The development of a suitability assessment framework for walnut production (Juglans regia), and its application to a Catalonian site

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Picture front page (figure 1): walnuts (source: Kwekerij de Smallekamp)

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Abstract

Many rural parts in Europe, as well as in the rest of the world, are likely to be suitable for walnut production. However, little or no confirmation on this exists in literature. Many countries are nowadays trying to improve their food security. Planting of nut trees can play an important role in this, with potentially large harvests per hectare of nutritious food while requiring relatively few inputs.
A universally applicable suitability analysis framework for walnuts will make it easier to provide interested users with advice.

This research consists of two parts. The first part is the design of a universally applicable suitability assessment framework for the production of walnuts. The suitability assessment framework will make it easier for people who are interested in setting up a walnut plantation, regardless of their geographic location, to find out whether their parcel is suitable for profitable production. This framework was composed according to existing literature and the opinion of professionals.

The second part is the application of this framework for a parcel in Catalonia, Spain. Fieldwork was carried out on location to obtain the necessary data. The result is an advice as to whether the parcel is suitable for the development of a profitable walnut plantation. The parcels were deemed suitable, and an advice is given as to what are the most suitable varieties to be planted.

Foreword

Since several years I have a passion for sustainable food production. Agriculture systems such as agroforestry and permaculture therefore sparked my interest. I believe that it is possible to produce a good yield, while making sensible use of natural resources. Furthermore, my opinion is that doing so will greatly reduce the negative impacts that climate change has on those areas that are most vulnerable.

This research is carried out in cooperation with nursery De Smallekamp in Nunspeet. This nursery is specialised in the sustainable propagation of special nut tree varieties. My brother has been working at this nursery for several years. I have since then got to know De Smallekamp as an extremely interesting company. Ever since I became acquainted with them, the owners of the company, Cees Barneveld and Ton Friesen, have regularly delighted me with interesting information about horticulture, walnuts, nursery work and more related matters.

In the second half of 2013, Mr Barneveld and Mr Friesen provided me with information about a Dutchman who was planning to set up a walnut plantation on a parcel he owns in Catalonia, Spain. He was seeking for advice on whether his site would be a suitable location for a walnut plantation. If this would be the case, he wondered which walnut varieties would be most suitable to be planted. As a means of combining my own interests with my search for a thesis subject, I offered him my help by conducting this research for him.

I would like to thank Mr Cees Barneveld and Mr Ton Friesen for all their enthusiastic and inspiring help and the wealth of knowledge they provided me with. Furthermore, I would like to thank Mr Richard Kraaijvanger for guiding me through the process of writing this report. Finally, I thank Ms Bernadet Tatje for her feedback on my draft writings, which were most helpful and encouraging. Of course, any errors that remain in this report are mine.

Nils de Koning

1. Introduction

1.1 Problem statement

In Catalonia, the Baix Ebre region has been known historically for containing productive orange, almond and olive plantations. However, little literature has been written about the possibilities for walnut production. The owner of a parcel in Benifallet, Catalonia, would like to know whether walnut production would be a feasible option for his parcel.

Likewise, there are many other rural parts in Europe that are likely to be suitable for walnut production, but for which little or no confirmation on this exists in literature. Many countries are nowadays trying to improve their food security. Planting of nut trees can play an important role in this, with potentially large harvests per hectare of nutritious food while requiring relatively few inputs.

Nursery De Smallekamp regularly receives guests from around Europe. They often request information about the suitability of their land for walnut production and which varieties are most suitable. As this suitability is determined by a wide range of factors, it is often difficult to provide them with an accurate advice.

A universally applicable suitability analysis framework for walnuts will make it easier to provide interested customers with a sensible and reliable advice. People who are interested in setting up a walnut plantation will also be able to use this framework themselves to find out whether the development of a walnut plantation is feasible on their parcel.

1.2 Previous research

Previous research on the characteristics of walnut trees and the requirements for walnut production includes:

Walnut Production Manual (Ramos DE, 1998)
El Nogal – Técnicas de Producción de Fruto y Madera (Muncharaz Pou M, 2012)
De Teelt van Walnoten (Wertheim SJ, 1981)
De Familie der Juglandaceae (Fontaine FJ, 1995)

The *Walnut Production Manual* focusses mainly on large-scale intensive walnut production in California. *El Nogal* focusses on walnut production possibilities on the Iberian peninsula. Although it is partly based on information from the *Walnut Production Manual*, it does provide information on growth requirements specific to Spain.

De Familie der Juglandaceae provides information about a broad range of walnut varieties and their characteristics. *De Teelt van Walnoten* provides information about all aspects of walnut production. It focusses more towards production in temperate climates, but it also contains information that is universally applicable.

The Forest Science Center of Catalonia (CTFC) and the Spanish Forest Ownership Center (CPF) have collaboratively carried out a project called Research on silvo-arable systems with valuable broadleaves in Catalonia (NE Spain). Most fieldwork in this project was carried out in the North-Eastern part of Catalonia, where species adaptation, plantation techniques and innovative plantation schemes for

broadleaf trees were tested. In this research hybrid walnut trees showed excellent adaptation to a wide variety of conditions.[1]

1.3 Objective

This research produces two results. Firstly, the aim of this research was to design a universally applicable suitability assessment framework for walnut production. This framework consists of two parts. Part A assesses general site characteristics, such as climatic factors and general soil properties. Part B is more specific and more focussed on professional users. This part deals with the chemical composition of the soil, and gives information on whether the soil has an appropriate fertility for walnut production.

Secondly, this suitability assessment framework was applied to a site in Catalonia, to find out to which extent this study area is suitable for walnut production. In the case of the results pointing towards favourable conditions for walnut production, suggestions were made as to which are the most suitable cultivars. Furthermore, an estimation of the expected yield is given. Simultaneously, the application of the framework on the study area in Catalonia tests whether the framework is well useable and functions properly.

Part A of the framework was performed on four regions around the world that are known to be suitable for walnut production, which acts as a calibration on whether the framework is universally applicable.

The results of this research can be used to support decision-making on whether or not it is sensible to develop a walnut plantation on a site.

The development of this framework will hopefully make the establishment of walnut plantations more popular on sites where this is feasible. On the other side, it will prevent the establishment of walnut plantations on sites that are not suitable or which will generate poor yields.

1.4 Research questions

In order to achieve the output mentioned in subchapter 1.3, three main questions were formulated. These main questions, along with their corresponding sub-questions, are written down below.

Main question:

Which parameters should be investigated in a universally applicable suitability assessment framework for walnut production, in order to achieve reliable results?

Sub-question:

What are the most important requirements for sufficient growth of walnuts?

Main question:

To what extent are the site characteristics of the designated study area in Benifallet suitable for a profitable production of walnuts?

Sub-questions:

What are the climatic characteristics of the study area?

What are the topographic characteristics of the study area?

What are the hydrological characteristics of the study area?

What are the characteristics of the study area, related to geography and soils.

What is the current land cover of the study area?

What are the main occurring erosion problems?

Main question:

To what extent can the framework be applied globally, as tested for four known walnut production regions?

Sub-question:

Does the framework give a "suitable" score for walnut production regions in France, the United States, Chile and Turkey?

2. Methodology

The research consisted of four separate phases. Firstly, a literature study was carried out in order to know which factors (or site characteristics) are determinant to the growth of walnut trees. Information on this subject was derived from literature or professionals from *De Smallekamp*. Recommendations from soil analysis institute *BLGG AgroXpertus* in Wageningen regarding the growth requirements for walnut trees were also taken into account.

Secondly, these factors were used to design a suitability assessment framework. For all factors, the optimal circumstances were determined. Following this, four suitability classes were designated for all factors, corresponding to the suitability of the circumstances. The conceptual framework had to have the following characteristics;

- Universally applicable (interested people from all countries should be able to use it, and thus taking all conditions into account for each parameter).
- Easy to use for non-specialists (relatively easy to carry out independently).
- Cost-effective (most investigations should be possible to carry out without expensive instruments. This is except for the soil analysis, which can be carried out by a soil analysis institute for a reasonable price).

The framework is divided in two parts; a general part (A), and a more specific part, which assesses the chemical composition of the soil (B). This is in order to ensure the framework can be used as well by non-specialists, at low cost, and when no detailed data on the chemical composition of the soil can be retrieved. When users are only able to retrieve the data on the parameters that make up part A, it will still be possible to assess the suitability of the parcel. Part B can be filled in after having done a soil analysis, and will provide information on the fertility of the soil. It deals with the presence of various chemical elements in the soil, and which values are desired for the growing of walnut trees.

When performing the suitability assessment on a parcel, all site characteristics were awarded a score related to its suitability class. The most suitable circumstances would fall in suitability class 1, the least suitable circumstances would fall in suitability class N (for Not Suitable). When all classes had been awarded a score, these scores could be added up and this would result in a final suitability classification for the total site.

Thirdly, this suitability assessment framework was applied to the aforementioned study area in Catalonia. During a field visit, all necessary data were obtained. The detailed description of this fieldwork can be found in subchapter 6.2. This was written in such a way that interested parties can use it as a reference as to how to perform the collection of data themselves. If the suitability classification of the site would turn out to be 3 or better (more suitable), the site characteristics would be judged in order to give an advice on the most suitable walnut varieties to be planted. An estimation of the yield can then be included as well.

Lastly, the framework was applied to four regions that are known to be suitable walnut production areas, to test whether it is universally applicable.

3. The parameters of the framework

A wide range of parameters was selected to be included in the framework. These parameters have to be investigated to assess the suitability of a parcel for walnut production. They were selected according to which factors are determinant for the growth of walnut trees. All parameters are listed below, with an explanation on the reason of importance. They were selected according to existing literature, and in consultation with nursery De Smallekamp.

In the explanatory text behind all parameters, one or more numbers can be found in superscript. These numbers correspond to the sources that were used for these parameters. According to those sources, the most important requirements for walnut growth and the related the ranges of suitable and unsuitable values for these parameters and ultimately the division of these values in classes were chosen.

Below follows a description of the parameters that are being investigated, and why they are of importance. All mentioned variables are enumerated in a table at the end of the chapter.

Climate
Climatic circumstances are very important factors that affect the suitability of a site for walnut production. The effects of these circumstances are only partly influenceable by management.

Parameter: Precipitation — Variable asked: Average rainfall per year.

Rainfall plays a very important role in providing vegetation with the moisture needed for growth, especially when irrigation is not being applied. For optimal growth, an average minimum of 800 mm rainfall per year is needed. An average rainfall of 400-800 mm per year causes suboptimal growth. An average rainfall per year below inhibits growth in such a way that the establishment of a walnut plantation is not advisable. [2,3,4]

Parameter: Temperature — Variable asked: Average temperature per month.

Temperature influences the speed of the photosynthesis process in the tree. The mean monthly temperature gives an indication on how suitable the temperature at the location is for the growth of walnut trees. An average monthly temperature of 15-30 °C is most favourable. Average monthly temperatures of 7-15 °C or 30-38 °C can cause suboptimal growth, whereas temperatures below 7 °C or above 38 °C are not suitable. [2,4]

Parameter: Temperature — Variable asked: Are temperatures of >38 degrees Celsius likely during summer?

Prolonged periods (7 days or more) of temperatures above 38 °C in the growing season, will cause quality loss in the nuts. The problem is magnified when there is not enough water present for the tree to evaporate, in order to cool down. To make it more easy for users of the framework to choose a value according to their situation, the question asked is if it is likely that such temperatures occur. [3,4,5,6]

Parameter: Temperature	Variable asked: Are temperatures of < -9 degrees Celsius likely during winter?

Although various walnut varieties can withstand heavy frosts in dormancy, it is generally considered insensible to plant walnut trees commercially when temperatures of below -9 °C are common in the winter time, as this could damage young branches. [3,4,5]

Parameter: Temperature	Variable asked: Frost (< -2 degrees Celsius) likely in early autumn?

If frosts occur in early autumn, before the trees have reached complete dormancy, there is a fairly high chance of damage to twigs and possibly branches. Locations where this happens frequently, are therefore not favourable. [3,4,5]

Parameter: Temperature	Variable asked: Frost (< -2 degrees Celsius) likely in late spring?

If frosts occur in late spring, after the buds have started to open, this will damage the buds of the tree. This inhibits that season's shoot growth from the buds that are affected. If the frost occurs during flowering, this will damage the flowers, which will lead to yield loss. Locations where this happens frequently, are therefore not suitable. [3,4,5]

Parameter: Temperature	Variable asked: How many hours is the temperature below 7 degrees Celsius in winter?

The majority of walnut varieties needs a period of about 800 hours in which the temperature is below 7 °C. This is to ensure a sufficient dormancy period, which is needed to produce satisfactorily. Some French varieties prefer a period of up to 1500 hours, some Californian varieties can deal with as few as 300 hours. [3,4,5]

Parameter: Humidity	Variable asked: Is the location's climate known to have hot and humid weather frequently?

Walnut trees are very susceptible to diseases in hot and humid conditions. Locations where hot and humid weather occurs frequently are therefore not suitable for the planting of walnut trees. [4]

Parameter: Strength of solar radiation	Variable asked: The latitudinal position on the Earth (in degrees).

Walnut trees can grow under a wide range of light circumstances. However, extremely low solar radiance circumstances can inhibit growth. These conditions do not occur in many locations, but since this is a universal framework, it is important to take this factor into account. Because light intensity is not easily determined in a standardised manner, the question asked is on which latitude of the earth the parcel is situated. Locations more northern than 60° N, or more southern than 60° S, are unsuitable in any case. [2]

Parameter: Amount of sunlight received

Variable asked: What is the predominant cloud cover during the growing season?

The amount of sunlight that reaches the tree canopy is also influenced by the average cloud cover. Because it is difficult or time consuming to obtain standardized data on the cloud cover, the framework asks to give an indication on the predominant cloud cover, which can be quite easily estimated. [2]

Parameter: Wind speed

Variable asked: The mean annual wind speed in meters per second.

Although normal winds cause no problems for walnut trees, they are very vulnerable to strong winds. In the flowering period, normal winds can even benefit pollination somewhat. However, strong winds in this period will cause damaged flowers. Strong winds in the fruiting period will cause yield loss as well. Strong winds will, furthermore, cause the trees to dehydrate more quickly as a result of increased evaporation. [3,4,5]

In the framework is asked for the mean annual wind speed, as this is a standardized number that can easily be found for each location on wind maps. A mean annual wind speed of below 6 meters per second is considered ideal, whereas 6-7 meters per second could cause problems. A mean annual wind speed of higher than 7 meters per second is unsuitable.

Parameter: Wind salinity

Variable asked: Wind salinity according to ISO 9223 Classification.

Walnut trees do not tolerate saline air.[4] What is asked for in the framework, is the wind salinity according to the ISO 9223 classification. This was chosen because for many areas wind salinity maps according to this classification system readily exist. Scores of C1 to C3 range from suitable to somewhat suitable, whereas scores of C4, C5 and CX are unsuitable.

Topography

Parameter: Altitude

Variable asked: The altitude in meters above sea level.

It is normally advised to establish walnut plantations between sea level and 1000 meters above sea level. Altitudes higher than 800 meters above sea level have a higher risk of frost damage. However, there are well-functioning plantations at 1200 meters as well.[4,6] Growth limiting factors at higher altitudes are for a large part related to other factors, such as the temperature. Therefore the score for this question does not count very heavy.

Hydrology

Parameter: Depth of groundwater level

Variable asked: The depth of the groundwater level.

Walnut trees need ample space for their roots to grow, and are very intolerant of a saturated wet soil. This means that the groundwater level should be at the very least 80 cm deep. It must also not fluctuate too much. [3,4,5]

Geography and soils

Parameter: Possible rooting depth — Variable asked: The possible rooting depth.

This question differs from the previous one, in that it incorporates other root-blocking factors as well. This can for example be an impermeable layer. For this parameter counts as well that the minimum depth is 80 cm. [3,4,5]

Parameter: Soil drainage — Variable asked: The soil drainage class.

Because walnut trees are very intolerant of soils saturated with water, it is important that the soil drains sufficiently. This prevents water damage in periods of heavy rainfall. The USDA soil drainage classification system is used in order to classify soils. The classes *somewhat poorly drained* to *very poorly drained* are unsuitable for walnut plantations. [7]

Parameter: Soil permeability — Variable asked: The permeability of the soil.

Because of the reasons concerning water saturated soils mentioned for the previous parameter, the soil permeability is taken into account as well. The classes *slow*, *very slow*, and *impermeable* are unsuitable for walnut plantations. [5]

Parameter: Soil structure — Variable asked: Soil structure, based on the CEC-complex. CEC as mmol+/kg is:

A good soil structure is important for sufficient establishment of the root system in the soil, and for adequate nutrient uptake. The cation exchange capacity can be used to determine the stability of the soil structure. A CEC higher than 89 mmol+/kg is very good, whereas a CEC lower than 45 mmol+/kg is not suitable. [7]

Chemical composition of the soil

Parameter: Organic carbon content — Variable asked: Organic carbon content.

The organic carbon content of a soil influences the stability of the soil. Furthermore, the organic carbon is able to withhold moisture and nutrients in the soil, acting as a buffer. An organic carbon content of between 2 and 4% (or more) is desirable. Lower contents are increasingly less desirable, and a content of below 1% is unsuitable. [2,3,8]

Parameter: Soil fertility — Variable asked: C/N ratio

The C/N ratio is the ratio between carbon and nitrogen in the organic matter in the soil. The number gives information on how effectively micro-organisms can break down organic matter. A ratio of between 13 and 17 is advisable. A higher ratio will force micro-organisms to extract the missing nitrogen from the soil. A lower ratio will result in the loss of unused nitrogen, in the form of ammonia.[7]

Parameter: Soil pH | Variable asked: pH

The pH of the soil influences how easily nutrients are dissolved into water, and therefore how easily the tree can take up nutrients from the soil. Walnut trees prefer a rather neutral pH of between 6,5 and 8. They are, however, tolerant of pH values between 5,5 and 6,5, and 8 and 8,5. Soil pH values below 5,5 or higher than 8,5 are unsuitable. [2,3,4,5,6,7]

Parameter: Soil fertility | Variable asked: Nitrogen supply (N) in kg N/ha

Nitrogen is needed in in relatively high quantities for the production of chlorophyll, amino acids and nucleic acids, and is most often the limiting factor in crop production.[8] A nitrogen supply of between 93 and 147 kg per hectare is most suitable. Amounts below 40 kg per hectare, or well above 200 kg per hectare, are not suitable.[7]

Parameter: Soil fertility | Variable asked: Sulfur supply (S) in kg S/ha

Sulfur is needed for the production of amino acids, oils, and chlorophyll.[8] A nitrogen supply of between 20 and 30 kg per hectare is most suitable. Amounts below 8 kg per hectare, or well above 45 kg per hectare, are not suitable.[7]

Parameter: Soil fertility | Variable asked: Phosphorus plant available (P) in mg P/kg

Phosphorus plays a role in the production of nucleic acids, phospholipids (for cell membranes), and for energy transfer reactions inside the tree.[8] Plant available phosphorus contents of between 1.1 mg and 1.9 mg per kg soil are most suitable. Contents lower than 0.5 mg, or well above 2.4 mg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Potassium plant available (K) in mg K/kg

Potassium functions as a catalyst in various processes in the tree, such as protein synthesis, enzyme activation and carbohydrate metabolism.[8] Plant available potassium contents of between 70 mg and 110 mg per kg soil are most suitable. Contents lower than 35 mg, or well above 145 mg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Calcium plant available (Ca) in kg Ca/ha

Calcium is an important component of cell structures. Calcium deficiency symptoms include fragile, malformed nut shells.[8] Plant available calcium contents of between 279 kg and 650 kg per hectare are most suitable. Contents lower than 60 kg, or well above 869 kg per hectare are not suitable.[7]

Parameter: Soil fertility | Variable asked: Sodium plant available (Na) in mg Na/kg

Walnut trees are very sensitive to salt. Small quantities of sodium are needed for growth, but an excess leads to wilting or even mortality. A high sodium content of the soil also influences the structure and water regulation.[5] Plant available phosphorus contents of between 35 mg and 50 mg per kg soil are most suitable. Contents much lower than 15 mg, or above 70 mg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Silicon plant available (Si) in µg Si/kg

Although silicon is not an essential element for plant growth, it is deemed beneficial. It is found in especially high quantities in the epidermal cells of roots and leafs.[8] Plant available silicon contents of between 6000 µg and 32000 µg per kg soil are most suitable. Contents lower than 1000 µg, or well above 37000 µg per kg soil are not suitable, although it appears that excess silicon content does not affect growth.[7]

Parameter: Soil fertility | Variable asked: Iron plant available (Fe) in µg Fe/kg

Iron is essential for the synthesis of chlorophyll and for enzyme activation.[4,8] Plant available iron contents of between 2500 µg and 4500 µg per kg soil are most suitable. Contents lower than 800 µg, or well above 6200 µg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Zinc plant available (Zn) in µg Zn/kg

Zinc plays a role in the production of various enzymes and phytohormones. It is also important for carbohydrate metabolism.[4,8] Plant available zinc contents of between 500 µg and 750 µg per kg soil are most suitable. Contents lower than 180 µg, or well above 1070 µg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Manganese plant available (Mn) in µg Mn/kg

Manganese is part of some enzymes and plays an important role in the photosynthesis process.[4] Plant available manganese contents of between 1000 µg and 1300 µg per kg soil are most suitable. Contents lower than 300 µg, or well above 2000 µg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Copper plant available (Cu) in µg Cu/kg

Copper plays a role in root metabolism and in the activation of several enzymatic systems.[4,8] Plant available copper contents of between 40 µg and 65 µg per kg soil are most suitable. Contents lower than 15 µg, or well above 90 µg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Cobalt plant available (Co) in µg Co/kg

Although cobalt is not an essential element for plant growth, it is deemed beneficial. It is supposed that cobalt deficiency could decrease chlorophyll formation.[8] Plant available cobalt contents of between 25 µg and 50 µg per kg soil are most suitable. Contents lower than 5 µg, or well above 70 µg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Boron plant available (B) in µg B/kg

Boron plays a role in the transport of carbohydrates, cell division, the formation of cell membranes, and in sustaining membrane permeability.[4,8] Plant available boron contents of between 77 µg and 120 µg per kg soil are most suitable. Contents lower than 45 µg, or well above 154 µg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Molybdenum plant available (Mo) in µg Mo/kg

Although only small amounts of molybdenum are required, the element plays an important role in nitrogen metabolism.[4] Plant available molybdenum contents of between 100 µg and 5000 µg per kg soil are most suitable. Contents lower than 40 µg, or well above 5400 µg per kg soil are not suitable.[7]

Parameter: Soil fertility | Variable asked: Selenium plant available (Se) in µg Se/kg

Although selenium is not an essential element for plant growth, it might have beneficial effects in small quantities. It appears to increase the tolerance to several types of stress.[8] However, excess selenium is toxic. Plant available selenium contents of between 3,5 µg and 4,5 µg per kg soil are most suitable. Contents much lower than 1 µg, or well above 7 µg per kg soil are not suitable.[7]

The table on the next page (table 1) summarises, per variable, which value corresponds to which suitability class. The last column indicates whether a knock-out factor is attributed to a variable. A “0 points” score for a variable with a knock-out factor is detrimental for the growth of walnut trees. If this is the case, the site is not suitable for walnut production, regardless of the scores for other variables.

Table 1 Summary of all variables used in the framework.

Nr.	Variable	S0	S1	S2	S3	KO factor
1	Average rainfall per year	0-400	-	400-800	800-1700 (or >)	x
2	Average temperature per month	<7 or >38	-	7-15 or 30-38	15-30	x
3	Are temperatures of >38 degrees Celsius likely during summer	(almost) certain	Likely	Somewhat likely	Not at all	
4	Are temperatures of < -9 degrees Celsius likely during winter	(almost) certain	Likely	Somewhat likely	Not at all	x
5	Frost (< -2 degrees Celsius) likely in early autumn	(almost) certain	Likely	Somewhat likely	Not at all	x
6	Frost (< -2 degrees Celsius) likely in late spring	(almost) certain	Likely	Somewhat likely	Not at all	x
7	How many hours is the temperature below 7 degrees Celsius in winter	0-200	-	200-300 or >1300	300-800 or 800-1300	x
8	Is the location's climate known to have hot and humid weather frequently	Yes	-	Mostly not	Not at all	x
9	The latitudinal position on the Earth (in degrees)	<-60 or >60	-	-30 to -60 or 30 to 60	-30 to 30	
10	What is the predominant cloud cover during the growing season	-	Mostly cloudy	Mix cloudy/clear sky	Mostly clear sky	
11	The mean annual wind speed in meters per second	>7,0	6-7	-	<6	x
12	Wind salinity according to ISO 9223 Classification	C4, C5 or CX	C3	C2	C1	x
13	The altitude in meters above sea level	>3000	1000-3000	800-1000	<800	
14	The depth of the groundwater level	<80	80-1.20	1.20-2.00	>2.00	x
15	The rootable soil depth	<80	80-1.20	1.20-200	>2.00	x
16	The soil drainage class	V. poorly drained - S. poorly drained.	-	M. well drained	W. drained to exc. Drained	x
17	The permeability of the soil	Impermeable, Very slow, Slow.	M. slow	Moderate	M. rapid, Rapid, V. rapid	x
18	Soil structure, based on the CEC-complex. CEC as mmol+/kg	<45	45-60	60-89	>89	
19	Organic carbon content	<1	1-1,5	1,5-2	2-4 (or >)	
20	C/N ratio	-	-	<13 or >17	13-17	
21	pH	<5,5 or >8,5	-	5,5-6,5 or 8-8,5	6,5-8	x
22	Nitrogen supply (N) in kg N/ha	<40 or >200	40-70 or 180-200	70-93 or 147-180	93 - 147	
23	Sulfur supply (S) in kg S/ha	<8 or >45	8-15 or 35-45	15-20 or 30-35	20 - 30	
24	Phosphorus plant available (P) in mg P/kg	<0,5 or >2,4	0,5-0,8 or 2,1-2,4	0,8-1,1 or 1,9-2,1	1,1 - 1,9	
25	Potassium plant available (K) in mg K/kg	<35 or >145	35-50 or 130-145	50-70 or 110-130	70 - 110	
26	Calcium plant available (Ca) in kg Ca/ha	<60 or >869	60-150 or 770-869	150-279 or 650-779	279 - 650	
27	Sodium plant available (Na) in mg Na/kg	<15 or >70	15-25 or 60-70	25-35 or 50-60	35 - 50	
28	Silicon plant available (Si) in µg Si/kg	<1000 or >37000	1000-3500 or 34500-37000	3500-6000 or 32000-34500	6000 - 32000	
29	Iron plant available (Fe) in µg Fe/kg	<800 or >6200	800-1500 or 5500-6200	1500-2500 or 4500-5500	2500 - 4500	
30	Zinc plant available (Zn) in µg Zn/kg	<180 or >1070	180-350 or 900-1070	350-500 or 750-900	500 - 750	
31	Manganese plant available (Mn) in µg Mn/kg	<300 or >2000	300-700 or 1600-2000	700-1000 or 1300-1600	1000 - 1300	
32	Copper plant available (Cu) in µg Cu/kg	<15 or >90	15-30 or 75-90	30-40 or 65-75	40 - 65	
33	Cobalt plant available (Co) in µg Co/kg	<5 or >70	5-20 or 55-70	20-25 or 50-55	25 - 50	
34	Boron plant available (B) in µg B/kg	<45 or >154	45-70 or 129-154	70-129	77 - 122	
35	Molybdenum plant available (Mo) in µg Mo/kg	<40 or >5400	40-70 or 5100-5400	70-100 or 5000-5100	100 - 5000	
36	Selenium plant available (Se) in µg Se/kg	<1 or >7	1-3 or 5-7	3-3,5 or 4,5-5	3,5 - 4,5	

4. The concept of the framework

The suitability assessment framework consists of forms that the user can fill in according to the specific circumstances that are present at the intended parcel. The parameters that comprise the questions in the framework are based on the most important factors that determine the growth of walnut trees. Since the forms are rather large, they are included in the appendix. The forms can be found under Appendix 3.

The framework is divided into two separate parts; part A and part B. Part A is more general, it is easy to apply for users with only basic knowledge of agriculture, and it is usable at low-cost. It focusses on site characteristics of the subjects Climate, Topography, Hydrology and Geography/Soils.

Part B investigates the chemical composition of the soil, and mainly deals with soil fertility. This part requires more knowledge from the user, and asks for a more specialised and costly investigation. It does, however, give an insight in the current presence of chemical elements in the soil, and can therefore give valuable predictions on future fertiliser needs and the risk of toxic quantities of elements in the soil.

When assessing the suitability of a site, the user can choose to either perform only part A, or part A and B. In principle, applying part A solely will lead to a solid suitability assessment. It must be said, however, that for projects of a larger scale, the extra cost and effort needed for part B will likely pay itself back in the long term. It will give an idea of the scale of inputs needed for sufficient production, and prevents the establishment of a plantation on potentially toxic soils.

A schematic view of the decision- and application process when using the framework is shown in figure 2. The solid line describes the path from start to end when only part A is applied. The dashed line describes the path when part A and B are both applied.

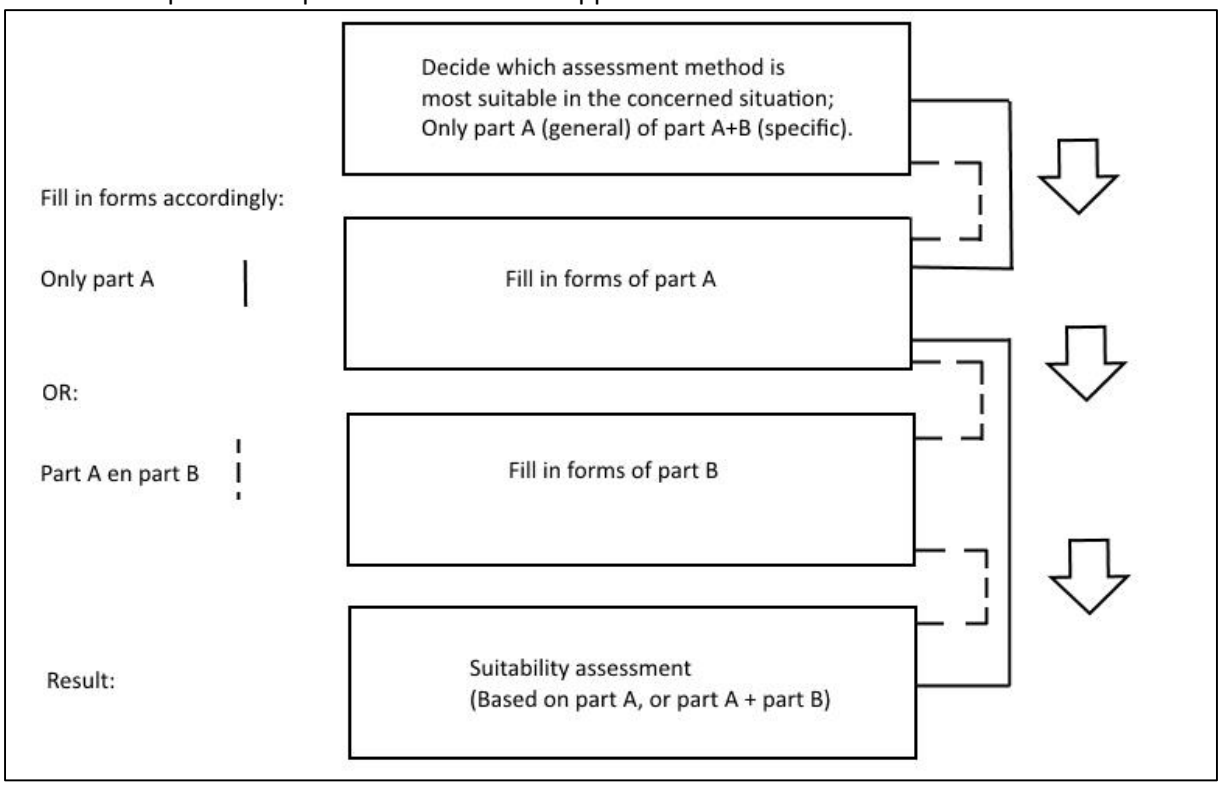

Figure 2 Schematic view of the concept of the framework.

As figure 2 shows, the user can apply the framework according to his preference and the possibilities in the concerned situation. This is done by filling in the forms that are desired with data from the intended parcel. When only part A is applied, this will lead to a score that indicates the suitability of the parcel for walnut production, according to the general site characteristics. When both part A and part B are applied, this will lead to the aforementioned outcome, plus a score that indicates the suitability of the parcel according to the presence of chemical elements in the soil.

Part A consists of three subject groups, all of which will receive a separate score. This has been done to ascertain that it is clear in which parameters possible constraints for walnut production are present. It also ensures a more even weight distribution of all variables in the total suitability score.

To further ensure a fair distribution of the weights of all variables, according to their importance for walnut growth, weighting factors are assigned to all variables. Per variable, the awarded score has to be multiplied by the weighting factor, to get the end result.

For variables that are detrimental to walnut growth in case of an unsuitable score, a knock-out factor is assigned. A score of 0 points for a variable with a Knock-out factor means that the site is unsuitable, regardless of the scores for other variables. Depending on the variable the knock-out factor is scored for, there might be possibilities to make the site suitable with management practices. However, in its current circumstances the site is unsuitable.

When categories corresponding to the site characteristics of the intended site have been selected for all variables, the resulting scores can be added up in the Suitability Assessment Result Sheet (Appendix 3). The suitability classes per subject group, as well as the total suitability class per part of the framework, can then be selected here.

The highest possible scores for the subject groups, as well as the highest possible scores for the two parts of the framework, were divided into 4 classes in order for the amounts of points to lead to a suitability class. These suitability classes are (from suitable to not suitable) S1, S2, S3 and N.

A parcel that falls in the S1 suitability class is deemed to be highly suitable for the production of walnuts. No, or insignificant limitations to the growth of walnuts exist on the parcel.

A parcel that falls in the S2 suitability class is considered moderately suitable for walnut production. However, there are some factors on the parcel that slightly limit the growth of walnut trees.

A parcel that falls in the S3 suitability class is still suitable for walnut production, but only slightly so. There are various factors on the parcel that limit the growth of walnut trees. Depending on the limiting factor(s), land management strategies (such as drainage) or inputs (such as fertilisers) can be used to improve the conditions.

A parcel that falls in the N suitability class is not suitable for walnut production. The conditions that limit the growth of walnut trees on the parcel are so severe that they inhibit the growth of walnut trees.

5. Instruction for the use of the framework

To assess an intended site, the user should fill in the forms of the framework with data corresponding to the site. These forms can be found under Appendix 3. Figure 1 shows a schematic view of the steps that are to be taken to apply the framework.

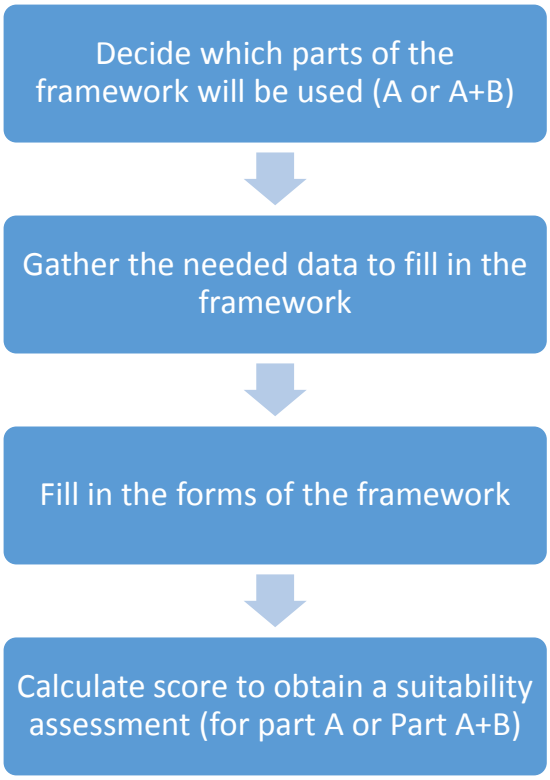

Figure 3 Schematic display of the steps to be taken to apply the framework.

For each parameter, the user has to choose which of the four categories represents the circumstances at the parcel. An example of such a parameter can be found in figure 4. The chosen category will lead to an amount of points, which can be found on top of the sheet. The amount of points awarded per parameter can be written down in a column on the right side of the sheet, under “Points awarded”. When it is not all possible to obtain data for a certain variable, choose the category that is deemed to best corresponds with the circumstances on the parcel.

Suitability assessment Juglans regia

		↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
Part A	**Climate**								
1	Average rainfall per year[1,2,3]								
		0-400	-	400-800	800-1700 (or up)		1		x

Figure 4 Example of a parameter that has to be filled in, in part A of the framework.

In the column next to it, called “Multiply by”, a number is given. This number functions as a weighting factor, to account for the relative importance of each parameter. The user has to multiply the number under “Points awarded” by the number mentioned under “Multiply by”. The outcome should be noted in the column “Result”.

The last column indicates whether a knock-out factor is assigned to a variable. If this is the case, when 0 points are scored for that variable, the site is not suitable for walnut production, regardless of the scores for other variables.

The parameters are organised per subject group (e.g. *Climate*, *Chemical composition of the soil*). The total amount of points from the "Result" column can be noted down per subject group by "Total points [subject name]" at the end of each subject. This should be done for all three subject groups. After this is done, the results from all subject groups can be filled in on the "Suitability Assessment Result Sheet". On this sheet, the results can be enumerated on the left side to find the "Total points". This "Total points" leads to the appointment of a suitability class under "Calculation of suitability class per subject".

6. The application of the framework - Benifallet

6.1 Study area

The study area (Appendix 1) is located in the Tarragona province, which is part of the autonomous community of Catalonia in the north east of Spain (Appendix 2). It is situated near the village of Benifallet. The village is situated about 19 meter above sea level, lying on the river bank.[9] However, it is surrounded by stretched-out mountainous areas. The study area is situated in such a mountainous area.

As of 2013, the municipality of Benifallet contained 725 inhabitants.[9] The village is located about 65 km southwest of the city of Tarragona. The area has a hot-summer Mediterranean climate, corresponding with a Csa classification in the Köppen climate classification system.[10]

6.2 Methods

In order to asses an intended parcel, the framework was applied. Therefore, site-specific data representing the parcel should be collected. For each parameter, as mentioned in chapter 4, a description is given on how to obtain the data that are needed.

For the application of the framework for the parcel in Benifallet, the data corresponding to all factors were measured in the field or taken from external databases. The methods as to how this was carried out will be described under each corresponding sub-header. In this way, it is easy for users of the framework to see how to carry out such an investigation themselves.

Climate

Numbers on precipitation are listed in the framework as the average amount of precipitation per year in mm.

Statistics about both the average temperature per month and temperature extremes are noted down in degrees Celsius. These statistics were derived from the national or regional meteorological institute. In this case this was the Servei Meteorològic de Catalunya; the Catalonian meteorological service. The opinions of local farmers were also used for the judgement of the climatic circumstances.

The strength of solar radiation is directly related to the latitude on the earth's surface. Therefore, data concerning the strength of solar radiation were noted down as the latitudinal position of the parcel on the Earth. The fraction of the daytime the sky is clouded was noted down as well. If this was not retrievable from the Catalonian meteorological service, a sensible estimation was made.

The mean annual wind speed was noted down in meters per second. These data were retrieved from the Catalonian meteorological service. If not retrievable from a meteorological institute, an accurate estimation of the mean annual wind speed of the location of the parcel can be derived from a national or regional wind map (also called wind atlas).

Wind salinity is divided in five classes, corresponding with the ISO 9223 Classification (Corrosion of metals and alloys -- Corrosivity of atmospheres);
C1) Very low, C2) Low, C3) Medium, C4) High, C5) Very high, CX) Extreme.
If no data is retrievable from a meteorological institute, an accurate estimation can be found on wind salinity maps.

Topography
The altitude in meters above sea level was measured at the parcel boundaries using a GPS device. The direction of the slope was determined using a compass. The percentage of slope was determined using a clinometer.

Hydrology
If present, surface water was visually determined and digitised on a map using a GPS. This is only used to exclude possible water areas from the potential planting area.
The depth of the groundwater level was determined by visual assessment during a soil survey, using a Dutch auger.

Geography and soils
During the field visit to the study area, the soil was studied with practical methods. Soil pits of 50 x 50 x 50 cm. were dug with a shovel. This was done at various points in the field. The amount of pits and their locations would be chosen in such a way that they gave a good representation of the field. When vegetation was present, this would give clues as to how many times the action had to be performed; when crops or other vegetation grew uniformly, only a few points needed to be examined. When vegetation did not grow uniformly, it would be examined for each visibly different area of crop growth.

In all of these soil pits, the possible rooting depth would be visually determined. The soil would be inspected on factors that barrier root growth, such as an impermeable layer. If such barriers existed, the depth at which they would occur were written down. The soil pits provide a good view of the soil. Therefore, to collect as much information as possible, a description of each soil profile was given, photographs of the soil were taken and for all layers the colour was noted down according to the Munsell soil colour chart.

The pH was measured in these soil pits separately for all differing soil layers. This was done using pH indicator strips. Firstly, broad range strips were used to determine which smaller-range strip should be used afterwards to get a more accurate result. Demineralised water was used to moisten the soil. Later in the process, soil analysis institute BLGG AgroXpertus performed a more accurate pH measurement from a soil sample (see under sub-header *Chemical composition of the soil*).

The soil moisture storage capacity was determined by the "Estimating soil moisture by feel and appearance"-method, according to the USDA guidelines.[11] These data were not used in the framework, but it is interesting to get an idea of the soil moisture storage capacity of the soil.

The soil drainage was classified according to the USDA Soil Survey Manual.[12] Soils are classified as one of seven different classes, ranging from excessively drained to very poorly drained. The relevant soil drainage class was derived from the soil sampling using a Dutch auger.

The soil texture was determined in the field by hand-texturing and the use of a sand ruler. Results fall in the following Wentworth classes: Clay, Silt, Very fine sand, Fine sand, Medium sand, Coarse sand, Very coarse sand, Very fine gravel, Fine gravel, Medium gravel, Coarse gravel and Very coarse gravel. These data were not used in the framework, since these soil texture classes do not have a standardised influence on the suitability for walnut production. However, it is interesting to know the texture of the soil and the characteristics that accompany it.

The permeability of the soil was determined by visual assessment during a soil survey, using a Dutch auger. It is classified according to the USDA Key for Estimating the Class of Permeability from Soil Properties.[13]

Chemical composition of the soil

Soil samples were taken in order to be analysed by soil analysis institute *BLGG AgroXpertus* in Wageningen. The soil samples were collected according to the guidelines in *Sampling Soils for Testing* by the agricultural extension service of the University of Wisconsin.[14] Every field with visually different characteristics was sampled separately. Using a Dutch auger, samples of the top 30 cm of the soil were taken. The separate samples from the different fields all contained between 15 and 25 subsamples (cores); more samples would be needed in a less uniform field, less samples would be needed in a more uniform field. The subsamples were mixed, then put in a labelled Ziploc bag and placed in a refrigerator until they were delivered at the soil analysis institute. The samples were collected on the last day of the trip, to ensure the freshness of the samples until they were delivered in Wageningen.

The institute determined the organic carbon content, C/N ratio, a more accurate pH measurement and a more accurate soil texture measurement. They also provided a determination of the soil structure, based on the measured calcium, magnesium and potassium ratio, as part of the CEC-complex.

Furthermore, the institute measured the soil content of the macronutrients nitrogen (N), sulfur (S), phosphorus (P), potassium (K), calcium (Ca) and sodium (Na) and the micronutrients silicon (Si), iron (Fe), zinc (Zn), manganese (Mn), copper (Cu), cobalt (Co), boron (B), molybdenum (Mo) and selenium (Se).

Local information

Local farmers were asked about their experiences farming the region, regarding local differences to regional or national characteristics of climate, geography, etc.

Land degradation

To assess the risk of erosion, the soil degradation status was visually assessed and classified according to chapter '3.2.2 Soil Degradation Status' of 'World map of the status of human-induced soil degradation - An explanatory note'.[15] The parcel will fall in one of the following classes: Light, Moderate, Strong or Extreme.

Land cover

The currently present land cover can give clues on the site characteristics and the suitability for walnut trees. It was visually assessed and classified using the FAO Land Cover Classification System. Currently present species were, as far as determinable, noted as well. If not, the vegetation type was noted.

6.3 Results

The suitability assessment was performed two times for the parcel in Benifallet, as there were two separate fields with quite clearly distinct soils. Figure 5 shows a map with the two parcels, parcel 1 being significantly smaller than parcel 2.

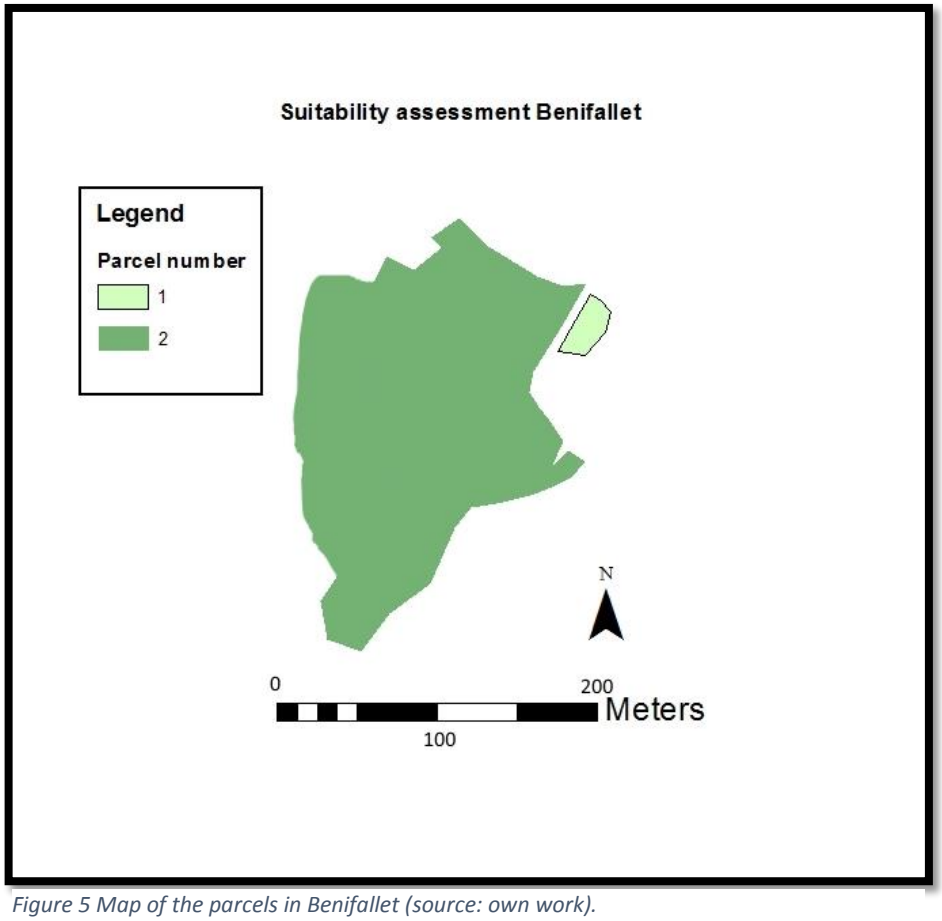

Figure 5 Map of the parcels in Benifallet (source: own work).

The completed suitability assessment forms, as applied for both parcels, can be found in the appendix under "Appendix 4–Suitability Assessment Parcel 1" and "Appendix 5-Suitability Assessment Parcel 2". The results of the suitability assessment will be discussed separately for each parcel below.

Parcel 1
With 46.5 points in part A, parcel number 1 falls in the S1 class. This means that the parcel **is suitable** for walnut production according to the general site characteristics. There are only minor limitations for the production of walnuts.

With 22 points in part B, parcel number 1 falls in the S3 class. This means that the parcel **is suitable** for walnut production when looking at the chemical elements in the soil, but with severe limitations. These limitations can largely be solved by following the fertilisation advice by BLGG AgroXpertus, as given in "Appendix 6–Soil Analysis Parcel 1".

Table 2 Suitability classes assigned to parcel 1.

			S Class:
Part A	Total points climate:	25.25	S1
	Total points topography, hydrology, geography and soils:	14.5	S1
	Total points chemical composition of the soil:	6.75	S1
	Total part A:	46.5	S1
Part B	Total points chemical composition of the soil:	22	S3
	Total part B:	22	S3

Land degradation status: Light
Current land cover: Orchard – FAO land cover code: 61. Light tree cover of Carob tree (Ceratonia siliqua).

Parcel 2
With 48.25 points in part A, parcel number 1 falls in the S1 class. This means that the parcel **is suitable** for walnut production according to the general site characteristics. There are only minor limitations for the production of walnuts. The score for this part is even a bit higher than that of parcel 1.

With 16 points in part B, parcel number 1 falls in the S3 class. This means that the parcel **is suitable** for walnut production when looking at the chemical elements in the soil, but with severe limitations. These limitations can largely be solved by following the fertilisation advice by BLGG AgroXpertus, as given in "Appendix 7–Soil Analysis Parcel 2".

Table 3 Suitability classes assigned to parcel 2.

			S Class:
Part A	Total points climate:	25.25	S1
	Total points topography, hydrology, geography and soils:	15.5	S1
	Total points chemical composition of the soil:	7.5	S1
	Total part A:	48.25	S1
Part B	Total points chemical composition of the soil:	16	S3
	Total part B:	16	S3

Land degradation status: Light
Current land cover: Orchard - FAO land cover code: 61. Light tree cover of olive (Olea europaea), carob tree (Ceratonia siliqua) and almond (Prunus dulcis).

Most parameters seem to have similar values for both parcel 1 and 2. The difference in score is largely caused by a difference in the content of some chemical elements in the soil. Parcel 2, for example, has a plant available calcium content so high that it places it in the least suitable category, whereas parcel 1 falls in the most suitable category for this parameter.

The results of the soil analysis, as performed by BLGG AgroXpertus, can be viewed in the appendix, under “Appendix 6–Soil Analysis Parcel 1” and “Appendix 7–Soil Analysis Parcel 2”.

6.4 Recommendations

Since both parcels fall in the same suitability class with only minor differences, the advice for the most suitable walnut varieties to be planted will count for both of them. The walnut varieties advised to be planted on the parcels are;

Juglans regia *Chandler*,
Juglans regia *Parisienne*,
Juglans regia *Cisco*,
Juglans regia *Ronde de Montignac* and,
Juglans regia *Buccaneer.*

These varieties should bloom in such a way that they overlap each other’s blooming period so that there will at all times be an adequate amount of pollen available for the pistillate flowers of all varieties. Furthermore, the varieties produce large yield of good quality tasty nuts, and are not very susceptible to diseases. They are very suitable for the climatic conditions in Benifallet, as they are very tolerant of higher temperatures, occasional dry periods, and shorter winter periods. The Buccaneer serves mainly as a pollinator, for this variety has a very long flowering period.

The trees can be planted in a quincunx design (a square with one tree in the middle, like the side with five dots on a dice), with the outer square-forming trees at a spacing of 11 meters. The *Cisco* would be a suitable tree for the middle of the square, since these trees tend to stay somewhat smaller in size. Following this orchard design, a hectare can fit approximately 173 trees.

Most trees will have reached a profitable productivity after about six years. By then, they will yield an average of at least 35 kg shelled walnut per tree. This means 6055 kg of shelled walnuts per hectare. Shelled nuts can be sold for about € 3,50 per kg.[16] This will lead to an income of € 21192,5 per hectare per year. This should be enough to make the investment viable in the long term. However, the first years require a rather large investment with no direct income.

7. Discussion

7.1 Outcome for the parcel in Benifallet

The expectation was that the parcel would be suitable for profitable walnut production, as almond, orange and olive plantations have been known to function productively in the region for years.

The conclusion of the EURAF report[1] suggested as well that walnuts could prove to grow well in the region. However, the suitability would depend on local factors.

Following the outcome of the suitability assessment, this report now also suggests that the parcels are suitable for walnut production. The future, however, will teach us how the trees on the parcels will perform. The performance of the trees will be monitored on a biyearly basis. Although tree growth is also dependant on management factors, these evaluations will give confirmation on how well the suitability assessment framework functions.

As both parts of the framework have been applied to the study area in Benifallet, this was a good way to study how the framework performs, if it functions as promised, and what kind of information both parts give about a parcel.

It seems that it is important, especially for professional orchard establishment, that both parts of the framework are applied. A parcel can potentially be very suitable for walnut production according to the general site characteristics, but be completely unsuitable according to the chemical composition of the soil. Not all deficiencies of chemicals in the soil have to be a major problem, as they can be solved by fertilisation. If this is an economically feasible option, however, remains an important question. Part A of the framework at itself gives a good general idea of the potential suitability of a site. The advice, however, is to apply both parts of the framework for a more detailed and informative outcome, especially for larger scale projects.

7.2 Applicability in other locations

The site characteristics of four locations that are known walnut production regions have been collected, in order to apply part A of the framework to these locations. This was done in order to verify whether the framework is indeed universally applicable.

The locations are Grenoble –France, California –United States, Maule – Chile, and Karaman – Turkey. Only part A would be applied, as it would be impossible for the scale of this research to obtain data on the chemical composition of the soil, as detailed as is needed for part B, for the mentioned locations.

Unfortunately, it appeared to be very hard as well to obtain information for some of the parameters of part A of the framework, in this timeframe. According to the information that *was* obtained, the parcels would indeed turn out to be suitable. However, this maintains uncertain to say with the missing information. It is hoped that the missing information will be present at the time of the presentation, where an update will be given.

As soon as this suitability assessment framework will be used by more people, the hope is that those people will cooperate with regular evaluations as well. This will lead to a better verified and therefore better functioning framework.

No problems were encountered using the suitability assessment framework for the application for Benifallet. The utmost dedication was put into it. However, if any problems arise, please do not hesitate to comment in order to improve the framework.

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2: Schematic view of the concept of the framework. Nunspeet (NL): Nils de Koning; 2014.
3: Schematic display of the steps that are needed to apply the framework. Nunspeet (NL): Nils de Koning; 2014.
4: Example of a parameter that has to be filled in, in part A of the framework. Nunspeet (NL): Nils de Koning; 2014.
5: Map of the parcels in Benifallet. Nunspeet (NL): Nils de Koning; 2014.

Tables

1: Summary of the variables in the framework. Nunspeet (NL): Nils de Koning; 2014.
2: Suitability classes assigned to parcel 1. Nunspeet (NL): Nils de Koning; 2014.
3: Suitability classes assigned to parcel 2. Nunspeet (NL): Nils de Koning; 2014.

Appendices

1: Satellite image of Spain [Internet]. 40° 4'0.38"N and 4°10'35.03"W. Mountain View CA (US): Google Earth; 10-04-2013 [viewed 19-03-2014]; [1 screen]; color. Available from: http://www.google.nl/intl/nl/earth/
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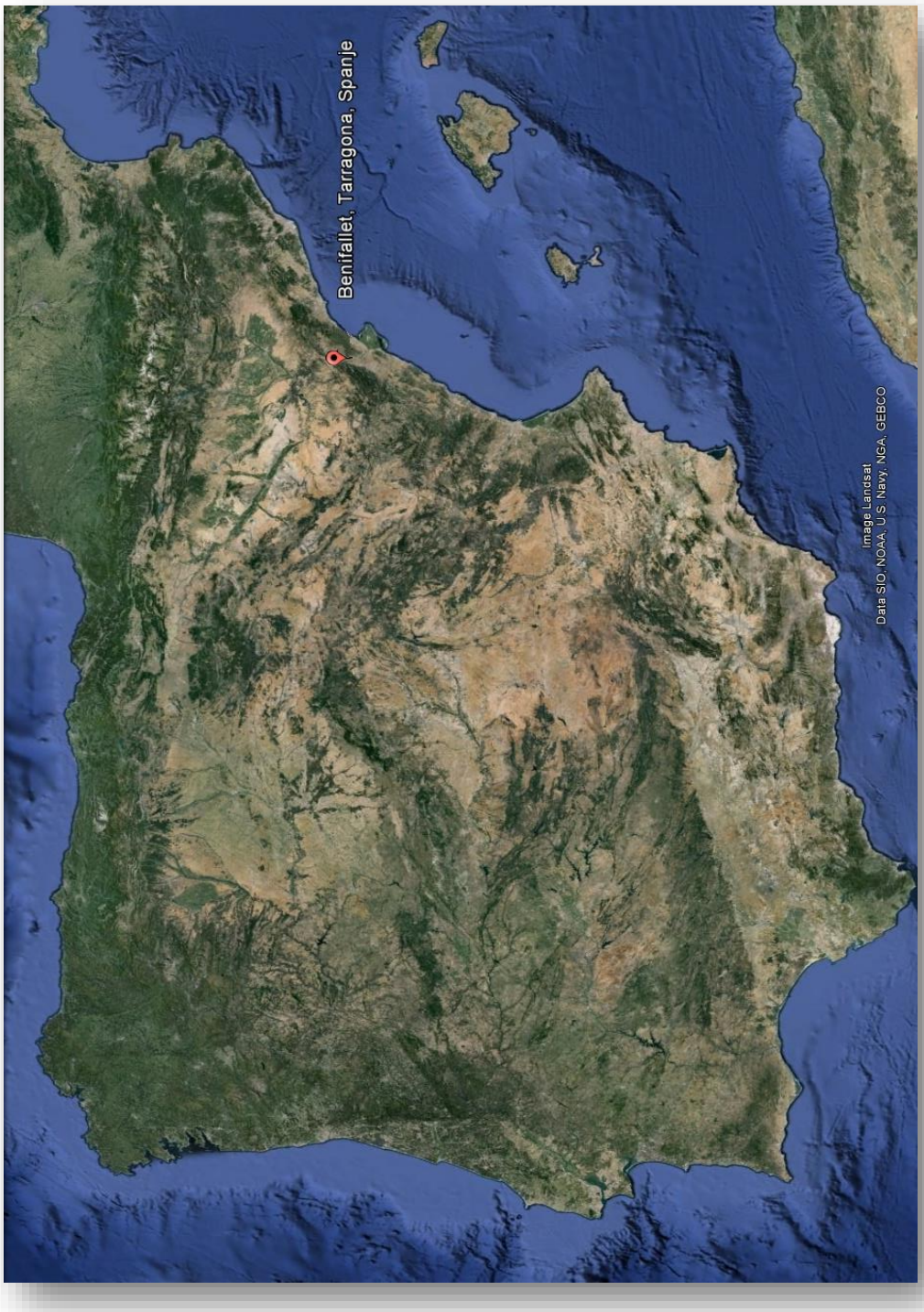
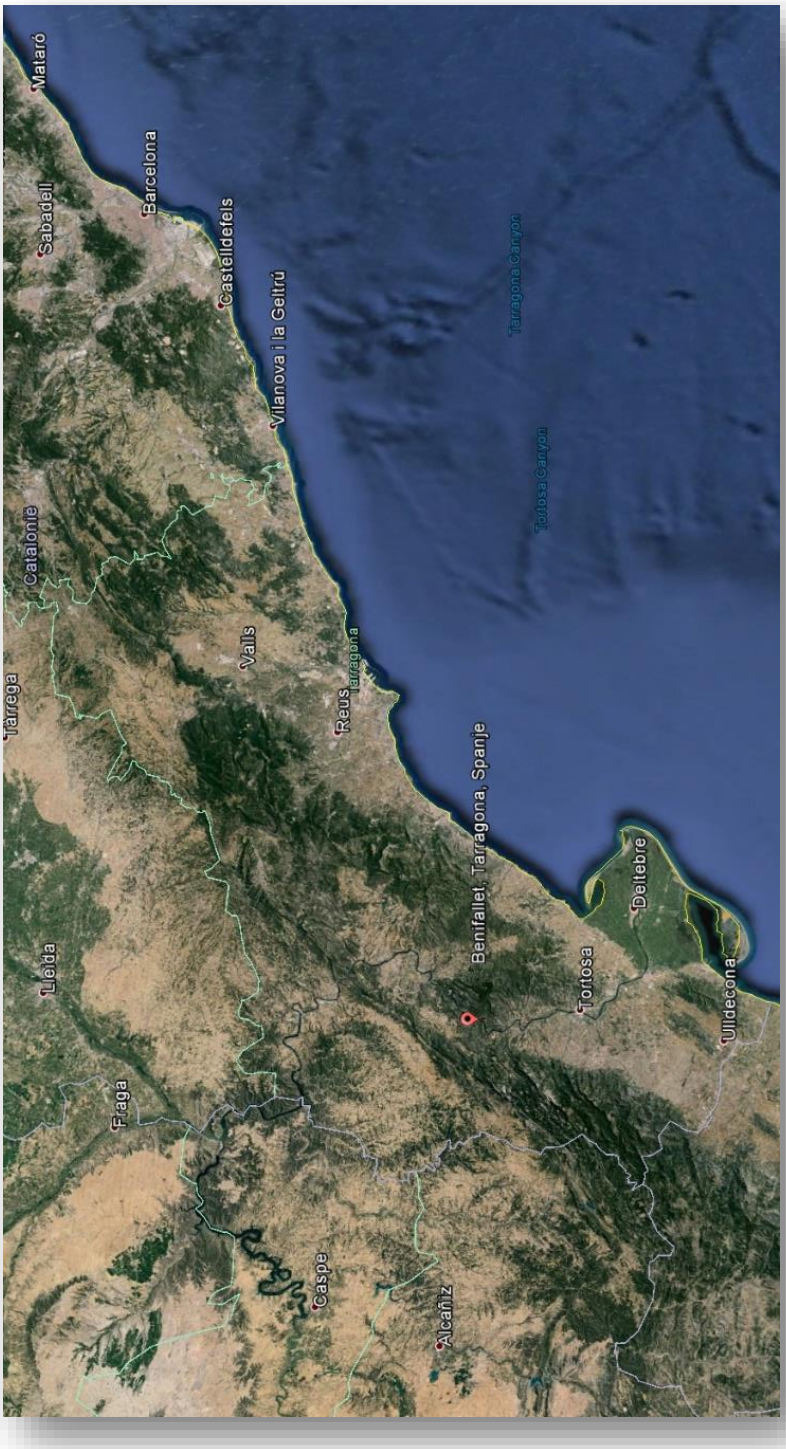
Appendix 1–Map of Spain



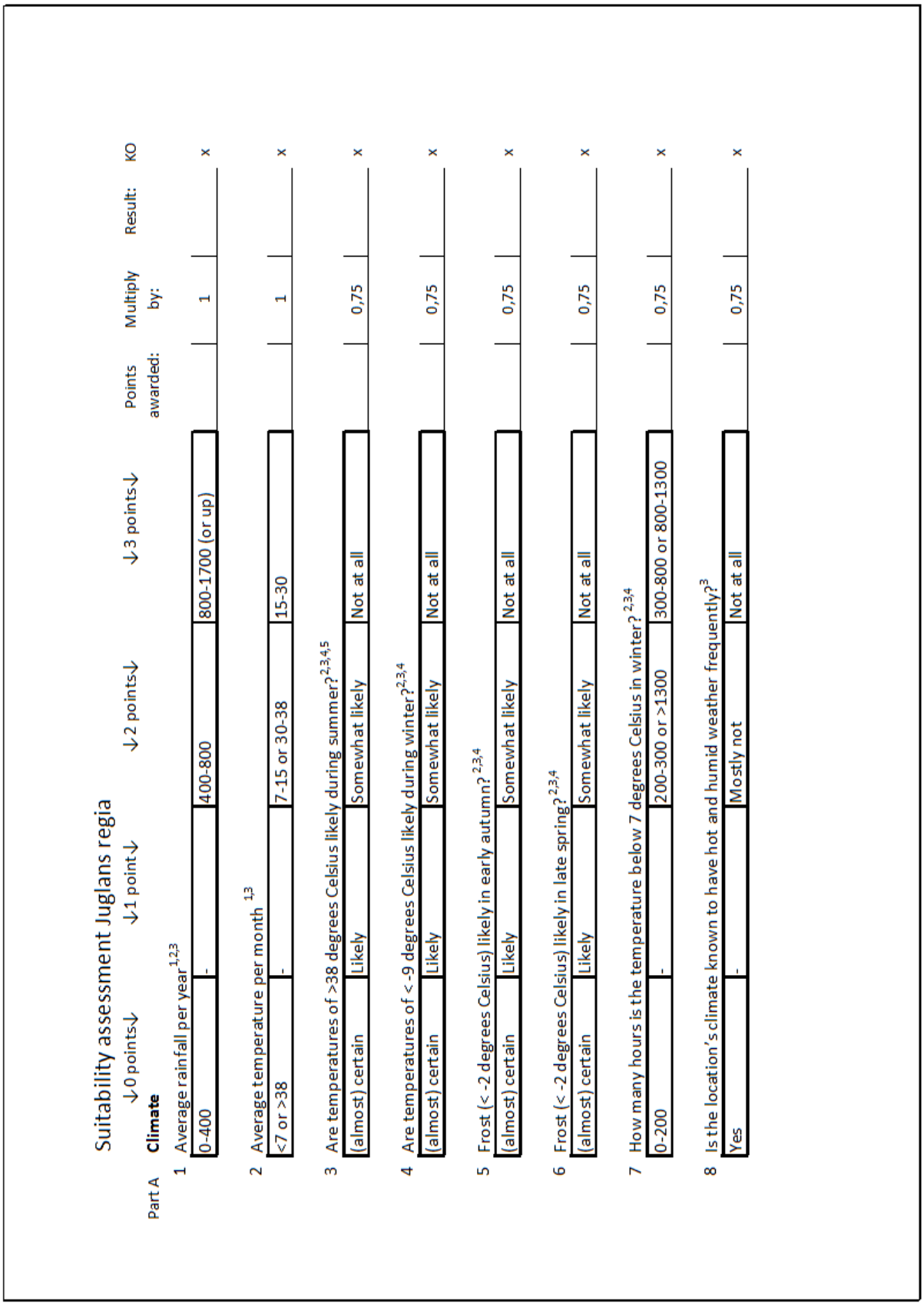
The location of Benifallet in relation to the Iberian peninsula. (source: Google Earth)

Appendix 2–Map of Catalonia



The location of Benifallet in relation to Catalonia. (source: Google Earth)

Appendix 3–The Suitability Assessment Forms



Suitability assessment Juglans regia

Part A	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
Climate								
1 Average rainfall per year[1,2,3]	0-400	-	400-800	800-1700 (or up)		1		x
2 Average temperature per month [1,3]	<7 or >38	-	7-15 or 30-38	15-30		1		x
3 Are temperatures of >38 degrees Celsius likely during summer?[2,3,4,5]	(almost) certain	Likely	Somewhat likely	Not at all		0,75		x
4 Are temperatures of < -9 degrees Celsius likely during winter?[2,3,4]	(almost) certain	Likely	Somewhat likely	Not at all		0,75		x
5 Frost (< -2 degrees Celsius) likely in early autumn?[2,3,4]	(almost) certain	Likely	Somewhat likely	Not at all		0,75		x
6 Frost (< -2 degrees Celsius) likely in late spring?[2,3,4]	(almost) certain	Likely	Somewhat likely	Not at all		0,75		x
7 How many hours is the temperature below 7 degrees Celsius in winter?[2,3,4]	0-200	-	200-300 or >1300	300-800 or 800-1300		0,75		x
8 Is the location's climate known to have hot and humid weather frequently?[3]	Yes	-	Mostly not	Not at all		0,75		x

Part A	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
9 The latitudinal position on the Earth (in degrees).[1]								
	<-60 or >60	-	-30 to -60 or 30 to 60	-30 to 30		1		
10 What is the predominant cloud cover during the growing season?[1]								
	-	Mostly cloudy	Mix cloudy/clear sky	Mostly clear sky		0,75		
11 The mean annual wind speed in meters per second.[2,3,4]								
	>7,0	6-7	-	<6		1		x
12 Wind salinity								
C1) Very low, C2) Low, C3) Medium, C4) High, C5) Very high, CX) Extreme.[3,4]								
	C4, C5 or CX	C3	C2	C1		1		

Total points climate: _____

Part A **Topography**

	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
13 The altitude in meters above sea level.[33]								
	>3000	1000-3000	800-1000	<800		0,50		
Hydrology								
14 The depth of the groundwater level.[2,4,5]								
	<80	80 1.20	1.20 2.00	>2.00		1		x
Geography and soils								
15 The rootable soil depth.[2,3,4]								
	<80	80-1.20	1.20-200	>2.00		1		x
16 The soil drainage class.[2]								
	Very poorly drained to somewhat poorly drained.	-	Moderately well drained.	Well drained to excessively drained.		1		x
17 The permeability of the soil.								
	Impermeable, Very slow, Slow.	Moderately slow.	Moderate.	Moderately rapid, Rapid, Very rapid.		1		x
18 Soil structure, based on the CEC-complex.* CEC as mmol+/kg is:								
	<45	45-60	60-89	>89		1		

Total points topography, hydrology, geography and soils: _____

Part A **Chemical composition of the soil**

	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
19 Organic carbon content.[2,3]	<1	1-1,5	1,5-2	2-4 (or >)		0,75		
20 C/N ratio	-	-	<13 or >17	13-17		0,75		
21 pH[1,2,3,4,5]	<5,5 or >8,5	-	5,5-6,5 or 8-8,5	6,5-8		1		x
22 Nitrogen supply (N) in kg N/ha	<40 or >200	40-70 or 180-200	70-93 or 147-180	93 - 147		0,75		

Total points chemical composition of the soil: _____

Part B **Chemical composition of the soil**

	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:
22 Nitrogen supply (N) in kg N/ha	<40 or >200	40-70 or 180-200	70-93 or 147-180	93 - 147		1	
23 Sulfur supply (S) in kg S/ha 21	<8 or >45	8-15 or 35-45	15-20 or 30-35	20 - 30		1	
24 Phosphorus plant available (P) in mg P/kg	<0,5 or >2,4	0,5-0,8 or 2,1-2,4	0,8-1,1 or 1,9-2,1	1,1 - 1,9		1	
25 Potassium plant available (K) in mg K/kg	<35 or >145	35-50 or 130-145	50-70 or 110-130	70 - 110		1	
26 Calcium plant available (Ca) in kg Ca/ha	<60 or >869	60-150 or 770-869	150-279 or 650-779	279 - 650		1	
27 Sodium plant available (Na) in mg Na/kg	<15 or >70	15-25 or 60-70	25-35 or 50-60	35 - 50		1	
28 Silicon plant available (Si) in µg Si/kg	<1000 or >37000	1000-3500 or 34500-37000	3500-6000 or 32000-34500	6000 - 32000		1	
29 Iron plant available (Fe) in µg Fe/kg	<800 or >6200	800-1500 or 5500-6200	1500-2500 or 4500-5500	2500 - 4500		1	

Part B	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:
30 Zinc plant available (Zn) in µg Zn/kg							
	<180 or >1070	180-350 or 900-1070	350-500 or 750-900	500 - 750		1	
31 Manganese plant available (Mn) in µg Mn/kg							
	<300 or >2000	300-700 or 1600-2000	700-1000 or 1300-1600	1000 - 1300		1	
32 Copper plant available (Cu) in µg Cu/kg							
	<15 or >90	15-30 or 75-90	30-40 or 65-75	40 - 65		1	
33 Cobalt plant available (Co) in µg Co/kg							
	<5 or >70	5-20 or 55-70	20-25 or 50-55	25 - 50		1	
34 Boron plant available (B) in µg B/kg							
	<45 or >154	45-70 or 129-154	70-129	77 - 122		1	
35 Molybdenum plant available (Mo) in µg Mo/kg							
	<40 or >5400	40-70 or 5100-5400	70-100 or 5000-5100	100 - 5000		1	
36 Selenium plant available (Se) in µg Se/kg							
	<1 or >7	1-3 or 5-7	3-3,5 or 4,5-5	3,5 - 4,5		1	

Total points chemical composition of the soil (part B): _____

Suitability Assessment Result Sheet

Add up of awarded points:

Part A	Total points climate:	
	Total points topography, hydrology, geography and soils:	
	Total points chemical composition of the soil:	
	Total part A:	
Part B	Total points chemical composition of the soil:	
	Total part B:	

Calculation of suitability class per subject:

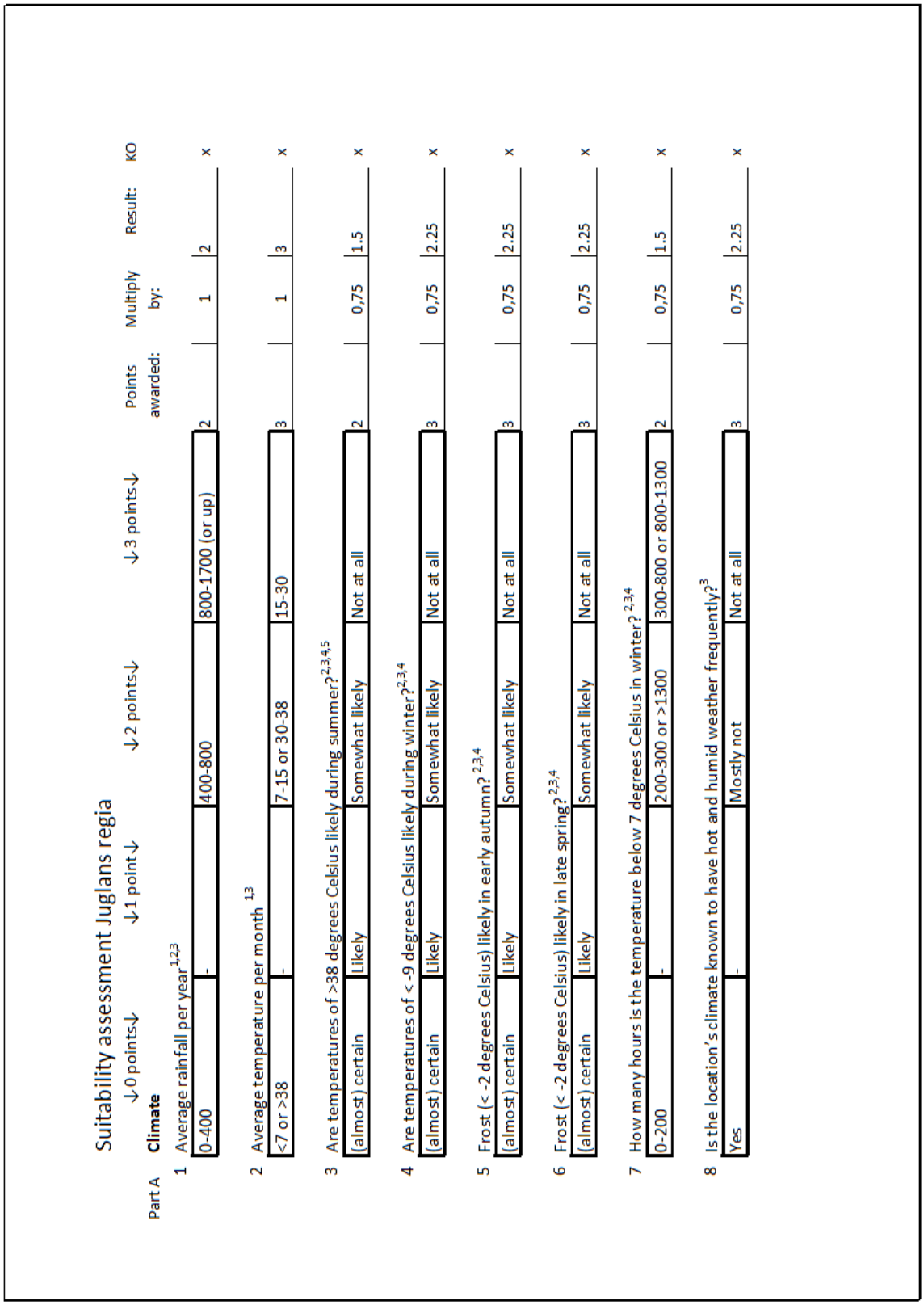
		N	S3	S2	S1
Part A	Climate	0 - 7.75	7.75 - 15.5	15.5 - 23.25	23.25 - 30.75
	Topo, hydro, geo, soils	0 - 3.5	3.5 - 7.5	7.5 - 11.5	11.5 - 15.5
	Chem. Comp. Of soil:	0 - 1.5	1.5 -3.5	3.5 - 5.5	5.5 - 7.5
Part B	Chem. Comp. Of soil:	0 - 11.25	11.25 -23.5	22.5 - 33.75	33.75 - 45

Calculation of suitability class per part:

	N	S3	S2	S1
Part A	0 - 12.75	12.75 - 26.5	26.5 - 40.25	40.25 - 53.75
Part B	0 - 11.25	11.25 -22.5	22.5 - 33.75	33.75 - 45

Suitability class:	Explanation:
N	Land with limitations for walnut production so severe that it excludes this as a sensible land use.
S3	Land with moderate to severe limitations for the production of walnuts.
S2	Land with minor to moderate limitations for the production of walnuts.
S1	Land with no, or insignificant limitations for the production of walnuts.

Appendix 4–Suitability Assessment Parcel 1



Suitability assessment Juglans regia

Part A		↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
	Climate								
1	Average rainfall per year[1,2,3]	0-400	-	400-800	800-1700 (or up)	2	1	2	x
2	Average temperature per month [1,3]	<7 or >38	-	7-15 or 30-38	15-30	3	1	3	x
3	Are temperatures of >38 degrees Celsius likely during summer?[2,3,4,5]	(almost) certain	Likely	Somewhat likely	Not at all	2	0,75	1.5	x
4	Are temperatures of < -9 degrees Celsius likely during winter?[2,3,4]	(almost) certain	Likely	Somewhat likely	Not at all	3	0,75	2.25	x
5	Frost (< -2 degrees Celsius) likely in early autumn? [2,3,4]	(almost) certain	Likely	Somewhat likely	Not at all	3	0,75	2.25	x
6	Frost (< -2 degrees Celsius) likely in late spring?[2,3,4]	(almost) certain	Likely	Somewhat likely	Not at all	3	0,75	2.25	x
7	How many hours is the temperature below 7 degrees Celsius in winter? [2,3,4]	0-200	-	200-300 or >1300	300-800 or 800-1300	2	0,75	1.5	x
8	Is the location's climate known to have hot and humid weather frequently?[3]	Yes	-	Mostly not	Not at all	3	0,75	2.25	x

Part A	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
9 The latitudinal position on the Earth (in degrees).[1]								
	<-60 or >60	-	-30 to -60 or 30 to 60	-30 to 30	2	1	2	
10 What is the predominant cloud cover during the growing season?[2]								
	-	Mostly cloudy	Mix cloudy/clear sky	Mostly clear sky	3	0,75	2,25	
11 The mean annual wind speed in meters per second.[2,3,4]								
	>7,0	6- 7	-	<6	3	1	3	x
12 Wind salinity								
C1) Very low, C2) Low, C3) Medium, C4) High, C5) Very high, CX) Extreme.[3,4]								
	C4, C5 or CX	C3	C2	C1	1	1	1	

Total points climate: 25,25

Part A **Topography**

	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
13 The altitude in meters above sea level. [3,5]								
	>3000	1000-3000	800-1000	<800	3	0,50	1.5	
Hydrology								
14 The depth of the groundwater level.[2,3,4]								
	<80	80-1.20	1.20-2.00	>2.00	3	1	3	x
Geography and soils								
15 The rootable soil depth.[2,3,4]								
	<80	80-1.20	1.20-200	>2.00	3	1	3	x
16 The soil drainage class.[6]								
	Very poorly drained to somewhat poorly drained.	-	Moderately well drained.	Well drained to excessively drained.	2	1	2	x
17 The permeability of the soil.								
	Impermeable, Very slow, Slow.	Moderately slow.	Moderate.	Moderately rapid, Rapid, Very rapid.	2	1	2	x
18 Soil structure, based on the CEC-complex.[6] CEC as mmol+/kg is:								
	<45	45-60	60-89	>89	3	1	3	

Total points topography, hydrology, geography and soils: 14.5

Part A **Chemical composition of the soil**

	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
19 Organic carbon content.[2,3]	<1	1-1,5	1,5-2	2-4 (or >)	1	0,75	0.75	
20 C/N ratio	-	-	<13 or >17	13-17	2	0,75	1.5	
21 pH[1,2,3,4,5]	<5,5 or >8,5	-	5,5-6,5 or 8-8,5	6,5-8	3	1	3	x
22 Nitrogen supply (N) in kg N/ha	<40 or >200	40-70 or 180-200	70-93 or 147-180	93 - 147	2	0,75	1.5	

Total points chemical composition of the soil: 6.75

Part B **Chemical composition of the soil**

	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:
22 Nitrogen supply (N) in kg N/ha	<40 or >200	40-70 or 180-200	70-93 or 147-180	93 - 147	2	1	2
23 Sulfur supply (S) in kg S/ha 21	<8 or >45	8-15 or 35-45	15-20 or 30-35	20 - 30	3	1	3
24 Phosphorus plant available (P) in mg P/kg	<0,5 or >2,4	0,5-0,8 or 2,1-2,4	0,8-1,1 or 1,9-2,1	1,1 - 1,9	0	1	0
25 Potassium plant available (K) in mg K/kg	<35 or >145	35-50 or 130-145	50-70 or 110-130	70 - 110	2	1	2
26 Calcium plant available (Ca) in kg Ca/ha	<60 or >869	60-150 or 770-869	150-279 or 650-779	279 - 650	3	1	3
27 Sodium plant available (Na) in mg Na/kg	<15 or >70	15-25 or 60-70	25-35 or 50-60	35 - 50	2	1	2
28 Silicon plant available (Si) in µg Si/kg	<1000 or >37000	1000-3500 or 34500-37000	3500-6000 or 32000-34500	6000 - 32000	3	1	3
29 Iron plant available (Fe) in µg Fe/kg	<800 or >6200	800-1500 or 5500-6200	1500-2500 or 4500-5500	2500 - 4500	3	1	3

Part B	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:
30 Zinc plant available (Zn) in µg Zn/kg							
	<180 or >1070	180-350 or 900-1070	350-500 or 750-900	500 - 750	0	1	0
31 Manganese plant available (Mn) in µg Mn/kg							
	<300 or >2000	300 700 or 1600 2000	700-1000 or 1300-1600	1000 - 1300	0	1	0
32 Copper plant available (Cu) in µg Cu/kg							
	<15 or >90	15 30 or 75 90	30 40 or 65 75	40 65	1	1	1
33 Cobalt plant available (Co) in µg Co/kg							
	<5 or >70	5-20 or 55-70	20-25 or 50-55	25 - 50	0	1	0
34 Boron plant available (B) in µg B/kg							
	<45 or >154	45-70 or 129-154	70-129	77 - 122	0	1	0
35 Molybdenum plant available (Mo) in µg Mo/kg							
	<40 or >5400	40 70 or 5100 5400	70 100 or 5000 5100	100 5000	1	1	1
36 Selenium plant available (Se) in µg Se/kg							
	<1 or >7	1-3 or 5-7	3-3,5 or 4,5-5	3,5 - 4,5	2	1	2

Total points chemical composition of the soil (part B): 22

Suitability Assessment Result Sheet Parcel 1

Add up of awarded points:

Part A	Total points climate:	22.25
	Total points topography, hydrology, geography and soils:	14.5
	Total points chemical composition of the soil:	9.75
	Total part A:	46.5
Part B	Total points chemical composition of the soil:	22
	Total part B:	22

Calculation of suitability class per subject:

		N	S3	S2	S1
Part A	Climate	0 - 7.75	7.75 - 15.5	15.5 - 23.25	23.25 - 30.75
	Topo, hydro, geo, soils	0 - 3.5	3.5 - 7.5	7.5 - 11.5	11.5 - 15.5
	Chem. Comp. Of soil:	0 - 1.5	1.5 - 3.5	3.5 - 5.5	5.5 - 7.5
Part B	Chem. Comp. Of soil:	0 - 11.25	11.25 - 22.5	22.5 - 33.75	33.75 - 45

Calculation of suitability class per part:

	N	S3	S2	S1
Part A	0 - 12.75	12.75 - 26.5	26.5 - 40.25	40.25 - 53.75
Part B	0 - 11.25	11.25 - 22.5	22.5 - 33.75	33.75 - 45

Suitability class:	Explanation:
N	Land with limitations for walnut production so severe that it excludes this as a sensible land use.
S3	Land with moderate to severe limitations for the production of walnuts.
S2	Land with minor to moderate limitations for the production of walnuts.
S1	Land with no, or insignificant limitations for the production of walnuts.

Appendix 5–Suitability Assessment Parcel 2

Suitability assessment Juglans regia

Part A	Climate	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
1	Average rainfall per year[1,2]	0-400	-	400-800	800-1,700 (or up)	2	1	2	x
2	Average temperature per month[1,5]	<7 or >38	-	7-15 or 30-38	15-30	3	1	3	x
3	Are temperatures of >38 degrees Celsius likely during summer?[1,2,4,5]	(almost) certain	Likely	Somewhat likely	Not at all	2	0,75	1.5	x
4	Are temperatures of < -9 degrees Celsius likely during winter?[1,2,4]	(almost) certain	Likely	Somewhat likely	Not at all	3	0,75	2.25	x
5	Frost (< -2 degrees Celsius) likely in early autumn?[1,2,4]	(almost) certain	Likely	Somewhat likely	Not at all	3	0,75	2.25	x
6	Frost (< -2 degrees Celsius) likely in late spring?[1,2,4]	(almost) certain	Likely	Somewhat likely	Not at all	3	0,75	2.25	x
7	How many hours is the temperature below 7 degrees Celsius in winter?[1,2,4]	0-200		200-300 or >1300	300-800 or 800-1300	2	0,75	1.5	x
8	Is the location's climate known to have hot and humid weather frequently?[2]	Yes	-	Mostly not	Not at all	3	0,75	2.25	x

Part A	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
9 The latitudinal position on the Earth (in degrees).[1]								
	<-60 or >60	-	-30 to -60 or 30 to 60	-30 to 30	2	1	2	
10 What is the predominant cloud cover during the growing season?[2]								
	-	Mostly cloudy	Mix cloudy/clear sky	Mostly clear sky	3	0,75	2,25	
11 The mean annual wind speed in meters per second.[2,3,4]								
	>7,0	6-7	-	<6	3	1	3	x
12 Wind salinity								
C1) Very low, C2) Low, C3) Medium, C4) High, C5) Very High, CX) Extreme.[3,4]								
	C4, C5 or CX	C3	C2	C1	1	1	1	
					Total points climate:		25,25	

Part A **Topography**

	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
13 The altitude in meters above sea level.[15]								
	>3000	1000-3000	800-1000	<800	3	0,50	1,5	
Hydrology								
14 The depth of the groundwater level.[2,4,5]								
	<80	80 1.20	1.20 2.00	>2.00	3	1	3	x
Geography and soils								
15 The rootable soil depth.[2,3,4]								
	<80	80-1.20	1.20-200	>2.00	3	1	3	x
16 The soil drainage class.[6]								
	Very poorly drained to somewhat poorly drained.	-	Moderately well drained.	Well drained to excessively drained.	2	1	2	x
17 The permeability of the soil.								
	Impermeable, Very slow, Slow.	Moderately slow.	Moderate.	Moderately rapid, Rapid, Very rapid.	2	1	2	x
18 Soil structure, based on the CEC-complex.[8] CEC as mmol+/kg is:								
	<45	45-60	60-89	>89	3	1	3	

Total points topography, hydrology, geography and soils: 15,5

Part A **Chemical composition of the soil**

	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:	KO
19 Organic carbon content.[2,5]								
	<1	1-1,5	1,5-2	2-4 (or >)	3	0,75	2,25	
20 C/N ratio								
	-	-	<13 or >17	13-17	2	0,75	1,5	
21 pH[3,4,5,6]								
	<5,5 or >8,5	-	5,5-6,5 or 8-8,5	6,5-8	3	1	3	x
22 Nitrogen supply (N) in kg N/ha								
	<40 or >200	40-70 or 180-200	70-93 or 147-180	93 - 147	1	0,75	0,75	

total points chemical composition of the soil: 7,5

Part B **Chemical composition of the soil**

	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:
22 Nitrogen supply (N) in kg N/ha							
	<40 or >200	40-70 or 180-200	70-93 or 147-180	93 - 147	1	1	1
23 Sulfur supply (S) in kg S/ha 21							
	<8 or >45	8-15 or 35-45	15-20 or 30-35	20 - 30	3	1	3
24 Phosphorus plant available (P) in mg P/kg							
	<0,5 or >2,4	0,5 0,8 or 2,1 2,4	0,8 1,1 or 1,9 2,1	1,1 1,9	0	1	0
25 Potassium plant available (K) in mg K/kg							
	<35 or >145	35-50 or 130-145	50-70 or 110-130	70 - 110	3	1	3
26 Calcium plant available (Ca) in kg Ca/ha							
	<60 or >869	60-150 or 770-869	150-279 or 650-779	279 - 650	0	1	0
27 Sodium plant available (Na) in mg Na/kg							
	<15 or >70	15 25 or 60 70	25 35 or 50 60	35 50	1	1	1
28 Silicon plant available (Si) in µg Si/kg							
	<1000 or >37000	1000-3500 or 34500-37000	3500-6000 or 32000-34500	6000 - 32000	3	1	1
29 Iron plant available (Fe) in µg Fe/kg							
	<800 or >6200	800-1500 or 5500-6200	1500-2500 or 4500-5500	2500 - 4500	3	1	1

Part B	↓0 points↓	↓1 point↓	↓2 points↓	↓3 points↓	Points awarded:	Multiply by:	Result:
30 Zinc plant available (Zn) in µg Zn/kg							
	<180 or >1070	180-350 or 900-1070	350-500 or 750-900	500 - 750	0	1	0
31 Manganese plant available (Mn) in µg Mn/kg							
	<300 or >2000	300-700 or 1600-2000	700-1000 or 1200-1600	1000 - 1300	0	1	0
32 Copper plant available (Cu) in µg Cu/kg							
	<15 or >90	15-30 or 75-90	30-40 or 65-75	40 - 65	1	1	1
33 Cobalt plant available (Co) in µg Co/kg							
	<5 or >70	5-20 or 55-70	20-25 or 50-55	25 - 50	0	1	0
34 Boron plant available (B) in µg B/kg							
	<45 or >154	45-70 or 129-154	70-129	77 - 122	0	1	0
35 Molybdenum plant available (Mo) in µg Mo/kg							
	<40 or >5400	40-70 or 5100-5400	70-100 or 5000-5100	100 - 5000	0	1	0
36 Selenium plant available (Se) in µg Se/kg							
	<1 or >7	1-3 or 5-7	3-3,5 or 4,5-5	3,5 - 4,5	1	1	1

Total points chemical composition of the soil (part B): 16

Suitability Assessment Result Sheet Parcel 2

Add up of awarded points:

Part A	Total points climate:	25.25
	Total points topography, hydrology, geography and soils:	15.5
	Total points chemical composition of the soil:	7.5
	Total part A:	48.25
Part B	Total points chemical composition of the soil:	16
	Total part B:	16

Calculation of suitability class per subject:

		N	S3	S2	S1
Part A	Climate	0 - 7.75	7.75 - 15.5	15.5 - 23.25	23.25 - 30.75
	Topo, hydro, geo, soils	0 - 3.5	3.5 - 7.5	7.5 - 11.5	11.5 - 15.5
	Chem. Comp. Of soil	0 - 1.5	1.5 - 3.5	3.5 - 5.5	5.5 - 7.5
Part B	Chem. Comp. Of soil	0 - 11.25	11.25 - 22.5	22.5 - 33.75	33.75 - 45

Calculation of suitability class per part:

	N	S3	S2	S1
Part A	0 - 12.75	12.75 - 26.5	26.5 - 40.25	40.25 - 53.75
Part B	0 - 11.25	11.25 - 22.5	22.5 - 33.75	33.75 - 45

Suitability class:	Explanation:
N	Land with limitations for walnut production so severe that it excludes this as a sensible land use.
S3	Land with moderate to severe limitations for the production of walnuts.
S2	Land with minor to moderate limitations for the production of walnuts.
S1	Land with no, or insignificant limitations for the production of walnuts.

Appendix 6–Soil Analysis Parcel 1

BEMESTINGSWIJZER

Boomteelt
Walnoten Sub 1

Uw klantnummer: 8501831

Nils de Koning
V Karnebeekstr 39
8072 BM NUNSPEET

BLGG AGROXPERTUS

Postbus 170
NL - 6700 AD Wageningen

T monstername: Bram Jansen: 0652002137
T klantenservice: +31 (0)88 876 1010
E klantenservice@blgg.agroxpertus.nl
I blgg.agroxpertus.nl

Onderzoek	Onderzoek-/ordernr:	Datum monstername:	Datum verslag:
	717333/003335392	07-05-2014	19-05-2014

Resultaat		Eenheid	Resultaat	Streeftraject	laag	vrij laag	goed	vrij hoog	hoog
hoofdelement	N-totale bodemvoorraad	mg N/kg	1020						
	C/N-ratio		6	13 - 17					
	N-leverend vermogen	kg N/ha	85	93 - 147					
	S-totale bodemvoorraad	mg S/kg	240						
	C/S-ratio		25	50 - 75					
	S-leverend vermogen	kg S/ha	21	20 - 30					
	P plant beschikbaar	mg P/kg	0,2	1,1 - 1,9					
	P-bodemvoorraad (P-Al)	mg P_2O_5/100 g	3	31 - 43					
	P-buffering		15	17 - 27					
	Pw	mg P_2O_5/l	8						
	K plant beschikbaar	mg K/kg	65	70 - 110					
	K-getal		15						
	K-bodemvoorraad	mmol+/kg	3,8	2,8 - 3,9					
	Ca plant beschikbaar	kg Ca/ha	495	279 - 650					
	Ca-bodemvoorraad	kg Ca/ha	7900	5570 - 8360					
	Mg plant beschikbaar	mg Mg/kg	127	131 - 164					
	Na plant beschikbaar	mg Na/kg	28	35 - 50					
sporenelement	Si plant beschikbaar	µg Si/kg	13820	6000 - 32000					
	Fe plant beschikbaar	µg Fe/kg	< 3040	2500 - 4500					
	Zn plant beschikbaar	µg Zn/kg	150	500 - 750					
	Mn plant beschikbaar	µg Mn/kg	< 250	1000 - 1300					
	Cu plant beschikbaar	µg Cu/kg	28	40 - 65					
	Co plant beschikbaar	µg Co/kg	2,7	25 - 50					
	B plant beschikbaar	µg B/kg	242	77 - 122					
	Mo plant beschikbaar	µg Mo/kg	43	100 - 5000					
	Se plant beschikbaar	µg Se/kg	3,4	3,5 - 4,5					
fysisch	Zuurgraad (pH)		7,4	5,5 - 6,8					
	C-organisch	%	0,6						
	Organische stof	%	1,2						
	C-anorganisch	%	3,59						
	Koolzure kalk	%	28,2	2,0 - 3,0					
	Klei	%	14						
	Silt	%	19						
	Zand	%	38						
	Klei-humus (CEC)	mmol+/kg	115	> 89					
	CEC-bezetting	%	100	> 95					
biologisch	Bodemleven	mg N/kg	< 1						

Walnoten Sub 1

Advies		Frequentie	Gewas	Adviesgift 2014	2015
in kg per ha per jaar	N-correctie			10	10
			Deze gift kunt u als correctie op de basisgift toepassen. Zie voor meer info de toelichting.		
	Sulfaat (SO_3)		Vruchtbomen	0	25
	Fosfaat (P_2O_5)		Vruchtbomen	200	200
	Kali (K_2O)		Vruchtbomen	125	125
	Calcium (CaO)		Vruchtbomen	30	30
	Magnesium (MgO)		Vruchtbomen	100	100
	Zink (Zn)	per jaar		1,0	
			De bemesting wordt geadviseerd voor Zn-gevoelige gewassen. Zie de toelichting.		
	Koper (Cu)	per jaar	Vruchtbomen	1,0	
	Borium (B)	per jaar	Vruchtbomen	0	
	Kalk (nw)	eenmalig	Vruchtbomen	0	
			Er wordt geadviseerd om zuurwerkende meststoffen te gebruiken.		

Toelichting

De resultaten en/of het advies van dit bemestingsonderzoek kunt u t/m 2015 gebruiken. Laat het perceel daarna opnieuw bemonsteren. Dan krijgt u een betrouwbaar bemestingsadvies gebaseerd op de actuele bodemtoestand.

gebruiksnorm

De adviezen die vermeld worden, zijn gebaseerd op het halen van een landbouwkundig optimale opbrengst op perceelsniveau. Vanuit de wetgeving zijn er gebruiksnormen. Gebruiksnormen gelden op bedrijfsniveau. Als de som van de landbouwkundige adviesgiften hoger is dan de gebruiksnorm, verlaag dan de gift bij de minst behoeftige gewassen. Overleg dit met uw adviseur.

Bij gebruik van organische mest dienen de hiermee gegeven voedingsstoffen op de geadviseerde hoeveelheden in mindering te worden gebracht.

Aanvulgronden: om een specifiek advies te kunnen geven voor het type aanvulgrond is het mogelijk hiervoor een onderzoek naar de granulaire samenstelling van de grond te laten uitvoeren. Dit kan tegelijk of aanvullend op het bemestingsonderzoek worden uitgevoerd. Nadere informatie hierover kan verstrekt worden door de rayonmedewerker of door Klantenservice.

Stikstof:
De N-levering is lager dan gemiddeld op deze grondsoort. Er wordt daarom geadviseerd om het basisadvies dat geldt voor het gewas te verhogen; deze aanpassing is als N-correctie aangegeven. De N-correctie gaat uit van een groeiseizoen van circa 5 maanden. Als het groeiseizoen korter is, bijv. 4 maanden; dan 4/5 deel van de genoemde N-correctie gebruiken voor verhoging van de N-gift.
Voor een goed stikstofadvies vindt de bemonstering plaats in het groeiseizoen. In de periode eind april tot eind juli kan hiervoor een stikstof-bijmestmonster (N-plus) worden genomen. Op basis hiervan wordt een stikstofadvies voor het betreffende gewas gegeven.

Zwavel:
Bij de adviesgift voor zwavel is rekening gehouden met capillaire opstijging, depositie, S-leverend vermogen (SLV) en onttrekking door het gewas.

Kali:
Het K-getal is berekend vanuit de kalium gemeten via de Plant Available Elements-methode (K-PAE).

Calcium:
Het calciumadvies is gebaseerd op de hoeveelheid calcium aan het klei-humuscomplex (CEC), voor de plant beschikbare calcium in de bodem (Ca-beschikbaar) en op gewaseigenschappen (o.a. type gewas en gevoeligheid voor Ca-gebrek).
Om de bodemtoestand te handhaven en/of omdat voor bepaalde gewassen de gevoeligheid voor Ca dusdanig is, kan er - ondanks een grote hoeveelheid Ca-beschikbaar - toch nog een Ca-advies gegeven zijn.
De adviesgift moet u nog corrigeren voor de hoeveelheid calcium in meststoffen zoals KAS, (tripel)superfosfaat en kalkmeststoffen.

Natrium:
Uit onderzoek blijkt dat een natriumgift voor deze teelt niet zinvol is. Er wordt dus geen waardering en advies gegeven. Natrium wordt echter wel gemeten omdat het onderdeel is van het klei-humuscomplex (CEC-bezetting).

Zink:
Zink is een sporenelement. Het is onder andere een onderdeel van plantenhormonen en het heeft een rol bij de vorming van eiwitten.
Gewassen met een hoge Zn-behoefte zijn: bonen, fruitbomen, vlas, maïs, spinazie, ui en groenten. Bij gebruik van dierlijke mest is de kans op een tekort aan zink kleiner.

Org.stofbalans In de gekleurde balk staat de informatie over organische stof (kg/ha) die u moet weten om het organische stofgehalte niet te laten dalen.

Jaarlijks afbraakpercentage van de totale voorraad organische stof: 3,5

- 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 om percentage organische stof op peil te houden.
- Aanvoer via gewasresten (gemiddeld binnen opgegeven bouwplan of gewassen).
- Nog aan te vullen via bijv. dierlijke mest, groenbemesters en/of compost.

Gewas(rest)	Aanvoer effectieve organische stof
Vruchtbomen	200
Gemiddelde aanvoer/jaar	200

De aanvoer kan variëren van 200 kg als het alleen om wortelresten gaat, tot 1200 kg voor overjarige bladverliezende gewassen met een volgroeide oppervlakte.

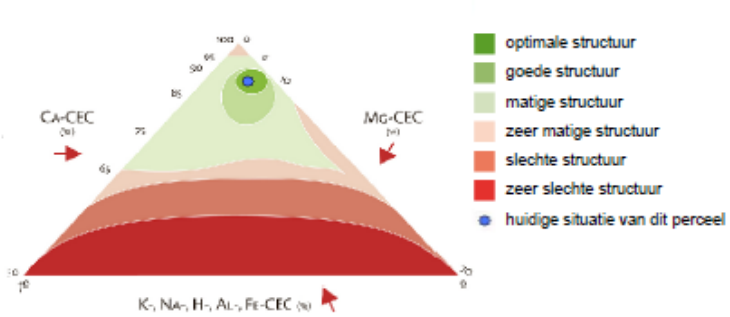
Om het organische stofgehalte met 0,1% te verhogen dient u een extra hoeveelheid effectieve organische stof aan te voeren van: 3860 kg per ha.

Walnoten Sub 1

Fysisch

De beoordeling van de structuur wordt gedaan op basis van de gemeten verhouding tussen calcium, magnesium en kali als bezetting 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 transportmiddelen en machines. De beoordeling is een basis voor de realisatie van een goede structuurvoorwaarde.

Weergave onderlinge verhouding van de CEC-bezetting.



	Eenheid	Resultaat	Streeftraject	laag	vrij laag	goed	vrij hoog	hoog
Klei-humus (CEC)	mmol+/kg	115	> 89					
Ca-bezetting	%	89	80 - 90					
Mg-bezetting	%	7,0	6,0 - 10					
K-bezetting	%	3,3	2,0 - 5,0					
Na-bezetting	%	1,0	2,0 - 4,0					
H-bezetting	%	< 0,1						
Al-bezetting	%	< 0,1						

in kg per ha per jaar

	Frequentie	Adviesgift
Calcium (CaO)	eenmalig	0

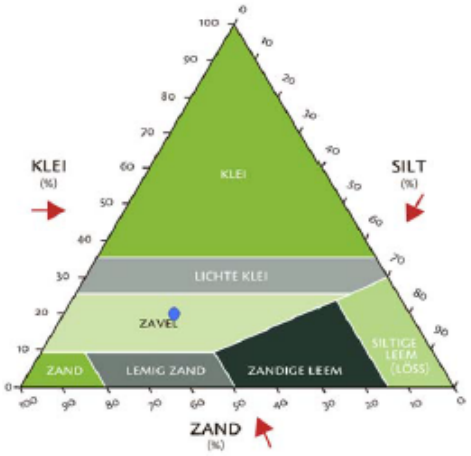
Een calciumgift op basis van de verhoudingen aan het complex is niet nodig. Het is mogelijk dat u wel een calciumadvies voor uw gewas geadviseerd krijgt. Dit kunt u gewoon opvolgen zonder dat dit nadelige gevolgen heeft voor de structuur.

Walnoten Sub 1

BLGG AGROXPERTUS

Fysisch

Weergave van de textuurdriehoek.



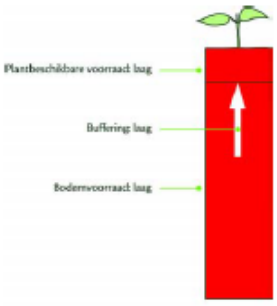
Naast klei (lutum), worden ook de silt- en zandfracties weergegeven. Klei is kleiner dan 2 micrometer (µm), siltdeeltjes zijn 2-50 µm en zanddeeltjes groter dan 50 µm. De onderlinge verdeling van bodemdeeltjes wordt onder andere gebruikt om het verslempingsrisico van een bodem in te schatten. Bij verslemping 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 een bepaalde verhouding aan bodemdeeltjes met 10-20% klei is het risico op slemp het grootst.
Indicatie van % afslibbaar = % klei plus 0,3 * % silt.

	Eenheid	Waardering	Streeftraject	laag	vrij laag	goed	zeer goed
Verkruimelbaarheid	rapportcijfer	8,1	6,0 - 8,0				
Verslemping	rapportcijfer	3,3	6,0 - 8,0				

De verkruimelbaarheid is goed te noemen. Echter is dit ook afhankelijk van de soort teelt.

Er is kans op verslemping. Het is raadzaam om de organische stof in de bodem op peil te houden of zelfs op termijn te verhogen. De organische stof zorgt namelijk voor binding tussen de gronddeeltjes.

Fosfaat



Op de voorkant van het verslag staan de resultaten voor fosfaat op de gebruikelijke manier gepresenteerd: een getal en een waarderingsbalkje. De cijfers zijn ook verwerkt in een 'bodemprofiel' (zie figuur). Hierin geven we de fosfaatvoorraad en de beschikbare hoeveelheid P met kleuren aan. De pijl symboliseert de nalevering vanuit de voorraad. De dikte van de pijl toont hoeveel nalevering van fosfaat per groeiseizoen mogelijk is.

Contact & info

Bemonsterde laag:	0 - 30 cm
Grondsoort:	Zavel
Monster genomen door:	Derden
Contactpersoon monstername:	Bram Jansen: 0652002137

Na verzending van dit verslag wordt, indien de aard en de onderzoeksmethode van het monster dit toelaat, het monster nog twee weken bij BLGG AgroXpertus voor u bewaard. Binnen deze tijd kunt u eventueel reclameren en/of aanvullend onderzoek aanvragen.

717333, 19-05-2014

Walnoten Sub 1

Methode						
	N-totale bodemvoorraad	Q	Em: NIRS (TSC®)	Co plant beschikbaar	Q	Em: CCL3(PAE®)
	C/N-ratio		afgeleide waarde	B plant beschikbaar	Q	Em: CCL3(PAE®)
	N-leverend vermogen		afgeleide waarde	Mo plant beschikbaar		Em: CCL3(PAE®)
	S-totale bodemvoorraad	Q	Em: NIRS (TSC®)	Se plant beschikbaar		Em: CCL3(PAE®)
	C/S-ratio		afgeleide waarde	Zuurgraad (pH)	Q	Em: PHC3:(Gw ISO 10390)
	S-leverend vermogen		afgeleide waarde	C-organisch	Q	Em: NIRS (TSC®)
	P plant beschikbaar	Q	Em: CCL3(PAE®)	Organische stof		afgeleide waarde
	P-bodemvoorraad (P-Al)	Q	PAL1: Gw NEN 5793	C-anorganisch		Em: NIRS (TSC®)
	Pw		afgeleide waarde	Koolzure kalk		afgeleide waarde
	K-getal		afgeleide waarde	Klei		Em: NIRS (TSC®)
	K plant beschikbaar	Q	Em: CCL3(PAE®)	Slit		Em: NIRS (TSC®)
	K-bodemvoorraad		Em: NIRS (TSC®)	Zand		Em: NIRS (TSC®)
	Ca plant beschikbaar		afgeleide waarde	Klei-humus (CEC)		Em: NIRS (TSC®)
	Ca-bodemvoorraad		afgeleide waarde	Ca-bezetting		Em: NIRS (TSC®)
	Mg plant beschikbaar	Q	Em: CCL3(PAE®)	Mg-bezetting		Em: NIRS (TSC®)
	Na plant beschikbaar	Q	Em: CCL3(PAE®)	K-bezetting		Em: NIRS (TSC®)
	Si plant beschikbaar		Em: CCL3(PAE®)	Na-bezetting		Em: NIRS (TSC®)
	Fe plant beschikbaar		Em: CCL3(PAE®)	H-bezetting		afgeleide waarde
	Zn plant beschikbaar		Em: CCL3(PAE®)	Al-bezetting		afgeleide waarde
	Mn plant beschikbaar	Q	Em: CCL3(PAE®)	CEC-bezetting		afgeleide waarde
	Cu plant beschikbaar	Q	Em: CCL3(PAE®)	Bodemleven		Em: NIRS (TSC®)

Q Methode geaccrediteerd door RvA
Em: Eigen methode, Gw: Gelijkwaardig aan, Cf: Conform
P plant beschikbaar Deze analyse is in duplo uitgevoerd.
P-bodemvoorraad (P-Al) Deze analyse is in duplo uitgevoerd.

De resultaten zijn weergegeven in droge grond.
Alle verrichtingen zijn binnen de gestelde houdbaarheidstermijn tussen monstername en analyse uitgevoerd.
De gerapporteerde resultaten hebben uitsluitend betrekking op het aan BLGG AgroXpertus aangeleverde materiaal op 08-05-2014

Appendix 7–Soil Analysis Parcel 2

BEMESTINGSWIJZER

Boomteelt
Walnoten Sub 2

Uw klantnummer: 8501831

Nils de Koning
V Kamebeekstr 39
8072 BM NUNSPEET

BLGG AGROXPERTUS

Postbus 170
NL - 6700 AD Wageningen

T monstername: Bram Jansen: 0652002137
T klantenservice: +31 (0)88 876 1010
E klantenservice@blgg.agroxpertus.nl
I blgg.agroxpertus.nl

Onderzoek	Onderzoek-/ordernr:	Datum monstername:	Datum verslag:
	717332/003335392	07-05-2014	19-05-2014

Resultaat		Eenheid	Resultaat	Streeftraject	laag	vrij laag	goed	vrij hoog	hoog
hoofdelement	N-totale bodemvoorraad	mg N/kg	890						
	C/N-ratio		12	13 - 17					
	N-leverend vermogen	kg N/ha	52	93 - 147					
	S-totale bodemvoorraad	mg S/kg	340						
	C/S-ratio		30	50 - 75					
	S-leverend vermogen	kg S/ha	28	20 - 30					
	P plant beschikbaar	mg P/kg	0,3	1,1 - 1,9					
	P-bodemvoorraad (P-Al)	mg P_2O_5/100 g	6	31 - 43					
	P-buffering		20	17 - 27					
	Pw	mg P_2O_5/l	12						
	K plant beschikbaar	mg K/kg	75	70 - 110					
	K-getal		15						
	K-bodemvoorraad	mmol+/kg	3,6	2,8 - 3,9					
	Ca plant beschikbaar	kg Ca/ha	2581	271 - 632					
	Ca-bodemvoorraad	kg Ca/ha	7470	5620 - 8430					
	Mg plant beschikbaar	mg Mg/kg	128	131 - 164					
	Na plant beschikbaar	mg Na/kg	22	35 - 50					
sporenelement	Si plant beschikbaar	µg Si/kg	16850	6000 - 32000					
	Fe plant beschikbaar	µg Fe/kg	3240	2500 - 4500					
	Zn plant beschikbaar	µg Zn/kg	< 100	500 - 750					
	Mn plant beschikbaar	µg Mn/kg	< 250	1000 - 1300					
	Cu plant beschikbaar	µg Cu/kg	20	40 - 65					
	Co plant beschikbaar	µg Co/kg	< 2,5	25 - 50					
	B plant beschikbaar	µg B/kg	251	77 - 122					
	Mo plant beschikbaar	µg Mo/kg	5	100 - 5000					
	Se plant beschikbaar	µg Se/kg	5,7	3,5 - 4,5					
fysisch	Zuurgraad (pH)		7,5	5,5 - 6,8					
	C-organisch	%	1,0						
	Organische stof	%	2,1						
	C-anorganisch	%	4,93						
	Koolzure kalk	%	38,9	2,0 - 3,0					
	Klei	%	8						
	Silt	%	36						
	Zand	%	15						
	Klei-humus (CEC)	mmol+/kg	116	> 64					
	CEC-bezetting	%	100	> 95					
biologisch	Bodemleven	mg N/kg	36						

Pagina: 1
Totaal aantal pagina's: 6

717332, 19-05-2014

Walnoten Sub 2

Advies		Frequentie	Gewas	Adviesgift 2014	2015
in kg per ha per jaar	N-correctie			10	10
			Deze gift kunt u als correctie op de basisgift toepassen. Zie voor meer info de toelichting.		
	Sulfaat (SO_3)		Vruchtbomen	0	25
	Fosfaat (P_2O_5)		Vruchtbomen	200	200
	Kali (K_2O)		Vruchtbomen	125	125
	Calcium (CaO)		Vruchtbomen	15	15
	Magnesium (MgO)		Vruchtbomen	100	100
	Zink (Zn)	per jaar		1,0	
			De bemesting wordt geadviseerd voor Zn-gevoelige gewassen. Zie de toelichting.		
	Koper (Cu)	per jaar	Vruchtbomen	2,0	
	Borium (B)	per jaar	Vruchtbomen	0	
	Kalk (nw)	eenmalig	Vruchtbomen	0	
			Er wordt geadviseerd om zuurwerkende meststoffen te gebruiken.		

Toelichting

De resultaten en/of het advies van dit bemestingsonderzoek kunt u t/m 2015 gebruiken. Laat het perceel daarna opnieuw bemonsteren. Dan krijgt u een betrouwbaar bemestingsadvies gebaseerd op de actuele bodemtoestand.

gebruiksnorm

De adviezen die vermeld worden, zijn gebaseerd op het halen van een landbouwkundig optimale opbrengst op perceelsniveau. Vanuit de wetgeving zijn er gebruiksnormen. Gebruiksnormen gelden op bedrijfsniveau. Als de som van de landbouwkundige adviesgiften hoger is dan de gebruiksnorm, verlaag dan de gift bij de minst behoeftige gewassen. Overleg dit met uw adviseur.

Bij gebruik van organische mest dienen de hiermee gegeven voedingsstoffen op de geadviseerde hoeveelheden in mindering te worden gebracht.

Aanvulgronden: om een specifiek advies te kunnen geven voor het type aanvulgrond is het mogelijk hiervoor een onderzoek naar de granulaire samenstelling van de grond te laten uitvoeren. Dit kan tegelijk of aanvullend op het bemestingsonderzoek worden uitgevoerd. Nadere informatie hierover kan verstrekt worden door de rayonmedewerker of door Klantenservice.

Stikstof:
De N-levering is lager dan gemiddeld op deze grondsoort. Er wordt daarom geadviseerd om het basisadvies dat geldt voor het gewas te verhogen; deze aanpassing is als N-correctie aangegeven. De N-correctie gaat uit van een groeiseizoen van circa 5 maanden. Als het groeiseizoen korter is, bijv. 4 maanden; dan 4/5 deel van de genoemde N-correctie gebruiken voor verhoging van de N-gift.
Voor een goed stikstofadvies vindt de bemonstering plaats in het groeiseizoen. In de periode eind april tot eind juli kan hiervoor een stikstof-bijmestmonster (N-plus) worden genomen. Op basis hiervan wordt een stikstofadvies voor het betreffende gewas gegeven.

Zwavel:
Bij de adviesgift voor zwavel is rekening gehouden met capillaire opstijging, depositie, S-leverend vermogen (SLV) en onttrekking door het gewas.

Kali:
Het K-getal is berekend vanuit de kalium gemeten via de Plant Available Elements-methode (K-PAE).

Calcium:
Het calciumadvies is gebaseerd op de hoeveelheid calcium aan het klei-humuscomplex (CEC), voor de plant beschikbare calcium in de bodem (Ca-beschikbaar) en op gewaseigenschappen (o.a. type gewas en gevoeligheid voor Ca-gebrek).
Om de bodemtoestand te handhaven en/of omdat voor bepaalde gewassen de gevoeligheid voor Ca dusdanig is, kan er - ondanks een grote hoeveelheid Ca-beschikbaar - toch nog een Ca-advies gegeven zijn.
De adviesgift moet u nog corrigeren voor de hoeveelheid calcium in meststoffen zoals KAS, (tripel)superfosfaat en kalkmeststoffen.

Natrium:
Uit onderzoek blijkt dat een natriumgift voor deze teelt niet zinvol is. Er wordt dus geen waardering en advies gegeven. Natrium wordt echter wel gemeten omdat het onderdeel is van het klei-humuscomplex (CEC-bezetting).

Zink:
Zink is een sporenelement. Het is onder andere een onderdeel van plantenhormonen en het heeft een rol bij de vorming van eiwitten.
Gewassen met een hoge Zn-behoefte zijn: bonen, fruitbomen, vlas, maïs, spinazie, ui en groenten. Bij gebruik van dierlijke mest is de kans op een tekort aan zink kleiner.

Org.stofbalans In de gekleurde balk staat de informatie over organische stof (kg/ha) die u moet weten om het organische stofgehalte niet te laten dalen.

Jaarlijks afbraakpercentage van de totale voorraad organische stof: 3,2

- 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 om percentage organische stof op peil te houden.
- Aanvoer via gewasresten (gemiddeld binnen opgegeven bouwplan of gewassen).
- Nog aan te vullen via bijv. dierlijke mest, groenbemesters en/of compost.

Gewas(rest)	Aanvoer effectieve organische stof
Vruchtbomen	200
Gemiddelde aanvoer/jaar	200

De aanvoer kan variëren van 200 kg als het alleen om wortelresten gaat, tot 1200 kg voor overjarige bladverliezende gewassen met een volgroeide oppervlakte.

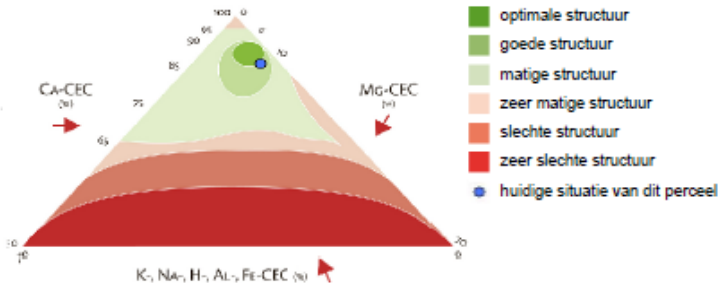
Om het organische stofgehalte met 0,1% te verhogen dient u een extra hoeveelheid effectieve organische stof aan te voeren van: 3755 kg per ha.

Walnoten Sub 2

Fysisch

De beoordeling van de structuur wordt gedaan op basis van de gemeten verhouding tussen calcium, magnesium en kali als bezetting 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 transportmiddelen en machines. De beoordeling is een basis voor de realisatie van een goede structuurvoorwaarde.

Weergave onderlinge verhouding van de CEC-bezetting.



	Eenheid	Resultaat	Streeftraject	laag	vrij laag	goed	vrij hoog	hoog
Klei-humus (CEC)	mmol+/kg	116	> 64					
Ca-bezetting	%	86	80 - 90					
Mg-bezetting	%	11	6,0 - 10					
K-bezetting	%	3,1	2,0 - 5,0					
Na-bezetting	%	0,8	2,0 - 4,0					
H-bezetting	%	< 0,1						
Al-bezetting	%	< 0,1						

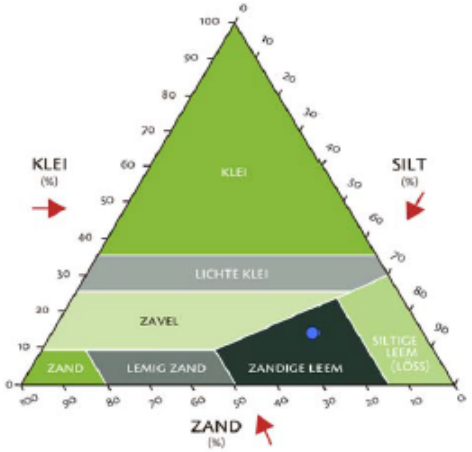
in kg per ha per jaar

	Frequentie	Adviesgift
Calcium (CaO)	eenmalig	0

Een calciumgift op basis van de verhoudingen aan het complex is niet nodig. Het is mogelijk dat u wel een calciumadvies voor uw gewas geadviseerd krijgt. Dit kunt u gewoon opvolgen zonder dat dit nadelige gevolgen heeft voor de structuur.

Fysisch

Weergave van de textuurdriehoek.



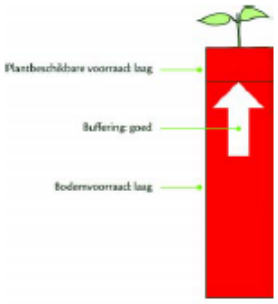
Naast klei (lutum), worden ook de silt- en zandfracties weergegeven. Klei is kleiner dan 2 micrometer (µm), siltdeeltjes zijn 2-50 µm en zanddeeltjes groter dan 50 µm. De onderlinge verdeling van bodemdeeltjes wordt onder andere gebruikt om het verslempingsrisico van een bodem in te schatten. Bij verslemping 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 een bepaalde verhouding aan bodemdeeltjes met 10-20% klei is het risico op slemp het grootst.
Indicatie van % afslibbaar = % klei plus 0,3 * % silt.

	Eenheid	Waardering	Streeftraject	laag	vrij laag	goed	zeer goed
Verkruimelbaarheid	rapportcijfer	9,1	6,0 - 8,0				
Verslemping	rapportcijfer	4,8	6,0 - 8,0				

De verkruimelbaarheid is goed te noemen. Echter is dit ook afhankelijk van de soort teelt.

Er is kans op verslemping. Het is raadzaam om de organische stof in de bodem op peil te houden of zelfs op termijn te verhogen. De organische stof zorgt namelijk voor binding tussen de gronddeeltjes.

Fosfaat



Op de voorkant van het verslag staan de resultaten voor fosfaat op de gebruikelijke manier gepresenteerd: een getal en een waarderingsbalkje. De cijfers zijn ook verwerkt in een 'bodemprofiel' (zie figuur). Hierin geven we de fosfaatvoorraad en de beschikbare hoeveelheid P met kleuren aan. De pijl symboliseert de nalevering vanuit de voorraad. De dikte van de pijl toont hoeveel nalevering van fosfaat per groeiseizoen mogelijk is.

Contact & info

Bemonsterde laag:	0 - 30 cm
Grondsoort:	Zandige leem
Monster genomen door:	Derden
Contactpersoon monstername:	Bram Jansen: 0652002137

Na verzending van dit verslag wordt, indien de aard en de onderzoeksmethode van het monster dit toelaat, het monster nog twee weken bij BLGG AgroXpertus voor u bewaard. Binnen deze tijd kunt u eventueel reclameren en/of aanvullend onderzoek aanvragen.

Walnoten Sub 2

Methode						
	N-totale bodemvoorraad	Q	Em: NIRS (TSC®)	Co plant beschikbaar	Q	Em: CCL3(PAE®)
	C/N-ratio		afgeleide waarde	B plant beschikbaar	Q	Em: CCL3(PAE®)
	N-leverend vermogen		afgeleide waarde	Mo plant beschikbaar		Em: CCL3(PAE®)
	S-totale bodemvoorraad	Q	Em: NIRS (TSC®)	Se plant beschikbaar		Em: CCL3(PAE®)
	C/S-ratio		afgeleide waarde	Zuurgraad (pH)	Q	Em: PHC3:(Gw ISO 10390)
	S-leverend vermogen		afgeleide waarde	C-organisch	Q	Em: NIRS (TSC®)
	P plant beschikbaar	Q	Em: CCL3(PAE®)	Organische stof		afgeleide waarde
	P-bodemvoorraad (P-Al)	Q	PAL1: Gw NEN 5793	C-anorganisch		Em: NIRS (TSC®)
	Pw		afgeleide waarde	Koolzure kalk		afgeleide waarde
	K-getal		afgeleide waarde	Klei		Em: NIRS (TSC®)
	K plant beschikbaar	Q	Em: CCL3(PAE®)	Slit		Em: NIRS (TSC®)
	K-bodemvoorraad		Em: NIRS (TSC®)	Zand		Em: NIRS (TSC®)
	Ca plant beschikbaar		afgeleide waarde	Klei-humus (CEC)		Em: NIRS (TSC®)
	Ca-bodemvoorraad		afgeleide waarde	Ca-bezetting		Em: NIRS (TSC®)
	Mg plant beschikbaar	Q	Em: CCL3(PAE®)	Mg-bezetting		Em: NIRS (TSC®)
	Na plant beschikbaar	Q	Em: CCL3(PAE®)	K-bezetting		Em: NIRS (TSC®)
	Si plant beschikbaar		Em: CCL3(PAE®)	Na-bezetting		Em: NIRS (TSC®)
	Fe plant beschikbaar		Em: CCL3(PAE®)	H-bezetting		afgeleide waarde
	Zn plant beschikbaar		Em: CCL3(PAE®)	Al-bezetting		afgeleide waarde
	Mn plant beschikbaar	Q	Em: CCL3(PAE®)	CEC-bezetting		afgeleide waarde
	Cu plant beschikbaar	Q	Em: CCL3(PAE®)	Bodemleven		Em: NIRS (TSC®)

Q Methode geaccrediteerd door RvA
Em: Eigen methode, Gw: Gelijkwaardig aan, Cf: Conform
P plant beschikbaar Deze analyse is in duplo uitgevoerd.
P-bodemvoorraad (P-Al) Deze analyse is in duplo uitgevoerd.

De resultaten zijn weergegeven in droge grond.
Alle verrichtingen zijn binnen de gestelde houdbaarheidstermijn tussen monstername en analyse uitgevoerd.
De gerapporteerde resultaten hebben uitsluitend betrekking op het aan BLGG AgroXpertus aangeleverde materiaal op 08-05-2014

Appendix 8–Budget

All costs described below were part of the field work that was carried out in Benifallet, Spain, for the practical application of the framework. The majority of the sum consists of transportation and accommodation costs. The soil analysis by *BLGG AgroXpertus* cost € 106,53 per sample. Two samples were needed from the parcel.

Type	**Amount**	**Specification**	**Total in Euros**
Camper hire	€69 per day	16 days	1104
Fuel (diesel)	€1.40 per litre	365 litres	511
Toll	€150 one-way	There and back	300
Accommodation	€18 per day (2 persons)	13 days	234
Accommodation en route	€ 80 per day (2 persons)	3 days	240
Soil analysis BLGG	€ 106,53 per sample	2 samples	213,06
			2602,06