with a pH <4.8. Without liming, these soils are too acidic for an optimal maize or soybean production.

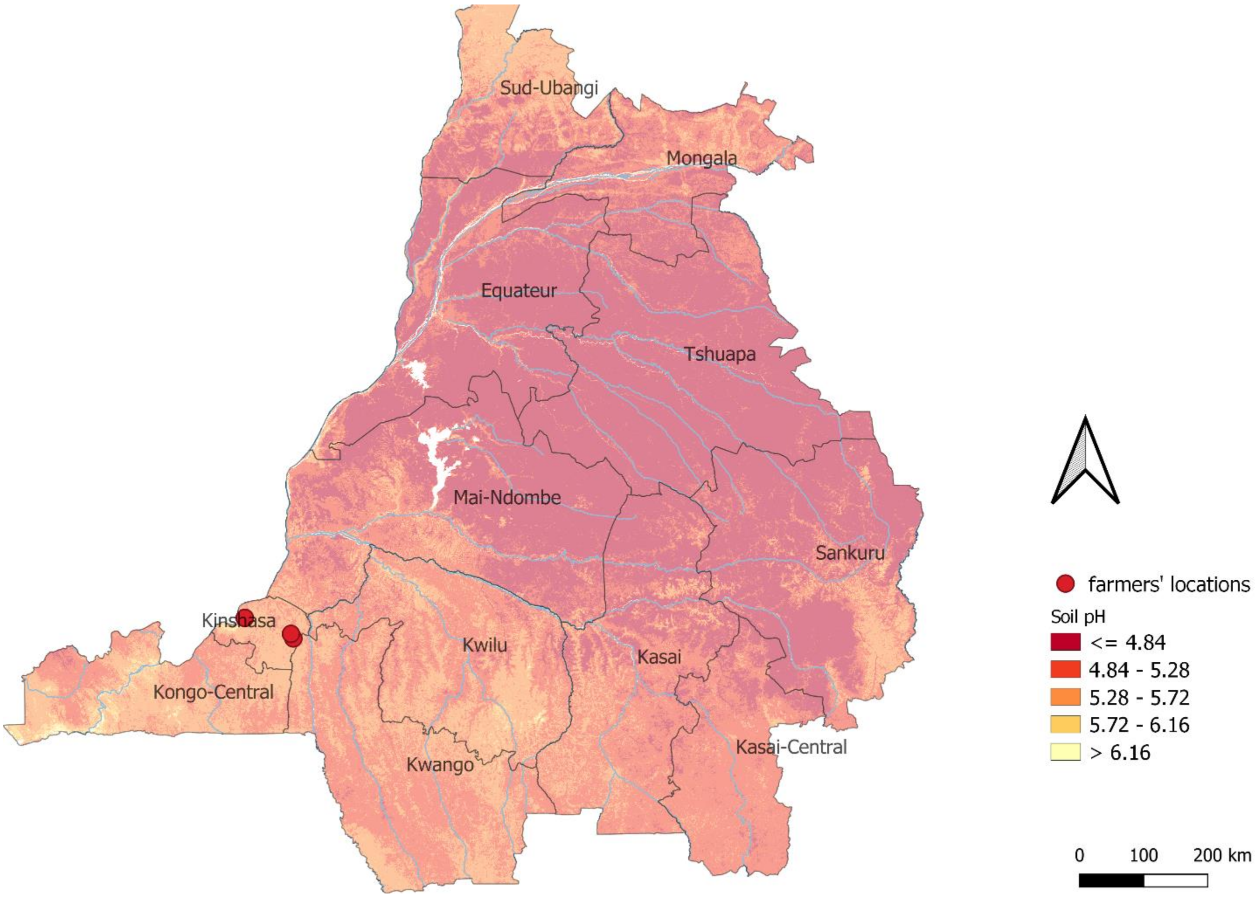

Figure 8 *Soil pH in the study area of the DRC. Source: ISRIC[14].*

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[14] https://data.isric.org/geonetwork/srv/eng/catalog.search#/metadata/a3364e47-9229-4a6d-aed2-487fd7e4dccc [visited June 25, 2023].

2.3.4 Cation Exchange Capacity

Figure 9 shows the CEC values for the feed ingredient supply area. The map shows that large parts of the study area have CEC values below 10 cmol/kg. Only some regions, like Kongo Central, have soils with CEC values up to 18 and 24 cmol/kg.

The low CEC values correspond with the values found in all four soil samples, as all of them had a CEC value of less than 2 cmol/kg.

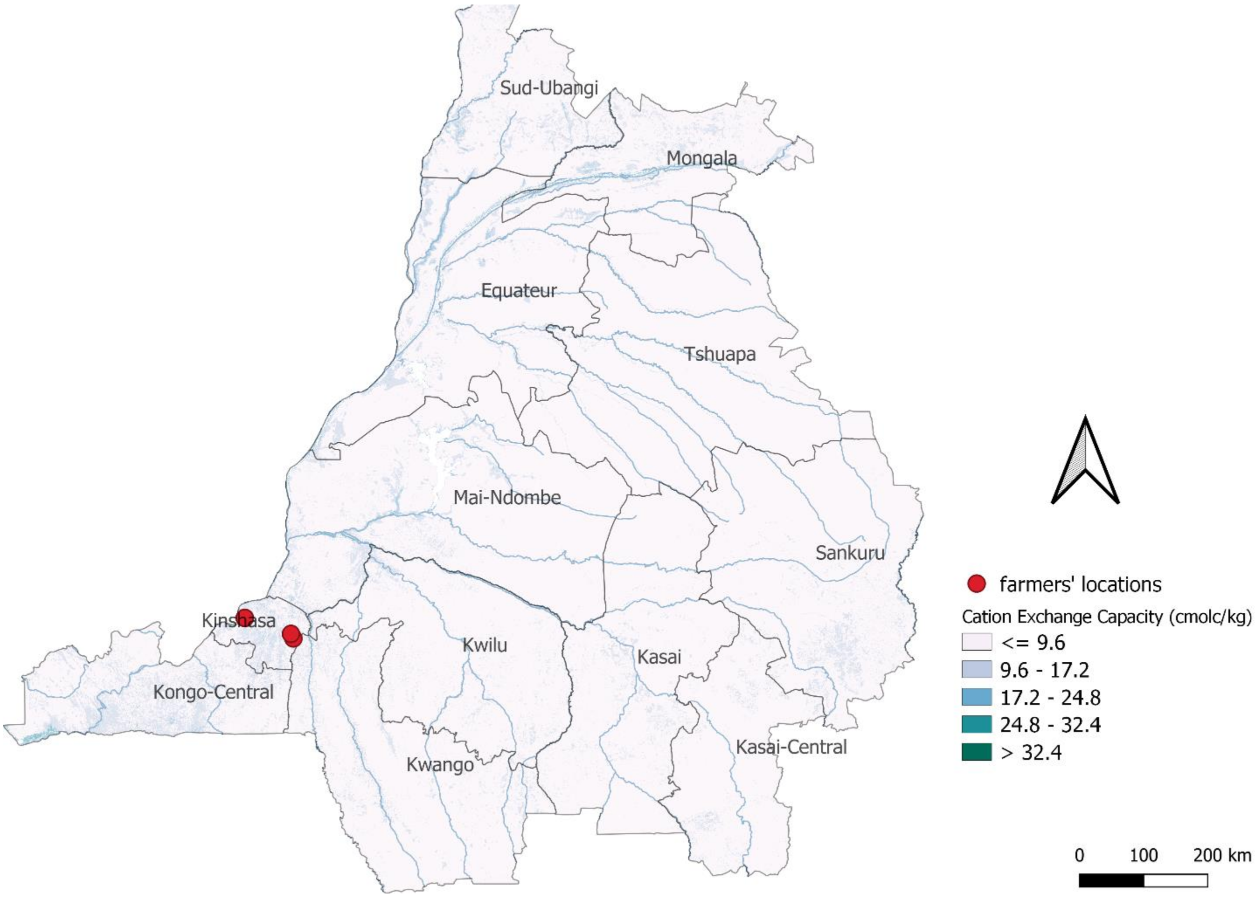

Figure 9 *Cation Exchange Capacity (CEC), in the study area of the DRC. Source: ISRIC[15].*

CEC increases with higher SOM- and clay contents. Therefore, the low CEC values are no surprise. CEC values of organic matter are hundreds of times higher than those of sand (University of Georgia, 2022). This illustrates how important the addition of organic matter is to improve soil fertility, especially on sandy soils where the CEC is naturally low. Please note that organic matter decomposes and needs to be replenished every year with cropping and conservation practices.

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[15] https://data.isric.org/geonetwork/srv/eng/catalog.search#/metadata/e0d921ff-5f7b-48e5-ae27-7c1515055e3b [visited June 25, 2023].

3 Yield potential

Current yields of maize and soybean in the DRC are very low with 0.75 and 0.5 t/ha per harvest, respectively, and there are no signs of yield improvement (FAOSTAT)[16]. Therefore, the question arises what feasible maize and soybean yield levels could be in the study area.

In the absence of experimental data on crop productivity, we decided to look at maize and soybean yields in other parts of the world at the same latitude as the study area where climate conditions are comparable (paragraph 3.1). We also looked at results of a study on simulated maize yield potentials for sub-Saharan Africa, including the DRC (paragraph 3.2). This study is from 2011 and the resolution is course, but the results help to gain insight in the potential to increase yields in the DRC.

3.1 Crop yields in analogue climates

Figure 10 shows a map with different climate zones in a part of the Southern hemisphere. The climate zones in **Figure 10** are according to the Köppen-Geiger classification (Kottek et al., 2006). The climate zones of the study area are mainly Tropical-Savanna (Aw), and parts of Tropical Monsoon (Am) and Tropical Rainforest (Af). These climate zones correspond with those in north-eastern Brazil, which are at the same latitude as the study area.

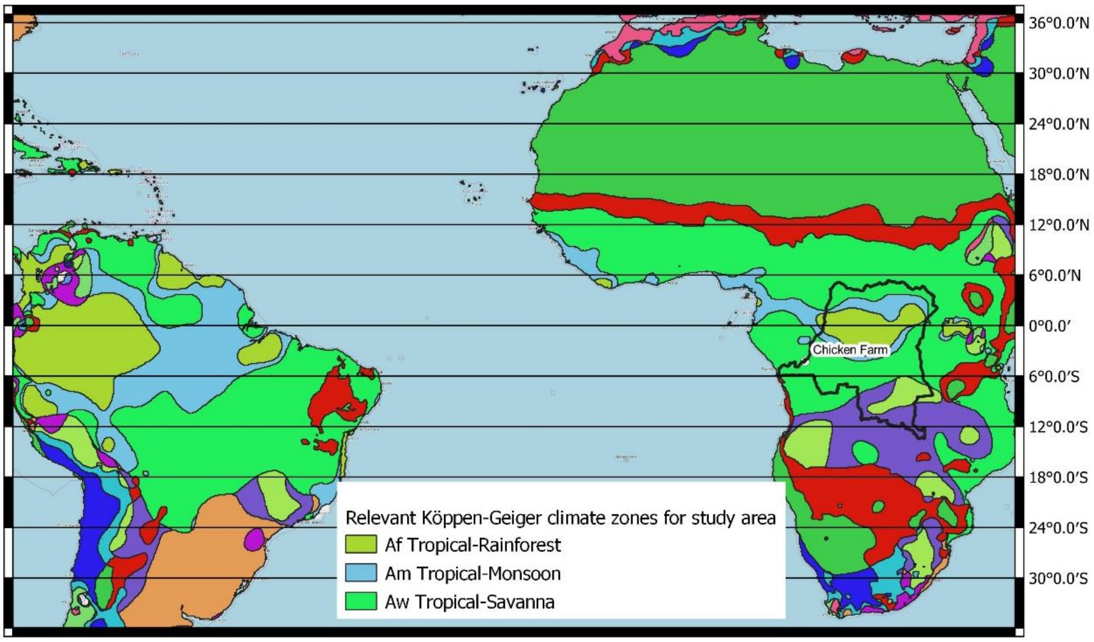

Figure 10 *Map with a part of the Southern hemisphere and the climate zones of Köppen-Geiger climate zones (Kottek et al., 2006). For simplicity reasons, only climate zones relevant to the study area are shown in the legend.*

When we zoom in on the state of Maranhão in north-eastern Brazil, the total annual rainfall (≈ 1,900 mm) is indeed comparable with the rainfall amount in the study area (≈ 1,500-1,600 mm, section 2.1). In the typical double cropping systems of Maranhão, average maize yields were 4.8 and 4.4 t/ha in the first and

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[16] https://www.fao.org/faostat/en/#data/QCL [visited May 24, 2023].

second season, respectively, in the last five years (2017-2022). The average soybean yield was 3.2 t/ha in the last five years[17].

This means that Maranhão has an **average total yield of about 7,8 t/ha/year** for a combination of maize and soybean, the yield of both crops together. These yields achieved in a similar climate as in the study area indicate the potential for reaching similar yields.

3.2 Maize yield potential

Conijn et al. (2011) quantified the potential number of maize crops that can be grown per year and simulated the potential rainfed maize yields in sub-Saharan Africa, including the DRC.

The potential number of annual crop cycles is based on the annual daily rainfall distribution, temperature, and from the crop side the temperatures needed to finish a growing season. The results suggest that two to three maize crops per year can be grown in the study area (**Figure 11**)[18].

Figure 11 *Based on the annual daily rainfall distribution and temperature, the number of possible maize cropping cycles in the study area of the DRC. Source: Conijn et al., 2011.*

Subsequently, using a crop simulation model, rainfed production potentials for maize have been simulated. These rainfed production potentials are simulated maize yields considering the prevailing weather conditions, soil-water balance, number of potential cropping cycles per year and a situation in which the crop does not face nutrient limitations and is not affected by pests, weeds and diseases.

The results shown in **Figure 12** suggest that potential rainfed maize yields increase from the West to the East in the study area and vary from 7.5 to about 20 tons of dry matter of grains per year, when calculating with two to three cropping cycles.

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[17] https://www.conab.gov.br/info-agro/safras/ [visited May 24, 2023].

[18] The number of cropping cycles in Figure 11 refers to an average at grid level and may vary between 0 and 3 including all values in between due to different soil conditions with one grid cell.

It is important to be aware that this yield ceiling is theoretical; it neglects all limiting factors related to soil, crops, water, nutrients and pests. Perfecting all circumstances is unrealistic, or at least economically not viable in farmer practice. Even with good farming practices, **yields stagnate at about 80% of the yield ceiling** (Cassman, 1999).

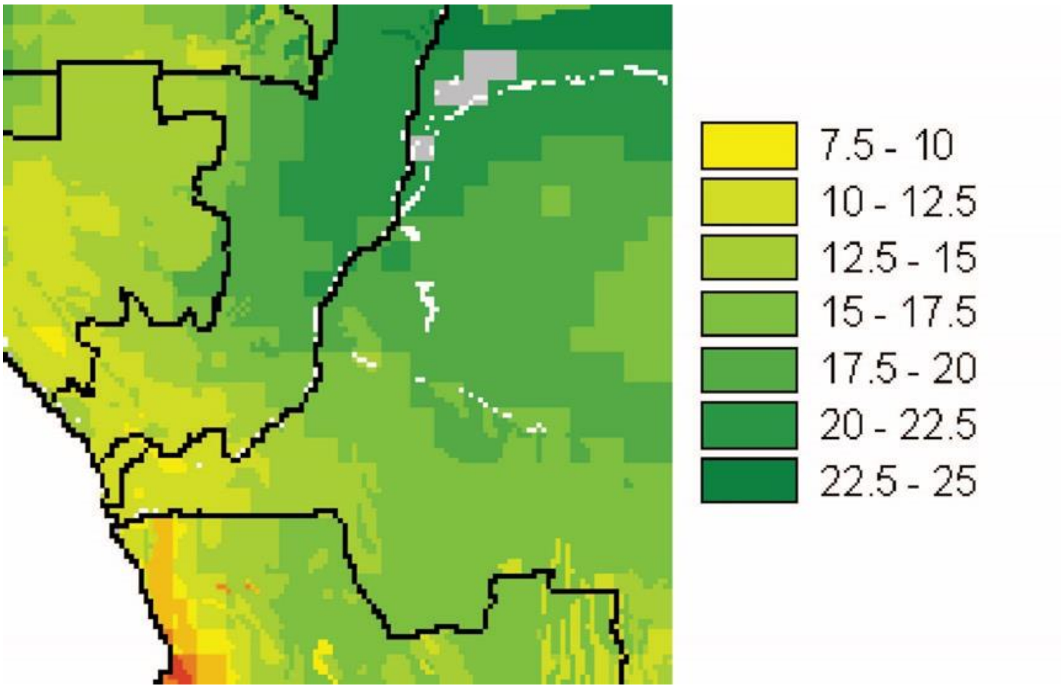

Figure 12 *Simulated rainfed maize yields (t dry matter/ha/y) under rainfed conditions based on the number of feasible production cycles of maize in a given location (Figure 11). Source: Conijn et al., 2011.*

In the DRC case, this would mean that yield levels between 6 and to 16 tons of grain dry matter/ha/year are attainable in a rainfed system, which is many times higher than the actual maize yields. Actual yields are 0.78 tons of fresh weight per *harvest*, which would theoretically mean <2.34 t of fresh weight/year based on three cropping cycles[19].

However, the area has very weathered, sandy soils with low organic matter content and nutrient holding capacity. Note that elevated yield levels can only be attained without nutrient stress, pests, weeds and diseases and is based on three harvests per year for most of the area.

3.3 Synthesis

Both analyses shown in paragraph 3.1 and 3.2 have their limitations related to the spatial resolution and the incomplete comparison of production factors (no information on soils, crop varieties, input use, famer capacity, etc.). Yields estimated in 3.2 are theoretical and will not be obtained with current farming practices. However, both analyses suggest that current crop yields in the study area around Kinshasa have a lot of potential to be improved. Climate conditions, i.e., radiation, temperature and precipitation are favourable to increase the yields in the study area.

The main bottlenecks to increase crop productivity are the extremely weathered soils (paragraph 2.2), the lack of organic matter and manure to improve the soil, and other production factors such as suitable crop varieties, fertilizers, adequate pest and disease management, and overall crop management.

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[19] Typical moisture content of harvested maize grain is 16%, which implies that 1 t fresh harvested maize corresponds with about 0.86 t dry matter maize.

4 Feed and land requirements

Based on the growth targets of the EFC project, the required amount of feed ingredients (maize and soybean) and associated areas to be cultivated areas with maize and soybean can be calculated for the parent stock farm and mother units. EFC is expected to need 4,200 tons of grains in 2023, 8,222 tons in 2026, increasing to 34,600 tons in 2030.

4.1 Three yield scenarios

To calculate the area needed to meet EFC's maize and soybean demands, several productivity scenarios are possible, which are described and analysed in this section.

The first scenario is called *Scenario 1: Status quo*. Current crop yields do not increase till 2030. Based on FAOSTAT, the average productivity is 0.775 t/ha of maize and 0.515 t/ha of soybean in the DRC. Both crops can potentially be grown in the same year (double cropping system), which means that the total annual productivity is 0.775+0.515=*1.29 t/ha/y* of maize and soybean, further referred to as feed ingredients. The ratio maize to soybean of these feed ingredients is 62/38, which approaches the common ratio of 70/30 used in standard chicken feed. This is convenient, as it means that the local feed ingredients needed to boost the poultry sector in the DRC can be cultivated on the same field.

Scenario 2: EFC is used by EFC in their business proposition. It assumes increased crop yields from a base level of 2 tons per hectare per year to *3.4 t/ha/y* in 2030. The business proposition does not further specify the maize/soybean ratio of the grains.

Scenario 3: Brazil assumes a gradually increasing yield, eventually reaching yield levels by 2030 like those currently attained in north-eastern Brazil (paragraph 3.1).

Table 2 *Yield levels of maize and soybean used in the three productivity scenarios. See text for explanation.*

Year / Scenario	Scenario 1: Status quo		Scenario 2: EFC	Scenario 3: Brazil	
	Maize	Soybean	Feed ingredients	Maize	Soybean
2023	0.8	0.5	2.0	0.8	0.5
2026	0.8	0.5	2.0	2.7	1.9
2030	0.8	0.5	3.4	4.6	3.2

Figure 13 shows the scenario results for the production targets in different years.

- In scenario 2 (EFC), about 10,000 ha is needed to produce 34,600 t in 2030, which is 62% less land than in scenario 1 (Status quo).
- In scenario 3 (Brazil), with increasing crop yields to the level of the Maranhão region, even 83% less land is needed in 2030. Only about 4,393 ha is needed to reach the production target of 34,600 t.

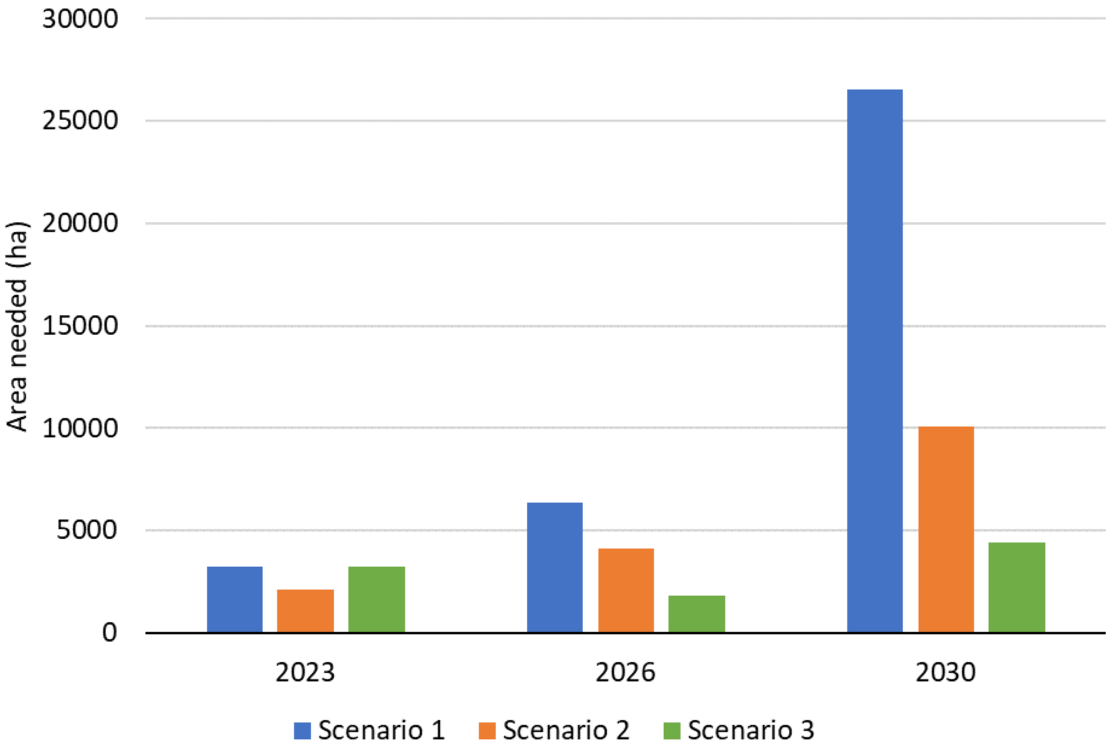

Figure 13 *Cultivation area needed to meet EFC s production targets in different years using three productivity scenarios. See **Table 2** and text for explanation of the scenarios.*

We assume that the 6-week-old hens and cockerels produced by the mother units will scavenge and get a large part of their feed from other (possibly less-nutrient dense) sources once they are sold to small farmers. The feed that these farmers require is not considered here for the sake of simplicity. Hence, our calculations are most likely an underestimation of the feed ingredient- and land requirements.

On the other hand, the areas calculated in the scenarios are based on a double cropping system, i.e., maize-soybean rotation, with one maize- and one soybean cycle per year. According to the model used by Conijn et al. (2011), three crops per year can be grown in some locations of the study area (section 3.2). This means that crop productivity could be higher than assumed and that less land may be required in the scenarios.

However, given the low soil fertility status of the samples, it is strongly recommended to use the third cropping cycle for a cover- or green manure crop to increase organic matter in the soil and to sustainably improve yields (Dos Santos, 2021; Rocha et al., 2020).

4.2 Why increasing productivity?

The scenarios in **Figure 13** demonstrate that potentially, the total surface needed to produce eight times the current amount of feed grains, is only 30% more than the current land area needed to produce the requirements for 2023 only (resp. 34,660 tons on 4,393 ha *vs* 4.2 tons on 3,256 ha).

This indicates the urgency to increase yield levels to improve land use efficiencies and other resource use efficiencies. Especially in the DRC, one of the countries in the world with the largest forest resources and undernourished population at the same time, it is of utmost importance to raise crop productivity. This may alleviate hunger and at the same time avoid further deforestation resulting in biodiversity loss and GHG emissions. The scenario results imply that stimulation of the local poultry sector by boosting crop productivity does not need to endanger the production of other local foods. On the contrary, increasing overall crop productivity in the area contributes to alleviating widespread hunger.

5 Boosting local feed ingredient production

As stated by Ndambi and Vernooy (2018): "*Local feed is important, both in terms of volume and its contribution to the cost price. The present **infrastructure** for commercial agricultural production is poor: required inputs such as quality seeds, mechanization, good transport and storage facilities are not yet available in the area. Opportunities to improve the situation therefore exist at different levels:*

*Agricultural **crop production**, requiring:*

- ***Mechanization** equipment, both for medium- and large-scale arable farming. Mechanization is needed for land preparation, sowing, weed control, harvesting, transport including storage facilities.*
- *Investments in more local production will require more **processing, drying and storage facilities** as well.*
- *Additional **inputs** such as lime, seeds and fertilizers will be needed in larger quantities.*

*The bulk of arable crops is produced by smallholders. **Stimulating small farmers to produce more efficiently** requires three different strategic steps:*

1. *Necessary **inputs such as seed, small scale mechanization, pesticides** should be made available. These are normally commercial inputs, but the availability in early stages of agricultural development could be improved through interventions of government and/or NGOs.*
2. ***Investing in more production requires finances and loans** to purchase the necessary inputs before the growing season and for crop management during the growing season. Most formal banks in countries such as the DRC are reluctant to provide loans to small scale farmers, mainly because of the risks of weather influences such as droughts, storms and floods. Micro finance agencies could fill this gap and this approach could also be supported in Congo.*
3. ***More intensive crop cultivation requires knowledge about cultivation practices**, crop management, harvesting techniques etc. To empower small scale farmers to step up their agricultural production, applied research and **specialized advice** is necessary from extension officers, advisors and* training institutes. This could be supported through targeted training programs".

In this chapter, we list the most important actions to be taken to increase overall soil fertility and obtain higher maize- and soybean yields in the study area.

5.1 Liming

The limited number of soil samples does not provide much evidence, but the mapping of the soil pH (**Figure 8**) and predominantly sandy and leached soils do raise concern that the pH of many soils in the study area is suboptimal for crop production. To improve the fertility of soils in the study area, an effective strategy to start with is to increase the soil pH to at least 5.5. This can be done by liming; adding materials high in calcium (Ca+) or magnesium (Mg+) to the soil. These materials react as a base, which helps neutralize soil acidity. Liming is an accessible and relatively cheap way of improving soil fertility. Any other soil fertility strategy following liming, such as adding external nutrients, will be much more effective in soils with an adequate pH.

5.2 Fertilization

The soils in the study area have low natural chemical fertility. To calculate the right amount of nutrients for longer-term soil management, one should consider the amounts of nutrients present in the soil and what is removed with crop harvests. A good fertilizer recommendation cannot simply be copied from one place to another. Soil sampling and professional guidance are recommended for deciding on an adequate fertilization scheme.

Specific recommendations for the Kinshasa area, and even for similar soils and climates, like Maranhão in Brazil, are lacking. Therefore, a general estimation of N, P, and K application is given.
The moment of application is important. It is very important to know which nutrient is necessary at which stage of plant development. Crops can even be harmed when nutrients are applied at the wrong time.
In the figures below, the stock of N, P and K is given for the soil samples that we took during the field visit. Each figure has two horizontal lines (a green and a blue line). The target stock for each nutrient is between these lines.

N

The total N soil stock was very low in all four soil samples, and consequently the plant-available nitrogen is low as well. Starting with a leguminous cover crop is a good way to add N to the soil. N can also be applied by organic- or synthetic fertilizer. Average N-recommendations are 120 kg/ha for maize and 20-30 kg/ha for soybean[20]. Split gifts are recommended to reduce leaching. Spraying of urea is the most efficient application for the second gift (Hijbeek et al., 2016)

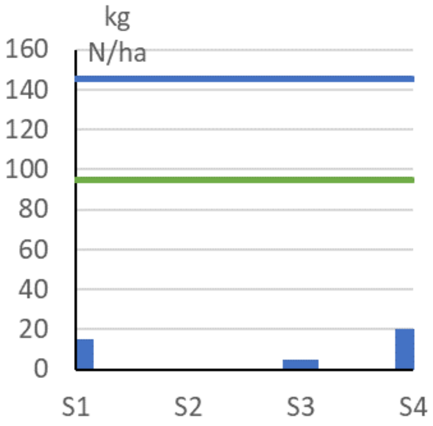

Figure 14 *Soil N supply in the four soil samples, with the target trajectory between the green and blue line.*

Soybean is a leguminous plant, which means that it is capable of biologically fixating nitrogen in symbiosis with a species of bacteria that lives around the roots (*Bradyrhizobium japonicum*, short: rhizobium). An efficient symbiosis can provide high N quantities, approximately 60% of the plant's requirement (Ciampiti & Salvagiotti, 2018). That is why soybean has lower nitrogen input requirements than other crops, like maize. Overapplication of N-fertilizer inhibits biological nitrogen fixation in soybean, especially in the vegetative stage (Tagliapietra et al., 2022).

To help the nitrogen fixation process, inoculating the seeds with living rhizobium bacteria shortly before sowing is important. For a good rhizobium activity, the pH of the soil has to be at least 5.5.

P

The amount of phosphorus (P) is low in all soil samples, as is, logically, the availability to plants. The amounts of P were <1.2 kg/ha in all four samples, so low that they were out of the measurement range. The blue bars at 1.2 kg/ha in **Figure 15** are probably an overestimation of the actual available P stock.

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[20] https://www.npct.com.br/npctweb/npct.nsf/article/BRS-3514/$File/Nutrient%20management%20for%20soybeans%20in%20Brazilian%20Cerrado%20-%20Eros%20Francisco.pdf [visited 14-07-2023]

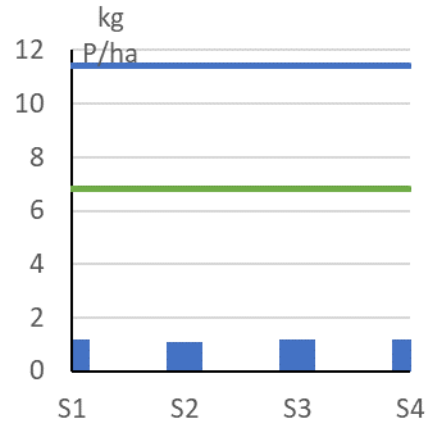

Figure 15 *Soil P supply in the four soil samples, with the target trajectory between the green and blue line.*

Phosphorus is often dosed in higher amounts than the plant requires, due to the high fixation of this nutrient to the soil. Tropical soils typically have low phosphorus availability to plants. This is probably the case for the study area, but the total P-levels are so low that the plant availability cannot be calculated individually at this point in time.

The amount of phosphorus to be applied varies according to the content in the soil and the expected productivity of the maize crop. When starting to cultivate a field, maintenance phosphate fertilization must be done in order to reach a certain level in the soil before phosphorus becomes available to plants. This must be combined with the restoration of soil chemical fertility (CEC) by liming and applying organic matter.

Therefore, conservationist practices such as cover crops, crop rotation, minimal soil tilling or intercropping maize with forage grasses, should be done to guarantee the increase and maintenance of organic matter. When the phosphorus levels in the soil have increased, P fertilizer amounts applied should compensate the amount that is removed with the harvest.

K

When looking at the soil samples, two of the samples have an average to high amount of potassium (K), but still a very low plant availability. The other two samples have low overall K-levels. Plant availability in all samples is similar and lower than the target trajectory. Note that the target trajectory varies slightly among samples. The amount of K needed is related to other chemical characteristics of the soil.

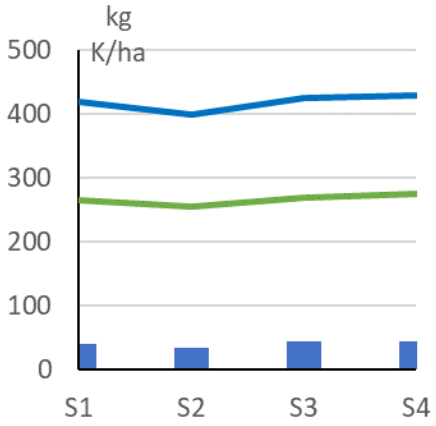

Figure 16 *Soil K supply in the four soil samples, with the target trajectory between the green and blue line.*

Several factors can reduce the potassium availability for plants. Important causes are a low initial concentration in the soil, a lack of replacement through fertilization, or incorrect fertilization practices. These conditions can lead to a shortage of K in the plant through leaching.
K has a high mobility in the soil, especially in soils with low cation exchange capacity (CEC), high infiltration, sandy texture and high rainfall, typical characteristics of the soils in the study area.

Potassium should be dosed carefully on sandy soils. Studies have indicated that leaching of K increases rapidly with doses above 80 kg/ha of K2O per year, starting at medium-light soil texture, regardless of the application method. Potassium losses through leaching in sandy soils in north-eastern Brazil range from 35% to 48% of the total applied amount[21].

5.3 Improved and adapted seeds

In order to increase yields, improved maize and soybean crop varieties are required that are adapted to the local conditions. These can be either hybrid or open-pollinated. Adapted seeds are bred and developed for a certain type of climate and are ideally resistant to associated pests and diseases.

Hybrid maize varieties generally give significantly higher yields than open pollinated varieties when inputs are available and growing conditions are good. However, hybrid seeds are more expensive and often less resilient under less optimal growing conditions than local varieties. If optimal growing conditions cannot be guaranteed, i.e., for smallholder farmers with less access to adequate inputs and a higher risk of not obtaining an optimal yield, choosing an open-pollinated variety might make more sense budget-wise.

The seeds need to be stored in cool and dry conditions to guarantee the quality until seeding. Leguminosae seeds like soybean perform much better when inoculated correctly with rhizobium bacteria before seeding. The rhizobium bacteria live in a symbiosis with the plant roots and help the plant to efficiently take up nitrogen. Since soybean is a day-length sensitive crop it is very important to choose soybean varieties suitable for the prevailing day-length in the study area.

It is also important to choose an adequate plant density (number of seeds per hectare, row distance, planting distance) that fits the soil nutrient- and moisture conditions.

5.4 Adding organic matter

Because of the sandy and the heavily weathered nature of the soils in the study area, the fertility is extremely low. Soil fertility can be improved by adding organic matter and manure to the soil. Organic matter improves water- and nutrient retention and is a source of nutrients. Sources of organic matter are animal manure, compost, cover crops that are left on the field, and residues of other crops left on the field. Minimum tillage practices help maintain the organic matter in the topsoil.

5.4.1 Organic manure and circularity

At the moment, most of the chicken manure produced in the EFC project is sold to a nearby horticulture farm. This might make more sense logistically and economically, but the manure would also be an excellent source of organic matter and nutrients for maize and soybean cultivation. On the EFC farms as well as on the smaller farms that the chickens will be sold to, the manure produced by the chickens can be used on the fields to growth feed crops so that nutrients are recirculated in the poultry system. Anyway, it is recommended to use organic manure in addition to the fertilizer to increase long-term soil health and -fertility.

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[21] https://revistacultivar.com.br/artigos/cultura-do-milho:-qual-o-melhor-adubo-para-o-plantio-nos-solos-do-cerrado [visited 14-07-2023].

The EFC project is planning to house 28,000 parent stock layers (permanent presence in the PS farm) and 5,000,000 one-day-chicks per year by 2025. The parent stock layers will be permanently present in the PS farm, and the one-day-chicks are likely to stay up to 5-6 weeks in the mother unit. When knowing the manure production of a Sasso pullet (<5 weeks) and an adult Sasso laying hen, one can calculate the total manure production per year. The total amount of manure does not only depend on the chicken droppings but also on the amount and type of litter that is used in the rearing system, like straw or wood chips.

Next step would be to know the nutrient contents in chicken manure. In **Table 3**, average nutrient contents of chicken manure from several studies are summarized.

Table 3 *Average nutrient amounts in chicken manure from two different studies. *Top table is in percentage of fresh weight, **Lower table is in percentage of dry weight. Sources: Chastain et al., Huang et al., 2011.*

Chicken/ Nutrient %*	**Total-N**	**P2O5**	**K2O**
Broiler	3.6	3.45	2.3
Broiler cake	2.3	2.65	1.8
Roaster litter	3.55	3.6	2.3
Breeder litter	1.7	2.8	1.65
Average %	**2.8**	**3.1**	**2.0**

Nutrient %*	**TN**	**TP**	**TK**
Min	1.8	0.5	0.7
Max	3.4	1.7	1.7
Average %	**2.6**	**1.1**	**1.2**

For example, using data from **Table 3**, a fertilization scheme of 50% chemical fertilizer and 50% chicken manure, and applying 120 kg N/ha would mean approximately 60*(100/2.6)= **2308 kg of chicken manure per hectare**. In case 100% of the N is given as chicken manure **4615 kg/ha** would be needed. This matches numbers found in literature (Ritz and Merka, 2013). Since livestock numbers are very low in the study area, it is obvious that organic manure availability will remain a limiting factor for improving soil fertility until more livestock is produced. But livestock needs feed. A "chicken and egg" situation…

Therefore, also other sources of organic manure should be considered as well. Since not many other livestock is available in the study area either, it might be interesting to look at fertilizing with processed human waste, starting on a small scale. With the fast-growing population in the DRC, the potential availability is high. Disadvantages are that there is no infrastructure present, social acceptance is low, and health risks are high if human waste is not processed adequately (Musazura and Oduor Odindo, 2022).

A few other things to consider when using the chicken manure:

1. Chicken manure has a high Phosphate (P) rate, which is suitable for maize.
2. Nitrogen volatilization losses from the manure can be high, therefore, it is important to store manure well to avoid such N losses, which can be up to 30% in uncovered chicken manure (Chastain et al.).
3. Straw and wood chips in the stable are a good addition to the manure, the ammonia will partly be absorbed or bound by the straw and becomes available later when applied to soil and digested (Van Dijk, 2023). It also increases the amount of organic matter of the chicken manure.

5.4.2 Compost

Compost is a valuable source of organic matter and can be made out of crop residues, kitchen waste, or any source of green (preferably humid) waste. Compost can be made on a large scale in a waste handling facility, but composting can also be done by (smallholder) farmers through collecting kitchen waste, crop residues, or any green waste. Training on composting can support farmers in preparing compost to increase crop productivity. A wide range of trainings on composting is available, for example, as done by the Netherlands Enterprise Agency in Rwanda[22], and Food for Life in Malawi[23].

5.5 Cropping systems and practices

5.5.1 Cropping calendars

The temperatures in the study area allow for two or more cropping seasons per year if sufficient water is available. Only during the dry season (June-August) rainfall may become a limiting factor depending on the soil water holding capacity of prevailing soils and capillary rise of groundwater.

On the other hand, the humid conditions during a large part of the year challenge harvesting and post-harvest management operations such as drying and storing of feed grains, especially because no adequate facilities are available. Therefore, EFC should aim at harvesting in the dry period to benefit from the relatively drier conditions. When a double cropping system is applied, the harvesting and post-harvest management of the second crop will be challenging as it needs to be harvested in the wet season.

Several efforts were done to get cropping calendars from DRC institutions. Unfortunately, at the time this report was written, no information about cropping calendars for the DRC was made available.

Based on the rainfall data, September-February and March-August seem to be the most logical growing periods for a double cropping system. February and August are relatively dry months for harvesting, and September and March are relatively wet which is favourable for seed germination and crop growth.

The date of sowing has to be carefully chosen, to make the best use of natural precipitation, dry periods and providing adequate time for land preparation for the following crop. The sowing date can also heavily influence the yield. For example, in the Maranhão region in Brazil, it is recommended to sow soybean before the 18th of November. Studies showed that yield decreases with an average of 20 kg/ha for each day sown later (Tagliapietra et al., 2022).

5.5.2 Intercropping and rotations

Studies show that cover crops have positive impact on soybean and soybean-maize cropping systems in tropical regions like the DRC. For example, soybean yields increase significantly (>33%) if maize before the soybean is intercropped with tropical forage grasses to increase soil biological health. The intercropping does not increase or affect the maize productivity on short term (dos Santos et al., 2021, Rocha et al., 2020).

More reasons to apply cover crops:

- Cover crops are a tool to improve N use efficiency, avoiding N loss to the environment (Rocha et al., 2020),
- Cover crops can help prevent N leaching on poor soils. N largely remains in the crop stubble that is left on the field,
- Cover crops prevent erosion, which is a risk with sandy soils and high rainfall, both conditions are present in the study area.

5.6 Synthesis

To improve soil fertility, adequate liming and fertilizing practices are needed using a mixture of organic sources and chemical fertilizers. Improved seeds adapted to the local conditions are needed to reach achieve the full yield potential as the local seeds are often of bad quality.

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[22] RVO project in Rwanda: https://sharingknowledge.rvo.nl/groups/view/4586030f-71c3-4bb6-a0eb-ef74c9c3bb24/cbi-organic-composting/blog/view/48793a22-2cc7-4a4f-8957-296c08ea326a/organic-composting-in-rwanda.

[23] Food for Life composting courses in Malawi (website in Dutch, video in English https://foodforlifemalawi.com/verrijkte-compost/).

Besides, any available source of (chicken) manure, plant waste, green manure (cover) crop or compostable material should be considered as a highly needed source of organic matter. These forms of circular agriculture make sense especially for the study area as they minimize the need for (often imported and expensive) external resources and reduce waste.

A combination of organic- and chemical fertilizer is known to give better yields and improve the soil fertility than chemical fertilizer alone, because of the organic matter that is present in manure (de Haan et al., 2017).

A shortlist of actions to increase organic matter in the soil:
1. Use the chicken (or other) manure as much as possible.
2. Consider the cultivation of a cover crop if possible in the third crop cycle.
3. Start composting practices.
4. Consider minimum tilling.
5. Do research on optimal cropping rotations for optimal crop yields (considering harvesting conditions) and soil health. Explore sustainable long-term rotations, and possibly a rotation for rapid initial organic matter addition before starting long-term rotations.

6 Important considerations

In this chapter, we discuss some topics that we think are very important but extended research did not fit within the limited budget and scope of this study. More research on these topics is recommended to support the EFC program.

6.1 Drying- and storage facilities

The feed crops will be produced under humid tropical conditions in the DRC. A double to triple cropping system is possible in the area, and one crop can theoretically be harvested in the dry season. The second crop will be harvested under more humid conditions. Drying, cleaning and storage facilities will thus be needed to guarantee the quality of the harvested feed grains.

It is important to make sure that seeds are dried up to a moisture content of max. 15% to avoid mould. After drying, good storage conditions (ventilation and adequate bags) are equally important to avoid that the grains become humid again after drying. Moulded and/or germinated seeds are useless as feed ingredient as well as for sowing.

Drying must take place shortly after harvest (unless the crop has dried out enough on the field), and that drying and-or storage facilities should be located intelligently, preferably within a reasonable distance from the crop cultivation locations to enable quick transport.

6.2 Mechanization

It needs to be further investigated what the mechanization needs are to produce almost 35 thousand tons of grains in 2030. A tractor, a seeding implement and a fertilizer spreader will be needed at the least. A sprayer and a combine can be purchased in a later stage as these operations are easier to do manually. Especially a combine is complex and requires diligent maintenance. When deciding on who will cultivate the grains and where the plots will be located, sharing machinery between farmers and cooperations is an option. Decent infrastructure should be present to transport machines quickly between fields, as farming operations are often done in a short time window.

6.3 Costs

Calculating the costs of locally available lime, fertilizer, seeds and manure has been done by SeedCo, one of the partners in the EFC cluster program. The results of their initial calculation can be found in Annex 1. We recommend to enrich the recommendations on input quantities with results from existing scientific literature.

6.4 Local farmers and smallholders

It is important that local farmers also get access to knowledge on cultivation methods, quality (OP or hybrid) maize seeds and other inputs, so they can increase the productivity of their crops. This could help create public support for the cultivation of maize for livestock in the area, as food availability is a concern. Another option to alleviate concerns about food availability is to cultivate 50% of the maize for the EFC project and the other 50% for sales for direct human consumption. Higher yields obtained with better knowledge and more input use would allow to do this, benefiting both the food and feed supply.

The availability and affordability of maize is currently one of the major reasons people do not keep chickens in the DRC. It is important that better and affordable inputs for farming become available to the local farmers, preferably for a lower, subsidized price or with loans or another credit scheme (Ndambi and Vernooy, 2018). If maize does not become more affordable, the EFC chicks will either find no market to be sold, or an elite market might emerge for medium and large farmers.
However, this is only a problem if farmers keep the poultry in a closed environment. The Sasso breed used by EFC is very robust and can scavenge their own feed after 4-6 weeks. When free roaming, theoretically no additional feed grains are needed, but production may be low.

6.5 Education

To have a properly functioning EFC model, the farmers involved need to have the capacity to carry out the jobs required: raising chickens, cultivating feed crops, post-harvest management, storage, transport, maintenance of equipment and service provision. The EFC project includes capacity building on chicken farming, which is essential for farmers to be successful and maximize revenues.

For the feed ingredient production part however, training should be provided as well. Education and training on maize and soybean cultivation practices can be done by extension of companies in the consortium and by Congolese knowledge institutes. Extension workers are the most important source of information for farmers in the DRC, as is the case in most African countries (Ndambi and Vernooy, 2018).

6.6 Avoid side-selling

Almost all maize in the DRC is imported. Maize prices are outrageous and seem to continue to increase. In June 2023, prices were over $45 dollars for a 25 kg bag of maize[24]. It is therefore very attractive to invest in increasing local maize production. EFC and chicken farmers need feed grains to be available at an attractive price to sustain and build their business, and more importantly, to make maize and poultry products affordable to the Congolese people.

An increase in (local) maize production is needed first, and then prices are likely to lower. A way to create some financial security for both the maize grower and the purchasing party, is contract farming. The purchaser and the farmer can agree on a prize before the crop is grown. This is no guarantee for the purchaser as the farmer can still sell a part of the yield to a third party. For the EFC project, trading the maize for pullets could be an interesting alternative, as pullets are hard to get in the area.

6.7 Feed ingredient alternatives

In the Kinshasa area, wheat bran and beer spent are available from flour mills and from a Heineken-owned beer brewery. These by-products may be affordable and available as feed components.

A study on soybean in the DRC was published very recently by USAID. This study stated that there is a lot of potential for a local soybean industry, delivering products such as soybean oil for human consumption and the remaining soybean cake as a cheap and high-quality feed ingredient. A growing soybean industry in the country will help investing in efforts for increasing yields. The remaining soybean cake can be sold relatively cheaply as chicken feed, providing multiple benefits for the poultry sector. An important challenge for boosting the soybean oil industry is the preference for (currently cheaper) palm oil amongst the DRC population (Poisson et al., 2023).

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[24] https://zoom-eco.net/a-la-une/rdc-malgre-la-flambee-des-prix-sur-le-marche-le-service-national-maintient-son-sac-de-farine-de-mais-de-25-kg-a-18-000-cdf/ [visited June 2023].

7 Conclusions and recommendations

Given the climatic circumstances in the Kinshasa area, maize and soybean production can potentially increase considerably compared to the current production levels. The moderately warm temperatures and rainfall year-round provide excellent conditions for crop growth. This is good news for both human food production and feed ingredient production for EFC.

However, an important challenge is the low soil fertility: soils in the area were found to be very sandy, weathered and low in nutrients. Liming operations, rotations with cover crops, organic matter application will be needed to increase soil fertility over the longer term and to avoid high nutrient inputs and -losses.

The EFC project provides a great initiative and potential to help decrease undernourishment and micro-nutrient deficiencies in the Kinshasa area by boosting the local poultry sector. This initiative can work only if supported by productive agricultural fields and, consequently, increasing maize yields and slowly decreasing maize prices because expensive maize imports can be reduced.

Several important things were beyond the scope of this study, i.e., the availability and market prices of agricultural inputs, organic matter, manure, and also on how local stakeholders and smallholder farmers should be involved to spread the EFC concept in the Kinshasa area. To summarize, more knowledge is needed on:

- Liming effects, costs and potential sources.
- Fertilizer: what amounts are needed and costs.
- Cover crops: what cover crops are best to improve soil health and productivity? And in which season can they be grown?
- Manure: how much chicken manure will EFC produce, and possibilities of sourcing alternative types of manure. Look at possibilities of safely using human manure.
- Hybrid and open-pollinated maize variety testing, to compare market prizes and obtained yields (cost/benefit).
- Much research still needs to be done on how to involve smallholder farmers, which are often women, and cooperations. Maize productivity improvements and lower prices will not benefit only the larger EFC farms but also smallholder chicken- or combined farmers due to a lower price. Training and active involvement in the project should improve the crop yields of smallholders as well.
- How an emerging soybean oil industry in the DRC can help increase yields and affordability of soybean and soybean products for chicken feed.

7.1 Further reading

Although we tried including as much relevant information as possible in this report, we want to highlight several interesting reports (some are in the references, some are not) that could be interesting for future research:

- On nutrient management in SSA: (https://cgspace.cgiar.org/handle/10568/93200)
- Soybean in the DRC: https://agrilinks.org/sites/default/files/media/file/SOYBEAN%20IN%20THE%20DEMOCRATIC%20REPUBLIC%20OF%20CONGO%E2%80%94A%20MARKET%20SYSTEMS%20ANALYSIS-final.pdf
- (Small scale) liming with egg shells:
  Luo, W., Ji, Y., Qu, L. *et al.* Effects of eggshell addition on calcium-deficient acid soils contaminated with heavy metals. *Front. Environ. Sci. Eng.* **12**, 4 (2018). https://doi.org/10.1007/s11783-018-1026-y
- Human manure:
  https://www.researchgate.net/publication/357829334_Characterisation_of_selected_human_excreta-derived_fertilisers_for_agricultural_use_A_scoping_review
- Green manure crops and fertility:
  https://www.cambridge.org/core/journals/experimental-agriculture/article/incorporating-shortseason-legumes-and-green-manure-crops-into-maizebased-systems-in-the-moist-guinea-savanna-of-west-africa/B1AB89D0476D7760010EDF089BA997B9
- Another one on green manure: https://www.sciencedirect.com/science/article/pii/S0378429011004175

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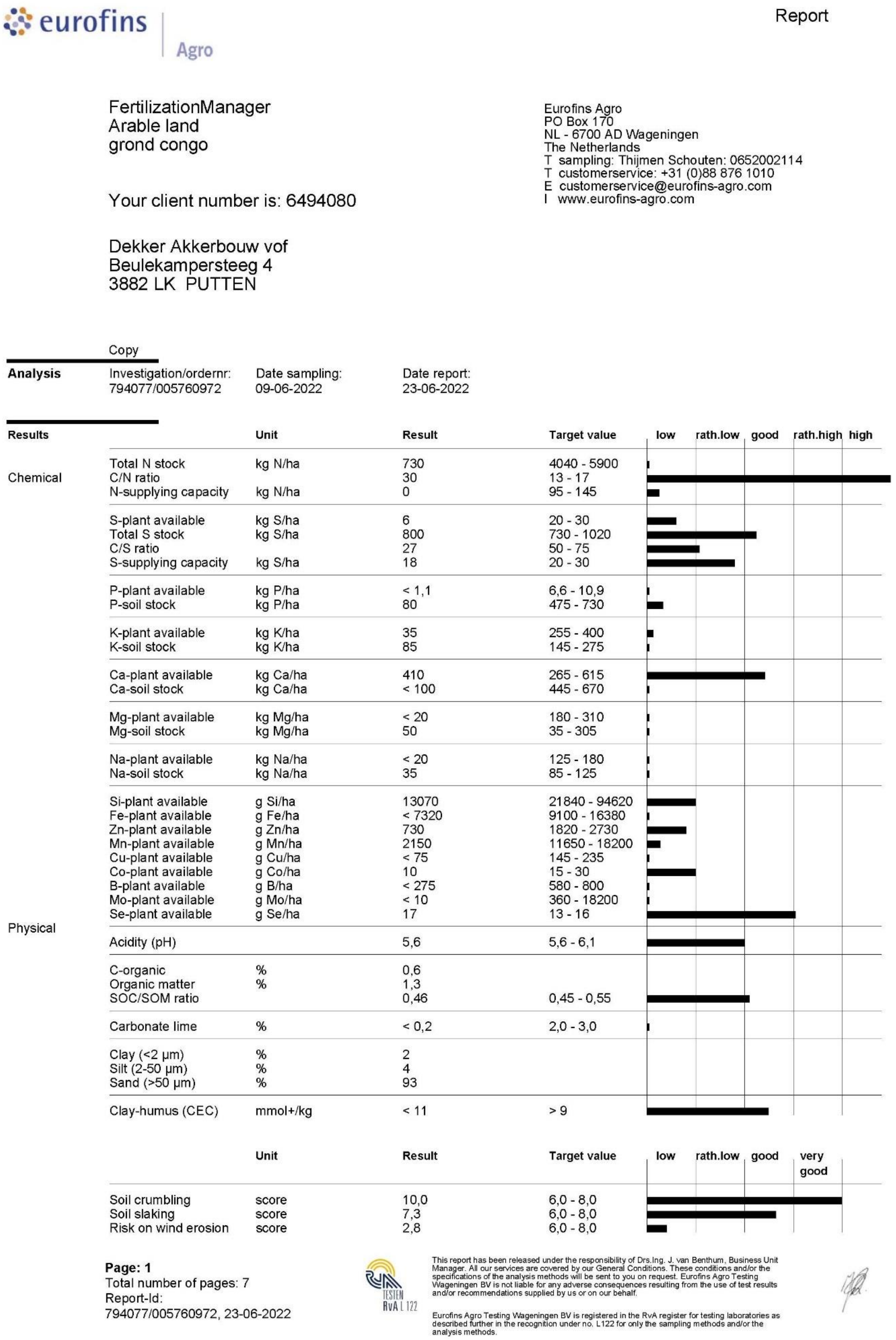
Annex 1 Maize Crop Budget by Seed Co

High Management Farmer							
Crop: Maize: Seed							
Season	**2023/2024**		**Plant: Feb for first season & Ju**	**Tonnes per ha**		**8.00**	
Area: Ha's				**Price per Tonne**		**1.290.00**	*Note: Selling price is dependent on current prices in the country of operation*
Inputs	**Rate per ha**	**Unit**	**Input Detail**	**Unit Cost USD$**	**% Total Cost**	**USD$ /ha**	***Notes***
Seed	25	kg	SC & LG Variety	10.000	11.36%	250.00	*As per seed production protocol to be provided by Seed Co*
					11.36%	**250.00**	
Fertilizer (NPK-15-15-15/23-	650	kg	Basal	0.847	25.01%	550.55	*Apply compound fertilizer (NPK 15-15-15/23-10-5+TE/25-10-10+TE/27-6-6+TE) at planting, Is it the only basal fertilize*
	250	kg	Urea	0.660	7.50%	165.00	*Apply 1st split at 4WAP then 2nd split at 6 WAP*
					32.51%	**715.55**	
Herbicides	3.000	l	Atrazine	5.000	0.68%	15.00	*Is mixed with Dual (S-metalachlor) for a wider coverage at pre-emergent stage, for the control of broad leaf weeds and*
	2.000	l	Metalachlor	7.500	0.68%	15.00	*Pre-emergent grass herbicide(can be in combination with Atrazine), for the control of annual graases and some broad*
	3.000	l	Nicosulfuron	8.333	1.14%	25.00	*Post-emergence herbicide for the control of shamva grass (itch grass) and some annual grasses*
					2.50%	**30.00**	
Insecticides	1	l	Emamectin benzoate+acetamipri	33.000	1.50%	33.00	*3 sprays (1 at 4WAP, 7WAP & 9 WAP) for fall army worm @0.25-0.5l/ha, Scout regularly for effective control*
					1.50%	**33.00**	
Labour	115	day	Permanent	4.300	22.46%	494.50	
					22.46%	**494.50**	
Tractor Hires	4	l	Chisel Ploughing, Discing, Planting, Spraying	85.000	15.45%	340.00	*1 hire Chisel plough, 1 hire discing, 1 hire planting, 3 hires spraying @ average of 15l/ha*
					15.45%	**340.00**	
Sodium Molybdate @120g/	0.12	l		55.000	0.30%	6.60	
						6.60	
Transport/30ton	1	l	Delivered 80Km Radius	200.000	9.09%	200.00	*Roughly $200/30t, 80km radius*
					9.09%	**200.00**	
Irrigation (Electricity)	140	mm	Pumped from water body	0.940	5.98%	131.60	*150mm for early crop establishment and supplimentary @ $0.781/mm inclusive of Electricity and Water charges*
					5.98%	**131.60**	
	Total Variable Costs				**100.00%**	**2.201.25**	
	Gross Income at 4.00 t/ha				**468.82%**	**10.320.00**	
	Gross Margin				**368.82%**	**8.118.75**	
	Return per $TVC					**4.7**	

Annex 2 Soil fertility analysis sample 1



Report

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Copy

Analysis	Investigation/ordernr:	Date sampling:	Date report:
	794077/005760972	09-06-2022	23-06-2022

Results		Unit	Result	Target value
	Total N stock	kg N/ha	730	4040 - 5900
Chemical	C/N ratio		30	13 - 17
	N-supplying capacity	kg N/ha	0	95 - 145
	S-plant available	kg S/ha	6	20 - 30
	Total S stock	kg S/ha	800	730 - 1020
	C/S ratio		27	50 - 75
	S-supplying capacity	kg S/ha	18	20 - 30
	P-plant available	kg P/ha	< 1,1	6,6 - 10,9
	P-soil stock	kg P/ha	80	475 - 730
	K-plant available	kg K/ha	35	255 - 400
	K-soil stock	kg K/ha	85	145 - 275
	Ca-plant available	kg Ca/ha	410	265 - 615
	Ca-soil stock	kg Ca/ha	< 100	445 - 670
	Mg-plant available	kg Mg/ha	< 20	180 - 310
	Mg-soil stock	kg Mg/ha	50	35 - 305
	Na-plant available	kg Na/ha	< 20	125 - 180
	Na-soil stock	kg Na/ha	35	85 - 125
	Si-plant available	g Si/ha	13070	21840 - 94620
	Fe-plant available	g Fe/ha	< 7320	9100 - 16380
	Zn-plant available	g Zn/ha	730	1820 - 2730
	Mn-plant available	g Mn/ha	2150	11650 - 18200
	Cu-plant available	g Cu/ha	< 75	145 - 235
	Co-plant available	g Co/ha	10	15 - 30
	B-plant available	g B/ha	< 275	580 - 800
	Mo-plant available	g Mo/ha	< 10	360 - 18200
	Se-plant available	g Se/ha	17	13 - 16
Physical	Acidity (pH)		5,6	5,6 - 6,1
	C-organic	%	0,6	
	Organic matter	%	1,3	
	SOC/SOM ratio		0,46	0,45 - 0,55
	Carbonate lime	%	< 0,2	2,0 - 3,0
	Clay (<2 µm)	%	2	
	Silt (2-50 µm)	%	4	
	Sand (>50 µm)	%	93	
	Clay-humus (CEC)	mmol+/kg	< 11	> 9

	Unit	Result	Target value
Soil crumbling	score	10,0	6,0 - 8,0
Soil slaking	score	7,3	6,0 - 8,0
Risk on wind erosion	score	2,8	6,0 - 8,0

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Results		Unit	Result	Target value	low	rath.low	good	rath.high	high
	Moisture retention cap.	mm	30						
Biological	Microbial biomass	mg C/kg	8	65 - 195	▬				
	Microbial activity	mg N/kg	30	60 - 80	▬				

Essential nutrients
Each crop requires nutrients. The essential nutrients that a crop needs most are nitrogen (N), sulphur (S), phosphate (P), potassium (K), calcium (Ca) and magnesium (Mg). The other essential nutrients are the micro nutrients iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), boron (B), molybdenum (Mo) and chloride (Cl). A crop require relatively low concentrations of these micro nutrients, however a deficit can cause loss of yield and/or quality in every crop.

A number of other nutrients (sodium, silicon, cobalt, selenium) can also be important to - amongst other factors - the yield, quality, resilience, sturdiness, fertility, palatability and (animal) health.

Elements can also compete with each other. For example, if the Mg status is "good" but the K status is "high", then an Mg deficiency can still occur. Therefore, the recommended dosages take these interactions into consideration.

Fertilisation recommendations and legislation
The fertilisation recommendations aim to achieve an agronomical optimum yield and crop quality. The recommendations do not take any legal restrictions into consideration.

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Recommend. in kg per ha per year		**Frequency**	**Crop**	**Application recommendation**	**Removal**
	Nitrogen (N)	per year	Ware potatoes	320	
			Temporary pasture	140	
			Green maize	225	
			Spring-sown onions	120	
			Spring rye	120	
	Sulphate (SO_3)	per year	Ware potatoes	0	60
			Temporary pasture	20	75
			Green maize	15	73
			Spring-sown onions	0	63
			Spring rye	0	25
	Phosphate (P_2O_5)	per year	Ware potatoes	580	55
			Temporary pasture	510	25
			Green maize	580	80
			Spring-sown onions	580	35
			Spring rye	495	45
	Potassium (K_2O)	per year	Ware potatoes	325	255
			Temporary pasture	270	50
			Green maize	370	300
			Spring-sown onions	270	90
			Spring rye	190	80
	Calcium (CaO)	per year	Ware potatoes	85	
			Temporary pasture	80	
			Green maize	65	
			Spring-sown onions	130	
			Spring rye	80	
	Magnesium (MgO)	per year	Ware potatoes	70	
			Temporary pasture	40	
			Green maize	80	
			Spring-sown onions	40	
			Spring rye	40	
	Zinc (Zn)	per year	Ware potatoes	0,5	
			Temporary pasture	0,5	
			Green maize	1,0	
			Spring-sown onions	1,0	
			Spring rye	0,5	
	Manganese (Mn)		Manganese deficiency is to be expected.		
	Copper (Cu)	per year	Ware potatoes	1,0	
			Temporary pasture	1,0	
			Green maize	1,0	
			Spring-sown onions	1,0	
			Spring rye	1,0	
	Boron (B)	per year	Ware potatoes	0,5	
			Temporary pasture	0,5	
			Green maize	1,5	
			Spring-sown onions	0,5	
			Spring rye	0,5	
	Lime (nw)	once		395	
			The lime gift is based on an optimal pH of 5,9		
			For every tenth increase in pH a lime gift is required of 130		
	Effective OM	per year		60	

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Explanation

The results and/or the recommendations of this analysis are valid until 2025 . Sample again after this period. You than obtain reliable new data based on the current status of your parcel.

Nitrogen:
The N recommendation relates to an annual dose. If possible, we recommend splitting this N dose into several applications. You can use our SoilCheck soil test in season to determine whether subsequent applications are necessary. This test measures the plant-available N (mineral N) in the soil among other things.
The N advice is crop-specific and not variety-specific. A variety-specific N advice can be important, particularly for potatoes. Choose SoilCheck if you want variety-specific advice.

Sulphur:
Sulphur (S) is released by the degradation (mineralisation) of organic matter or manure. This mineralisation is performed by soil organisms. Soil organisms are not very active under colder conditions, which means not much S is released from the soil early in the spring. Therefore, it is sensible to fertilise with S for many early crops, even if the soil content is good or high (consult with your adviser).

Phosphate:
P-supplying capacity is 17 . The target range is 17 - 27
The P-buffering capacity indicates whether the P-soil stock is high enough to maintain the level of plant available P. When the buffering capacity (buffering power) is low, the plant available P will not remain on level during the growing season: it will decrease.

Potassium:
Potassium is a mobile element. The potassium recommendations are therefore valid for only two years.
Temporary pasture: The recommended dose counts for two mowing cuts. If you harvest more than two cuts, adjust the gift with 80 kg K_2O per cut per ha.

Calcium:
Depending on the state of the soil, the calcium recommendation is partly crop-based and partly soil-based.
The crop-based CaO fertilisation recommendation (directly below the potassium advice) is primarily intended to improve the quality of the crops.
The soil-based recommendation is intended to supplement the soil supply of calcium and will also have a positive effect on the soil structure (see CEC triangle). Please note: you may also be advised to give a dose of lime. You do not have to give several doses of calcium; you should subtract calcium from nitrogen, phosphate and lime fertilisers from the total.

Manganese:
During periods of rapid growth, please apply foliar fertilizers containing Manganese. The frequency is every 2 weeks.
The crops potatoes, beets, grains, peas, onions, beans, cabbage, carrots, lettuce and rapeseed are most susceptible to a manganese deficiency.

Lime:
Divide the lime application equally over the crop rotation or give the lime prior to the most lime needing crop.

Clay-humus (CEC):
The concentrations of Ca, Mg, K and Na at the clay-humus complex (CEC) cannot be calculated because the results are too low.

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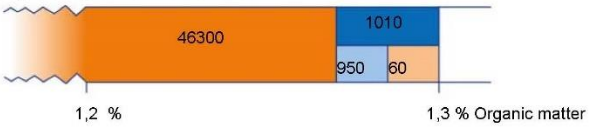
Organic matter **Figure: Organic matter balance**



Yearly breakdown rate (percentage) of the total organic matter content (%): 2,1

- 🟧 Stock of organic matter which will remain after 1 year in the sampled layer if no (effective) organic matter is supplied.
- 🟦 Total required supply of effective organic matter as a result of the degradation of the organic matter.
- ▨ Supply through crop residues (average within provided rotation scheme or crops).
- ▧ Remaining to be supplied through e.g. animal manure, green manures and/or compost.

Crop (residue)	Input of effective organic matter
Ware potatoes	875
Temporary pasture	1600
Green maize	660
Spring-sown onions	300
Spring rye	1310

Average input/year	950

In case of cereals we assume removal of straw.

For increasing the soil organic matter content by 0.1%: 3640 kg effective organic matter per hectare is needed.

Figure: Quality of the organic matter

Organic matter consists primarily of C, N, P, S. If the organic matter contains relatively high amounts of N and/or S, this makes it attractive to soil organisms. Soil organisms happily eat this organic matter. N and S are released in the process and the amount of organic matter decreases slightly (dynamic organic matter). Organic matter can also contain a lot of C. This is generally less attractive to soil organisms (bacteria). As a result, the organic matter is not consumed as quickly by the soil organisms; making the organic matter more stable. Stable organic matter contributes - among other factors - to the workability of the soil and the looseness. Dynamic organic matter contributes primarily to the release of N and S and is therefore a source of these nutrients for the crop. The quality of the organic matter can be changed (gradually) by paying attention to the properties of soil improvers such as animal manure, compost and crop residues.

Physical Because the results are too low, the concentrations of Ca, Mg, K and Na in the clay-humus complex (CEC) cannot be calculated and no calcium advice can be provided for increasing the Ca concentration.

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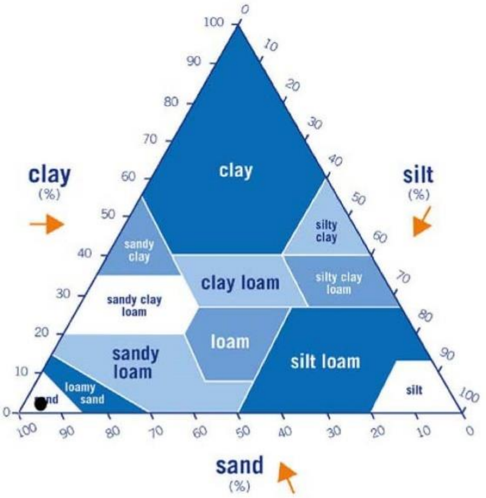
Physical

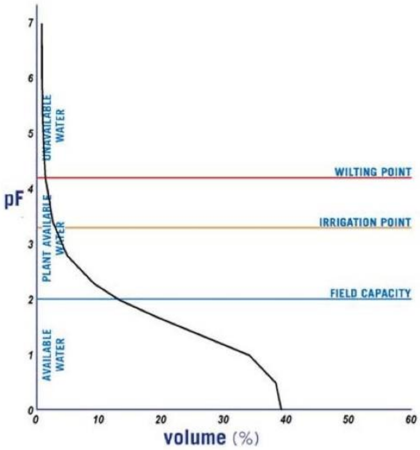
Figure: Texture triangle



Besides clay, the silt and sand fractions are presented as well. Clay is smaller than 2 micrometer (µm), silt particles are 2-50 µm and sand particles are larger than 50 µm. The relative distribution of soil particles is used to estimate the risk of slaking. Slaking causes the soil pores to be clogged with smaller particles and degrades soil structure. The risk of slaking is greatest at 10-20% clay.

Soil crumbling score is: good, however the evaluation of soil crumbling status is also depending on crop type.
Considering the results, the chance of soil slaking is small.

Figure: Water retention curve



The amount of plant available water in the sampled layer is 30 mm. This is the maximum amount you should irrigate. All excess irrigation will drain off the parcel or will sink to deeper layers.

Crops have difficulties to obtain water when the actual moisture level is below pF 3,3. When you are able to measure the moisture level, start with irrigation if the moisture content of the parcel is at 3,1 % and irrigate 26 mm.

The actual moisture level can be measured by using a soil moisture sensor, or collect soil from ten spots in the parcel. Measure the weight of the moist soil and the weight after 24 h drying. The difference between moist and dry soil is an indication of the moisture level of the parcel.

Contact & info

Soil layer:	0 - 25 cm
Calculated bulk density:	1456 kg/m^3
Sample was taken by:	Third party
Contact sample taking:	Thijmen Schouten: 0652002114

If the following information is shown in the reports, this information may have been provided by the client and may affect the valuation, advice and/or analysis result:
sampling depth, soil type, crop.

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grond congo

Method		Result	Unit	Method	RvA
Results analyses	Total nitrogen stock	< 200	mg N/kg	Em: NIRS	Q
	S-plant available	1,7	mg S/kg	Em: CCL3 (Gw NEN 17294-2)	
	Total sulphur stock	220	mg S/kg	Em: NIRS	Q
	P-plant available	< 0,3	mg P/kg	Em: CCL3 (Gw NEN 15923-1)	Q
	P-soil stock	5	mg P_2O_5/100 g	PAL1: Gw NEN 5793	Q
	K-plant available	9	mg K/kg	Em: CCL3 (Gw NEN 17294-2)	
	K-soil stock	< 0,6	mmol+/kg	Em: NIRS	
	Ca-plant available	1,4	mmol Ca/l	Em: NIRS	
	Ca-soil stock	< 11	mmol+/kg	Em: NIRS	
	Mg-plant available	< 5	mg Mg/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mg-soil stock	< 1,1	mmol+/kg	Em: NIRS	
	Na-plant available	< 6	mg Na/kg	Em: CCL3 (Gw NEN 17294-2)	
	Na-soil stock	< 0,4	mmol+/kg	Em: NIRS	
	Si-plant available	3590	µg Si/kg	Em: CCL3 (Gw NEN 17294-2)	
	Fe-plant available	< 2010	µg Fe/kg	Em: CCL3 (Gw NEN 17294-2)	
	Zn-plant available	200	µg Zn/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mn-plant available	590	µg Mn/kg	Em: CCL3 (Gw NEN 17294-2)	
	Cu-plant available	< 21	µg Cu/kg	Em: CCL3 (Gw NEN 17294-2)	Q
	Co-plant available	3,0	µg Co/kg	Em: CCL3 (Gw NEN 17294-2)	Q
	B-plant available	< 76	µg B/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mo-plant available	< 4	µg Mo/kg	Em: CCL3 (Gw NEN 17294-2)	
	Se-plant available	4,6	µg Se/kg	Em: CCL3 (Gw NEN 17294-2)	
	Acidity (pH)	5,6		Em:PHC3(Cf NEN ISO 10390)	Q
	C-organic	0,6	%	Em: NIRS	Q
	Organic matter	1,3	%	Em: NIRS	Q
	C-inorganic	< 0,03	%	Em: NIRS	
	Carbonate lime	< 0,2	%		
	Clay (<2 µm)	2	%	Em: NIRS	
	Silt (2-50 µm)	4	%	Em: NIRS	
	Sand (>50 µm)	93	%	Em: NIRS	
	Clay-humus (CEC)	< 11	mmol+/kg	Em: NIRS	
	Microbial biomass	8	mg C/kg	Em: NIRS	
	Microbial activity	30	mg N/kg	Em: NIRS	
	Fungal biomass	5	mg C/kg	Em: NIRS	
	Bacterial biomass	< 10	mg C/kg	Em: NIRS	

The values stated on page 1 and 2 under 'Result' are calculated from the above mentioned analysis results.

Q Method accredited by RvA
Em: Method Eurofins Agro, Gw: Equivalent of, Cf: In conformity with

Results are reported in dry soil.
The analyses were done at Eurofins Agro, Wageningen (NL).
The results relate exclusively to the material supplied, which Eurofins Agro received and was processed on 10-06-2022, and therefore to the sample analysed. For a detailed description of the sampling and analysis methods used, visit www.eurofins-agro.com

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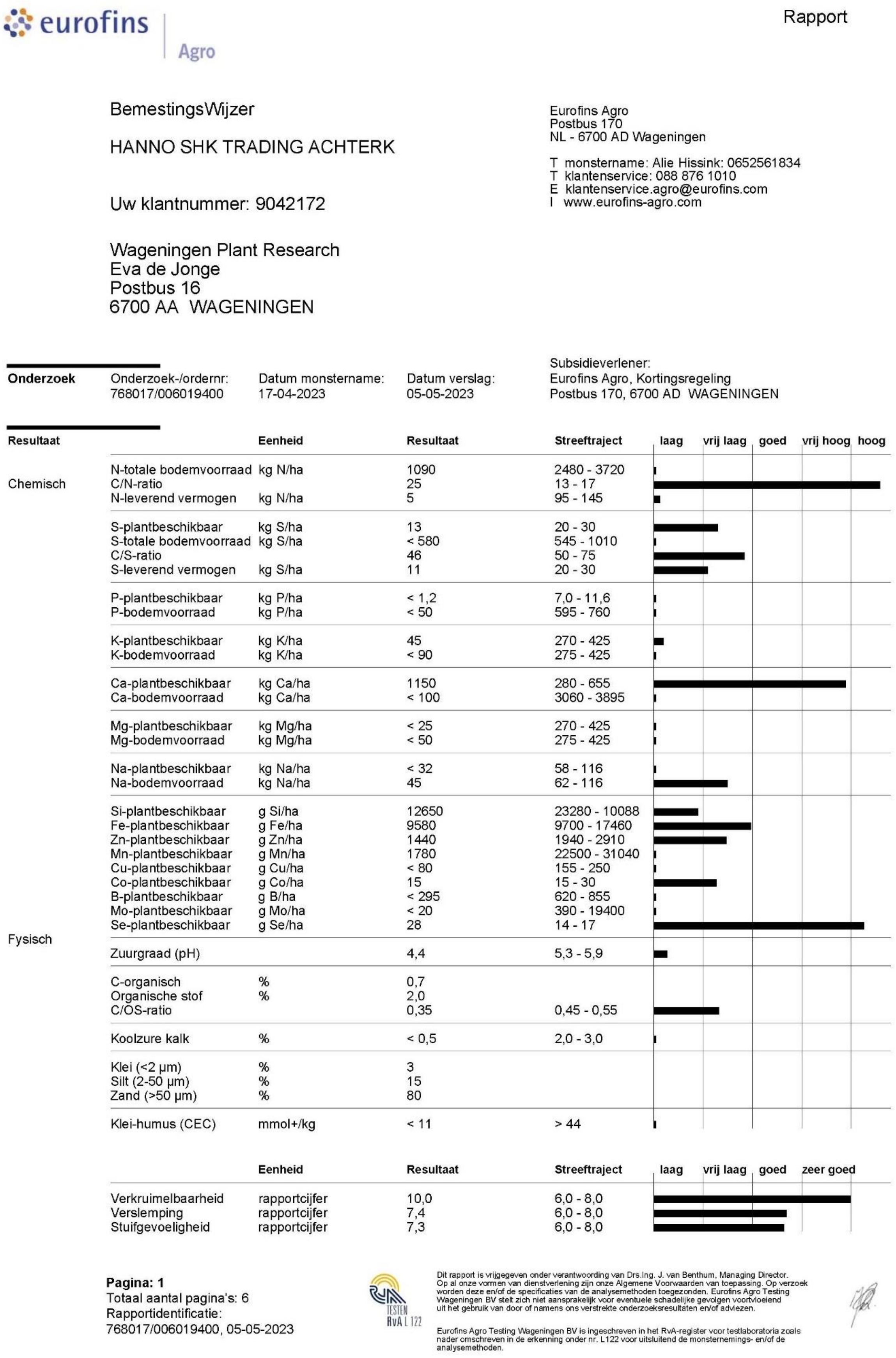
This report has been released under the responsibility of Drs.Ing. J. van Benthum, Business Unit Manager. All our services are covered by our General Conditions. These conditions and/or the specifications of the analysis methods will be sent to you on request. Eurofins Agro Testing Wageningen BV is not liable for any adverse consequences resulting from the use of test results and/or recommendations supplied by us or on our behalf.

Eurofins Agro Testing Wageningen BV is registered in the RvA register for testing laboratories as described further in the recognition under no. L122 for only the sampling methods and/or the analysis methods.

Annex 3 Soil fertility analysis sample 2



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Rapport

BemestingsWijzer

HANNO SHK TRADING ACHTERK

Uw klantnummer: 9042172

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I www.eurofins-agro.com

Onderzoek	Onderzoek-/ordernr:	Datum monstername:	Datum verslag:	Subsidieverlener:
	768017/006019400	17-04-2023	05-05-2023	Eurofins Agro, Kortingsregeling Postbus 170, 6700 AD WAGENINGEN

Resultaat		**Eenheid**	**Resultaat**	**Streeftraject**
	N-totale bodemvoorraad	kg N/ha	1090	2480 - 3720
Chemisch	C/N-ratio		25	13 - 17
	N-leverend vermogen	kg N/ha	5	95 - 145
	S-plantbeschikbaar	kg S/ha	13	20 - 30
	S-totale bodemvoorraad	kg S/ha	< 580	545 - 1010
	C/S-ratio		46	50 - 75
	S-leverend vermogen	kg S/ha	11	20 - 30
	P-plantbeschikbaar	kg P/ha	< 1,2	7,0 - 11,6
	P-bodemvoorraad	kg P/ha	< 50	595 - 760
	K-plantbeschikbaar	kg K/ha	45	270 - 425
	K-bodemvoorraad	kg K/ha	< 90	275 - 425
	Ca-plantbeschikbaar	kg Ca/ha	1150	280 - 655
	Ca-bodemvoorraad	kg Ca/ha	< 100	3060 - 3895
	Mg-plantbeschikbaar	kg Mg/ha	< 25	270 - 425
	Mg-bodemvoorraad	kg Mg/ha	< 50	275 - 425
	Na-plantbeschikbaar	kg Na/ha	< 32	58 - 116
	Na-bodemvoorraad	kg Na/ha	45	62 - 116
	Si-plantbeschikbaar	g Si/ha	12650	23280 - 10088
	Fe-plantbeschikbaar	g Fe/ha	9580	9700 - 17460
	Zn-plantbeschikbaar	g Zn/ha	1440	1940 - 2910
	Mn-plantbeschikbaar	g Mn/ha	1780	22500 - 31040
	Cu-plantbeschikbaar	g Cu/ha	< 80	155 - 250
	Co-plantbeschikbaar	g Co/ha	15	15 - 30
	B-plantbeschikbaar	g B/ha	< 295	620 - 855
	Mo-plantbeschikbaar	g Mo/ha	< 20	390 - 19400
	Se-plantbeschikbaar	g Se/ha	28	14 - 17
Fysisch	Zuurgraad (pH)		4,4	5,3 - 5,9
	C-organisch	%	0,7	
	Organische stof	%	2,0	
	C/OS-ratio		0,35	0,45 - 0,55
	Koolzure kalk	%	< 0,5	2,0 - 3,0
	Klei (<2 µm)	%	3	
	Silt (2-50 µm)	%	15	
	Zand (>50 µm)	%	80	
	Klei-humus (CEC)	mmol+/kg	< 11	> 44

	Eenheid	**Resultaat**	**Streeftraject**
Verkruimelbaarheid	rapportcijfer	10,0	6,0 - 8,0
Verslemping	rapportcijfer	7,4	6,0 - 8,0
Stuifgevoeligheid	rapportcijfer	7,3	6,0 - 8,0

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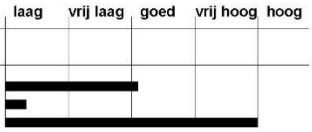
Dit rapport is vrijgegeven onder verantwoording van Drs.Ing. J. van Benthum, Managing Director. Op al onze vormen van dienstverlening zijn onze Algemene Voorwaarden van toepassing. Op verzoek worden deze en/of de specificaties van de analysemethoden toegezonden. Eurofins Agro Testing Wageningen BV stelt zich niet aansprakelijk voor eventuele schadelijke gevolgen voortvloeiend uit het gebruik van door of namens ons verstrekte onderzoeksresultaten en/of adviezen.

Eurofins Agro Testing Wageningen BV is ingeschreven in het RvA-register voor testlaboratoria zoals nader omschreven in de erkenning onder nr. L122 voor uitsluitend de monsternemings- en/of de analysemethoden.

HANNO SHK TRADING ACHTERK

Resultaat		Eenheid	Resultaat	Streeftraject
	Vochthoudend vermogen	mm	41	
Biologisch				
	Microbiële biomassa	mg C/kg	122	100 - 300
	Microbiële activiteit	mg N/kg	2	6 - 9
	Schimmel/bacterie-ratio		1,2	0,6 - 0,9



Bemestingsadviezen
Het resultaat wordt afgezet tegen het landbouwkundig streeftraject en krijgt een waardering; laag, vrij laag, goed, vrij hoog, hoog. Dit is geen beoordeling zoals bedoeld in ISO 17025 (par. 7.8.6).

Wetgeving
De bemestingsadviezen streven een landbouwkundig optimale opbrengst en kwaliteit na. De adviezen houden geen rekening met restricties vanuit wetgeving. Wanneer u op bedrijfsniveau niet voldoende ruimte heeft, adviseren we de giften van de minst behoeftige gewassen te verminderen, overleg met uw adviseur.

Advies

Bodemgericht advies (4-jarig)

	Gift	Eenheid
Fosfaat (P_2O_5)	640	kg/ha
Kalk (nw)	1045	kg/ha
Effectieve org.stof	5580	kg/ha

Bij hoge adviesgiften is een verdeling van de gift gedurende de 4 jaar aan te raden, bijvoorbeeld tweejaarlijks de helft geven. De bodemgerichte adviezen zijn bedoeld om de bodemvoorraden van fosfaat, kalium, calcium en magnesium op peil te brengen.

De kalkgift is gebaseerd op een optimale pH van 5,6
Voor elk tiende pH-verhoging is een kalkgift (nw) nodig van 85 kg/ha.
De benodigde hoeveelheid effectieve organische stof is weergegeven voor 4 jaar. Zie de OS-balans voor de berekening van de gemiddelde jaarlijkse gift.

Gewasgericht advies (jaarlijks)

in kg/ha

	Gewas	Ras/Teelttype	Gift
Stikstof (N)	Overige akkerbouwgewassen		96
Sulfaat (SO_3)	Overige akkerbouwgewassen		0
Fosfaat (P_2O_5)	Overige akkerbouwgewassen		40
Kali (K_2O)	Overige akkerbouwgewassen		75
Calcium (CaO)	Overige akkerbouwgewassen		75
Magnesium (MgO)	Overige akkerbouwgewassen		40
Natrium (Na_2O)	Overige akkerbouwgewassen		
Zink (Zn)	Overige akkerbouwgewassen		0
Mangaan (Mn)	-		Zie de toelichting.
Koper (Cu)	Overige akkerbouwgewassen		0,25
Borium (B)	Overige akkerbouwgewassen		0,5

Gewasgericht advies
Het gewasgerichte advies is gebaseerd op de gewasbehoefte, gemiddelde opbrengst en klimaatomstandigheden en is gecorrigeerd voor de bodemvoorraad en bodemnalevering. Tijdens het seizoen kan worden bijgestuurd met bijmestonderzoek.

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Toelichting

De resultaten en/of het advies van dit bemestingsonderzoek kunt u t/m 2026 gebruiken.
Voor een uitgebreide toelichting kunt u onderstaande link gebruiken:
https://www.eurofins-agro.com/nl-nl/toelichting-grondonderzoek

Het bodemgerichte advies is bedoeld om de bodemvoorraad van de nutriënten op peil te houden. Voor het K, Ca en Mg advies betekent dit dat de samenstelling aan het klei-humus complex (CEC) geoptimaliseerd wordt. Het is verstandig het bodemgerichte advies van nutriënten en kalk over de 4 jaar te verdelen. Wanneer er een bodemgerichte bemesting is uitgevoerd kunnen de bodemkengetallen worden bijgewerkt door een nieuw bodemgericht onderzoek uit te voeren.

De gewasgerichte adviezen zijn bedoeld om het gewas te voeden en de kwaliteit te verbeteren. Door hogere/lagere opbrengsten en verliezen zoals uitspoeling kan de hoeveelheid plantbeschikbare nutriënten fluctueren. Het is raadzaam elk jaar voor het seizoen een gewasgericht onderzoek uit te voeren (pakket Teelt) voor de actuele hoeveelheid plantbeschikbare nutriënten en een update van het gewasgerichte advies.

Bekijk de waardering van de nutriënten op pagina 1 goed. Geven de streefwaarden aan dat één of meerdere nutriënten heel laag zijn, overleg dan met uw adviseur om dit weer op peil te krijgen.

Bij de berekening van de adviezen is uitgegaan van de volgende opbrengsten in ton/ha:

Overige akkerbouwgewassen	-

Zijn uw opbrengsten, lager dan wel hoger, dan is het verstandig uw bemesting daar op aan te passen.

Stikstof:
We adviseren de N-gift - zo mogelijk - op te delen in meerdere giften. Of de vervolggift nodig is, kunt u tijdens het groeiseizoen laten controleren via ons BodemCheck onderzoek. In dit onderzoek wordt onder andere de plantbeschikbare (=minerale) N in de bodem gemeten.

Zwavel:
Zwavel (S) komt vrij bij de afbraak van organische stof of mest. Deze afbraak vindt plaats door bodemleven. Bodemleven is onder koudere omstandigheden niet erg actief. Vroeg in het voorjaar komt er derhalve weinig S vrij uit de bodem. Voor veel vroege gewassen kan het dan ook verstandig zijn om S te bemesten, zelfs al is de bodemvoorraad goed of hoog.

Fosfaat:
Het berekende Pw-getal is voor dit perceel 6 mg P_2O_5/l.
De P-buffering is 10 . Het streeftraject ligt tussen de 17 - 27
De P-buffering geeft aan of de P-bodemvoorraad in staat is de P-plantbeschikbaar op het huidige peil te houden. Als de P-buffering laag is, dan zal de P-plantbeschikbaar tijdens het groeiseizoen niet op peil blijven en zal op termijn ook de P-bodemvoorraad terug gaan lopen.

Kali:
Het berekende K-getal is voor dit perceel 10
K-getal wordt niet meer gebruikt bij de adviesberekening.

Calcium:
Calcium bemesting kan ook een positief effect hebben op de bodemstructuur.

Mangaan:
Er is Mn-gebrek te verwachten.
Het advies is om in de periode dat het gewas het snelst groeit een bladbemesting uit te voeren.

Kalk:
Geef de kalk voorafgaand aan het meest kalkbehoeftige gewas in het bouwplan.
Let op, bij een bemesting met kalk kunnen calcium en magnesium worden aangevoerd.

Klei-humus (CEC):
Als gevolg van te lage resultaten is geen berekening van de Ca-, Mg-, K- en Na-bezetting aan het klei-humuscomplex (CEC) mogelijk.
U kunt uw CEC verhogen door organische stof toe te dienen en/of de pH van uw grond te verhogen.

Bodemleven:
De biologische bodemvruchtbaarheid wordt nu weergegeven via 3 kengetallen, te weten de microbiële biomassa, de microbiële activiteit en de schimmel/bacterie-ratio.
Op basis van de huidige kennis wordt een waardering gegeven die afhankelijk is van de hoeveelheid organische stof. Er wordt nu nog geen advies gegeven. Via diverse onderzoeksprojecten zal er meer informatie beschikbaar komen.

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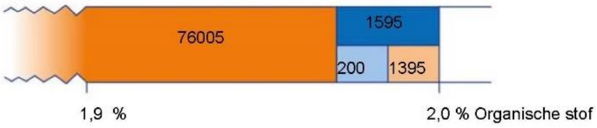
Organische stof **Figuur: Organische stofbalans**



Jaarlijks afbraakpercentage van de totale voorraad organische stof (%): 2,1

- 🟧 Voorraad organische stof die over 1 jaar in de bemonsterde laag nog aanwezig zal zijn als er geen (effectieve) organische stof wordt aangevoerd.
- 🟦 Totaal benodigde aanvoer van effectieve organische stof als gevolg van afbraak van de organische stof.
- 🟦 Aanvoer via gewasresten (gemiddeld binnen opgegeven rotatie of gewassen).
- 🟧 Nog aan te vullen via bijv. dierlijke mest, groenbemesters en/of compost.

Gewas(rest)	Teelt/ras	Aanvoer effectieve organische stof
Overige akkerbouwgewassen		200

Gemiddelde aanvoer/jaar		200

Om het organische stofgehalte met 0,1% te verhogen dient u een extra hoeveelheid effectieve organische stof aan te voeren van: 3880 kg per ha.

Figuur: Kwaliteit van de organische stof
Gebaseerd op C/OS-ratio.

Organische stof bestaat uit met name C, N, P, S. Wanneer de organische stof relatief veel N en of S bevat is dit aantrekkelijk voor bodemleven. Bodemleven vreet deze organische stof graag. Hierbij komt N en S vrij en het gehalte aan organische stof daalt licht (dynamische organische stof). Organische stof kan ook veel C bevatten. Dat is over het algemeen minder aantrekkelijk voor bodemleven. De organische stof wordt derhalve minder aangevreten door bodemleven; de organische stof is stabieler. Stabiele organische stof draagt onder andere bij aan de bewerkbaarheid van de bodem en aan de rulheid. Dynamische organische stof draagt bij aan met name het vrijkomen van N en S en is daarmee een bron van deze nutriënten voor het gewas. De kwaliteit van de organische stof is (geleidelijk) aan te passen door onder andere te letten op de eigenschappen van bodemverbeteraars als dierlijke mest, compost en gewasresten.

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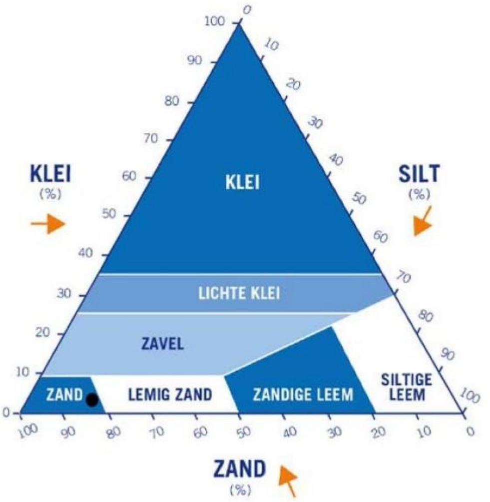
Fysisch

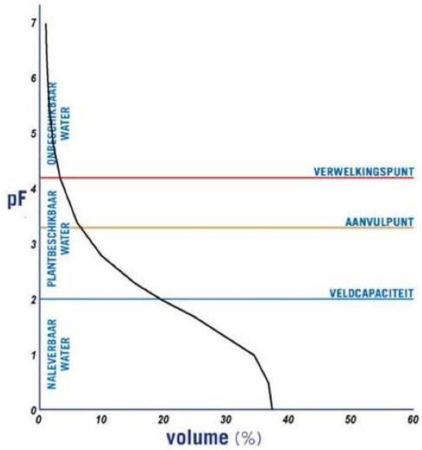
Figuur: Textuurdriehoek



Naast klei (lutum), worden ook de silt- en zandfracties weergegeven. Klei is kleiner dan 2 micrometer (µm), siltdeeltjes zijn 2-50 µm en zanddeeltjes groter dan 50 µm. De onderlinge verdeling van bodemdeeltjes wordt onder andere gebruikt om het verslempingsrisico van een bodem in te schatten. Bij verslemping wordt de bodem dichtgesmeerd met kleinere deeltjes (klei en silt). Een heel eenzijdige verdeling (bijvoorbeeld hoofdzakelijk zand- of kleideeltjes) levert het minste risico van slemp op. Bij 10-20% klei is het risico op slemp het grootst.

De verkruimelbaarheid is goed te noemen. Echter is dit ook afhankelijk van de soort teelt.
Gezien het resultaat is de kans op verslemping klein.

Figuur: Waterretentiecurve



De hoeveelheid plant beschikbaar water in de bemonsterde laag is 41 mm, dit is wat u maximaal zou moeten beregenen. Alles wat u meer geeft spoelt af van het perceel of zakt naar diepere lagen.

Veldcapaciteit (pF 2,0):	19,8	% vocht
Aanvulpunt (pF 3,3):	6,7	% vocht
Verwelkingspunt (pF 4,2):	3,5	% vocht

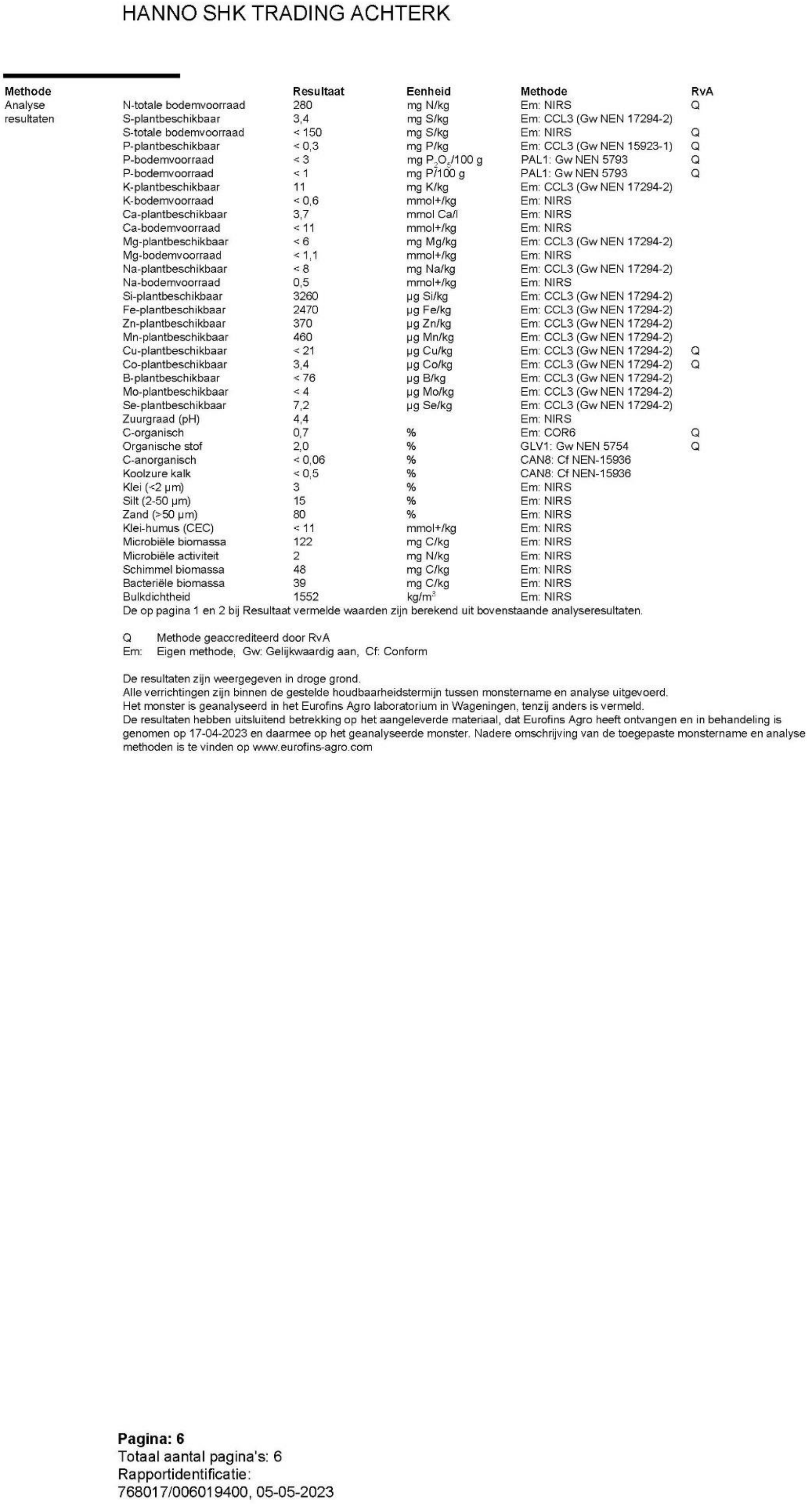
Als het vochtgehalte van het perceel daalt hebben gewassen moeite om voldoende water op te nemen, de grens ligt bij pF 3,3. Wanneer u het vochtgehalte kan bepalen, begin dan met beregenen als het vochtgehalte van dit perceel op 6,7 % vocht zit en geef dan 33 mm.

Het actuele vochtgehalte kan bepaald worden door een vochtsensor of verzamel grond van een tiental plekken in het perceel. Meet het gewicht van de vochtige grond en het gewicht van de grond na 24 uur drogen, het verschil tussen de twee is een indicatie van het vochtgehalte van het perceel.

Contact & info

Bemonsterde laag:	0 - 25 cm
Grondsoort:	Lemig zand
Monster genomen door:	Derden
Contactpersoon monstername:	Alie Hissink: 0652561834

Indien de volgende informatie wordt getoond op de rapporten kan deze informatie verstrekt zijn door de opdrachtgever en van invloed zijn op de waardering, advisering en/of het analyseresultaat:
bemonsteringsdiepte, gewas, teelttype/ras.



HANNO SHK TRADING ACHTERK

Methode		**Resultaat**	**Eenheid**	**Methode**	**RvA**
Analyse resultaten	N-totale bodemvoorraad	280	mg N/kg	Em: NIRS	Q
	S-plantbeschikbaar	3,4	mg S/kg	Em: CCL3 (Gw NEN 17294-2)	
	S-totale bodemvoorraad	< 150	mg S/kg	Em: NIRS	Q
	P-plantbeschikbaar	< 0,3	mg P/kg	Em: CCL3 (Gw NEN 15923-1)	Q
	P-bodemvoorraad	< 3	mg P_2O_5/100 g	PAL1: Gw NEN 5793	Q
	P-bodemvoorraad	< 1	mg P/100 g	PAL1: Gw NEN 5793	Q
	K-plantbeschikbaar	11	mg K/kg	Em: CCL3 (Gw NEN 17294-2)	
	K-bodemvoorraad	< 0,6	mmol+/kg	Em: NIRS	
	Ca-plantbeschikbaar	3,7	mmol Ca/l	Em: NIRS	
	Ca-bodemvoorraad	< 11	mmol+/kg	Em: NIRS	
	Mg-plantbeschikbaar	< 6	mg Mg/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mg-bodemvoorraad	< 1,1	mmol+/kg	Em: NIRS	
	Na-plantbeschikbaar	< 8	mg Na/kg	Em: CCL3 (Gw NEN 17294-2)	
	Na-bodemvoorraad	0,5	mmol+/kg	Em: NIRS	
	Si-plantbeschikbaar	3260	µg Si/kg	Em: CCL3 (Gw NEN 17294-2)	
	Fe-plantbeschikbaar	2470	µg Fe/kg	Em: CCL3 (Gw NEN 17294-2)	
	Zn-plantbeschikbaar	370	µg Zn/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mn-plantbeschikbaar	460	µg Mn/kg	Em: CCL3 (Gw NEN 17294-2)	
	Cu-plantbeschikbaar	< 21	µg Cu/kg	Em: CCL3 (Gw NEN 17294-2)	Q
	Co-plantbeschikbaar	3,4	µg Co/kg	Em: CCL3 (Gw NEN 17294-2)	Q
	B-plantbeschikbaar	< 76	µg B/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mo-plantbeschikbaar	< 4	µg Mo/kg	Em: CCL3 (Gw NEN 17294-2)	
	Se-plantbeschikbaar	7,2	µg Se/kg	Em: CCL3 (Gw NEN 17294-2)	
	Zuurgraad (pH)	4,4		Em: NIRS	
	C-organisch	0,7	%	Em: COR6	Q
	Organische stof	2,0	%	GLV1: Gw NEN 5754	Q
	C-anorganisch	< 0,06	%	CAN8: Cf NEN-15936	
	Koolzure kalk	< 0,5	%	CAN8: Cf NEN-15936	
	Klei (<2 µm)	3	%	Em: NIRS	
	Silt (2-50 µm)	15	%	Em: NIRS	
	Zand (>50 µm)	80	%	Em: NIRS	
	Klei-humus (CEC)	< 11	mmol+/kg	Em: NIRS	
	Microbiële biomassa	122	mg C/kg	Em: NIRS	
	Microbiële activiteit	2	mg N/kg	Em: NIRS	
	Schimmel biomassa	48	mg C/kg	Em: NIRS	
	Bacteriële biomassa	39	mg C/kg	Em: NIRS	
	Bulkdichtheid	1552	kg/m^3	Em: NIRS	

De op pagina 1 en 2 bij Resultaat vermelde waarden zijn berekend uit bovenstaande analyseresultaten.

Q Methode geaccrediteerd door RvA
Em: Eigen methode, Gw: Gelijkwaardig aan, Cf: Conform

De resultaten zijn weergegeven in droge grond.
Alle verrichtingen zijn binnen de gestelde houdbaarheidstermijn tussen monstername en analyse uitgevoerd.
Het monster is geanalyseerd in het Eurofins Agro laboratorium in Wageningen, tenzij anders is vermeld.
De resultaten hebben uitsluitend betrekking op het aangeleverde materiaal, dat Eurofins Agro heeft ontvangen en in behandeling is genomen op 17-04-2023 en daarmee op het geanalyseerde monster. Nadere omschrijving van de toegepaste monstername en analyse methoden is te vinden op www.eurofins-agro.com

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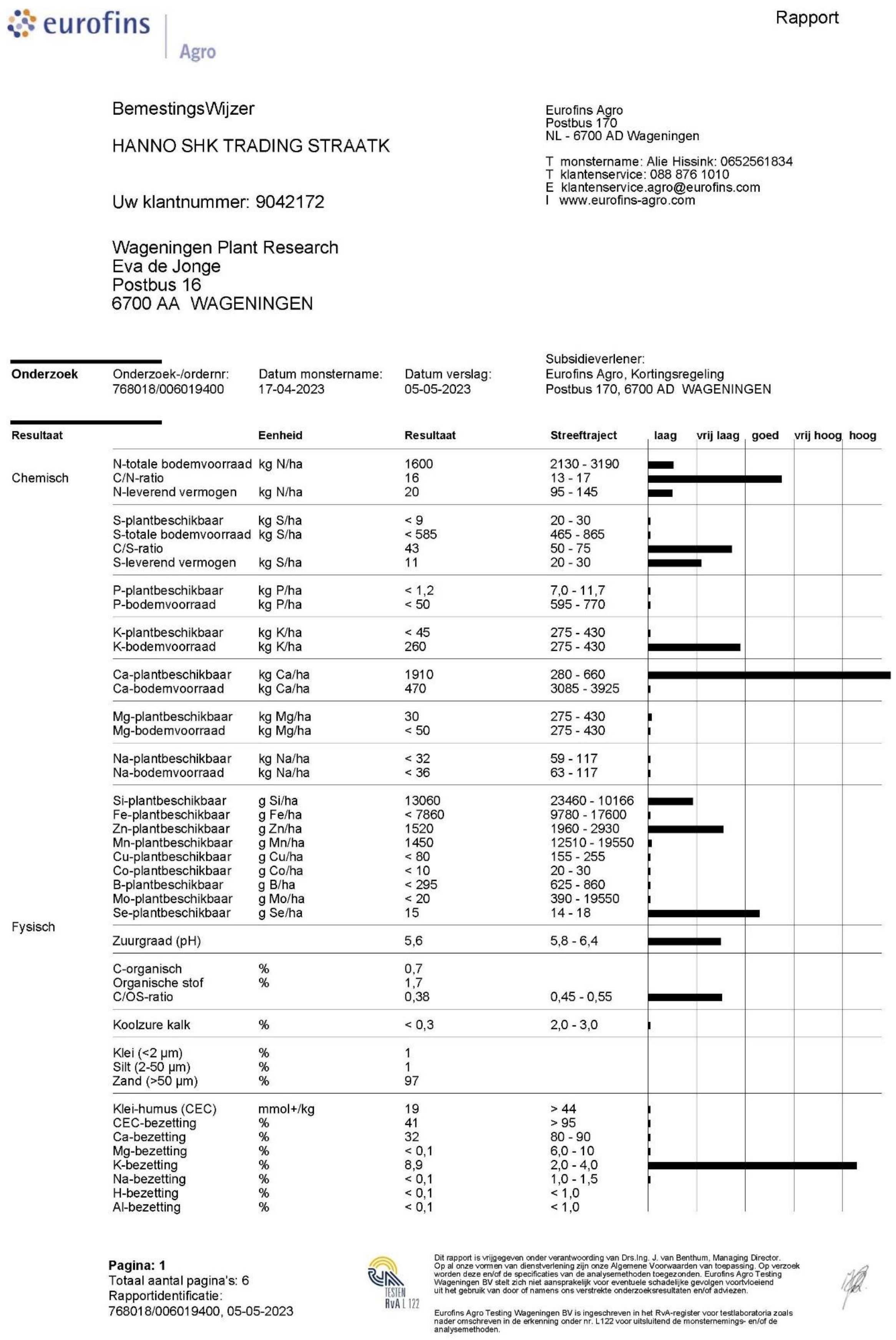
Annex 4 Soil fertility analysis sample 3



eurofins | Agro

Rapport

BemestingsWijzer

HANNO SHK TRADING STRAATK

Uw klantnummer: 9042172

Wageningen Plant Research
Eva de Jonge
Postbus 16
6700 AA WAGENINGEN

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Postbus 170
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T monstername: Alie Hissink: 0652561834
T klantenservice: 088 876 1010
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Onderzoek

Onderzoek-/ordernr:	Datum monstername:	Datum verslag:	Subsidieverlener:
768018/006019400	17-04-2023	05-05-2023	Eurofins Agro, Kortingsregeling Postbus 170, 6700 AD WAGENINGEN

Resultaat		**Eenheid**	**Resultaat**	**Streeftraject**
Chemisch	N-totale bodemvoorraad	kg N/ha	1600	2130 - 3190
	C/N-ratio		16	13 - 17
	N-leverend vermogen	kg N/ha	20	95 - 145
	S-plantbeschikbaar	kg S/ha	< 9	20 - 30
	S-totale bodemvoorraad	kg S/ha	< 585	465 - 865
	C/S-ratio		43	50 - 75
	S-leverend vermogen	kg S/ha	11	20 - 30
	P-plantbeschikbaar	kg P/ha	< 1,2	7,0 - 11,7
	P-bodemvoorraad	kg P/ha	< 50	595 - 770
	K-plantbeschikbaar	kg K/ha	< 45	275 - 430
	K-bodemvoorraad	kg K/ha	260	275 - 430
	Ca-plantbeschikbaar	kg Ca/ha	1910	280 - 660
	Ca-bodemvoorraad	kg Ca/ha	470	3085 - 3925
	Mg-plantbeschikbaar	kg Mg/ha	30	275 - 430
	Mg-bodemvoorraad	kg Mg/ha	< 50	275 - 430
	Na-plantbeschikbaar	kg Na/ha	< 32	59 - 117
	Na-bodemvoorraad	kg Na/ha	< 36	63 - 117
	Si-plantbeschikbaar	g Si/ha	13060	23460 - 10166
	Fe-plantbeschikbaar	g Fe/ha	< 7860	9780 - 17600
	Zn-plantbeschikbaar	g Zn/ha	1520	1960 - 2930
	Mn-plantbeschikbaar	g Mn/ha	1450	12510 - 19550
	Cu-plantbeschikbaar	g Cu/ha	< 80	155 - 255
	Co-plantbeschikbaar	g Co/ha	< 10	20 - 30
	B-plantbeschikbaar	g B/ha	< 295	625 - 860
	Mo-plantbeschikbaar	g Mo/ha	< 20	390 - 19550
	Se-plantbeschikbaar	g Se/ha	15	14 - 18
Fysisch	Zuurgraad (pH)		5,6	5,8 - 6,4
	C-organisch	%	0,7	
	Organische stof	%	1,7	
	C/OS-ratio		0,38	0,45 - 0,55
	Koolzure kalk	%	< 0,3	2,0 - 3,0
	Klei (<2 µm)	%	1	
	Silt (2-50 µm)	%	1	
	Zand (>50 µm)	%	97	
	Klei-humus (CEC)	mmol+/kg	19	> 44
	CEC-bezetting	%	41	> 95
	Ca-bezetting	%	32	80 - 90
	Mg-bezetting	%	< 0,1	6,0 - 10
	K-bezetting	%	8,9	2,0 - 4,0
	Na-bezetting	%	< 0,1	1,0 - 1,5
	H-bezetting	%	< 0,1	< 1,0
	Al-bezetting	%	< 0,1	< 1,0

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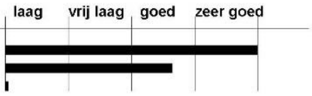
HANNO SHK TRADING STRAATK

Resultaat		Eenheid	Resultaat	Streeftraject
	Verkruimelbaarheid	rapportcijfer	10,0	6,0 - 8,0
	Verslemping	rapportcijfer	7,3	6,0 - 8,0
	Stuifgevoeligheid	rapportcijfer	2,0	6,0 - 8,0



		Eenheid	Resultaat	Streeftraject
Biologisch	Vochthoudend vermogen	mm	20	
	Microbiële biomassa	mg C/kg	221	85 - 255
	Microbiële activiteit	mg N/kg	36	8 - 14
	Schimmel/bacterie-ratio		0,8	0,6 - 0,9

Bemestingsadviezen
Het resultaat wordt afgezet tegen het landbouwkundig streeftraject en krijgt een waardering; laag, vrij laag, goed, vrij hoog, hoog. Dit is geen beoordeling zoals bedoeld in ISO 17025 (par. 7.8.6).

Wetgeving
De bemestingsadviezen streven een landbouwkundig optimale opbrengst en kwaliteit na. De adviezen houden geen rekening met restricties vanuit wetgeving. Wanneer u op bedrijfsniveau niet voldoende ruimte heeft, adviseren we de giften van de minst behoeftige gewassen te verminderen, overleg met uw adviseur.

Advies

Bodemgericht advies (4-jarig)

	Gift	Eenheid
Fosfaat (P_2O_5)	640	kg/ha
Kali (K_2O)	0	kg/ha
Calcium (CaO)	1105	kg/ha
Magnesium (MgO)	120	kg/ha
Kalk (nw)	370	kg/ha
Effectieve org.stof	4820	kg/ha

Bij hoge adviesgiften is een verdeling van de gift gedurende de 4 jaar aan te raden, bijvoorbeeld tweejaarlijks de helft geven. De bodemgerichte adviezen zijn bedoeld om de bodemvoorraden van fosfaat, kalium, calcium en magnesium op peil te brengen.

De kalkgift is gebaseerd op een optimale pH van 6,1
Voor elk tiende pH-verhoging is een kalkgift (nw) nodig van 75 kg/ha.
De benodigde hoeveelheid effectieve organische stof is weergegeven voor 4 jaar. Zie de OS-balans voor de berekening van de gemiddelde jaarlijkse gift.

Gewasgericht advies (jaarlijks)

		Gewas	Ras/Teelttype	Gift
in kg/ha	Stikstof (N)	Overige akkerbouwgewassen		96
	Sulfaat (SO_3)	Overige akkerbouwgewassen		0
	Fosfaat (P_2O_5)	Overige akkerbouwgewassen		40
	Kali (K_2O)	Overige akkerbouwgewassen		65
	Calcium (CaO)	Overige akkerbouwgewassen		0
	Magnesium (MgO)	Overige akkerbouwgewassen		35
	Natrium (Na_2O)	Overige akkerbouwgewassen		
	Zink (Zn)	Overige akkerbouwgewassen		0
	Mangaan (Mn)	-		Zie de toelichting.
	Koper (Cu)	Overige akkerbouwgewassen		0,25
	Borium (B)	Overige akkerbouwgewassen		0,5

Gewasgericht advies
Het gewasgerichte advies is gebaseerd op de gewasbehoefte, gemiddelde opbrengst en klimaatomstandigheden en is gecorrigeerd voor de bodemvoorraad en bodemnalevering. Tijdens het seizoen kan worden bijgestuurd met bijmestonderzoek.

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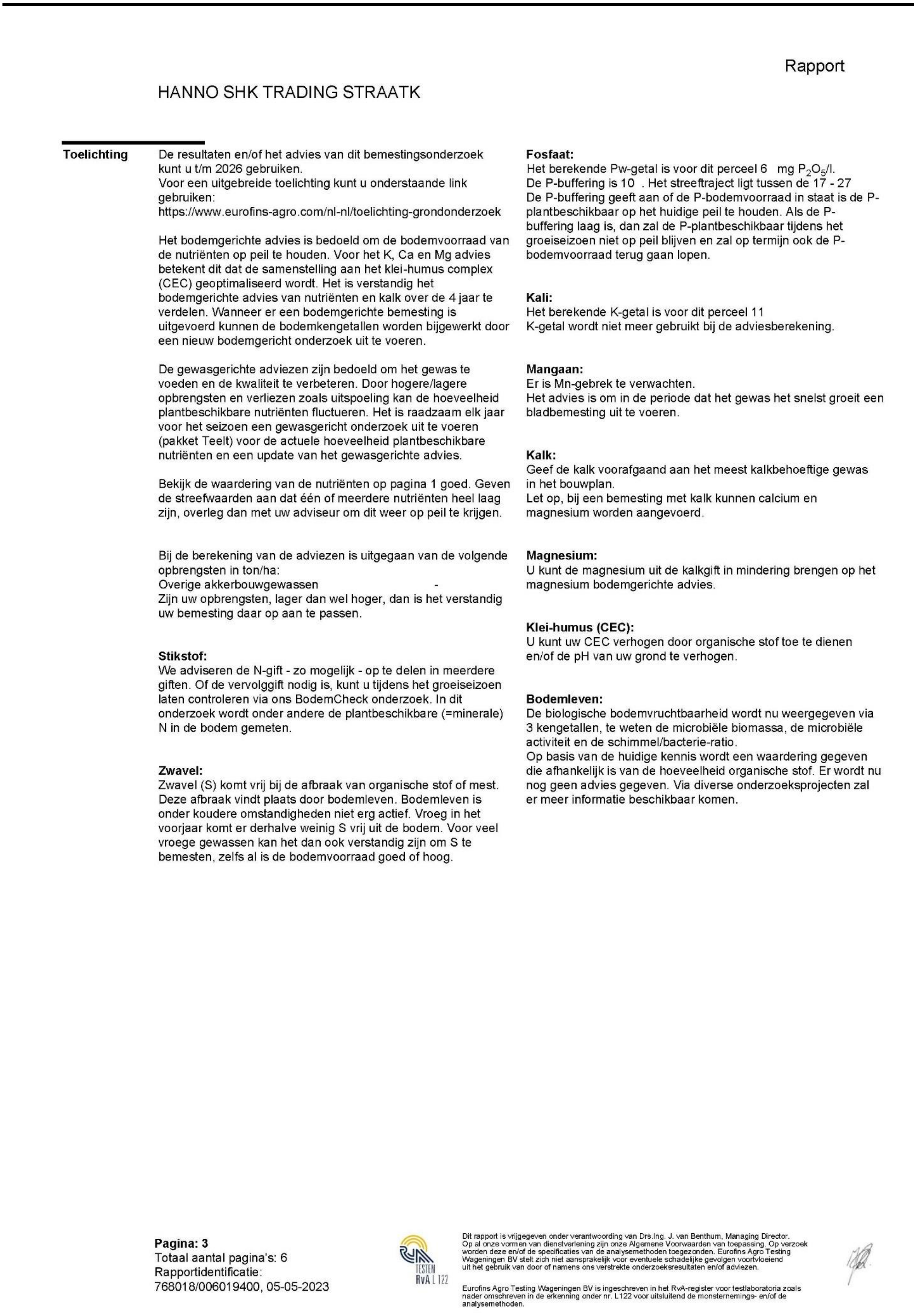

Rapport

HANNO SHK TRADING STRAATK

Toelichting

De resultaten en/of het advies van dit bemestingsonderzoek kunt u t/m 2026 gebruiken.
Voor een uitgebreide toelichting kunt u onderstaande link gebruiken:
https://www.eurofins-agro.com/nl-nl/toelichting-grondonderzoek

Het bodemgerichte advies is bedoeld om de bodemvoorraad van de nutriënten op peil te houden. Voor het K, Ca en Mg advies betekent dit dat de samenstelling aan het klei-humus complex (CEC) geoptimaliseerd wordt. Het is verstandig het bodemgerichte advies van nutriënten en kalk over de 4 jaar te verdelen. Wanneer er een bodemgerichte bemesting is uitgevoerd kunnen de bodemkengetallen worden bijgewerkt door een nieuw bodemgericht onderzoek uit te voeren.

De gewasgerichte adviezen zijn bedoeld om het gewas te voeden en de kwaliteit te verbeteren. Door hogere/lagere opbrengsten en verliezen zoals uitspoeling kan de hoeveelheid plantbeschikbare nutriënten fluctueren. Het is raadzaam elk jaar voor het seizoen een gewasgericht onderzoek uit te voeren (pakket Teelt) voor de actuele hoeveelheid plantbeschikbare nutriënten en een update van het gewasgerichte advies.

Bekijk de waardering van de nutriënten op pagina 1 goed. Geven de streefwaarden aan dat één of meerdere nutriënten heel laag zijn, overleg dan met uw adviseur om dit weer op peil te krijgen.

Bij de berekening van de adviezen is uitgegaan van de volgende opbrengsten in ton/ha:

Overige akkerbouwgewassen	-

Zijn uw opbrengsten, lager dan wel hoger, dan is het verstandig uw bemesting daar op aan te passen.

Stikstof:
We adviseren de N-gift - zo mogelijk - op te delen in meerdere giften. Of de vervolggift nodig is, kunt u tijdens het groeiseizoen laten controleren via ons BodemCheck onderzoek. In dit onderzoek wordt onder andere de plantbeschikbare (=minerale) N in de bodem gemeten.

Zwavel:
Zwavel (S) komt vrij bij de afbraak van organische stof of mest. Deze afbraak vindt plaats door bodemleven. Bodemleven is onder koudere omstandigheden niet erg actief. Vroeg in het voorjaar komt er derhalve weinig S vrij uit de bodem. Voor veel vroege gewassen kan het dan ook verstandig zijn om S te bemesten, zelfs al is de bodemvoorraad goed of hoog.

Fosfaat:
Het berekende Pw-getal is voor dit perceel 6 mg P_2O_5/l.
De P-buffering is 10 . Het streeftraject ligt tussen de 17 - 27
De P-buffering geeft aan of de P-bodemvoorraad in staat is de P-plantbeschikbaar op het huidige peil te houden. Als de P-buffering laag is, dan zal de P-plantbeschikbaar tijdens het groeiseizoen niet op peil blijven en zal op termijn ook de P-bodemvoorraad terug gaan lopen.

Kali:
Het berekende K-getal is voor dit perceel 11
K-getal wordt niet meer gebruikt bij de adviesberekening.

Mangaan:
Er is Mn-gebrek te verwachten.
Het advies is om in de periode dat het gewas het snelst groeit een bladbemesting uit te voeren.

Kalk:
Geef de kalk voorafgaand aan het meest kalkbehoeftige gewas in het bouwplan.
Let op, bij een bemesting met kalk kunnen calcium en magnesium worden aangevoerd.

Magnesium:
U kunt de magnesium uit de kalkgift in mindering brengen op het magnesium bodemgerichte advies.

Klei-humus (CEC):
U kunt uw CEC verhogen door organische stof toe te dienen en/of de pH van uw grond te verhogen.

Bodemleven:
De biologische bodemvruchtbaarheid wordt nu weergegeven via 3 kengetallen, te weten de microbiële biomassa, de microbiële activiteit en de schimmel/bacterie-ratio.
Op basis van de huidige kennis wordt een waardering gegeven die afhankelijk is van de hoeveelheid organische stof. Er wordt nu nog geen advies gegeven. Via diverse onderzoeksprojecten zal er meer informatie beschikbaar komen.

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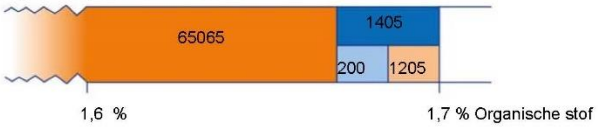
HANNO SHK TRADING STRAATK

Organische stof

Figuur: Organische stofbalans



Jaarlijks afbraakpercentage van de totale voorraad organische stof (%): 2,1

- 🟧 Voorraad organische stof die over 1 jaar in de bemonsterde laag nog aanwezig zal zijn als er geen (effectieve) organische stof wordt aangevoerd.
- 🟦 Totaal benodigde aanvoer van effectieve organische stof als gevolg van afbraak van de organische stof.
- ▨ Aanvoer via gewasresten (gemiddeld binnen opgegeven rotatie of gewassen).
- ▨ Nog aan te vullen via bijv. dierlijke mest, groenbemesters en/of compost.

Gewas(rest)	Teelt/ras	Aanvoer effectieve organische stof
Overige akkerbouwgewassen		200

Gemiddelde aanvoer/jaar		200

Om het organische stofgehalte met 0,1% te verhogen dient u een extra hoeveelheid effectieve organische stof aan te voeren van: 3910 kg per ha.

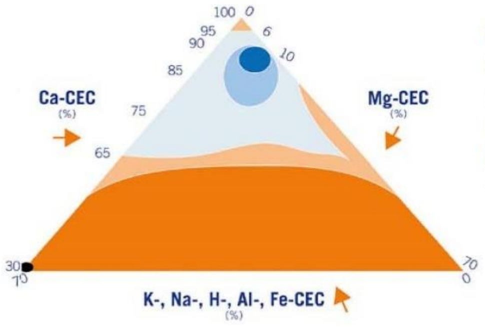
Figuur: Kwaliteit van de organische stof
Gebaseerd op C/OS-ratio.

Organische stof bestaat uit met name C, N, P, S. Wanneer de organische stof relatief veel N en of S bevat is dit aantrekkelijk voor bodemleven. Bodemleven vreet deze organische stof graag. Hierbij komt N en S vrij en het gehalte aan organische stof daalt licht (dynamische organische stof). Organische stof kan ook veel C bevatten. Dat is over het algemeen minder aantrekkelijk voor bodemleven. De organische stof wordt derhalve minder aangevreten door bodemleven; de organische stof is stabieler. Stabiele organische stof draagt onder andere bij aan de bewerkbaarheid van de bodem en aan de rulheid. Dynamische organische stof draagt bij aan met name het vrijkomen van N en S en is daarmee een bron van deze nutriënten voor het gewas. De kwaliteit van de organische stof is (geleidelijk) aan te passen door onder andere te letten op de eigenschappen van bodemverbeteraars als dierlijke mest, compost en gewasresten.

Fysisch

De beoordeling van de potentiële structuur wordt gedaan op basis van de verhouding tussen calcium, magnesium en overige kationen aan het klei-humuscomplex. Uiteraard is de werkelijke structuur ook afhankelijk van weersomstandigheden en vochttoestand van de bodem tijdens berijden en bewerken en de zwaarte van machines.

Figuur: Structuurdriehoek

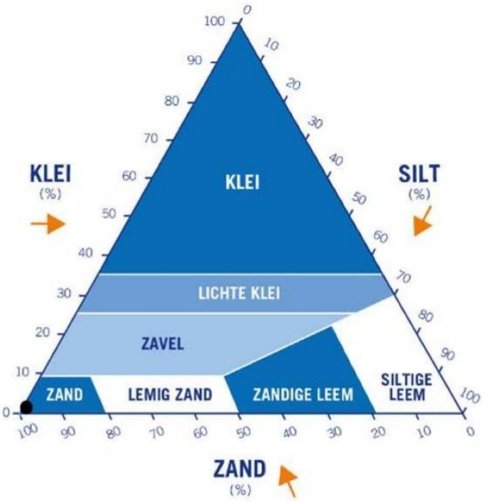


- 🟦 optimale structuur
- ▨ goede structuur
- ▨ matige structuur
- ▨ zeer matige structuur
- 🟧 slechte structuur
- ● huidige situatie van dit perceel

HANNO SHK TRADING STRAATK

Fysisch

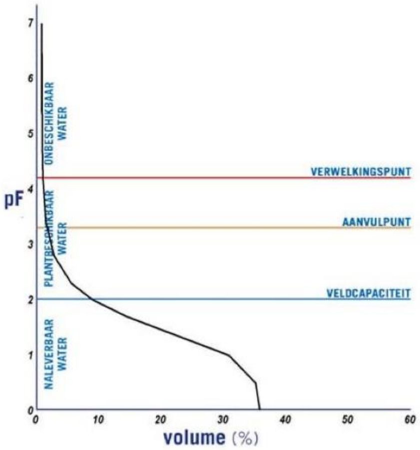
Figuur: Textuurdriehoek



Naast klei (lutum), worden ook de silt- en zandfracties weergegeven. Klei is kleiner dan 2 micrometer (µm), siltdeeltjes zijn 2-50 µm en zanddeeltjes groter dan 50 µm. De onderlinge verdeling van bodemdeeltjes wordt onder andere gebruikt om het verslempingsrisico van een bodem in te schatten. Bij verslemping wordt de bodem dichtgesmeerd met kleinere deeltjes (klei en silt). Een heel eenzijdige verdeling (bijvoorbeeld hoofdzakelijk zand- of kleideeltjes) levert het minste risico van slemp op. Bij 10-20% klei is het risico op slemp het grootst.

De verkruimelbaarheid is goed te noemen. Echter is dit ook afhankelijk van de soort teelt.
Gezien het resultaat is de kans op verslemping klein.

Figuur: Waterretentiecurve



De hoeveelheid plant beschikbaar water in de bemonsterde laag is 20 mm, dit is wat u maximaal zou moeten beregenen. Alles wat u meer geeft spoelt af van het perceel of zakt naar diepere lagen.

Veldcapaciteit (pF 2,0):	9,2	% vocht
Aanvulpunt (pF 3,3):	1,8	% vocht
Verwelkingspunt (pF 4,2):	1,2	% vocht

Als het vochtgehalte van het perceel daalt hebben gewassen moeite om voldoende water op te nemen, de grens ligt bij pF 3,3. Wanneer u het vochtgehalte kan bepalen, begin dan met beregenen als het vochtgehalte van dit perceel op 1,8 % vocht zit en geef dan 19 mm.

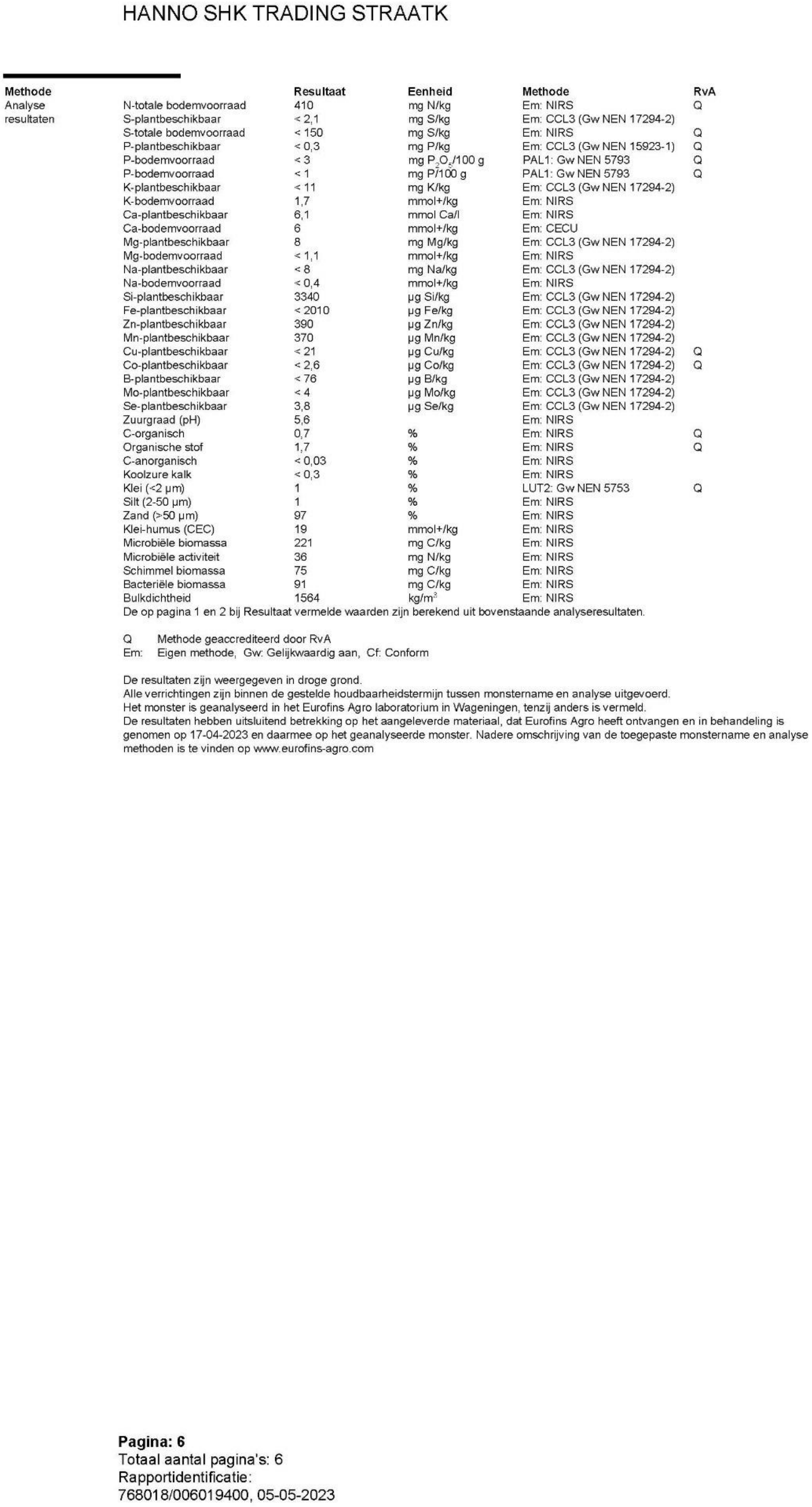
Het actuele vochtgehalte kan bepaald worden door een vochtsensor of verzamel grond van een tiental plekken in het perceel. Meet het gewicht van de vochtige grond en het gewicht van de grond na 24 uur drogen, het verschil tussen de twee is een indicatie van het vochtgehalte van het perceel.

Contact & info

Bemonsterde laag:	0 - 25 cm
Grondsoort:	Zand
Monster genomen door:	Derden
Contactpersoon monstername:	Alie Hissink: 0652561834

Indien de volgende informatie wordt getoond op de rapporten kan deze informatie verstrekt zijn door de opdrachtgever en van invloed zijn op de waardering, advisering en/of het analyseresultaat:
bemonsteringsdiepte, gewas, teelttype/ras.

TESTEN
RvA L 122



HANNO SHK TRADING STRAATK

Methode		Resultaat	Eenheid	Methode	RvA
Analyse resultaten	N-totale bodemvoorraad	410	mg N/kg	Em: NIRS	Q
	S-plantbeschikbaar	< 2,1	mg S/kg	Em: CCL3 (Gw NEN 17294-2)	
	S-totale bodemvoorraad	< 150	mg S/kg	Em: NIRS	Q
	P-plantbeschikbaar	< 0,3	mg P/kg	Em: CCL3 (Gw NEN 15923-1)	Q
	P-bodemvoorraad	< 3	mg P_2O_5/100 g	PAL1: Gw NEN 5793	Q
	P-bodemvoorraad	< 1	mg P/100 g	PAL1: Gw NEN 5793	Q
	K-plantbeschikbaar	< 11	mg K/kg	Em: CCL3 (Gw NEN 17294-2)	
	K-bodemvoorraad	1,7	mmol+/kg	Em: NIRS	
	Ca-plantbeschikbaar	6,1	mmol Ca/l	Em: NIRS	
	Ca-bodemvoorraad	6	mmol+/kg	Em: CECU	
	Mg-plantbeschikbaar	8	mg Mg/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mg-bodemvoorraad	< 1,1	mmol+/kg	Em: NIRS	
	Na-plantbeschikbaar	< 8	mg Na/kg	Em: CCL3 (Gw NEN 17294-2)	
	Na-bodemvoorraad	< 0,4	mmol+/kg	Em: NIRS	
	Si-plantbeschikbaar	3340	µg Si/kg	Em: CCL3 (Gw NEN 17294-2)	
	Fe-plantbeschikbaar	< 2010	µg Fe/kg	Em: CCL3 (Gw NEN 17294-2)	
	Zn-plantbeschikbaar	390	µg Zn/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mn-plantbeschikbaar	370	µg Mn/kg	Em: CCL3 (Gw NEN 17294-2)	
	Cu-plantbeschikbaar	< 21	µg Cu/kg	Em: CCL3 (Gw NEN 17294-2)	Q
	Co-plantbeschikbaar	< 2,6	µg Co/kg	Em: CCL3 (Gw NEN 17294-2)	Q
	B-plantbeschikbaar	< 76	µg B/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mo-plantbeschikbaar	< 4	µg Mo/kg	Em: CCL3 (Gw NEN 17294-2)	
	Se-plantbeschikbaar	3,8	µg Se/kg	Em: CCL3 (Gw NEN 17294-2)	
	Zuurgraad (pH)	5,6		Em: NIRS	
	C-organisch	0,7	%	Em: NIRS	Q
	Organische stof	1,7	%	Em: NIRS	Q
	C-anorganisch	< 0,03	%	Em: NIRS	
	Koolzure kalk	< 0,3	%	Em: NIRS	
	Klei (<2 µm)	1	%	LUT2: Gw NEN 5753	Q
	Silt (2-50 µm)	1	%	Em: NIRS	
	Zand (>50 µm)	97	%	Em: NIRS	
	Klei-humus (CEC)	19	mmol+/kg	Em: NIRS	
	Microbiële biomassa	221	mg C/kg	Em: NIRS	
	Microbiële activiteit	36	mg N/kg	Em: NIRS	
	Schimmel biomassa	75	mg C/kg	Em: NIRS	
	Bacteriële biomassa	91	mg C/kg	Em: NIRS	
	Bulkdichtheid	1564	kg/m^3	Em: NIRS	

De op pagina 1 en 2 bij Resultaat vermelde waarden zijn berekend uit bovenstaande analyseresultaten.

Q Methode geaccrediteerd door RvA
Em: Eigen methode, Gw: Gelijkwaardig aan, Cf: Conform

De resultaten zijn weergegeven in droge grond.
Alle verrichtingen zijn binnen de gestelde houdbaarheidstermijn tussen monstername en analyse uitgevoerd.
Het monster is geanalyseerd in het Eurofins Agro laboratorium in Wageningen, tenzij anders is vermeld.
De resultaten hebben uitsluitend betrekking op het aangeleverde materiaal, dat Eurofins Agro heeft ontvangen en in behandeling is genomen op 17-04-2023 en daarmee op het geanalyseerde monster. Nadere omschrijving van de toegepaste monstername en analyse methoden is te vinden op www.eurofins-agro.com

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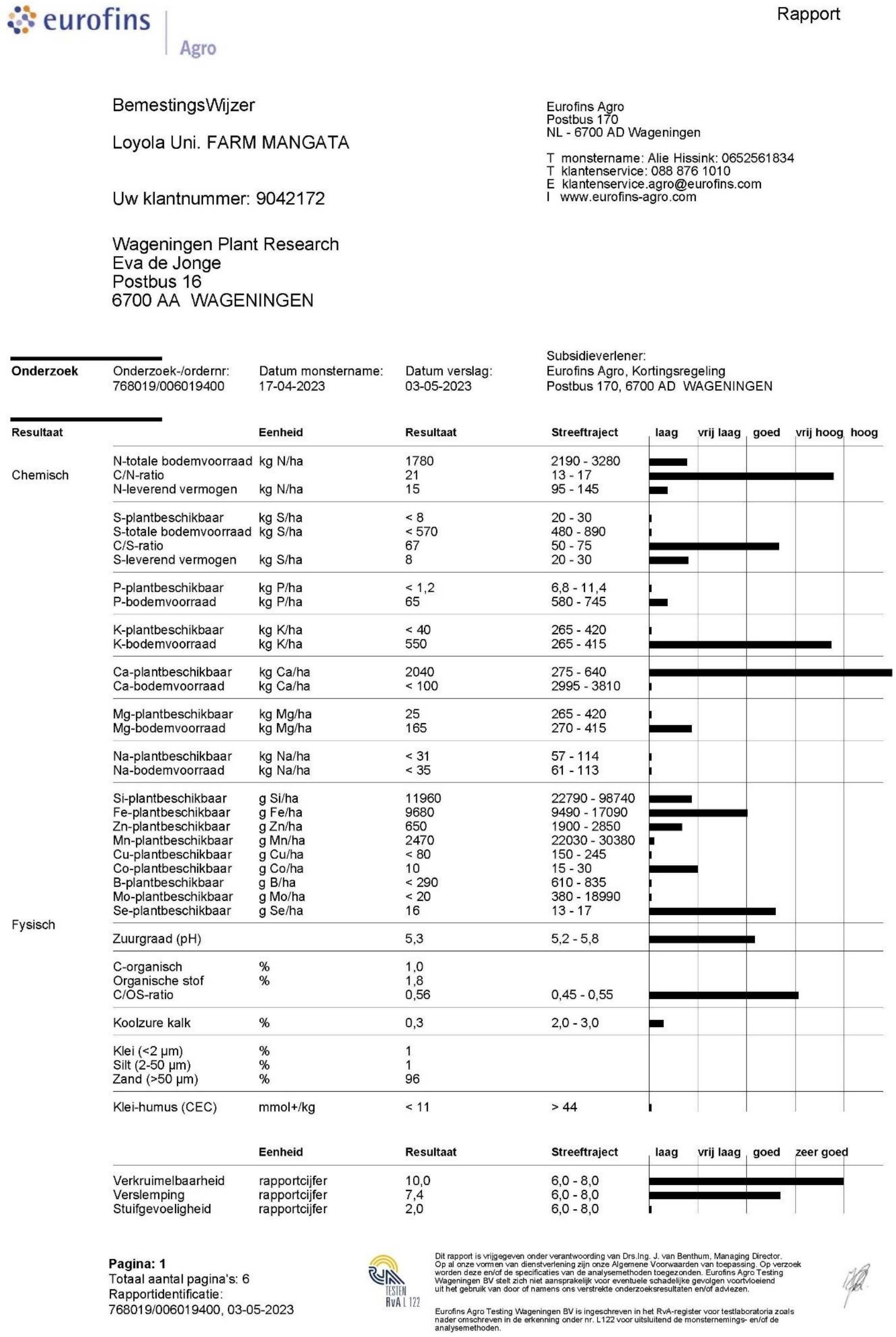
Annex 5 Soil fertility analysis sample 4



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Rapport

BemestingsWijzer

Loyola Uni. FARM MANGATA

Uw klantnummer: 9042172

Wageningen Plant Research
Eva de Jonge
Postbus 16
6700 AA WAGENINGEN

Eurofins Agro
Postbus 170
NL - 6700 AD Wageningen

T monstername: Alie Hissink: 0652561834
T klantenservice: 088 876 1010
E klantenservice.agro@eurofins.com
I www.eurofins-agro.com

Onderzoek
Onderzoek-/ordernr: 768019/006019400
Datum monstername: 17-04-2023
Datum verslag: 03-05-2023

Subsidieverlener:
Eurofins Agro, Kortingsregeling
Postbus 170, 6700 AD WAGENINGEN

Resultaat		Eenheid	Resultaat	Streeftraject
Chemisch	N-totale bodemvoorraad	kg N/ha	1780	2190 - 3280
	C/N-ratio		21	13 - 17
	N-leverend vermogen	kg N/ha	15	95 - 145
	S-plantbeschikbaar	kg S/ha	< 8	20 - 30
	S-totale bodemvoorraad	kg S/ha	< 570	480 - 890
	C/S-ratio		67	50 - 75
	S-leverend vermogen	kg S/ha	8	20 - 30
	P-plantbeschikbaar	kg P/ha	< 1,2	6,8 - 11,4
	P-bodemvoorraad	kg P/ha	65	580 - 745
	K-plantbeschikbaar	kg K/ha	< 40	265 - 420
	K-bodemvoorraad	kg K/ha	550	265 - 415
	Ca-plantbeschikbaar	kg Ca/ha	2040	275 - 640
	Ca-bodemvoorraad	kg Ca/ha	< 100	2995 - 3810
	Mg-plantbeschikbaar	kg Mg/ha	25	265 - 420
	Mg-bodemvoorraad	kg Mg/ha	165	270 - 415
	Na-plantbeschikbaar	kg Na/ha	< 31	57 - 114
	Na-bodemvoorraad	kg Na/ha	< 35	61 - 113
	Si-plantbeschikbaar	g Si/ha	11960	22790 - 98740
	Fe-plantbeschikbaar	g Fe/ha	9680	9490 - 17090
	Zn-plantbeschikbaar	g Zn/ha	650	1900 - 2850
	Mn-plantbeschikbaar	g Mn/ha	2470	22030 - 30380
	Cu-plantbeschikbaar	g Cu/ha	< 80	150 - 245
	Co-plantbeschikbaar	g Co/ha	10	15 - 30
	B-plantbeschikbaar	g B/ha	< 290	610 - 835
	Mo-plantbeschikbaar	g Mo/ha	< 20	380 - 18990
	Se-plantbeschikbaar	g Se/ha	16	13 - 17
Fysisch	Zuurgraad (pH)		5,3	5,2 - 5,8
	C-organisch	%	1,0	
	Organische stof	%	1,8	
	C/OS-ratio		0,56	0,45 - 0,55
	Koolzure kalk	%	0,3	2,0 - 3,0
	Klei (<2 µm)	%	1	
	Silt (2-50 µm)	%	1	
	Zand (>50 µm)	%	96	
	Klei-humus (CEC)	mmol+/kg	< 11	> 44

	Eenheid	Resultaat	Streeftraject
Verkruimelbaarheid	rapportcijfer	10,0	6,0 - 8,0
Verslemping	rapportcijfer	7,4	6,0 - 8,0
Stuifgevoeligheid	rapportcijfer	2,0	6,0 - 8,0

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TESTEN
RvA L 122

Eurofins Agro Testing Wageningen BV is ingeschreven in het RvA-register voor testlaboratoria zoals nader omschreven in de erkenning onder nr. L122 voor uitsluitend de monsternemings- en/of de analysemethoden.

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Resultaat		Eenheid	Resultaat	Streeftraject
	Vochthoudend vermogen	mm	21	
Biologisch	Microbiële biomassa	mg C/kg	265	90 - 270
	Microbiële activiteit	mg N/kg	50	9 - 16
	Schimmel/bacterie-ratio		2,0	0,6 - 0,9

Bemestingsadviezen
Het resultaat wordt afgezet tegen het landbouwkundig streeftraject en krijgt een waardering; laag, vrij laag, goed, vrij hoog, hoog. Dit is geen beoordeling zoals bedoeld in ISO 17025 (par. 7.8.6).

Wetgeving
De bemestingsadviezen streven een landbouwkundig optimale opbrengst en kwaliteit na. De adviezen houden geen rekening met restricties vanuit wetgeving. Wanneer u op bedrijfsniveau niet voldoende ruimte heeft, adviseren we de giften van de minst behoeftige gewassen te verminderen, overleg met uw adviseur.

Advies

Bodemgericht advies (4-jarig)	Gift	Eenheid
Fosfaat (P_2O_5)	640	kg/ha
Kalk (nw)	155	kg/ha
Effectieve org.stof	4640	kg/ha

Bij hoge adviesgiften is een verdeling van de gift gedurende de 4 jaar aan te raden, bijvoorbeeld tweejaarlijks de helft geven. De bodemgerichte adviezen zijn bedoeld om de bodemvoorraden van fosfaat, kalium, calcium en magnesium op peil te brengen.

De kalkgift is gebaseerd op een optimale pH van 5,5
Voor elk tiende pH-verhoging is een kalkgift (nw) nodig van 75 kg/ha.
De benodigde hoeveelheid effectieve organische stof is weergegeven voor 4 jaar. Zie de OS-balans voor de berekening van de gemiddelde jaarlijkse gift.

Gewasgericht advies (jaarlijks) in kg/ha	Gewas	Ras/Teelttype	Gift
Stikstof (N)	Overige akkerbouwgewassen		96
Sulfaat (SO_3)	Overige akkerbouwgewassen		0
Fosfaat (P_2O_5)	Overige akkerbouwgewassen		40
Kali (K_2O)	Overige akkerbouwgewassen		60
Calcium (CaO)	Overige akkerbouwgewassen		0
Magnesium (MgO)	Overige akkerbouwgewassen		35
Natrium (Na_2O)	Overige akkerbouwgewassen		
Zink (Zn)	Overige akkerbouwgewassen		0,5
Mangaan (Mn)	-		Zie de toelichting.
Koper (Cu)	Overige akkerbouwgewassen		0,25
Borium (B)	Overige akkerbouwgewassen		0,5

Gewasgericht advies
Het gewasgerichte advies is gebaseerd op de gewasbehoefte, gemiddelde opbrengst en klimaatomstandigheden en is gecorrigeerd voor de bodemvoorraad en bodemnalevering. Tijdens het seizoen kan worden bijgestuurd met bijmestonderzoek.

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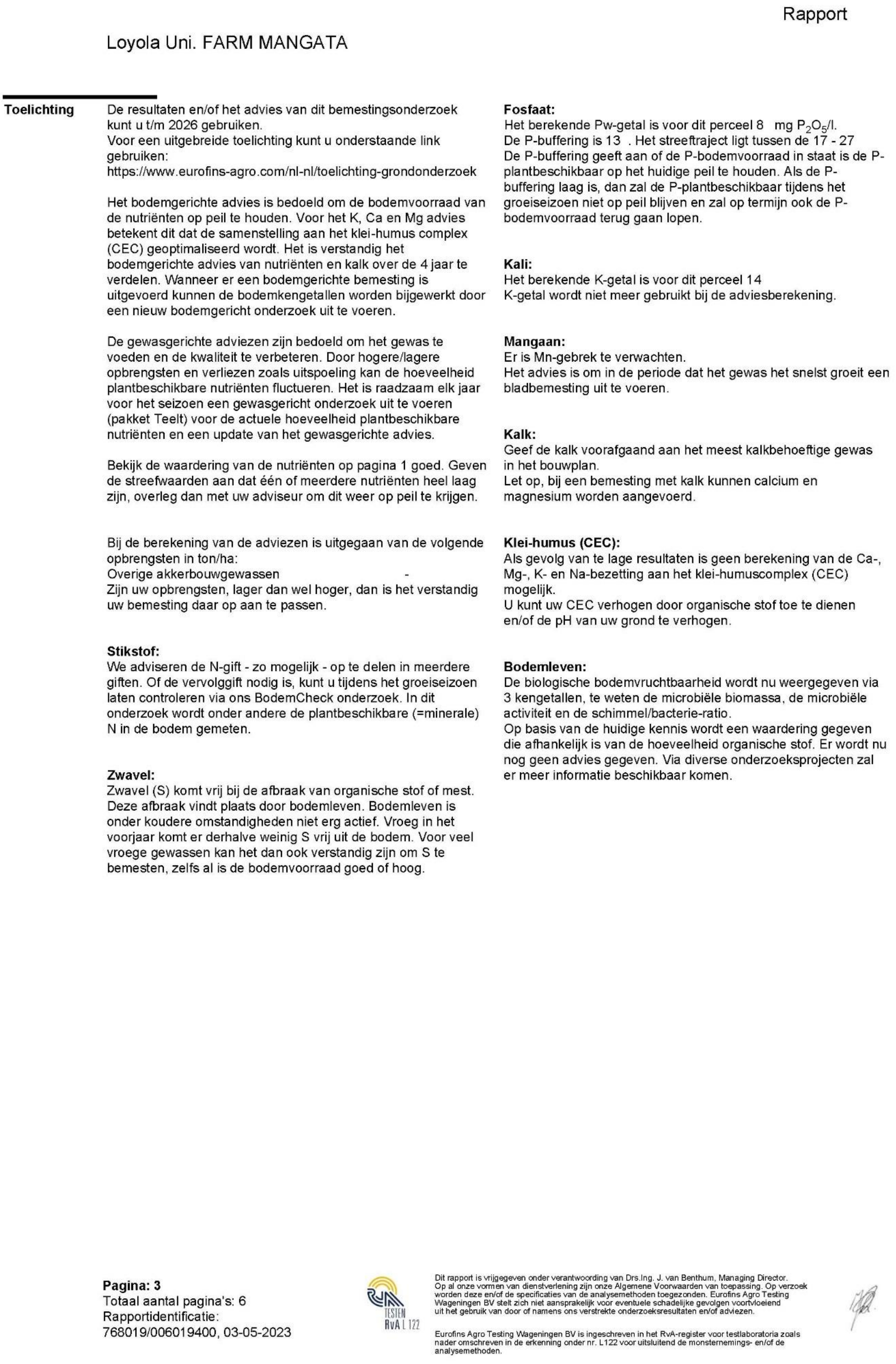

Rapport

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Toelichting

De resultaten en/of het advies van dit bemestingsonderzoek kunt u t/m 2026 gebruiken.
Voor een uitgebreide toelichting kunt u onderstaande link gebruiken:
https://www.eurofins-agro.com/nl-nl/toelichting-grondonderzoek

Het bodemgerichte advies is bedoeld om de bodemvoorraad van de nutriënten op peil te houden. Voor het K, Ca en Mg advies betekent dit dat de samenstelling aan het klei-humus complex (CEC) geoptimaliseerd wordt. Het is verstandig het bodemgerichte advies van nutriënten en kalk over de 4 jaar te verdelen. Wanneer er een bodemgerichte bemesting is uitgevoerd kunnen de bodemkengetallen worden bijgewerkt door een nieuw bodemgericht onderzoek uit te voeren.

De gewasgerichte adviezen zijn bedoeld om het gewas te voeden en de kwaliteit te verbeteren. Door hogere/lagere opbrengsten en verliezen zoals uitspoeling kan de hoeveelheid plantbeschikbare nutriënten fluctueren. Het is raadzaam elk jaar voor het seizoen een gewasgericht onderzoek uit te voeren (pakket Teelt) voor de actuele hoeveelheid plantbeschikbare nutriënten en een update van het gewasgerichte advies.

Bekijk de waardering van de nutriënten op pagina 1 goed. Geven de streefwaarden aan dat één of meerdere nutriënten heel laag zijn, overleg dan met uw adviseur om dit weer op peil te krijgen.

Bij de berekening van de adviezen is uitgegaan van de volgende opbrengsten in ton/ha:

Overige akkerbouwgewassen	-

Zijn uw opbrengsten, lager dan wel hoger, dan is het verstandig uw bemesting daar op aan te passen.

Stikstof:
We adviseren de N-gift - zo mogelijk - op te delen in meerdere giften. Of de vervolggift nodig is, kunt u tijdens het groeiseizoen laten controleren via ons BodemCheck onderzoek. In dit onderzoek wordt onder andere de plantbeschikbare (=minerale) N in de bodem gemeten.

Zwavel:
Zwavel (S) komt vrij bij de afbraak van organische stof of mest. Deze afbraak vindt plaats door bodemleven. Bodemleven is onder koudere omstandigheden niet erg actief. Vroeg in het voorjaar komt er derhalve weinig S vrij uit de bodem. Voor veel vroege gewassen kan het dan ook verstandig zijn om S te bemesten, zelfs al is de bodemvoorraad goed of hoog.

Fosfaat:
Het berekende Pw-getal is voor dit perceel 8 mg P_2O_5/l.
De P-buffering is 13 . Het streeftraject ligt tussen de 17 - 27
De P-buffering geeft aan of de P-bodemvoorraad in staat is de P-plantbeschikbaar op het huidige peil te houden. Als de P-buffering laag is, dan zal de P-plantbeschikbaar tijdens het groeiseizoen niet op peil blijven en zal op termijn ook de P-bodemvoorraad terug gaan lopen.

Kali:
Het berekende K-getal is voor dit perceel 14
K-getal wordt niet meer gebruikt bij de adviesberekening.

Mangaan:
Er is Mn-gebrek te verwachten.
Het advies is om in de periode dat het gewas het snelst groeit een bladbemesting uit te voeren.

Kalk:
Geef de kalk voorafgaand aan het meest kalkbehoeftige gewas in het bouwplan.
Let op, bij een bemesting met kalk kunnen calcium en magnesium worden aangevoerd.

Klei-humus (CEC):
Als gevolg van te lage resultaten is geen berekening van de Ca-, Mg-, K- en Na-bezetting aan het klei-humuscomplex (CEC) mogelijk.
U kunt uw CEC verhogen door organische stof toe te dienen en/of de pH van uw grond te verhogen.

Bodemleven:
De biologische bodemvruchtbaarheid wordt nu weergegeven via 3 kengetallen, te weten de microbiële biomassa, de microbiële activiteit en de schimmel/bacterie-ratio.
Op basis van de huidige kennis wordt een waardering gegeven die afhankelijk is van de hoeveelheid organische stof. Er wordt nu nog geen advies gegeven. Via diverse onderzoeksprojecten zal er meer informatie beschikbaar komen.

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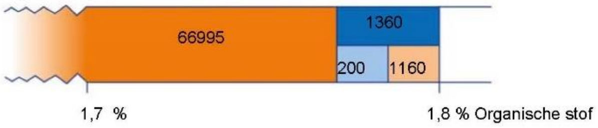
Organische stof **Figuur: Organische stofbalans**



Jaarlijks afbraakpercentage van de totale voorraad organische stof (%): 2,0

- 🟧 Voorraad organische stof die over 1 jaar in de bemonsterde laag nog aanwezig zal zijn als er geen (effectieve) organische stof wordt aangevoerd.
- 🟦 Totaal benodigde aanvoer van effectieve organische stof als gevolg van afbraak van de organische stof.
- ▧ Aanvoer via gewasresten (gemiddeld binnen opgegeven rotatie of gewassen).
- ▨ Nog aan te vullen via bijv. dierlijke mest, groenbemesters en/of compost.

Gewas(rest)	Teelt/ras	Aanvoer effectieve organische stof
Overige akkerbouwgewassen		200

Gemiddelde aanvoer/jaar		200

Om het organische stofgehalte met 0,1% te verhogen dient u een extra hoeveelheid effectieve organische stof aan te voeren van: 3800 kg per ha.

Figuur: Kwaliteit van de organische stof
Gebaseerd op C/OS-ratio.

Organische stof bestaat uit met name C, N, P, S. Wanneer de organische stof relatief veel N en of S bevat is dit aantrekkelijk voor bodemleven. Bodemleven vreet deze organische stof graag. Hierbij komt N en S vrij en het gehalte aan organische stof daalt licht (dynamische organische stof). Organische stof kan ook veel C bevatten. Dat is over het algemeen minder aantrekkelijk voor bodemleven. De organische stof wordt derhalve minder aangevreten door bodemleven; de organische stof is stabieler. Stabiele organische stof draagt onder andere bij aan de bewerkbaarheid van de bodem en aan de rulheid. Dynamische organische stof draagt bij aan met name het vrijkomen van N en S en is daarmee een bron van deze nutriënten voor het gewas. De kwaliteit van de organische stof is (geleidelijk) aan te passen door onder andere te letten op de eigenschappen van bodemverbeteraars als dierlijke mest, compost en gewasresten.

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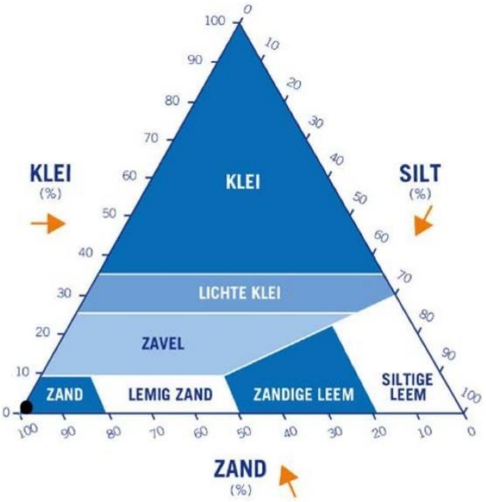
Fysisch

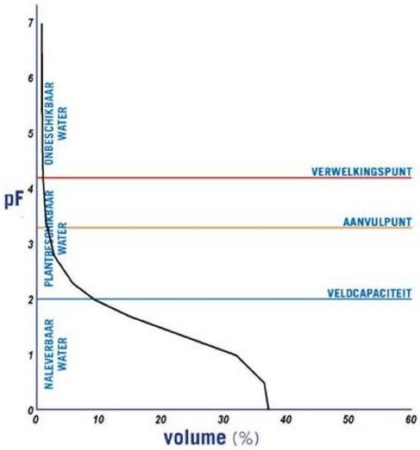
Figuur: Textuurdriehoek



Naast klei (lutum), worden ook de silt- en zandfracties weergegeven. Klei is kleiner dan 2 micrometer (µm), siltdeeltjes zijn 2-50 µm en zanddeeltjes groter dan 50 µm. De onderlinge verdeling van bodemdeeltjes wordt onder andere gebruikt om het verslempingsrisico van een bodem in te schatten. Bij verslemping wordt de bodem dichtgesmeerd met kleinere deeltjes (klei en silt). Een heel eenzijdige verdeling (bijvoorbeeld hoofdzakelijk zand- of kleideeltjes) levert het minste risico van slemp op. Bij 10-20% klei is het risico op slemp het grootst.

De verkruimelbaarheid is goed te noemen. Echter is dit ook afhankelijk van de soort teelt.
Gezien het resultaat is de kans op verslemping klein.

Figuur: Waterretentiecurve



De hoeveelheid plant beschikbaar water in de bemonsterde laag is 21 mm, dit is wat u maximaal zou moeten beregenen. Alles wat u meer geeft spoelt af van het perceel of zakt naar diepere lagen.

Veldcapaciteit (pF 2,0):	9,5	% vocht
Aanvulpunt (pF 3,3):	1,8	% vocht
Verwelkingspunt (pF 4,2):	1,2	% vocht

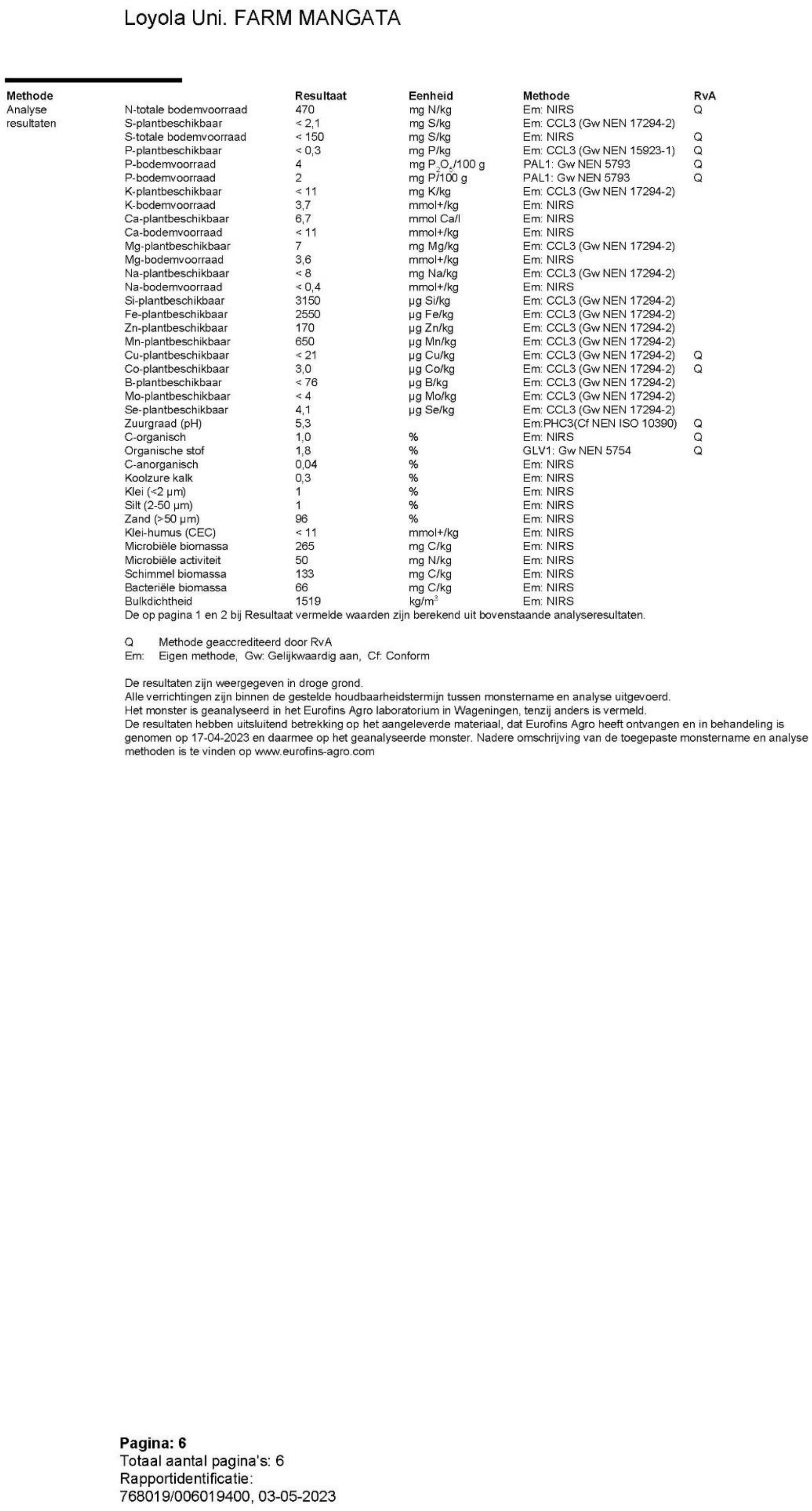
Als het vochtgehalte van het perceel daalt hebben gewassen moeite om voldoende water op te nemen, de grens ligt bij pF 3,3. Wanneer u het vochtgehalte kan bepalen, begin dan met beregenen als het vochtgehalte van dit perceel op 1,8 % vocht zit en geef dan 19 mm.

Het actuele vochtgehalte kan bepaald worden door een vochtsensor of verzamel grond van een tiental plekken in het perceel. Meet het gewicht van de vochtige grond en het gewicht van de grond na 24 uur drogen, het verschil tussen de twee is een indicatie van het vochtgehalte van het perceel.

Contact & info

Bemonsterde laag:	0 - 25 cm
Grondsoort:	Zand
Monster genomen door:	Derden
Contactpersoon monstername:	Alie Hissink: 0652561834

Indien de volgende informatie wordt getoond op de rapporten kan deze informatie verstrekt zijn door de opdrachtgever en van invloed zijn op de waardering, advisering en/of het analyseresultaat:
bemonsteringsdiepte, gewas, teelttype/ras.



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Methode		**Resultaat**	**Eenheid**	**Methode**	**RvA**
Analyse resultaten	N-totale bodemvoorraad	470	mg N/kg	Em: NIRS	Q
	S-plantbeschikbaar	< 2,1	mg S/kg	Em: CCL3 (Gw NEN 17294-2)	
	S-totale bodemvoorraad	< 150	mg S/kg	Em: NIRS	Q
	P-plantbeschikbaar	< 0,3	mg P/kg	Em: CCL3 (Gw NEN 15923-1)	Q
	P-bodemvoorraad	4	mg P_2O_5/100 g	PAL1: Gw NEN 5793	Q
	P-bodemvoorraad	2	mg P/100 g	PAL1: Gw NEN 5793	Q
	K-plantbeschikbaar	< 11	mg K/kg	Em: CCL3 (Gw NEN 17294-2)	
	K-bodemvoorraad	3,7	mmol+/kg	Em: NIRS	
	Ca-plantbeschikbaar	6,7	mmol Ca/l	Em: NIRS	
	Ca-bodemvoorraad	< 11	mmol+/kg	Em: NIRS	
	Mg-plantbeschikbaar	7	mg Mg/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mg-bodemvoorraad	3,6	mmol+/kg	Em: NIRS	
	Na-plantbeschikbaar	< 8	mg Na/kg	Em: CCL3 (Gw NEN 17294-2)	
	Na-bodemvoorraad	< 0,4	mmol+/kg	Em: NIRS	
	Si-plantbeschikbaar	3150	µg Si/kg	Em: CCL3 (Gw NEN 17294-2)	
	Fe-plantbeschikbaar	2550	µg Fe/kg	Em: CCL3 (Gw NEN 17294-2)	
	Zn-plantbeschikbaar	170	µg Zn/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mn-plantbeschikbaar	650	µg Mn/kg	Em: CCL3 (Gw NEN 17294-2)	
	Cu-plantbeschikbaar	< 21	µg Cu/kg	Em: CCL3 (Gw NEN 17294-2)	Q
	Co-plantbeschikbaar	3,0	µg Co/kg	Em: CCL3 (Gw NEN 17294-2)	Q
	B-plantbeschikbaar	< 76	µg B/kg	Em: CCL3 (Gw NEN 17294-2)	
	Mo-plantbeschikbaar	< 4	µg Mo/kg	Em: CCL3 (Gw NEN 17294-2)	
	Se-plantbeschikbaar	4,1	µg Se/kg	Em: CCL3 (Gw NEN 17294-2)	
	Zuurgraad (pH)	5,3		Em:PHC3(Cf NEN ISO 10390)	Q
	C-organisch	1,0	%	Em: NIRS	Q
	Organische stof	1,8	%	GLV1: Gw NEN 5754	Q
	C-anorganisch	0,04	%	Em: NIRS	
	Koolzure kalk	0,3	%	Em: NIRS	
	Klei (<2 µm)	1	%	Em: NIRS	
	Silt (2-50 µm)	1	%	Em: NIRS	
	Zand (>50 µm)	96	%	Em: NIRS	
	Klei-humus (CEC)	< 11	mmol+/kg	Em: NIRS	
	Microbiële biomassa	265	mg C/kg	Em: NIRS	
	Microbiële activiteit	50	mg N/kg	Em: NIRS	
	Schimmel biomassa	133	mg C/kg	Em: NIRS	
	Bacteriële biomassa	66	mg C/kg	Em: NIRS	
	Bulkdichtheid	1519	kg/m^3	Em: NIRS	

De op pagina 1 en 2 bij Resultaat vermelde waarden zijn berekend uit bovenstaande analyseresultaten.

Q Methode geaccrediteerd door RvA
Em: Eigen methode, Gw: Gelijkwaardig aan, Cf: Conform

De resultaten zijn weergegeven in droge grond.
Alle verrichtingen zijn binnen de gestelde houdbaarheidstermijn tussen monstername en analyse uitgevoerd.
Het monster is geanalyseerd in het Eurofins Agro laboratorium in Wageningen, tenzij anders is vermeld.
De resultaten hebben uitsluitend betrekking op het aangeleverde materiaal, dat Eurofins Agro heeft ontvangen en in behandeling is genomen op 17-04-2023 en daarmee op het geanalyseerde monster. Nadere omschrijving van de toegepaste monstername en analyse methoden is te vinden op www.eurofins-agro.com

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Report WPR-1302

The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 7,600 employees (6,700 fte) and 13,100 students and over 150,000 participants to WUR's Life Long Learning, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.

To explore the potential of nature to improve the quality of life

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