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Planty Organic evaluation 2012-2024

English version

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More information from project Groene Mest Groningen: go to kennisboeren.agrifirm.nl and search on Groene Mest Groningen, and look at the above mentioned Fascinating site.

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Preface

Crop nitrogen requirements are one of the biggest challenges facing arable farmers today. At a time when nitrogen availability is reduced more and more, finding sustainable solutions is more urgent than ever. The reduction of legal space especially in NV areas (nutrient polluted areas), means that less and less nitrogen can be applied, while society demands more and more high nutritional food. Left or right, arable farmers will therefore have to fix more nitrogen from the atmosphere and make it available for their crops.

Achieving an efficient and sustainable nitrogen cycle requires more than just short-term trials. The dynamics of soil processes and crop uptake are complex and heavily influenced beyond the control of farmers by temperature and rainfall, among others. Therefore, long-term trials are essential to get a good understanding of how nitrogen can be made available to crops in a natural and sustainable way. A few growing seasons is simply too short for robust conclusions. Planty Organic has played a crucial role in this. The project has provided valuable insights on sustainable nitrogen availability with minimal environmental impact. In addition, it has exposed where our knowledge is still lacking. In particular, the role of the soil microbiome is unfortunately still largely a black box. How to control this microbiome, to make more nutrients (including nitrogen) plant available at the right time, is one of the key questions for the future of many arable farmers.

Planty Organic's pilot plots, on which no external nitrogen has been applied for many years, are of crucial value to gain knowledge of the soil microbiome, in addition to practical insights. Practical follow-up research with a scientific ánd farmer steering group will be of great value in this respect. In addition, further development of the NDICEA model is of great importance because, so far, this model is the only one that visualises nitrogen fluxes and organic matter dynamics at farmer level: a tool in response to the challenge for arable farming today.

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Content

Summary

The Planty Organic experimental field was started in 2012 at the SPNA research farm Kollumerwaard with the question what the features are of an organic arable crop rotation based exclusively on farm-own produced nitrogen. In order to be able to answer that question as precisely as possible, a set-up without any external supply was chosen. It concerns a six-year crop rotation in which one year, with a clover-lucerne mixture, fixes a large part of the required nitrogen that is applied as Cut&Carry fertilizer on other plots.

From 2021, the plots have been split into a part (continued) without external supply, and a part with 15 tons of green compost applied per year, aimed at an absolute phosphate balance. In 2022, a small change took place in the crop rotation and spring wheat/field bean was replaced by green bean.

This report discusses the soil development with an emphasis on nitrogen and organic matter, and the nitrogen use efficiency is determined. The yields are also evaluated. The changes in nitrogen dynamics due to the change in the crop rotation and the compost application are discussed. The system without external supply is stable and can be simulated well in the NDICEA model. The annually measured organic matter content is almost stable or increases very slightly, and the measured soil N-total is stable or decreases slightly. The new crop rotation appears to be less efficient with nitrogen than the old one. According to the model calculations, the compost supply hardly provides more nitrogen in the first six years; the organic matter content and N-total do increase in the meantime. The new crop rotation is less efficient in nitrogen utilization and organic matter build-up.

1 Introduction

For organic arable farming, the role of crop nitrogen supply requires special attention in three respects:

- The amount of nitrogen is limited: a maximum of 170 kg can be supplied annually per hectare as “A fertilizer” (www.skal.nl). The consequence is that deployment must be well thought out and it is important to minimize losses as much as possible.
- Nitrogen can also be obtained independently of (manure) supply, namely by using the nitrogen fixing capacity of leguminous plants. This can be done as a main crop or as (part of) green manures.
- The nitrogen obtained is usually organically bound. Its availability for crop growth depends on the decomposition of organic matter by soil life, and is therefore strongly time- and temperature-dependent. Timing within the year and over the years therefore plays a crucial role.

These three points prompted the growers' association “Biowad” in 2011 to submit the following question to SPNA experimental farm:

> *How far can you get in an organic arable crop rotation based solely on own nitrogen fixation from leguminous plants?*

This resulted in the long-term trial field ‘Planty Organic’ (van der Burgt 2012) that was started in 2012 at SPNA trial farm Kollumerwaard in Friesland adjacent to the Lauwersmeer area. An evaluation took place after five years (Van der Burgt and others 2017), and a new assessment was made after nine years (Van der Burgt and others 2021).

The experimental field has been financially supported by various parties over time, and SPNA has also contributed to it financially itself. In 2022 and 2023, Planty Organic was part of the Groene Mest Groningen (Green Manure Groningen) Project, as a demonstration and learning site. This publication takes place within the framework of this project. This report is the third evaluation of the pilot field with one repeated topic and two new topics:

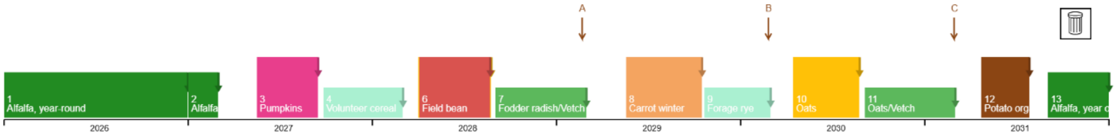
- Review: a four-year longer measurement series makes statements about the system (soil, crop yield, nitrogen fixation) increasingly plausible.
- New: the comparison of the old with the new crop rotation.
- New: the comparison of the crop rotation without (old) and with (new) compost application.

2 Setup of the experiment

2.1 Experimental field

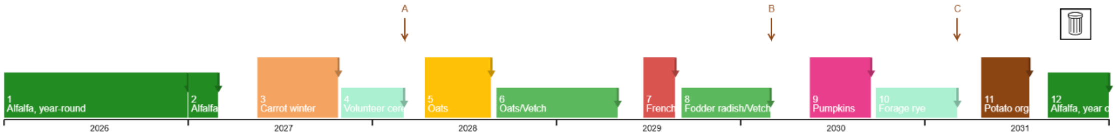
The ‘Planty Organic’ experimental plot is located on SPNA's Kollumerwaard experimental farm. Parcel 1 of the organic plot (4.8 ha, Figure 1), coordinates 53°20'15 ‘N ; 6°16'03 ’E, sandy loam) is divided into six fields 1A to 1F of about 0.8 ha each. A six-year crop rotation is practiced that (apart from the early years) looks as in Figure 2. From 2022 onwards, a slight change in the crop rotation has taken place; the crops from 2022 onwards and their order is shown in Figure 3. The tillage is non-tilling. Cultivation is done on fixed beds with a distance of 3.20 metres, GPS controlled. Only harvesting does not take place from the fixed row paths; all other operations do. For further description, please refer to previous publications, see bibliography.

Figure 1: Location of experimental field at SPNA experimental farm Kollumerwaard. Blue: demarcation common cultivated plot. Orange: boundary organic plot. Yellow: location Planty Organic trial plot



Year 1 2 3 4 5 6
Clover/alfalfa Pumpkin Wheat/Fieldbean Carrots Oats Seed potatoes
Greenmanure Greenm. Greenm. Greenm. Cl/Alf.
A, B, C: Application of cut&carry fertilizer

Figure 2: Crop rotation up to and including 2021

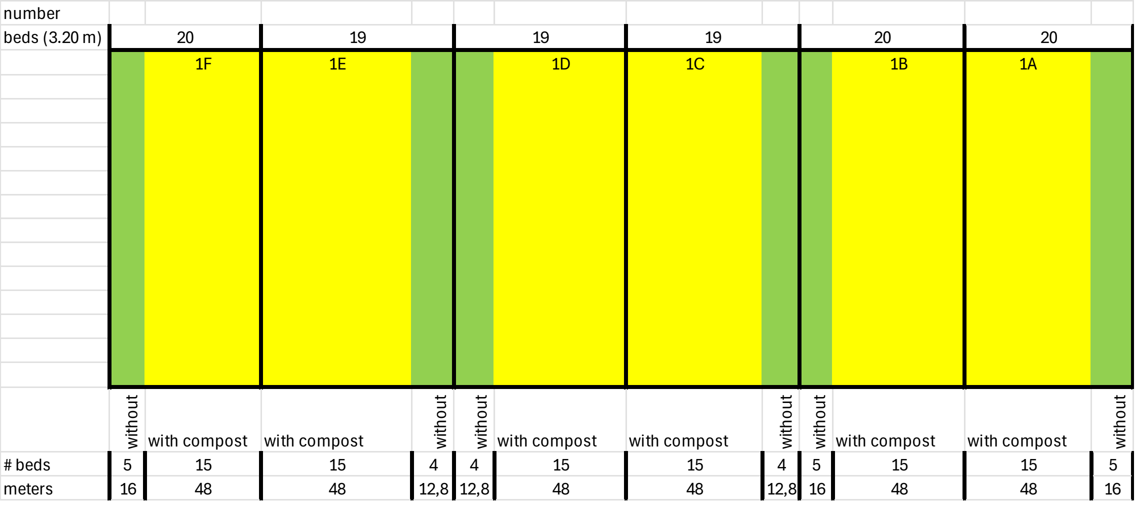


Year 1 2 3 4 5 6
Clover/Alfalfa Carrots Oats French beans Pumpkin Seed potatoes
Greenmanure Greenm. Greenm. Greenm. Cl/Alf.
A, B, C: Application of cut&carry fertilizer

Figure 3: Crop rotation since 2022

Fertilization until 2020 consisted almost exclusively[1] of internal cut manure. The first two years this was grass/clover, then a clover/alfalfa mix. The clover/alfalfa mix is harvested, baled and used as cut&carry fertilizer the following year in early spring. Thus, apart from the first year, nothing was brought in from outside the farm, apart from seeds and deposition. This was chosen to approach the question around the potentials of own N fixation as unambiguously as possible.

From spring 2021, plots 1A to 1F were divided into two strips: a wide strip where compost is applied, and a narrow strip where the policy of 'no external supply' is continued (Figure 4). Since 2021, these plot sections are sampled separately as far as possible in terms of crops, soil fertility and soil N-mineral, with the exception of the plot where the clover-luzerne mix is located that year. The annual compost dosage is tailored to an absolute P-balance where an average of around 35 kg P2O5 is removed annually per hectare. This amount of phosphate has been applied in the form of green compost in early spring on the compost strip of all plots since 2021.



number beds (3.20 m)	20		19		19		19		20		20	
		1F	1E			1D	1C			1B	1A	
	without	with compost	with compost	without	without	with compost	with compost	without	without	with compost	with compost	without
# beds	5	15	15	4	4	15	15	4	5	15	15	5
meters	16	48	48	12,8	12,8	48	48	12,8	16	48	48	16

Figure 4: subdivision of plots, without/with composting.

2.2 Data set

Over the 13 years of the trial, an extensive dataset of observations has been compiled. This can be divided into three groups.

- Crops

Gross yield was measured; always of the product and irregularly of the crop residue. Products were analysed for dry matter content, N, P2O5, K2O, Ca and Mg, and so were crop residues in a number of years and a number of crops. From the cuts of the clover-luzerne mixture, yield and dry matter content, N, P2O5 and K2O were determined for each cut. Several times the green manures were sampled and yield, dry matter and N, P2O5 and K2O contents were determined. The analyses were carried out by Eurofins Agro. The results of the crop analyses are given in Annex 1.

- Soil fertility

Annually in November or December, the soil was sampled 0-30 cm and analysed according to Eurofins package ‘FertilisationWijzer Akkerbouw’. This covers a very large number of soil chemical, physical and biological parameters. The results are given in Annex 2.

- Soil mineral nitrogen

Until the end of 2020, N-mineral measurements 0-30 cm were taken several times a year on all plots, thereafter only incidentally. These were partly analysed in-house with the RQflex and mostly by Eurofins. The results have been incorporated into the NDICEA plot scenarios, are available in all annual reports and can be requested from the author.

2.3 Method

In answering the question of how far you can get with own nitrogen extraction, it was included from the beginning that insight could also be gained into the ‘how’ of performance. For that, drawing up annual mineral balances and monitoring soil fertility annually do not suffice. To obtain answers on how the system works in terms of organic matter and nitrogen dynamics, the simulation model NDICEA (Van der Burgt et al, 2006; www.ndiceaweb.eu) was deployed. This model is calculating at individual field level and shows the interrelationship between organic matter and nitrogen dynamics and between crop nitrogen demand and soil nitrogen availability. It shows where, when and how much nitrogen losses occur. The many N-mineral measurements served, among other things, to validate the model for this situation.

- NDICEA **plot scenarios** were made of all plots, which were completed annually and thus now cover 13 years. Until 2021, these were six scenarios; after that, 12 because of the plot split into without/with compost.
- After it was shown that the model simulated the measurements at an acceptable level, a summary **crop rotation scenario** was created based on the model settings of the plot scenarios. This crop rotation scenario is the material used for the system performance analysis in this report. See Figure 2; details can be requested from the first author.

After the minor change in crop rotation in 2022, a new crop rotation scenario was created. Its performance is put in this report alongside that of the first crop rotation system. This is therefore a **comparison of model outputs**; three years is too short to make a physical comparison using various measurements.
Since 2021, there are 12 plot scenarios because since that year there have been two different sub-fields: with and without compost (Figure 4). The history of these is identical. The first results of a difference due to compost application are presented and discussed in this report, both in terms of measurements and model comparison.

For the statistical analysis of the soil measurements, the statistical program Genstat Twenty-third Edition - Version 23.0.0.578 was used. In it, the analysis was performed using 'Simple Linear Regression with Groups'. This took time as the explanatory variable and the different fields as groups (each with the same 'treatment' but each in a different crop of the crop rotation). In this analysis, successive regression was then performed with three different models. First, a single linear function with one intercept was fit through all fields (model: Constant + year). Then a series of parallel lines, with each field having its own intercept (model: Constant + year + Plot), and finally a model with its own intercept and directional coefficient for each of the fields (model: Constant + year + Plot + year.Plot). The significance of all three models was determined. In the results further on, a figure is always shown with the results of the third model. In the text, one can then distinguish between the different fields. The significance in the text is always the most comprehensive of the three models tested, to highlight any differences between the fields.

3 Results and discussion

This report covers three topics (see introduction). They are presented one after the other in this chapter. For the sake of clarity, the results for each topic are shown and discussed immediately afterwards.

Figure 5 Aerial view of the experimental field. Each of the six subfields is about 0.8 ha in size

3.1 Evaluation of soil fertility and crop production 2012-2024.

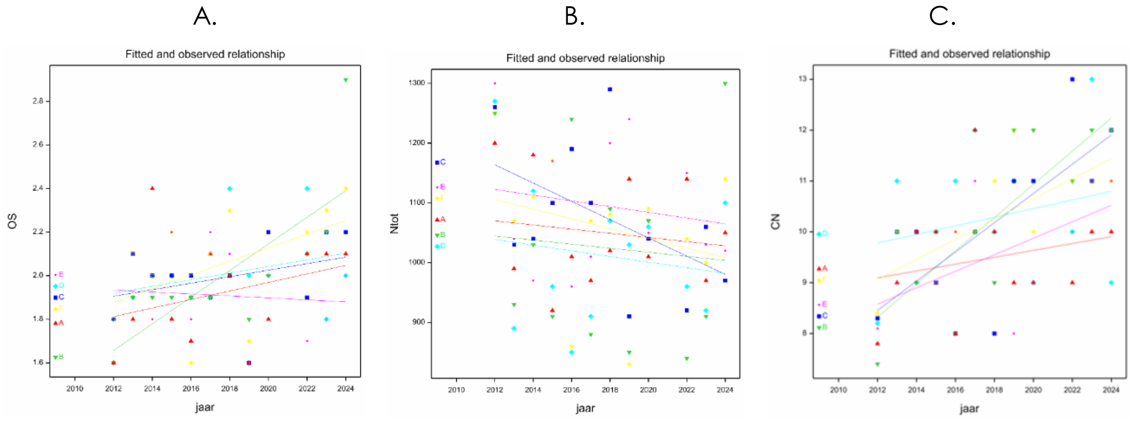
3.1.1 Soil fertility

In setting up this long-term experiment, it was decided not to introduce any external nitrogen at all. In a well-organized agriculture-society cycling process, there is a return of nutrients, including nitrogen and phosphate, from society (town and village) to arable land. This is discussed further in section 3.3.

Soil fertility is approached in two ways. First through a number of measured soil parameters, and second through the modelling approach.

Organic matter measurements, N total, C/N ratio

Since there has been a small change in crop rotation, strictly speaking there is no 13-year continuous series. This section nevertheless uses the continuous soil series of the plots without compost (also since 2021) because the small change in crop rotation is expected to have little impact on soil quality in the short term. This is further discussed in section 3.3.
All measurements Eurofins Fertilisation Guide Complete 2012-2024 are in Appendix 2. No analysis took place in 2021. The most relevant parameters are shown and explained below.



Figuur 6 A: Organic matter; B: N total; C: C/N ratio. Measured values (symbols) and fitted lines of the six plots 2012-2024. Line color corresponds to the color of the plot designation (A ... F) on the left side of the graph.

Organic matter. Five of the six pseudo repetitions show an increase, and only plot E shows a slight decrease with a very large spread over the years.
Statistically, there is an increase in OS content (F pr. = 0.001) of 0.0229% per year. This is in the order of magnitude of 1000 kg increase OS per year.
N total. All plots show a decreasing trend of 6 kg N ha-1 year-1 on average, but this is not statistically significant.
C/N ratio. All plots show an increase, and this is statistically highly significant, F pr. < 0.001

Discussion organic matter, N totaal, C/N ratio

The sharp increase in plot B in terms of organic matter is largely caused by the extremely high result (2.9%) in 2024, which is considered measurement error. Omitting the last measurement on plot B, the increase remains statistically significant but is smaller.
The 2012 results fall outside the trend of the other years for all three parameters. This obviously affects the picture and the statistical assessment. If all 2012 measurements are excluded and also plot B measurements in 2024, a different picture emerges. Instead of an increase in organic matter content of 0.0229%, the increase drops to 0.012% and statistical significance is lost. For N total, the loss of N decreases from 6.64 to 0.79 kg ha^{-1} and there would no longer be a decrease in N content at all. Logically, this also decreases the increase in C/N ratio, from 0.188 yr^{-1} to 0.140 yr^{-1}.
The three parameters show a consistent picture among themselves: an increase in organic matter and a trend of decrease in N total logically results in an increasing C/N ratio. The C/N value is not a measurement but a calculation from measured C (corrected for inorganic C) and measured N.

The conclusions on the development of the three soil parameters depend rather on the interpretation of the measured data. Without excluding remarkably different measurements, there is a slight increase in organic matter content and small decrease in N content.

Excluding the 2012 starting measurements and the obviously erroneous measurement plot B 2024, the increase in organic matter content is smaller and no longer significant, and the decrease in N content disappears.

Apart from the interpretation above of some measurements, it is noteworthy that an arable system without any input of organic matter from outside the farm is able to maintain or even slightly increase soil organic matter content. The standard Dutch calculation of the OS balance based on Effective Organic Matter results in a slight decrease (data not shown here). This will be addressed when discussing the modelling.

Measurements PAL, PPAE en Pw

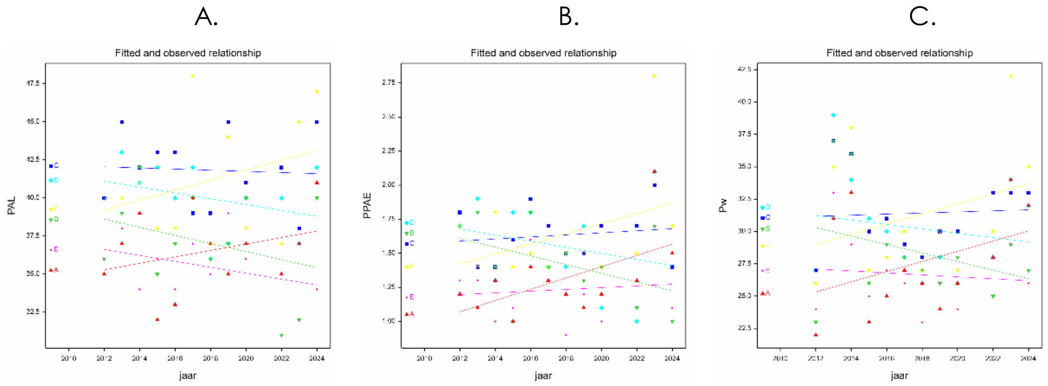


Figure 7 A: PAL; B: PPAE; C: Pw. Measured values (symbols) and fit lines of the six plots 2012-2024. The colour of the line corresponds to the colour of the plot designation (A ... F) on the left side of the graph.

All three parameters show plots with an increase and plots with a decrease. On average, only P-Al shows a small but significant (F pr. < 0.001) decrease.
For Pw, the large contrast between the measurements of 2012 on the one hand and those of 2013 and 2014 on the other, and of these first three years compared to the other years, is striking. From an agronomic point of view, this is beyond expectation. Pw is not a measurement but a calculation based on measurements.

Discussion PAL, PPAE en Pw

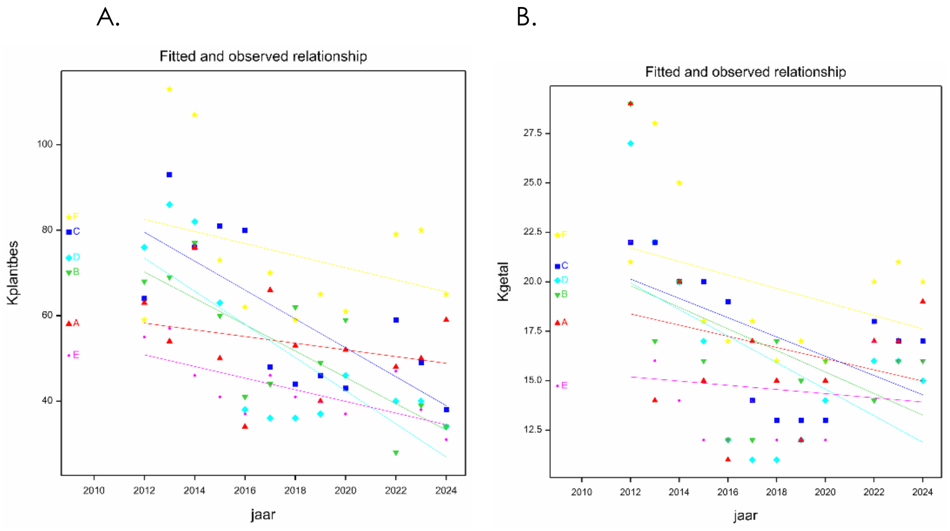
There is an annual extraction of around 35 kg P2O5 from the soil. Over 13 years, this does not lead to a (strong) deterioration of the usual phosphate-related soil parameter 0-30 cm. Several processes may play a role in this

- Relative insensitivity of the measurement/calculation
- Very small abstraction of P relative to the P soil stock
- Plant uptake not only from the topsoil 0-30 cm (which is what the measurements refer to) but also from the second soil layer 30-90 cm

- Net transport of P from the second soil layer to the top soil via crop residues, green manures and cut&carry fertilizers.
- Low expected P leaching.

Despite keeping the P-related parameters as good as level, there is indeed a negative P balance of 32 kg P2O5 ha^{-1} $year^{-1}$, which is a pre-calculated result of the chosen trial design.

Measurements K plant available en Knumber



Figuur 8 A: K plant available (Kplantbes); B: K number (Kgetal). Measured values (symbols) and fitted lines of the six plots 2012-2024. The color of the line corresponds to the color of the plot designation (A … F) on the left side of the graph.

Both parameters show a decrease, with the decrease at K plant available being statistically significant (F pr. < 0.001).

Discussion K plant available and K number

In first view, the decline seems to have taken place mainly in the first five years and then the situation seems to have stabilized (K plant available) or even reversed (K number). This has not been analyzed separately statistically.

These two K-related parameters seem to respond slightly more clearly to the zero supply policy than the P-related parameters. The average K2O abstraction is 93 kg ha-1 yr-1. For the K dynamics within the plot, partly the same processes apply as what was described above for P.

Other measurements

The other parameters in the Eurofins ‘BemestingWijzer Compleet’ measurement package show no clear trend of increase or decrease. See annex 2 for all results.

Model calculations

Many quantifiable goals can be imagined to assess an organic arable system on. Two are discussed here: nitrogen dynamics, including nitrogen efficiency and losses, and related organic matter dynamics. This is done on the basis of the crop rotation scenario, which in turn is based on validated six plot scenarios. For their justification, please refer to previously published evaluations and annual reports.

The crop rotation scenario and results used here differ slightly from the scenarios used in the previous evaluations. This involves the following subjects.

- Average crop yields are adjusted to 13 years of measurement data
- The average fertilization with cut&carry fertilizer has been slightly adjusted
- Some changes have been made to NDICEA's calculation methodology.
- A newly compiled standard weather dataset (daily values temperature, precipitation, evapotranspiration) is used. The new set is an aggregation of monthly values from the past decade. Thus, the new set reflects climate change. In particular, temperature is higher in the new set than in the old one.

The crop sequence is shown in Figure 2. The yields used are the average yields from 2012 to 2024. Although in the last three years of that period a small change in the crop order was practiced (Figure 3), its short-term effects on soil fertility are considered very small.

The default setting of soil parameters showed a Soil Nitrogen decrease of 16 kg ha^{-1} yr^{-1} and a decrease in organic matter from 1.77% to 1.70%. This is not consistent with the measurements and trends therein. Therefore, manual calibration was done with three soil parameters to get closer to an N loss of 1 - 6 kg ha^{-1} yr^{-1} and an organic matter increase of 0.01 - 0.02%. This resulted in the following parameters (Table 1).

Table 1 Old and newly calibrated parameter values and the resulting effects

		old	new	unit
Parameter	Decay factor	0,56	0,42	-
Parameter	C/N soil life	6,5	6,5	-
Parameter	As/Dis soillife	0,4	0,32	-
Result	OM change	-0,07	0,01	%
Result	N change	-16	-3	kg ha^{-1} yr^{-1}

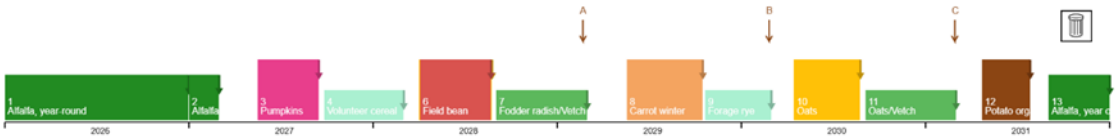


Figure 9 Crop sequence from the crop rotation scenario (see also Figure 2)

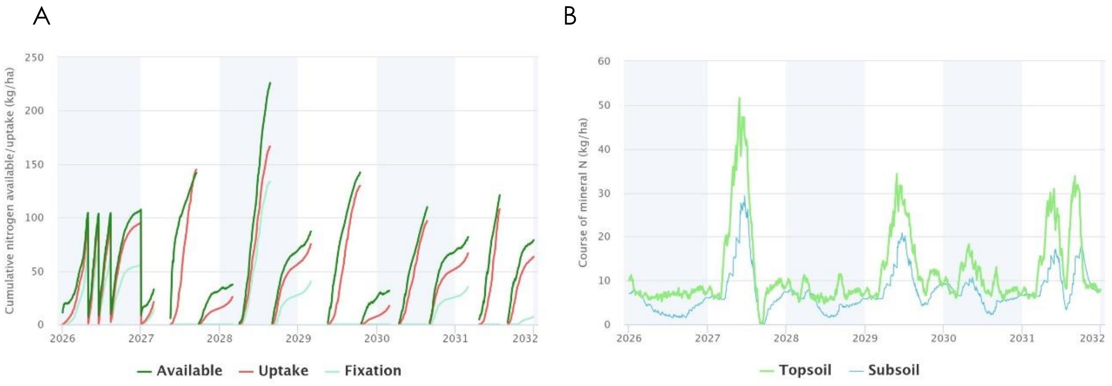


Figure 10 A Nitrogen availability, uptake and fixation; B Course of N-mineral

Note, Figure 10 B: topsoil 0-30 cm, 2^{e} soil layer 30-60 cm.

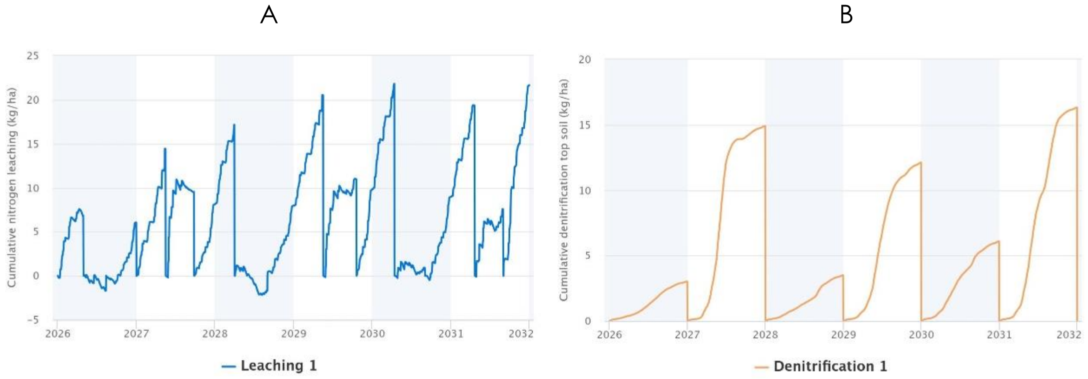


Figure 11 A Cumulative N leaching; B Cumulative denitrification

Note: In Figure 11A, the graph line is reset to zero at the start of a new crop or green manure crop. In Figure 11 B, the graph line is reset to zero each year on 1 January.

Table 2 Mineral balance in kg ha^{-1} jr^{-1}

In kg ha^{-1} yr^{-1}	**N**	**P_2O_5**	**K_2O**
Fertilizer supplied	0	0	0
Nitrogen fixation	80		
Seeds/Plants	3		
Irrigation	0		
Deposition	21	3	8
Total supply	104	3	8
Product removal	75	35	93
Calculated remainder	29	-32	-84
Volatilization	0		
Denitrification	9		
Leaching / denitrification subsoil	25		
Increase / decrease soil organic N	-3		
Increase / decrease soil mineral N	0		

Discussion model results

Nitrogen availability (Figure 10 A). All crops, except pumpkin, have sufficient nitrogen available to achieve the assumed yield. The margins between availability and uptake are very small. The system is nitrogen-limited: higher yields are hardly possible from the point of view of N dynamics.

Course of mineral nitrogen (Figure 10 B). Only in pumpkin does the level of mineral nitrogen drop to zero. A very large part of the time during the six years, the N-mineral level is below or well below 20 kg ha^{-1}. The crops never have an ample N supply, and the risk of leaching and denitrification is therefore low.

Nitrogen leaching (Figure 11 A). The peaks of leaching are maximum around 20 kg and they are fairly spread over the crop rotation. There is no one crop that shoots out.

Denitrification

Denitrification (Figure 11 B) is directly linked to the level of mineral nitrogen, and it is low. The years with higher denitrification coincide with those with relatively high N-mineral level.

Mineral balance (Table 2).

For nitrogen, the calculated surplus is 29 kg ha^{-1} yr^{-1}, plus 3 kg from net decomposition of soil organic nitrogen. Most of this surplus is lost through leaching (25 kg), and partly through denitrification (9 kg). At a rainfall surplus of 400 mm yr^{-1}, the water leaching from the root zone would have an N concentration of 6.25 mg Nitrate-N per liter. With a nitrogen leaching fraction of 0.36 in the case of arable land on clayish soil (Fraters and others, 2007; Fraters and others 2012), this results in an average annual load of upper groundwater of 2.25 mg Nitrate-N per liter. The limit for sufficient water quality is 11 mg Nitrate-N per liter.

For phosphate, there is a net discharge, as a result of the trial design not to bring in anything from outside. For potash, the same applies. There is no evidence of (temporary) nutrient deficiencies in crop growth, but it cannot be ruled out. Soil analyses of phosphate and potash do not decline or only slowly, see above.

3.1.2 Nitrogen use efficiency NUE

The calculation method used here includes all incoming nitrogen. This is related to production (nitrogen in product sold) and environmental losses (leaching and volatilization; in this case only leaching). The data in Table 3 are taken from Table 2.

Table 3 Nitrogen supply vs production and leaching losses.

Supply	104	kg
Product removal	75	kg
Nitrogen use efficiency	72	%
Leaching	25	kg
Leaching related to supply	24	%
kg N leaching per kg N product	0,33	-

NB please note, when comparing with other numbers on NUE, whether the calculation method is the same. Often deposition, nitrogen fixation and/or nitrogen in seed/plant material are not included as supply items. This is discussed in more detail in Chapter 4.

3.1.3 Production

The yields of the main crops were measured all years and are shown in Table 4. Three crops were grown all 13 years (column #year: 13): clover/alfalfa, winter carrots, seed potato. Two crops were grown in 11 years: pumpkin and oats.

Table 4 Yields of the main crops, in kg ha^{-1}.

Sequence	Crop	Green manure	**# jaar**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
1	Clover/alfalfa (in d.m.)		13	8799	9024	11434	8836	10008	10429	4511	9019	10939
2	Pumpkin	Green manure	11	*	*	16000	14400	27181	24697	19300	22583	20495
3	Wheat/fieldbean(85% d.s.)	Green manure	8	*	*	*	2980	2545	4776	4486	4339	8308
4	Carrots	Green manure	13	77477	80000	59725	82800	61000	59688	46566	71680	70313
5	Oats	Green manure	11	*	7836	*	3600	5188	5428	5827	4411	7164
6	Seed potatoes	Clover/alfalfa	13	29229	34879	38000	35900	27550	39198	29367	42381	42213
	French beans	Green manure	3	*	*	*	*	*	*	*	*	*
Volgorde	Hoofdteelt		**2021-C**	**2021+C**	**2022-C**	**2022+C**	**2023-C**	**2023+C**	**2024-C**	**2024+C**	**Average -C**	
1	Clover/alfalfa (in d.m.)		9812	9812	7171	7171	9468	9468	7826	7826	9021	
2	Pumpkin	Green manure	20000	20000	22844	24141	23234	19329	19300	19300	20912	
3	Wheat/fieldbean(85% d.s.)	Green manure	4589	4575	*	*	*	*	*	*	4575	
4	Carrots	Green manure	0	0	71406	78416	66979	71875	62656	69167	67967	
5	Oats	Green manure	6631	6161	5040	5863	2968	3198	2982	4928	4923,9	
6	Seed potatoes	Clover/alfalfa	16234	16934	40254	38888	34150	33707	12157	9274	32424	
	French beans	Green manure	*	*	14297	13594	14375	15625	14400	14400	14357	

Notes to Table 4: yield of clover/alfalfa in dry matter. The 2021 carrot crop failed due to germination and weed problems. This zero yield is not included in the calculation of average yield. Cell with * : crop not grown that year. Starting in 2021: measurements in strip without compost (-C) and strip with compost (+C). Average yield refers to the situation without compost. The yields of pumpkin in 2021 and of pumpkin and french bean in 2024 were not determined separately; the value is therefore the average of the two strips without and with compost.

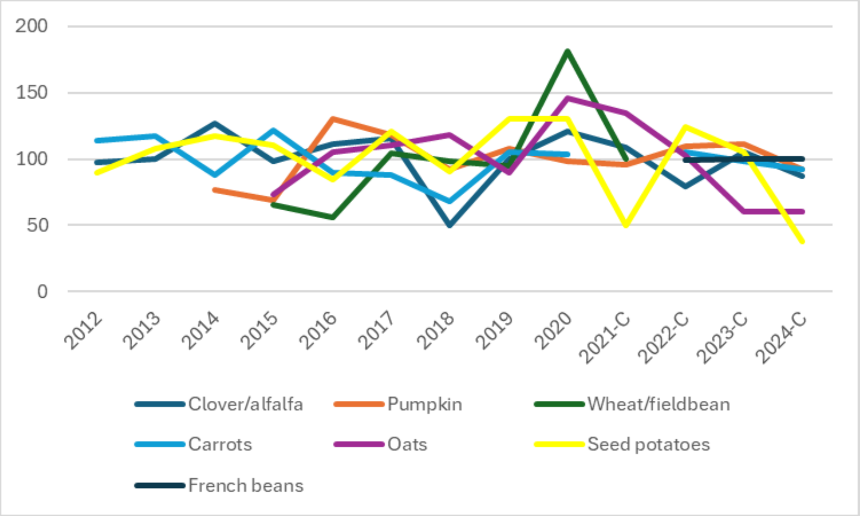


Figure 12 Relative yield of individual crops, without compost. 100 = Average yield of that crop over all crop years.

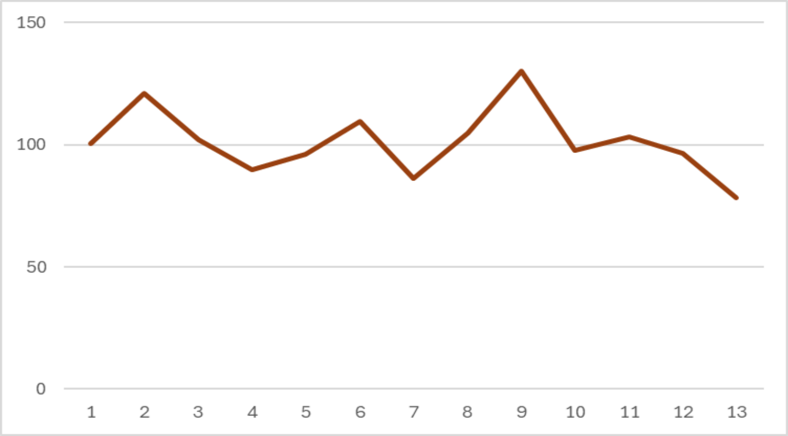


Figure 13 Average relative yield of all crops combined, without compost.

Discussion of the yields.

The yields of pumpkin, winter carrots and seed potato are on average somewhat lower than those of the other organic plot on test farm Kollumerwaard (data not shown) where there is fertilization with mainly solid goat manure. This difference in external nitrogen inputs is disproportionate to the differences in yield. Own nitrogen fixation is thus quite capable of largely sustaining production.

In Figure 12, the dataset of yields is compressed by looking at relative yields, where 100 per crop equals the average yield over all crop years of that crop. The variation in yield between years is visible, and it can be substantial. Whether that is a specific feature of this system has not been investigated further. The annual effect is often, but not always, in the same direction (more or less yield) for the different crops. The order of magnitude of change certainly varies by crop. The zero yield of carrots in 2021 is not visible as 'zero' but as a break in the line. Whether that one-time zero yield is a systemic feature of Planty Organic or of organic cultivation cannot be said here; weed control is a recognized key focus in organic cultivation.

In Figure 13, the yield dataset is again compressed and the relative average yields of all crops together are shown. Here, at first glance, there appears to be a slight trend towards lower yields the longer the system is maintained without external nutrient inputs. Statistically, this is not significant. The relatively low values in 2023 and 2024 are mainly caused by the very disappointing yields of oats in these years, and by the extremely low yield of seed potato in 2024. Whether the low oat yield is a system feature of Planty Organic cannot be said at this stage. The low seed potato yield is indeed a system feature, in this case of organic farming and not specifically Planty Organic. That relates to Phytophthora as a dominant factor in yield reduction.

3.2 Comparison of old and new crop rotation

Over the course of nine years, root weed pressure seemed to increase. With the consistent application of green manures, there was little room in the cropping plan to specifically control root weeds. The one-and-a-half years of clover/alfalfa contributed to this but not adequately. It was therefore decided to replace the mixed crop wheat/field bean by french bean: also a leguminous crop with its own N-fixing, but with a very short growth period, allowing time for root weed control either before or after the crop. This changed the sequence of the crops.

- Crop order in the years 2014-2021: Buttercup mixture - pumpkin - wheat/field bean - carrot - oat - seed potato (Figure 14)
- Crop order from 2022 onwards: legume mixture - carrot - oats - green bean - pumpkin - seed potato (Figure 15)

The three years with this crop rotation are not sufficient to make a judgement on organic matter and nitrogen dynamics. In the following text, the NDICEA crop rotation scenario of the old crop rotation is compared with that of the new crop rotation, both without compost.

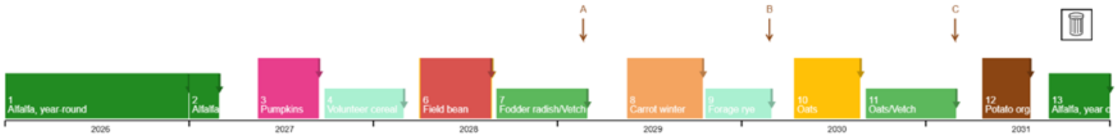


Figure 14 Old crop rotation

Figure 15 New crop rotation

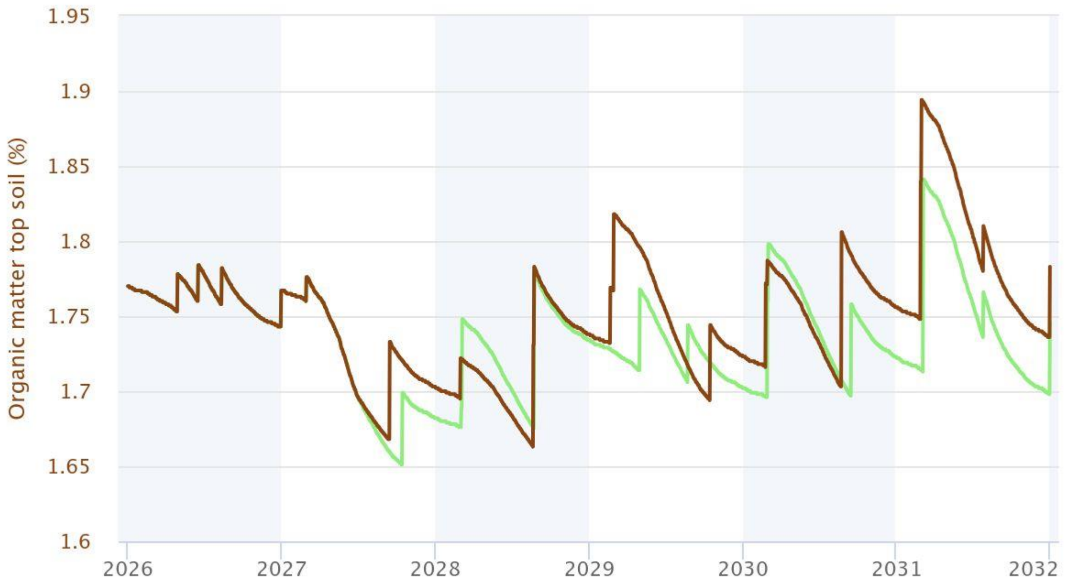


Figure 16 Organic matter turnover. Brown: old crop rotation with wheat/field bean. Green: new crop rotation with french bean

Because of the partially different crop order, the progression over the six years is markedly different. The organic matter build-up of the new crop rotation is smaller. After six years, there is a decrease from 1.77% OS to 1.75%, OS while the crop rotation with summer wheat/field bean shows a minute increase from 1.77% to 1.78%. The significantly smaller crop residue and root residue of green bean, increased by slightly more green manure yield, does not outweigh straw and root mass of wheat/field bean.

Table 5 Mineral balance old and new crop rotation.

	With wheat/fieldbean			**With french bean**		
In kg ha^{-1} yr^{-1}	**N**	**P_2O_5**	**K_2O**	**N**	**P_2O_5**	**K_2O**
Fertilizer supplied	0	0	0	0	0	0
Nitrogen fixation	80			62		
Seeds/Plants	3			2		
Irrigation	0			0		
Deposition	21	3	8	21	3	8
Total supply	104	3	8	85	3	8
Product removal	75	35	93	57	28	88
Calculated remainder	29	-32	-85	28	-25	-80
Volatilization	0			0		
Denitrification	9			9		
Leaching / denitrification subsoil	25			33		
Increase / decrease soil organic N	-3			-8		
Increase / decrease soil mineral N	0			-3		

Nitrogen fixation is significantly lower in the new crop rotation and product removal is also lower, resulting in a one-kilogram lower calculated surplus. Losses through leaching below the root zone are higher with the new crop rotation and soil nitrogen decreases slightly more. Overall, from a nitrogen and organic matter dynamic point of view, it is a small decline. The modelled nitrogen availability per crop is similar for both crop rotations, and both systems are strongly nitrogen-limited.

Nitrogen use efficiency

Table 6 compares the original crop rotation with spring wheat/field bean with the new one, with french beans

Tabel 6 Nitrogen supply vs production and leaching losses.

	Wheat/Bean	**French b**
Fertilizer supplied	104	85
Product removal	75	57
Nitrogen use efficiency	72	67
N leaching	25	33
N leaching compared to product removal	0,24	0,39
kg N leaching per kg N product	0,33	0,58

Also here it becomes clear that from the point of view of nitrogen dynamics, the change in crop rotation is not an improvement. If the increased loss of soil nitrogen and organic matter is also included, the picture becomes even more negative.

3.3 Comparing without and with compost

3.3.1 Model calculation

The starting point is the crop rotation scenario in NDICEA without compost. The results differ very slightly from what was published earlier (Van der Burgt and others 2021). See for this under the heading Model calculations on page 19. In addition, minor changes in the calculation procedure have been made in NDICEA version 7. The two most important ones are:

- The overall organic matter decay factor no longer has a fixed value throughout the length of the scenario but has been made partly crop-dependent. The starting point here is that intensity of tillage has a direct effect on organic matter decomposition. In the modelling, if there is no tillage for a long time, in this case one and a half years of clover/alfalfa, the basic decomposition is scaled down. With intensive tillage, on the contrary, it is scaled up, in this case when potatoes and carrots are grown on ridges. Decomposition is higher shortly before planting/sowing (tillage, ridge construction), during cultivation (warmer soil, better air access to the soil) and a period after harvesting (after intensive soil disturbance).
- Nitrogen delivery after finishing clover/alfalfa. This is calculated in a different way and scaled a bit higher than in version 6.

From the crop rotation scenario without compost, soil organic matter was initialized in NDICEA 7, which resulted in slightly different initial values given the above changes. In this scenario annual compost applications were introduced this was initialized. The initialized scenarios without and with compost, both starting at 1.77% organic matter but with a difference in properties of that organic matter, are compared here. The scenario data are obtainable from the first author.

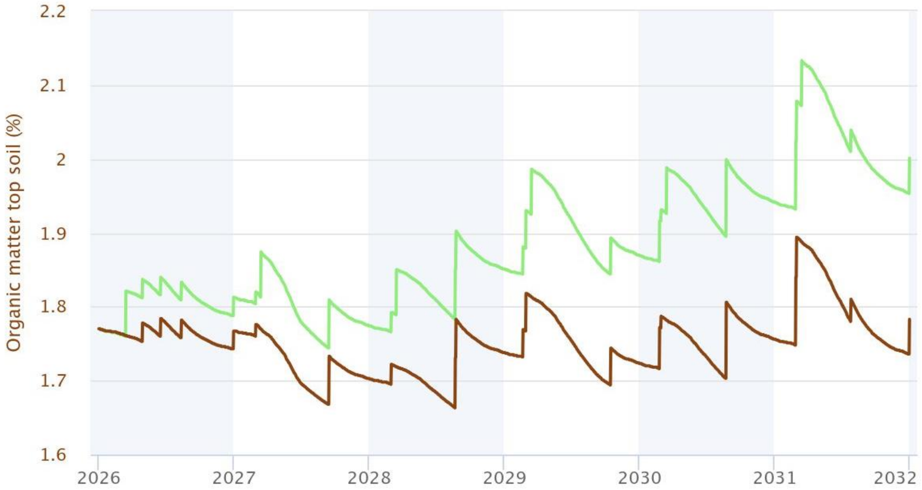


Figure 17 Course of organic matter. Brown: without compost. Green: with compost

Over six years, the application of 15 tons of green compost per year leads to a soil organic matter difference compared to no compost of 0.28% . At a bulk density of 1.46, this is 12,264 kg of organic matter in 0-30 cm. The mineral balance (Table 7) shows an annual difference of 65 kg N, so over six years 390 kg N has been fixed in organic matter. At an assumed C content of 50% organic matter, this results in a C/N of 12.0. This seems reasonable.

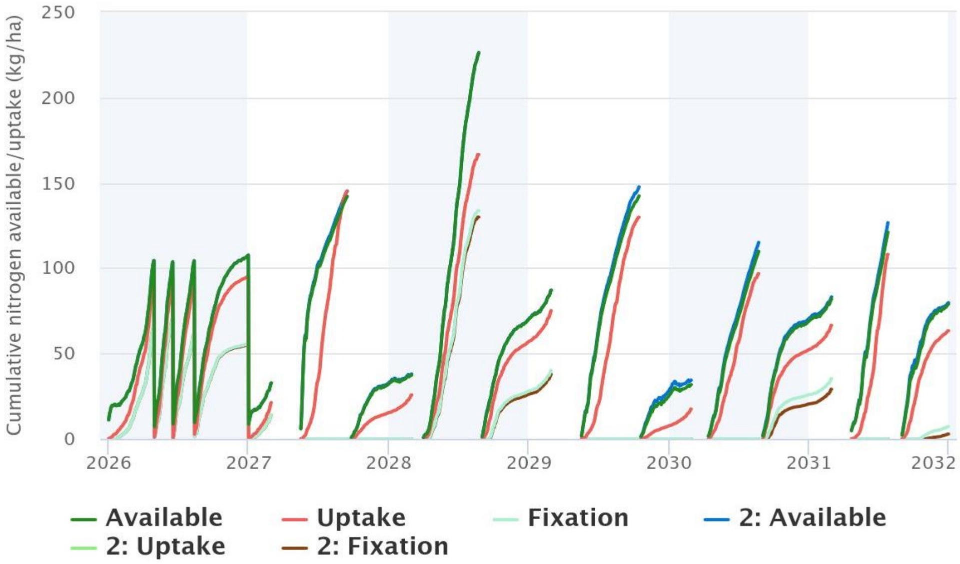


Figure 18 Nitrogen uptake and availability. 2 = with compost

The calculated differences in N availability are minimal in the first years. Starting at the fourth year (2029), the blue line (+ compost) tends to be slightly higher than the green line (-compost). This is confirmed by the calculated total N mineralization for six years: 897 without compost, 956 with compost. Assuming that this is correct, hardly any effect on N availability and yield increase from N dynamics can be expected. That does not alter the fact that yield increases may well occur, due to influences that are not accounted for in NDICEA. By the way, the influence of an increase in soil organic matter should not be overestimated (Ros 2020).

Table 7 Mineral balance without and with compost

	without compost			**with compost**		
In kg/ha/yr	**N**	**P_2O_5**	**K_20**	**N**	**P_2O_5**	**K_2O**
Fertilizer supplied	0	0	0	75	33	63
Nitrogen fixation	80			77		
Seeds/Plants	3			3		
Irrigation	0			0		
Deposition	21	3	8	21	3	8
Total supply	104	3	8	176	36	71
Product removal	75	35	104	75	35	104
Calculated remainder	29	-32	-96	101	1	-33
Volatilization	0			0		
Denitrification	9			11		
Leaching / denitrification subsoil	25			26		
Increase / decrease soil organic N	-3			63		
Increase / decrease soil mineral N	0			0		

Phosphate, when compost is applied, is just about balanced, which was the starting point for calculating the amount of compost to be applied. Potassium is significantly less deficient than without compost, but still deficient. On these soils and with these yields, this need not be a problem for many years. Of the extra supply of nitrogen with compost, 6*75 = 450 kg, 6*(63+3) = 396 kg is still in the soil after six years. This is not surprising given the nature of compost: relatively high C/N and relatively low decomposition rate and thus high humification coefficient.

Conclusion: purely on the basis of organic matter and nitrogen dynamics, an annual green compost donation of 15 tons can hardly be expected to have any effect in six years.

When compost is applied and assuming the same yields (more on this in the next section), the NUE is much lower than without compost: 41% versus 72% (Table 3). However, the losses are hardly higher: the nitrogen surplus is still present in the system as capital (accumulated soil fertility). Whether and how that capital can be utilized in the future depends on many factors. The determination of NUE could be supplemented for this by including accrued soil fertility as a ‘product’ in the calculation.

3.3.2 Measurements

Compost has now been applied for four years. Four times, soil fertility was determined in November (see Annex 2) and yields were measured (see Table 4 and Table 8).

Soil.

The measurements often vary greatly from plot to plot and the differences from year to year cannot be explained. This noise is much stronger than any difference in treatment. So no conclusion can yet be drawn from this.

Yields

Table 8 Yields in kg ha^{-1} . -C = without compost ; +C = with compost

	2021-C	2022-C	2023-C	2024-C	gemiddeld		2021+C	2022+C	2023+C	2024+C	gemiddeld
Pompoen	20000	22844	23234	19300	21345		20000	24141	19329	19300	20693
Winterpeen		71406	66979	62656	67014			78416	71875	69167	73153
Haver	6631	5040	2968	2982	4405		6161	5863	3198	4928	5038
Pootaardappel	16234	40254	34150	12157	25699		16934	38888	33707	9274	24701
Sperzieboon		14297	14375	14400	14357			13594	15625	14400	14540

Note to Table 8: The yield measurement of pumpkin in 2021 and of pumpkin and green bean in 2024 shown are the average of the strips without and with compost. The zero yield of carrot in 2021 is not included in determining the average yield.

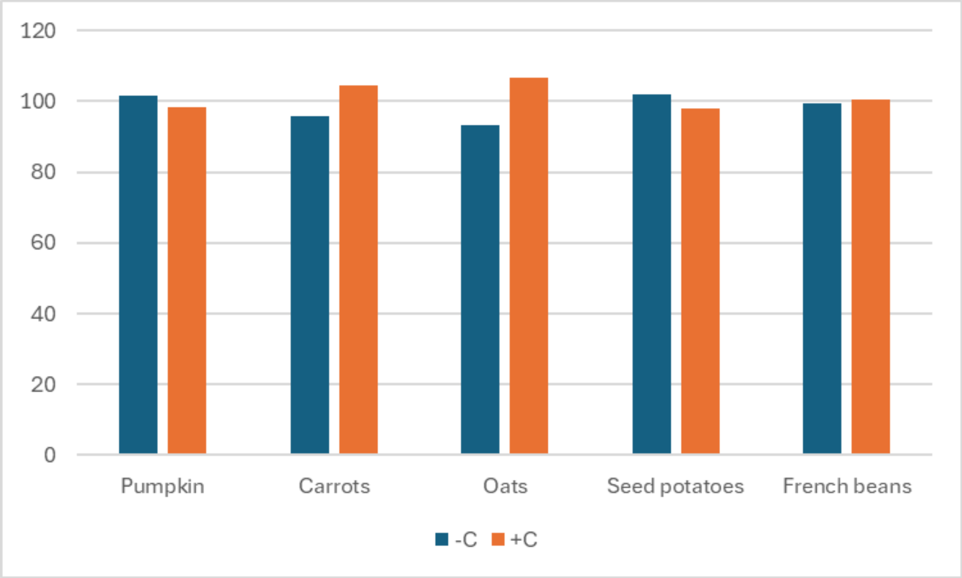


Figure 19 Relative yields. - C = without compost; + C = with compost.

Notes to Figure 19: For pumpkin in 2021 and for pumpkin and french bean in 2024, yields were not determined separately, so this reduces any difference between the strip without and with compost. For french bean, this covers three years of cultivation, not four. The clover/alfalfa strips were not sampled separately.

Discussion on yield

Pumpkin shows no clear difference from compost application, but two of the four years lack separate yield determinations.

Carrots show higher yields in all four years with compost compared to without compost. On average, over 6000 kg more product harvested with compost application. The additional yield is in the same order of magnitude in all four years. The first year of compost application seems to have an immediate substantial effect, and a development in four years seems to be absent.

For oats, with the exception of the third year with compost application, compost treatment results in significantly higher yields. On average, this is over 600 kg more harvested product with compost application. The yield difference in the fourth year, 2024, is very large.

Seed potato shows no clear picture, except that Phytoftora determined the yield in 2021 and 2024 and in the other years the yield without and with compost is in the same order of magnitude.

French bean shows a very stable production level over the three years. The two years with separate production determination without and with compost do not provide a clear picture of any effect of compost application.

4 General reflections and conclusions

Figure 20 Experimental field Planty Organic with adjacent nature reserve Lauwersmeer.

Soil fertility is a long-term issue. A trial field of13 years seems a lot, and indeed it provides enough data to draw tentative conclusions. Its underpinnings are somewhat firmer than in the 2012-2016 and 2012-2021 evaluations (bibliography), but even after 13 years uncertainty about the accuracy of measurements plays a role in the interpretation of results.

4.1 Original crop rotation

Organic matter content

The organic matter content is not declining according to the 13 annual measurements on the six plots. The fluctuations in the OM results do give pause for thought about the reliability of the measurements, but statistically there is no doubt, and there may even be a very slight increase. For a system without any external inputs, this is still a remarkable result.
The modelling seems to describe this well, but there is a catch. With the standard setting of soil parameters, the organic matter content drops sharply according to the model calculations. In the previous evaluations, there was already an intervention: not 'reduced tillage' but 'no tillage' as a choice, resulting in a lower decomposition rate. With the expansion of the dataset, this still appears to yield too high a degradation rate. Manually the model is calibrated aiming at a six-year growth in soil organic matter content of 0.01%. This was achieved partly by lowering the overall degradation factor to 0.42. The default

value for very light loam with normal tillage is 0.89, with reduced tillage 0.75 , and with minimal tillage 0.62. So the model setting 0.42 is well outside the normal range. Can this be explained? Some thoughts are:

- The specific conditions, including exclusive application of plant fertilizers and a highly nitrogen-limited production system, **strongly inhibits the decomposition rate**.
- It may not so much be **less decomposition** but **more organic matter input** than expected. Because the crops have to 'search' for nitrogen, they will develop a stronger and more intensive root system, and that is not part of the standard model crop settings. The crop residues are not to blame; they have been measured in a number of cases and do not deviate from expectations.
- Another option for more organic matter supply is the 'liquid carbon pathway' (Jones 2008). Because crops have to 'search' for nutrients, there could be **extra root exudates** that are not accounted for in the model but do contribute to humus formation.

Based on the current dataset, nothing further can be said about these three suggestions. Additional measurements in the coming years might shed light on this. But for now, the conclusion is that the standard model settings cannot explain this result.

Soil organic nitrogen.

Depending on the interpretation of the measurements, there would be a slight decrease in soil nitrogen supply. For a system that runs solely on home-grown nitrogen and where production seems to be strongly limited by nitrogen, it does not seem an odd picture that the newly added organic matter could be relatively more nitrogen-poor. The mechanism could then be that fungi would occupy a somewhat more dominant position in organic matter decomposition over bacteria.

Phosphorus and potasium

The measurements show limited decreases in two of the five parameters. This is not surprising. With zero external inputs, there is a net drain of minerals, and that can lead to a decrease in mineral stock and mineral availability. Could, but need not, over a 13-year period. The soil mineral stock in this situation is very high, and there may be movement of minerals from the 2nd soil layer to the topsoil.

Nitrogen supply with leguminous crops

More than 50% of the time there is a legume in the field. So far, there is no evidence that this is too much, i.e. that soil-borne diseases or pests would inhibit nitrogen fixation, but this has not been investigated. Production of the main nitrogen-fixing crop, the clover/alfalfa, averages 9 tons of dry matter per year. However, it does seem that production in the last four years lags behind previous years (Table 4). An annual grass clover in many an organic arable farm on sandy soil, sown in autumn and incorporated after a year and a half, can end up with a production of at least 10-12 tons of dry matter per year. It is not clear whether the somewhat lower production in Planty Organic is caused by the fact that it is a pure legume crop (nitrogen fixation requires energy from the plant, which cannot then be used for dry matter production), or whether weed pressure in the first cut is a hindrance, or whether there is a N fixation reduction due to soil-borne disease/pest pressure. Since own N fixation is crucial in this system, it is worth finding out. It could also be reconsidered to mix grasses again with the clover/alfalfa.

4.2 Comparing old and new crop rotation

The replacement of the mixed crop wheat/field bean with french bean was prompted by the desire to have more time to control root weeds in particular. A possible financial balance benefit is a nice bonus in this respect. The consequence of this switch is a lower nitrogen use efficiency, less supply of organic matter to the soil and lower production in terms of ‘nitrogen in product’. Whether this is ultimately a justifiable choice is, after four years, not yet to be said. If, as a result, one of the following years a failure of carrot cultivation can be avoided, it would be a big win.

4.3 System comparison without / with compost

Since 2021, green compost has been applied in spring to about 75% of the area on all plots, with the aim of achieving phosphate balance there. On the remaining part of the plots, the policy of zero application is maintained. This constitutes a comparative trial design, even though it involves pseudo-replications and not experimentation with independent real replicates.

Soil measurements. Over four years, an effect on soil fertility measurements can hardly expected. This indeed appears to be the case: measurements vary widely, and a trend for a difference between without and with compost is not (yet) visible.

Modelling nitrogen dynamics. Over six years, the effect of annual application of compost is barely visible in increased nitrogen mineralisation. In other words, model-wise, almost no effect of nitrogen on yield should be expected in the first six years.

Measurements yield. Surprisingly, there does seem to be an increased yield when compost is applied to carrots and oats. This effect seems to occur immediately in the first year and cannot be interpreted as a nitrogen effect at all, unless we simply do not understand the nitrogen dynamics sufficiently. Anyway, four years is too short to make clear statements, and that compost can have a lot more effects than just on nitrogen availability is well known. Measurements at the pilot farms Vredepeel (De Haan and others, 2018 A) and Broekemahoeve (Selin Norén and others 2021) also show no strong effect on yield.

Differences in organic matter supply in general do eventually show significant differences in yields and farm profit (De Haan and others, 2018 B).

Nitrogen-phosphate relationship.

To compensate for phosphate runoff, greenwaste compost is used, as a kind of proxy for 'feedbacks from society'. Recycling 100% of phosphate is practically very difficult, but theoretically possible. The situation is different for nitrogen: part of it is always lost in the various process steps. The discharge from Planty Organic amounts to 35 P_2O_5kg and 75 kg N ha^{-1} yr^{-1}. The input with compost is 33 P_2O_5 and 75 kg N ha^{-1} yr^{-1}. This means that more nitrogen is 'returned' to the field than is theoretically and practically possible: it is not a cycle. Planty Organic is therefore charging for too much nitrogen with the current supply of compost from a recycling point of view.

Long-term effect of compost application.

Through compost application, there is an increase in organic matter content and increase of soil N stock. As a result of the cumulative effect, nitrogen mineralization will increase over time. Whether this will change the NUE cannot be determined in advance. Nevertheless something can be said about it.

- If productivity does not increase, leaching losses will increase and the NUE in its complete form will deteriorate (i.e. including soil mutation, see below).
- The investment in soil nitrogen, expressed in kg per hectare, is very high compared to the expected increase in mineralization and unforeseen effect on yield. Is it really worth the investment?

4.4 Nitrogen use efficiency NUE.

When developing and studying an arable system that runs entirely on own fixed nitrogen, the obvious thing to do is to look at the utilization rate of that nitrogen, and of course to visualize and reduce losses. This NUE is expressed either as a factor (output/input) or as a percentage (100*output/input). Output is then expressed in kg N in sold product. Determining input is more complicated: what do you include and what do you exclude? For the most complete picture possible, all inputs should be included. This then involves (for an arable farm):

- Inputs from outside: N in manure, N in seed.
- Uncontrolled inputs: deposition.
- Own supply: nitrogen fixation by leguminous crops.

This systematics was applied in this study, and the NUE of Planty Organic is reasonably high. The losses (leaching and volatilization) are low. But there is another factor at play. That is the net balance of soil nitrogen. When soil organic matter levels drop, soil nitrogen levels usually drop as well, and that means that, unseen, nitrogen is supplied from the stock. The NUE then seems good, but the system is invisibly running down in soil nitrogen supply. The reverse is also possible: by supplying compost, for example, the organic matter content and soil nitrogen content increase. This supply leads to a lower NUE if only the above three inputs are included, but the surplus is not lost: it is still present in the soil and can feed crops in the future. This is the situation under the Planty Organic scenario with compost application.

The best NUE calculation therefore includes the mutation in soil-N, and could consist in counting the investment in soil-N as a ‘product’. Unfortunately, this is largely theory because this mutation is hardly measurable, and certainly not in the short term. A modelling approach cannot simply provide a solution: surely that model will also have to be validated site-specifically, and that requires measurements. In the Planty Organic example, nine years were needed (with measurements each year on the six plots) to show that organic matter levels did not decline, and after 13 years it is still not fully established whether there is a small growth or equibalance in organic matter levels and a small or no decline in soil N total.

Finally, there is another possible source of nitrogen that does not come into the picture: a net decomposition of soil organic matter in the second soil layer (in this case: 30-60 cm depth) that releases net nitrogen, available for crop uptake. In recently cleared soils such as in Flevoland and also the 55 years ago reclaimed farmlands of the Lauwersmeer area, this may play a role, but finding out whether it does, let alone quantifying it, is very difficult. An attempt has been made by Gerard Oomen. His findings will be published in the report on the nitrogen dynamics of four top performers in biological N utilisation (Burgt and Oomen 2025, in preparation).

4.5 Conclusions

The conclusions below are not only based on this 13-year evaluation. The findings from the two previous evaluations have been included.

- An organic arable system based solely on own leguminous nitrogen fixation is possible. If nothing is supplied, it is, of course, at the expense of soil reserves and availability of other nutrients. On richer (clay) soils this can go well for a long time (in this case proven for 13 years), on poorer (sandy) soils it will probably lead to problems much sooner. However, there is nothing against, in the case of a similar experiment on sandy soils, compensating for nutrient run-off from the outset, according to a methodology of justified return from society, further to be defined how and what.
- Soil organic matter content is stable or increasing very slightly, nitrogen content is stable or decreasing very slightly. The fact that the organic matter content here does not decrease without external inputs is not well explained for the time being.
- The production per hectare in such a system is much lower than in a conventional arable system and also lower than in an organic arable system with manure fertilization of 170 kg N ha^{-1} yr^{-1} on similar soil. The productivity per hectare does have to take into account the area needed to extract nitrogen (here 1/6 of the area). This

also applies to the normal organic arable system using manure from outside the own farm, but is not easy to calculate. How many hectares of land are allocated to manure supply? In case of conventional production with (partly) artificial fertilizer-N, it becomes an even more complicated picture and it becomes comparing apples and pears.

- If organic agriculture really wants to fend for itself in terms of nitrogen supply, a lot of nitrogen is lost via the grass/clover -> fodder -> manure route, especially ammonia losses in the livestock phase, while the grass/clover -> cut&carry fertilizer route has hardly any nitrogen losses. Whether NUE differs after application of manure or cut&carry fertilizer is highly system-dependent, but the N release out of cut&carry fertilizer can be described as well as that from manure.
- Nitrogen losses to the environment are very low in absolute terms and low in relative terms, i.e. per kilogram of N in product sold. Ammonium losses connected with the use of animal manure are almost zero when cut&carry fertilizer is applied; leaching losses are low.
- The implemented change in crop rotation (different crop order, and wheat/field bean replaced by french bean) results in a lower NUE, slightly higher nitrogen loss and lower organic matter input. Whether this outweighs the intended gain in weed control remains to be seen. Besides, green beans are fit for human consumption while wheat/field bean was sold as fodder due to lack of market options for human consumption of such small quantities.
- The annual supply of 15 tons ha^{-1} of green compost leads to negligible effect on nitrogen availability in the first six years according to the modelling, and no yield effect can be expected of solely nitrogen availability.
- This compost supply does nevertheless seem to lead to substantial yield increases in two of the six crops. However, four years of measurements is too short to get a clear view on this.

5 Preview

The trial field with a well-documented history of 13 years is still there, but it is not a foregone conclusion that it can be continued. Funding has constantly been an issue during these 13 years and is so again now. Of course, it does help if there are concrete research questions that can be taken up with the current experimental set-up, or with slight changes to it.

- Since 2021, there have been two adjacent treatments that can be compared: without and with compost. No random distribution and independent replicates, but six pseudo replicates. There is something to do with that statistically soon; now, after four years, it is not possible. The results can then be compared with the compost treatments at the WUR trial sites Broekemahoeve and Vredepeel. Getting a picture of the effect of a (sharp) increase in organic matter content on yield and nitrogen use efficiency is essential to ultimately be able to weigh up whether or not (large) investments in soil organic matter is a defensible strategy overall. Considering only carbon storage is too lean an assessment framework. Every 10-12 kg of carbon sequestered also sequesters 1 kg of nitrogen. With increasing organic matter levels, the dynamics of N supply shift from short-lived peaks (artificial fertilizer, animal manure) towards very gradual N supply, and this requires careful fine-tuning of crop choice, crop order, green manuring and the timing of all this. This applies to both conventional and organic arable farming. If that fine-tuning does not succeed sufficiently, it will lead to increased nitrogen losses, especially through leaching.
- The continuation of the strips without any external inputs can be used to describe in more detail how it is possible that organic matter levels do not fall here. This would require measurements other than just yield and annual soil quality as is done so far. This would first require careful consideration: what is to be measured to gain more insight into both the supply and decomposition of organic matter.
- It is inevitable that agriculture will move towards an absolute phosphate balance or even (in the Netherlands, with accumulated P soil reserves on many soils) a slightly negative phosphate balance. We can anticipate this. This requires a new approach to phosphate fertilization, or much broader: a more detailed insight into the availability of phosphate for crop growth in the event of a (slightly) negative P-balance. This considers not only an annual balance, but also a dynamic approach with components such as soil life, rooting, organically bound phosphate and the mineralization of phosphate from it, all varying throughout the year and over the years. The trial field, with a 13-year history of zero P supply, and since 2021 a possibility to study differences in P supply side by side, can play a role in this. Again, careful consideration would have to be given to how this should be done in terms of research questions to gain new insights.
- If own nitrogen fixation is crucial, we need to know whether there is a maximum utilization of leguminous plants within a crop rotation. The proportion of leguminous

plants in the Planty Organic system is high. Consideration could be given to sampling the soil for fungi or nematodes that specifically target legumes, to find out if this inhibits nitrogen fixation. If it does not, it sheds new light on the (pre-)concerns around too high a proportion of leguminous plants in a crop rotation.

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Appendix 1: Crop and crop residue analysis (Eurofins laboratory)

Crops

2012		Seed potato	Carrots		Spring wheat	Cauliflower
N-tot	%	1,38	0,94		1,73	3,48
P2O5	%	0,6	0,53			1,35
K2O	%	3,05	3,40			5,09

2013		Seed potato	Carrots	Oats	Spring wheat	Cauliflower
N	%	1,32	0,83	1,70	1,68	2,59
P2O5	%	0,44	1,11	2,64	1,91	2,49
K2O	%	2,52	3,15	0,67	0,47	5,38
Ca	g/kg d.m.	1,15	3,59	1,35	0,53	3,02
Mg	g/kg d.m.	0,93	1,11	1,43	1,21	1,00
S	g/kg d.m.	1,04	1,04	1,53	1,07	
Cu	mg/kg d.m.	4,4	5,3	3,7	3,60	
Fe	mg/kg d.m.	87,2	69,1	63,9	29,20	
Mn	mg/kg d.m.	4,7	6,6	16,8	10,60	
Zn	mg/kg d.m.	19,10	22,00	40,70	32,90	

2014		Seed potato	Carrots	Winter wheat	Pumpkin	Rye
N	%	1,01	1,36	1,55	1,58	1,32
P2O5	%	0,60	0,71	0,80	0,62	0,94
K2O	%	2,71	3,72	0,56	3,01	0,66
Calcium	g/kg d.m.	0,71	3,20	0,33	1,10	0,47
Magnesium	g/kg d.m.	1,1	1,2	1,0	1,1	1,0
S	g/kg d.m.	1,4	1,9	1,3	1,5	1,2
Cu	mg/kg d.m.	6,9	7,6	4,2	4,5	4,6
Fe	mg/kg d.m.	56,7	36,2	27,3	39,8	29,9
Mn	mg/kg d.m.	2,6	2,9	5,4	1,8	11,8
Zn	mg/kg d.m.	19,7	34,5	39,9	28,0	40,0

2015		Seed potato	Carrots	Oats	Pumpkin	Field bean/ Spring wheat
N	%	1,16	1,26	1,92	1,70	4,41
P2O5	%	0,48	0,60	1,10	0,76	1,40
K2O	%	2,72	3,32	0,67	2,47	1,50
Calcium	g/kg d.m.	0,6	3,4	0,9	0,9	1,7
Magnesium	g/kg d.m.	1,0	0,9	1,5	1,2	1,5
S	g/kg d.m.	1,3	1,1	1,8	1,5	1,9
Cu	mg/kg d.m.	4,3	5,0	4,0	5,7	14,9
Fe	mg/kg d.m.	90	61	106	83	57
Mn	mg/kg d.m.	6	5	18	5	15
Zn	mg/kg d.m.	15	21	34	26	47

2016		Seed potato	Carrots	Oats	Pumpkin	Field bean/ Spring wheat
N	%	1,53	1,10	1,67	1,28	3,49
P2O5	%	0,85	0,69	0,98	1,03	1,63
K2O	%	3,42	2,32	0,71	3,26	1,48
Calcium	g/kg d.m.	1,3	3,5	1,0	1,5	1,7
Magnesium	g/kg d.m.	1,3	1,0	1,3	1,2	1,8
S	g/kg d.m.	1,9	1,0	1,9	2,6	2,4
Cu	mg/kg d.m.	7,07	6,86	3,05	8,09	12,3
Fe	mg/kg d.m.	284	149	76	337	88
Mn	mg/kg d.m.	12	7	23	6	13
Zn	mg/kg d.m.	17	16	26	24	46

2017		Seed potato	Carrots	Oats	Pumpkin	Field bean/ Spring wheat
N	%	1,28	1,04	1,47	1,49	4,13
P2O5	%	0,62	0,66	0,80	0,55	1,35
K2O	%	2,99	2,06	0,56	2,17	1,44
Calcium	g/kg d.m.	0,70	2,90	0,80	1,10	1,30
Magnesium	g/kg d.m.	1,00	0,80	1,00	1,00	1,30
S	g/kg d.m.	1,40	0,90	1,30	1,40	1,90
Cu	mg/kg d.m.	5,28	4,40	3,30	4,65	12,84
Fe	mg/kg d.m.	145	290	77	162,43	113
Mn	mg/kg d.m.	6,22	5,90	12,39	2,76	14,00
Zn	mg/kg d.m.	16,44	29,55	23,49	16,86	41,10

2018		Seed potato	Carrots	Oats	Pumpkin	Field bean/ Spring wheat
N	%	1,07	1,44	1,26	2,79	2,63
P2O5	%	0,48	0,62	0,85	0,82	0,87
K2O	%	2,21	1,73	0,68	3,17	0,80
Calcium	g/kg d.m.	0,40	3,10	1,00	2,90	0,70
Magnesium	g/kg d.m.	1,00	0,90	1,40	1,80	1,20
S	g/kg d.m.	1,30	1,10	1,40	2,20	1,70
Cu	mg/kg d.m.	4,80	7,70	3,90	7,40	6,70
Fe	mg/kg d.m.	60	48	110	170	43
Mn	mg/kg d.m.	4,00	5,00	12,00	9	9,00
Zn	mg/kg d.m.	12,00	23,00	26,00	29	36,00

2019		Seed potato	Carrots	Oats	Pumpkin	Field bean/ Spring wheat
N	%	0,89	1,53	1,8	1,71	3,1
P2O5	%	0,458	0,55	1	0,57	0,94
K2O	%	2,0812	2,15	0,7139	2,55	0,93
Calcium	g/kg d.m.	0,7	3,1	1,2	1,3	0,94
Magnesium	g/kg d.m.	0,8	1	1,7	1,3	1,36
S	g/kg d.m.	1,1	0,9	1,7	1,7	1,56
Cu	mg/kg d.m.	3,6	6,6	4,8	6	8,1
Fe	mg/kg d.m.	260	110	76	95	43,76
Mn	mg/kg d.m.	7	6	15	6	12,3
Zn	mg/kg d.m.	10	19	35	20	40,2

2020		Aardappel	Peen	Haver	Pompoen	Veldboon/ Zomertarwe
N	%	0,94	1,52	1,55	2,03	4,36
P2O5	%	0,53	0,8	1	0,76	1,3
K2O	%	2,53	3,12	0,77	2,36	1,55
Calcium	g/kg d.s.	0,6	3,6	1,2	1,3	2,03
Magnesium	g/kg d.s.	1	1	1,4	1,3	1,7
Zwavel	g/kg d.s.	1	1,5	1,6	1,8	1,83
Koper	mg/kg d.s.	4,1	5,7	4,2	6,2	12,58
Ijzer	mg/kg d.s.	67	198	65	66	59,06
Mangaan	mg/kg d.s.	4	8	12	5	16,65
Zink	mg/kg d.s.	12	22	27	27	46,4

Vanaf 2021, geen additionele compost

2021-C		Aardappel	Peen	Haver	Pompoen	Veldboon/ Zomertarwe
N	%	1,69		1,63	2,28	2,54
P2O5	%	0,66		0,89	1,15	0,98513
K2O	%	2,75		0,56635	2,84	0,6989
Calcium	g/kg d.s.	0,8		1,1	1,4	0,7
Magnesium	g/kg d.s.	0,9		1,4	1,7	1,4

2022-C		Aardappel	Peen	Haver	Pompoen	Sperzieboon
N	%	1,32	1,42	1,37	2,31	2,06
P2O5	%	0,57	0,46	0,78	0,78	0,73
K2O	%	2,92	1,43	0,61	2,78	2,63
Calcium	g/kg d.s.	0,8	3,4	1,1	1,4	6,3
Magnesium	g/kg d.s.	1,0	1,3	1,3	1,7	2,3
d.s.	%	202	121	839	176	142

2023-C		Aardappel	Peen	Haver	Pompoen	Sperzieboon
N	%	1,21	1,33	2,00	1,95	2,53
P2O5	%	0,55	0,55	0,96	0,82	
K2O	%	2,86	1,84	0,53	2,70	
Calcium	g/kg d.s.	0,6	3,5	1,4	0,7	
Magnesium	g/kg d.s.	1,1	1,2	1,5	1,3	
d.s.	%	22,2	10,7	80,6	18,2	10,4

2024-C		Aardappel	Peen	Haver	Pompoen	Sperzieboon
N	%	1,86	0,99	1,20	1,45	2,97
P2O5	%	0,85	0,53	0,73	0,73	1,05
K2O	%	3,45	1,78	0,63	2,24	2,77
Calcium	g/kg d.s.	0,9	3,2	0,8	0,6	8,5
Magnesium	g/kg d.s.	1,3	1,2	1,1	1,2	2,6
d.s.	%	17,6	10,8	83,5	21,4	10,0

Vanaf 2021, met additionele compost

2021+C		Aardappel	Peen	Haver	Pompoen	Veldboon/ Zomertarwe
N	%	1,98		1,63	1,69	2,54
P2O5	%	0,78		0,89349	0,84	0,98513
K2O	%	3,19		0,56635	2,48	0,6989
Calcium	g/kg d.s.	1		1,1	0,9	0,7
Magnesium	g/kg d.s.	1,1		1,4	1,4	1,4

2022+C		Aardappel	Peen	Haver	Pompoen	Sperzieboon
N	%	1,28	1,48	1,33	2,68	2,34
P2O5	%	0,50	0,48	0,82	0,82	0,76
K2O	%	2,66	1,69	0,64	3,76	2,77
Calcium	g/kg d.s.	0,6	3,5	1,2	1,2	6,6
Magnesium	g/kg d.s.	0,9	1,2	1,3	1,8	2,3
d.s.	%	196	104	842	180	126

2023+C		Aardappel	Peen	Haver	Pompoen	Sperzieboon
N	%	1,24	1,28	2,00	1,21	2,54
P2O5	%	0,57	0,55	0,99	0,96	
K2O	%	2,93	2,17	0,54	3,02	
Calcium	g/kg d.s.	0,6	3,4	1,3	0,9	
Magnesium	g/kg d.s.	1,1	1,3	1,4	1,7	
d.s.	%	21,9	10,4	81,7	17,9	10,8

2024+C		Aardappel	Peen	Haver	Pompoen	Sperzieboon
N	%	1,82	0,99	1,09		2,93
P2O5	%	0,82	0,57	0,73		0,96
K2O	%	2,77	1,99	0,63		2,78
Calcium	g/kg d.s.	1,0	3,1	0,8		8,4
Magnesium	g/kg d.s.	1,3	1,3	1,1		2,5
d.s.	%	18,0	11,3	84,4	21,3	10,1

Crop residues

2019		Aardappel	Peen	Haver	Pompoen	Tarwe
N	%	2,44	2,52	0,28	2,66	0,44
P2O5	%	0,50	1,03	0,27	0,69	0,29
K2O	%	3,23	3,62	1,40	3,73	0,83
DS	%	11,7	15,7		11,7	

						Tarwe/
2020		**Aardappel**	**Peen**	**Haver**	**Pompoen**	**Veldboon**
N	%	2,66	1,42	0,60	3,04	1,30
P2O5	%	0,53	0,44	0,32	0,66	0,30
K2O	%	5,96	2,77	4,45	4,19	1,10
DS	%	10,5	21,6	43,7	10,5	82,5

Vanaf 2021, geen additionele compost

						Veldboon/
2021-C		**Aardappel**	**Peen**	**Haver**	**Pompoen**	**Zomertarwe**
N	%			0,58	2,9	
P2O5	%			0,41238	1,09968	
K2O	%			2,95225	2,8679	
Calcium	g/kg d.s.			3,3	63,2	
Magnesium	g/kg d.s.			0,7	7,2	

2022-C		**Aardappel**	**Peen**	**Haver**	**Pompoen**	**Sperzieboon**
N	%		2,90		1,88	2,29
P2O5	%		0,55		0,50	0,46
K2O	%		1,67		4,42	1,61
Calcium	g/kg d.s.		26,2		42,2	32,3
Magnesium	g/kg d.s.		4,3		2,8	4,1
d.s.	%		208		100	216

Gewasrest						
2023-C		**Aardappel**	**Peen**	**Haver**	**Pompoen**	**Sperzieboon**
N	%		1,89	1,28	2,54	1,71
P2O5	%		0,57	0,53	1,10	
K2O	%		1,23	1,64	4,01	
Calcium	g/kg d.s.		24,8	9,1	> 40,2	
Magnesium	g/kg d.s.		4,5	2,2	4,0	
d.s.	%		24,7	42,7	74,0	19,5

Gewasrest						
2024-C		**Aardappel**	**Peen**	**Haver**	**Pompoen**	**Sperzieboon**
N	%		1,82	0,53	2,95	2,81
P2O5	%		0,55	0,41	0,73	0,55
K2O	%		1,51	2,96	2,70	1,64
Calcium	g/kg d.s.		26,5	3,5	76,8	32,2
Magnesium	g/kg d.s.		4,4	0,6	5,2	3,4
d.s.	%		28,1	62,9	13,0	17,3

Vanaf 2021, met additionele compost

2021+C		**Aardappel**	**Peen**	**Haver**	**Pompoen**	**Veldboon/ Zomertarwe**
N	%			0,49	2,4	
P2O5	%			0,37	1,05386	
K2O	%			2,66305	2,2172	
Calcium	g/kg d.s.			4	57	
Magnesium	g/kg d.s.			0,8	7,2	

2022+C		**Aardappel**	**Peen**	**Haver**	**Pompoen**	**Sperzieboon**
N	%		2,70		1,40	2,97
P2O5	%		0,50		0,44	0,50
K2O	%		1,39		4,15	1,84
Calcium	g/kg d.s.		27,3		>42,6	30,0
Magnesium	g/kg d.s.		4,3		3,6	3,9
d.s.	%		237		107	206

2023+C		**Aardappel**	**Peen**	**Haver**	**Pompoen**	**Sperzieboon**
N	%		1,90	1,04	2,96	1,54
P2O5	%		0,69	0,50	1,19	
K2O	%		2,12	1,99	3,84	
Calcium	g/kg d.s.		24,4	8,1	> 40,2	
Magnesium	g/kg d.s.		4,6	2,0	4,0	
d.s.	%		23,1	42,9	73,0	20,0

2024+C		**Aardappel**	**Peen**	**Haver**	**Pompoen**	**Sperzieboon**
N	%		2,20	0,67	2,73	2,70
P2O5	%		0,64	0,44	0,82	0,50
K2O	%		1,54	3,12	3,27	1,46
Calcium	g/kg d.s.		27,2	3,7	73,6	35,9
Magnesium	g/kg d.s.		4,5	0,7	4,5	3,7
d.s.	%		27,1	62,3	10,5	17,4

Appendix 2: Soil (Eurofins laboratory)

2012		A	B	C	D	E	F
N-Tot	mg N/kg	1200	1250	1260	1270	1300	1250
C/N		7,80	7,40	8,30	8,20	8,10	8,40
N-PAE	kg N/jaar	73,00	75,00	76,00	76,00	77,00	75,00
P-PAE	mg P/kg	1,20	1,70	1,80	1,70	1,30	1,70
P-AL	mg P2O5/100 gr	35	36	40	40	36	40
Pw	mg P2O5/l	22	23	27	27	24	26
K-PAE	mg K/kg	63	68	64	76	55	59
K number		29	29	22	27	22	21
Mg PAE	mg Mg/kg	34	41	45	44	44	46
Na PAE	mg Na/kg	30	38	86	55	11	30
pH		7,6	7,6	7,6	7,6	7,6	7,5
O.M.	%	1,6	1,6	1,8	1,8	1,8	1,8
C-inorg	%	0,9	0,9	1,0	1,0	1,0	1,0
CaO	%	4,1	4,3	4,3	4,5	4,6	4,4
Lutum	%	11	11	11	12	12	12

2013		**A**	**B**	**C**	**D**	**E**	**F**
N-Tot	mg N/kg	990	930	1030	890	1040	1070
C/N		9	10	10	11	9	10
N-PAE	kg N/jaar	59	53	60	47	64	60
S-tot	mg S/kg	520	600	570	380	440	350
C/S		17	16	19	25	22	30
S PAE	kg S/jaar	40	44	42	27	32	24
P-PAE	mg P/kg	1,1	1,8	1,4	1,9	1,3	1,4
P-AL	mg P2O5/100 gr	37	39	45	43	38	40
Pw	mg P2O5/l	31	37	37	39	33	35
K-PAE	mg K/kg	54	69	93	86	57	113
K-tot	mmol+/kg	2,6	2,3	3,1	2,9	2,7	3,0
K number		14	17	22	22	16	28
Ca-PAE	kg Ca/ha	177	278	226	328	177	326
Ca-tot	kg Ca/ha	4745	5035	5300	5020	5305	5165
Mg PAE	mg Mg/kg	37	48	51	48	42	48
Na PAE	mg Na/kg	7	9	8	10	9	14
Si -PAE	µ Si/kg	26660	31730	28350	34090	28940	28570
Fe -PAE	µ Fe/kg	< 3020	7860	<3020	4800	< 3020	<3020
Zn -PAE	µ Zn/kg	< 100	< 100	< 100	< 100	< 100	< 100
Mn-PAE	µ Mn/kg	< 250	<250	< 250	820	<250	3610
Cu-PAE	µ Cu/kg	<20	<20	20	20	22	21
Co-PAE	µ Co/kg	<2,5	<2,5	<2,5	3,6	< 2,5	6,6
B-PAE	µ B/kg	186	262	244	225	206	218
Mo-PAE	µ Mo/kg	5	8	8	10	8	16
Se-PAE	µ Se/kg	2,7	3,9	2,3	3,4	2,7	2,8
pH		7,1	7,1	7,1	7,2	7,3	7,4
C-org	%	0,9	0,9	1,1	1	1	1,1
O.M.	%	1,8	1,9	2,1	1,9	1,9	2,1
C-inorg	%	0,72	0,69	0,71	0,7	0,75	0,61
CaO	%	5,3	5	5,2	5,1	5,5	4,4

2014		**A**	**B**	**C**	**D**	**E**	**F**
N-Tot	mg N/kg	1180	1030	1040	1120	970	1110
C/N		10	9	10	9	9	9
N-PAE	kg N/jaar	67	63	56	69	61	67
S-tot	mg S/kg	570	500	450	490	350	380
C/S		21	19	22	21	26	27
S PAE	kg S/jaar	41	37	33	36	25	26
P-PAE	mg P/kg	1,3	1,4	1,4	1,3	1,0	1,8
P-AL	mg P2O5/100 gr	39	42	42	41	34	41
Pw	mg P2O5/l	33	36	36	34	29	38
K-PAE	mg K/kg	76	77	76	82	46	107
K-tot	mmol+/kg	3,6	3,4	3,1	3,5	3,0	3,4
K number		20	20	20	20	14	25
Ca-PAE	kg Ca/ha	25	50	26	26	177	327
Ca-tot	kg Ca/ha	6020	5550	5225	6070	4795	5650
Mg PAE	mg Mg/kg	49	48	49	51	45	48
Na PAE	mg Na/kg	13	11	10	13	11	12
Si -PAE	µ Si/kg	43840	37080	34090	42730	42270	37780
Fe -PAE	µ Fe/kg	<2010	<2010	<2010	<2010	2320	<2010
Zn -PAE	µ Zn/kg	<100	<100	<100	<100	<100	<100
Mn-PAE	µ Mn/kg	<250	<250	260	<250	<250	<250
Cu-PAE	µ Cu/kg	36	49	36	43	42	46
Co-PAE	µ Co/kg	<2,5	<2,5	<2,5	<2,5	<2,5	<2,5
B-PAE	µ B/kg	312	247	260	334	238	235
Mo-PAE	µ Mo/kg	6	12	12	11	9	12
Se-PAE	µ Se/kg	3,6	3,7	3,5	3,7	3,4	3,4
pH		7,4	7,4	7,4	7,1	7,2	7,2
C-org	%	1,2	1,0	1,0	1,1	0,9	1,0
O.M.	%	2,4	1,9	2,0	2,0	1,8	2,0
C-inorg	%	0,92	0,87	0,67	0,91	0,7	0,83
CaO	%	6,9	6,5	4,9	6,8	5,1	6,1
Lutum	%	13	10	10	12	10	11
Silt	%	33	29	14	30	19	24
Sand	%	45	53	69	49	64	57
CEC	mmol+/kg	107	96	91	106	83	98
CEC-occu	%	100	100	100	100	100	100
Soil life	mg N/kg	33	28	39	40	29	27

2015		**A**	**B**	**C**	**D**	**E**	**F**
N-Tot	mg N/kg	920	910	1100	960	1170	1170
C/N		10	10	9	10	9	9
N-PAE	kg N/jaar	52	53	67	56	71	71
S-tot	mg S/kg	680	640	430	350	460	620
C/S		13	15	24	28	24	17
S PAE	kg S/jaar	45	45	30	24	32	45
P-PAE	mg P/kg	1,0	1,0	1,6	1,8	1,1	1,4
P-AL	mg P2O5/100 gr	32	35	43	42	36	38
Pw	mg P2O5/l	23	26	30	31	25	27
K-PAE	mg K/kg	50	60	81	63	41	73
K-tot	mmol+/kg	2,8	2,7	2,9	3,0	2,4	2,8
K number		15	16	20	17	12	18
Ca-PAE	kg Ca/ha	25	202	377	151	100	250
Ca-tot	kg Ca/ha	5165	5255	5980	5535	6065	5910
Mg PAE	mg Mg/kg	35	39	43	42	41	54
Na PAE	mg Na/kg	10	9	9	9	10	11
Si -PAE	µ Si/kg	32710	31930	33440	37050	30450	33940
Fe -PAE	µ Fe/kg	<2020	<2020	<2020	<2020	<2020	<2020
Zn -PAE	µ Zn/kg	<100	<100	<100	<100	<100	110
Mn-PAE	µ Mn/kg	<250	<250	<250	<250	<250	440
Cu-PAE	µ Cu/kg	<20	<20	<20	<20	<20	<20
Co-PAE	µ Co/kg	<2,5	<2,5	<2,5	<2,5	<2,5	<2,5
B-PAE	µ B/kg	93	203	227	210	200	238
Mo-PAE	µ Mo/kg	11	12	13	8	9	4
Se-PAE	µ Se/kg	3,6	3,8	3,6	3,1	3,9	3,2
pH		7,1	7,1	7,3	7,3	7,4	7,1
C-org	%	0,9	0,9	1,0	1,0	1,1	1,1
O.M.	%	1,8	1,9	2,0	2,0	2,2	2,2
C-inorg	%	0,73	0,74	0,78	0,81	0,77	0,69
CaO	%	5,3	5,4	5,7	6,0	5,7	5,0
Lutum	%	11	11	12	9	11	11
Silt	%	27	26	25	26	23	29
Sand	%	55	56	55	57	58	53
CEC	mmol+/kg	88	90	103	96	104	102
CEC-occu	%	100	100	100	100	100	100
Soil life	mg N/kg	36	35	34	29	40	41

2016		**A**	**B**	**C**	**D**	**E**	**F**
N-Tot	mg N/kg	1010	1240	1190	850	960	860
C/N		8	8	8	11	10	10
N-PAE	kg N/jaar	66	73	77	46	52	47
S-tot	mg S/kg	530	540	500	420	540	450
C/S		16	17	20	22	17	18
S PAE	kg S/jaar	40	42	36	31	41	34
P-PAE	mg P/kg	1,4	1,8	1,9	1,8	1,6	1,5
P-AL	mg P2O5/100 gr	33	37	43	40	34	38
Pw	mg P2O5/l	25	29	31	30	27	28
K-PAE	mg K/kg	34	41	80	38	37	62
K-tot	mmol+/kg	2,4	2,8	3,3	3,1	2,5	3,1
K number		11	12	19	12	12	17
Ca-PAE	kg Ca/ha	254	278	302	177	228	178
Ca-tot	kg Ca/ha	5040	5615	5800	5850	5665	5425
Mg PAE	mg Mg/kg	23	30	39	32	33	34
Na PAE	mg Na/kg	<6	7	8	7	7	7
Si -PAE	µ Si/kg	32770	48350	35340	36650	48760	34470
Fe -PAE	µ Fe/kg	<2020	2460	<2020	<2020	3360	<2020
Zn -PAE	µ Zn/kg	<100	<100	<100	<100	110	<100
Mn-PAE	µ Mn/kg	<250	<250	<250	<250	<250	<250
Cu-PAE	µ Cu/kg	53	58	61	42	48	53
Co-PAE	µ Co/kg	<2,6	2,7	<2,6	<2,6	3,1	<2,6
B-PAE	µ B/kg	137	175	229	173	189	216
Mo-PAE	µ Mo/kg	23	22	22	8	14	24
Se-PAE	µ Se/kg	4,4	5,2	6,3	5,5	5	5,3
pH		7,5	7,5	7,3	7,6	7,5	7,3
C-org	%	0,8	0,9	1,0	0,9	0,9	0,8
O.M.	%	1,7	1,9	2,0	1,9	1,8	1,6
C-inorg	%	0,73	0,71	0,69	0,82	0,75	0,78
CaO	%	5,3	5,2	5	6,1	5,5	5,7
Lutum	%	9	11	11	10	10	9
Silt	%	22	26	24	26	22	16
Sand	%	62	56	58	56	61	68
CEC	mmol+/kg	85	96	101	100	96	93
CEC-occu	%	100	100	100	100	100	100
Soil life	mg N/kg	55	51	52	45	44	49

2017		**A**	**B**	**C**	**D**	**E**	**F**
N-Tot	mg N/kg	970	880	1100	910	1010	1070
C/N		12	10	10	12	11	10
N-PAE	kg N/jaar	60	65	80	55	65	70
S-tot	mg S/kg	485	425	270	350	435	505
C/S		24	22	42	31	25	20
S PAE	kg S/jaar	41	36	20	29	36	45
P-PAE	mg P/kg	1,3	1,4	1,7	1,4	1,3	1,4
P-AL	mg P2O5/100 gr	40	40	39	42	37	48
Pw	mg P2O5/l	27	28	29	28	26	30
K-PAE	mg K/kg	66	44	48	36	46	70
K-tot	mmol+/kg	2,6	3,1	2,7	2,6	2,6	2,9
K number		17	12	14	11	14	18
Ca-PAE	kg Ca/ha	150	240	275	335	270	510
Ca-tot	kg Ca/ha	6695	6435	7190	6740	7350	7750
Mg PAE	mg Mg/kg	39	39	39	39	38	47
Na PAE	mg Na/kg	11	11	10	10	16	10
Si -PAE	µ Si/kg	32930	49890	48730	28770	34800	45160
Fe -PAE	µ Fe/kg	< 2020	9310	7730	< 2010	< 2010	< 2020
Zn -PAE	µ Zn/kg	< 100	110	110	<100	< 100	< 100
Mn-PAE	µ Mn/kg	< 250	370	370	< 250	390	320
Cu-PAE	µ Cu/kg	25	30	28	21	28	27
Co-PAE	µ Co/kg	< 2,6	3,5	3,4	< 2,6	< 2,6	3,2
B-PAE	µ B/kg	212	232	219	169	178	223
Mo-PAE	µ Mo/kg	11	10	12	12	10	15
Se-PAE	µ Se/kg	3,2	3,1	3,1	2,8	2,8	3,0
pH		7,1	7	7,3	7,2	7,3	7,4
C-org	%	1,2	0,9	1,1	1,1	1,1	1,0
O.M.	%	2,1	1,9	1,9	1,9	2,2	2,1
CaO	%	6,2	5,8	6,1	6,6	6,3	5,8
Lutum	%	11	10	13	10	10	12
Silt	%	23	14	19	21	23	24
Sand	%	58	68	60	61	59	56
CEC	mmol+/kg	99	95	104	97	107	112
CEC-occu	%	100	100	100	100	100	100
Soil life	mg N/kg	28	34	26	26	43	41

2018		A	B	C	D	E	F
N-Tot	mg N/kg	1020	1090	1290	1070	1200	1080
C/N		10	9	8	10	9	11
N-PAE	kg N/jaar	70	80	95	70	80	70
S-tot	mg S/kg	405	445	345	375	535	565
C/S		26	23	30	27	19	21
S PAE	kg S/jaar	34	38	28	31	45	45
P-PAE	mg P/kg	1,2	1,5	1,5	1,4	0,9	1,5
P-AL	mg P2O5/100 gr	37	36	39	36	35	37
Pw	mg P2O5/l	26	27	28	26	23	27
K-PAE	mg K/kg	53	62	44	36	41	59
K-tot	mmol+/kg	2,7	3	2,8	2,3	2,5	3
K number		15	17	13	11	12	16
Ca-PAE	kg Ca/ha	30	150	180	30	180	270
Ca-tot	kg Ca/ha	7170	6945	7395	7010	7150	7255
Mg PAE	mg Mg/kg	39	47	43	43	41	43
Na PAE	mg Na/kg	12	14	11	11	14	10
Si -PAE	µ Si/kg	29770	35140	37290	31930	33620	42250
Fe -PAE	µ Fe/kg	< 2020	< 2020	3230	< 2020	< 2021	< 2022
Zn -PAE	µ Zn/kg	< 100	< 101	100	< 100	< 101	160
Mn-PAE	µ Mn/kg	380	280	320	580	290	340
Cu-PAE	µ Cu/kg	34	34	33	30	38	37
Co-PAE	µ Co/kg	< 2,6	< 2,6	< 2,6	< 2,6	< 2,6	< 2,6
B-PAE	µ B/kg	183	223	205	192	211	211
Mo-PAE	µ Mo/kg	14	12	14	9	13	13
Se-PAE	µ Se/kg	3,7	3,9	4,3	4	3,6	4,9
pH		7,2	7,4	7,1	7	7,3	7,1
C-org	%	1,1	1	1	1	1	1,2
O.M.	%	2	2	2	2,4	2,1	2,3
CaO	%	6,2	5,8	6,1	6,6	6,3	5,8
Lutum	%	10	12	13	10	11	10
Silt	%	30	20	17	15	23	24
Sand	%	53	61	63	68	59	58
CEC	mmol+/kg	102	100	106	101	102	106
CEC-occu	%	100	100	100	100	100	100
Soil life	mg N/kg	41	50	49	29	50	37
microb.bm	mg C/kg	5	9	7	7	5	1
bact.bm	mg C/kg	53	83	84	72	47	11
fungal bm	mg C/kg	48	54	61	65	52	7
fung./bact.		0,9	0,7	0,7	0,9	1,1	0,6

2019		A	B	C	D	E	F
N-Tot	mg N/kg	1140	850	910	1030	1240	830
C/N		9	12	11	11	8	12
N-PAE	kg N/jaar	80	50	60	65	90	50
S-tot	mg S/kg	515	505	455	525	455	455
C/S		19	20	22	21	21	22
S PAE	kg S/jaar	45	44	39	45	40	40
P-PAE	mg P/kg	1,1	1,3	1,5	1,7	1,2	1,5
P-AL	mg P2O5/100 gr	35	37	45	37	39	44
Pw	mg P2O5/l	24	26	30	28	26	30
K-PAE	mg K/kg	40	49	46	37	40	65
K-tot	mmol+/kg	2,8	3	2	3,2	2,6	2,7
K number		12	15	13	12	12	17
Ca-PAE	kg Ca/ha	185	30	490	210	365	30
Ca-tot	kg Ca/ha	6265	6685	6725	7470	6495	6780
Mg PAE	mg Mg/kg	40	38	41	44	38	44
Na PAE	mg Na/kg	13	12	10	11	9	7
Si -PAE	µ Si/kg	47880	38040	45380	39250	34470	34640
Fe -PAE	µ Fe/kg	3810	< 2020	3800	2420	< 2020	< 2010
Zn -PAE	µ Zn/kg	140	230	130	120	110	< 100
Mn-PAE	µ Mn/kg	410	< 250	370	330	< 250	< 250
Cu-PAE	µ Cu/kg	30	31	27	24	24	21
Co-PAE	µ Co/kg	2,6	2,6	2,8	< 2,6	< 2,6	< 2,6
B-PAE	µ B/kg	223	214	230	227	228	235
Mo-PAE	µ Mo/kg	11	9	10	8	11	14
Se-PAE	µ Se/kg	3,4	3,8	3,5	3,2	3,1	3,1
pH		7,3	7,3	7,4	7,4	7,1	7
C-org	%	1	1	1	1,1	1	1
O.M.	%	1,6	1,8	1,6	2	1,6	1,7
CaO	%	5,4	5,7	5,6	6	5,7	4,7
Lutum	%	11	11	12	11	10	11
Silt	%	28	32	17	21	33	28
Sand	%	54	50	64	60	50	55
CEC	mmol+/kg	88	95	94	107	91	96
CEC-occu	%	100	100	100	100	99	100
Soil life	mg N/kg	44	30	12	52	44	46
microb.bm	mg C/kg	98	173	190	179	130	257
bact.bm	mg C/kg	47	66	89	65	53	102
fungal bm	mg C/kg	31	71	54	43	48	91
fung./bact.		0,7	1,1	0,6	0,7	0,9	0,9

2020		**A**	**B**	**C**	**D**	**E**	**F**
N-Tot	mg N/kg	1010	1070	1040	1060	1050	1090
C/N		9	12	11	9	9	10
N-PAE	kg N/jaar	85	60	45	50	65	45
S-tot	mg S/kg	635	425	410	655	555	430
C/S		17	28	17	9	15	15
S PAE	kg S/jaar	45	34	39	45	45	41
P-PAE	mg P/kg	1,2	1,4	1,7	1,1	1,0	1,4
P-AL	mg P2O5/100 gr	37	40	41	40	36	38
Pw	mg P2O5/l	26	28	30	26	24	27
K-PAE	mg K/kg	52	59	43	46	37	61
K-tot	mmol+/kg	3,3	2,8	2,3	1,9	2,3	1,8
K number		15	16	13	14	12	16
Ca-PAE	kg Ca/ha	210	360	95	805	30	250
Ca-tot	kg Ca/ha	7570	7450	5275	5820	5960	4825
Mg PAE	mg Mg/kg	43	43	44	43	38	42
Na PAE	mg Na/kg	10	9	11	15	11	9
Si -PAE	µg Si/kg	47380	42690	52450	47020	57370	52580
Fe -PAE	µg Fe/kg	3590	< 2020	3760	2480	6550	3860
Zn -PAE	µg Zn/kg	<100	< 100	120	< 100	110	< 100
Mn-PAE	µg Mn/kg	<250	< 250	250	260	280	820
Cu-PAE	µg Cu/kg	43	41	38	33	41	35
Co-PAE	µg Co/kg	<2,6	< 2,6	2,6	< 2,6	3,3	4,6
B-PAE	µg B/kg	197	226	211	241	217	211
Mo-PAE	µg Mo/kg	14	12	12	11	9	12
Se-PAE	µg Se/kg	4,3	3,7	3,9	4,1	3,6	3,9
pH		7,6	7,6	7,2	7,5	7,5	7,3
C-org	%	1,1	1,2	0,7	0,6	0,8	0,7
O.M.	%	1,8	2,0	2,2	2,0	2,0	2,0
CaO	%	6,2	5,9	4,6	4,2	4,5	3,7
Lutum	%	12	11	8	7	8	7
Silt	%	34	25	10	12	14	16
Sand	%	46	56	76	76	72	72
CEC	mmol+/kg	108	106	73	80	83	67
CEC-occu	%	100	100	100	100	100	100
microb. activ	mg N/kg	48	29	36	36	79	31
microb.bm	mg C/kg	169	178	194	164	289	192
bact.bm	mg C/kg	54	77	93	36	69	55
fungal bm	mg C/kg	38	67	53	38	62	36
fung./bact.		0,7	0,9	0,6	1,1	0,9	0,7

No soil samples taken in 2021 in the strips without compost.

2022 without compost		A	B	C	D	E	F
N-Tot	mg N/kg	1240	1100	970	1040	900	1060
C/N		7	10	10	11	10	10
N-PAE	kg N/jaar	100	75	65	65	60	75
S-tot	mg S/kg	525	645	415	595	385	505
C/S		18	18	23	19	23	22
S PAE	kg S/jaar	45	45	36	45	33	43
P-PAE	mg P/kg	1,3	1,4	1,6	1,1	0,9	2,0
P-AL	mg P2O5/100 gr	36	40	43	41	32	46
Pw	mg P2O5/l	29	30	33	29	24	37
K-PAE	mg K/kg	39	41	52	35	30	80
K-tot	mmol+/kg	2,6	3,0	2,8	2,8	2,4	3,4
K number		15	16	17	15	15	21
Ca-PAE	kg Ca/ha	60	325	150	150	215	180
Ca-tot	kg Ca/ha	6845	7765	6520	7595	6530	7230
Mg PAE	mg Mg/kg	32	40	37	34	30	39
Na PAE	mg Na/kg	10	13	10	13	11	11
Si -PAE	µg Si/kg	39550	44530	37390	36690	38870	46600
Fe -PAE	µg Fe/kg	2020	< 2020	<2020	<2020	< 2010	<2020
Zn -PAE	µg Zn/kg	< 100	110	< 100	100	<100	< 100
Mn-PAE	µg Mn/kg	< 250	< 250	< 250	< 250	< 250	< 250
Cu-PAE	µg Cu/kg	28	40	35	32	29	31
Co-PAE	µg Co/kg	< 2,6	< 2,6	< 2,6	< 2,6	< 2,6	< 2,6
B-PAE	µg B/kg	154	221	199	206	149	228
Mo-PAE	µg Mo/kg	6	11	9	8	7	10
Se-PAE	µg Se/kg	3,3	3,8	3,4	3,0	3,3	3,9
pH		7,4	7,5	7,4	7,1	7,4	7,4
C-org	%	0,9	1,1	1,0	1,1	0,9	1,1
O.M.	%	2,1	2,1	1,9	2,4	1,7	2,2
CaO	%	4,7	5,6	4,7	5,7	4,5	5,3
Lutum	%	9	14	11	12	9	11
Silt	%	33	31	22	28	28	32
Sand	%	51	47	60	52	57	50
CEC	mmol+/kg	98	113	93	110	92	106
CEC-occu	%	100	100	100	100	100	100
microb. activ	mg N/kg	61	35	28	70	38	35
microb.bm	mg C/kg	180	211	189	195	192	198
bact.bm	mg C/kg	71	75	72	73	76	70
fungal bm	mg C/kg	64	61	65	63	62	57
fung./bact.		0,9	0,8	0,9	0,9	0,8	0,8

2023 without compost		**A**	**B**	**C**	**D**	**E**	**F**
N-Tot	mg N/kg	970	910	1060	920	1020	1000
C/N		10	12	11	13	11	11
N-PAE	kg N/jaar	70	55	70	55	65	65
S-tot	mg S/kg	525	565	565	300	375	475
C/S		19	19	21	22	29	24
S PAE	kg S/jaar	45	45	45	40	31	40
P-PAE	mg P/kg	2,1	1,7	2	2,1	1,7	2,8
P-AL	mg P2O5/100 gr	37	32	38	37	32	45
Pw	mg P2O5/l	34	29	33	34	29	42
K-PAE	mg K/kg	50	39	49	40	38	80
K-tot	mmol+/kg	3	3,1	3,2	2,7	2,6	3,5
K number		17	16	17	16	16	21
Ca-PAE	kg Ca/ha	300	360	150	480	365	420
Ca-tot	kg Ca/ha	6715	6950	7885	6695	7530	7020
Mg PAE	mg Mg/kg	32	30	35	31	30	36
Na PAE	mg Na/kg	12	10	11	13	11	8
Si -PAE	µg Si/kg	45460	40240	52390	59560	46230	46230
Fe -PAE	µg Fe/kg	2480	< 2020	3880	5780	< 2020	< 2010
Zn -PAE	µg Zn/kg	< 100	< 100	100	490	< 100	< 100
Mn-PAE	µg Mn/kg	440	410	530	620	500	620
Cu-PAE	µg Cu/kg	56	62	69	77	65	60
Co-PAE	µg Co/kg	2,9	< 2,6	3,5	5,9	3,3	3,3
B-PAE	µg B/kg	200	215	224	221	206	256
Mo-PAE	µg Mo/kg	13	14	15	20	15	19
Se-PAE	µg Se/kg	6,4	6,5	6,9	7,4	7,3	7,1
pH		7,3	7,3	7,3	7,4	7,6	7,3
C-org	%	1,0	1,1	1,2	1,2	1,1	1,1
O.M.	%	2,1	2,2	2,2	1,8	1,8	2,3
CaO	%	5,2	5,3	5,5	4,7	6,2	5,1
Lutum	%	11	12	11	10	12	10
Silt	%	31	30	29	36	21	38
Sand	%	51	51	52	48	59	45
CEC	mmol+/kg	98	102	113	98	107	104
CEC-occu	%	100	100	100	100	100	100
microb. activ	mg N/kg	42	38	26	51	20	36
microb.bm	mg C/kg	151	171	203	184	178	189
bact.bm	mg C/kg	59	64	73	64	72	67
fungal bm	mg C/kg	57	65	82	77	81	65
fung./bact.		1,0	1,0	1,1	1,2	1,1	1,0

2024 without compost		**A**	**B**	**C**	**D**	**E**	**F**
N-Tot	mg N/kg	1050	1300	970	1100	1020	1140
C/N		10	12	12	9	11	11
N-PAE	kg N/jaar	85	95	70	95	80	85
S-tot	mg S/kg	410	710	480	350	500	420
C/S		26	22	25	28	22	29
S PAE	kg S/jaar	42	45	45	35	45	41
P-PAE	mg P/kg	1,5	1	1,4	1,4	1,1	1,7
P-AL	mg P2O5/100 gr	41	40	45	42	34	47
Pw	mg P2O5/l	32	27	33	32	26	35
K-PAE	mg K/kg	59	34	38	34	31	65
K-tot	mmol+/kg	3,7	3,9	3,7	2,8	3,9	3,9
K number		19	16	17	15	16	20
Ca-PAE	kg Ca/ha	110	210	35	220	505	360
Ca-tot	kg Ca/ha	8500	11800	9720	8120	9305	8445
Mg PAE	mg Mg/kg	44	37	38	36	34	40
Na PAE	mg Na/kg	9	10	11	10	9	9
Si -PAE	µg Si/kg	34220	38480	41740	47530	38750	34030
Fe -PAE	µg Fe/kg	< 2020	< 2020	< 2020	3260	< 2020	< 2020
Zn -PAE	µg Zn/kg	< 100	< 100	< 100	< 100	< 100	< 100
Mn-PAE	µg Mn/kg	< 250	< 250	370	< 250	< 250	< 250
Cu-PAE	µg Cu/kg	27	28	37	23	27	28
Co-PAE	µg Co/kg	< 2,6	4,7	< 2,6	< 2,6	< 2,6	< 2,6
B-PAE	µg B/kg	238	189	193	166	192	221
Mo-PAE	µg Mo/kg	9	4	15	11	6	8
Se-PAE	µg Se/kg	3,3	3,6	3,8	2,7	3,4	3,5
pH		7,5	7,3	7,5	7,4	7,6	7,3
C-org	%	1,08	1,59	1,20	0,99	1,11	1,22
O.M.	%	2,1	2,9	2,2	2,0	2,0	2,4
CaO	%	5,7	7,6	6,1	5,4	6,2	5,2
Lutum	%	10	15	12	10	12	11
Silt	%	20	32	33	19	23	28
Sand	%	62	43	47	64	57	53
CEC	mmol+/kg	102	147	117	95	111	105
CEC-occu	%	100	100	100	100	100	100
microb. activ	mg N/kg	32	39	39	30	32	50
microb.bm	mg C/kg	212	230	190	180	192	229
bact.bm	mg C/kg	87	84	69	69	68	88
fungal bm	mg C/kg	84	80	85	69	78	81
fung./bact.		1,0	1,0	1,2	1,0	1,1	0,9

Starting in 2021, strips with additional compost:

2021 with compost		A	B	C	D	E	F
N-Tot	mg N/kg	1240	1320	1330	1280	1290	1230
C/N		11	10	10	10	9	9
N-PAE	kg N/jaar	60	60	70	60	75	75
S-tot	mg S/kg	870	455	615	475	700	605
C/S		14	24	20	22	16	19
S PAE	kg S/jaar	45	31	45	35	45	45
P-PAE	mg P/kg	1	1	1,3	1,4	0,9	1,2
P-AL	mg P2O5/100 gr	33	39	45	43	36	42
Pw	mg P2O5/l						
K-PAE	mg K/kg	53	34	49	45	33	49
K-tot	mmol+/kg	2,6	2,8	2,3	3,1	2,7	2,2
K number		15	12	14	14	12	15
Ca-PAE	kg Ca/ha	100	350	450	100	150	50
Ca-tot	kg Ca/ha	5770	6195	6440	6535	6800	6340
Mg PAE	mg Mg/kg	39	38	41	42	4,5	39
Na PAE	mg Na/kg	11	9	12	12	11	9
Si -PAE	µg Si/kg	32260	45570	44450	42740	40300	42380
Fe -PAE	µg Fe/kg	<2020	<2020	<2020	<2020	<2020	<2020
Zn -PAE	µg Zn/kg	<100	<100	<100	<100	<100	<100
Mn-PAE	µg Mn/kg	320	<250	<250	<250	<250	<250
Cu-PAE	µg Cu/kg	26	34	33	31	26	25
Co-PAE	µg Co/kg	<2,6	2,6	2,6	<2,6	2,6	<2,6
B-PAE	µg B/kg	143	138	168	196	126	169
Mo-PAE	µg Mo/kg	5	5	11	14	11	10
Se-PAE	µg Se/kg	3	3,2	3,3	3,5	3,2	3,1
pH		7,4	7,3	7,3	7,5	7,5	7,7
C-org	%	1,2	1,1	1,2	1,1	1,1	1,2
O.M.	%	2,2	2,3	2,2	2,2	2,4	2,3
CaO	%	4,4	6,7	4,7	6,9	5,5	5,8
Lutum	%	12	12	12	13	13	11
Silt	%	33	24	17	23	29	22
Sand	%	48	55	64	55	51	59
CEC	mmol+/kg	100	106	110	111	116	109
CEC-occu	%	100	100	100	100	100	100
microb. activity	mg N/kg	72	30	51	37	58	52
microb.bm	mg C/kg	249	327	195	230	258	207
bact.bm	mg C/kg						
fungal bm	mg C/kg						
fung./bact.		0,7	0,6	0,9	0,7	0,9	1,1

2022 with compost		A	B	C	D	E	F
N-Tot	mg N/kg	1140	840	920	960	1150	1040
C/N		9	11	13	10	10	11
N-PAE	kg N/jaar	85	55	50	65	80	65
S-tot	mg S/kg	475	495	555	475	565	445
C/S		23	19	21	21	21	25
S PAE	kg S/jaar	40	43	45	41	45	37
P-PAE	mg P/kg	1,3	1,1	1,7	1,0	1,3	1,5
P-AL	mg P2O5/100 gr	35	31	42	40	35	37
Pw	mg P2O5/l	28	25	33	28	28	30
K-PAE	mg K/kg	48	28	59	40	47	79
K-tot	mmol+/kg	2,9	2,5	3,1	3,0	2,9	3,1
K number		17	14	18	16	17	20
Ca-PAE	kg Ca/ha	240	450	270	180	270	420
Ca-tot	kg Ca/ha	7145	6460	7320	6900	7435	7020
Mg PAE	mg Mg/kg	39	32	42	38	33	41
Na PAE	mg Na/kg	12	10	11	15	12	10
Si -PAE	µg Si/kg	49070	39170	43140	39190	43070	38750
Fe -PAE	µg Fe/kg	2880	< 2020	<2020	<2020	2440	<2020
Zn -PAE	µg Zn/kg	110	100	< 100	< 100	170	< 100
Mn-PAE	µg Mn/kg	< 250	< 250	< 250	< 250	< 250	< 250
Cu-PAE	µg Cu/kg	30	34	31	34	34	32
Co-PAE	µg Co/kg	< 2,6	< 2,6	< 2,6	< 2,6	< 2,6	< 2,6
B-PAE	µg B/kg	203	163	251	200	198	330
Mo-PAE	µg Mo/kg	10	10	9	10	7	11
Se-PAE	µg Se/kg	2,9	2,9	3,0	3,8	2,8	4,1
pH		7,4	7,3	7,2	7,3	7,3	7,4
C-org	%	1,1	0,9	1,2	1,0	1,2	1,1
O.M.	%	2,1	2,0	2,2	1,7	2,1	2,3
CaO	%	4,7	4,3	5,0	4,9	4,4	5,0
Lutum	%	11	10	13	11	11	10
Silt	%	29	21	22	27	35	27
Sand	%	53	63	58	55	48	56
CEC	mmol+/kg	103	92	105	99	108	102
CEC-occu	%	100	100	100	100	100	100
microb. activity	mg N/kg	38	29	34	30	33	31
microb.bm	mg C/kg	196	154	234	162	192	208
bact.bm	mg C/kg	81	65	82	73	85	75
fungal bm	mg C/kg	73	61	87	61	71	58
fung./bact.		0,9	0,9	1,1	0,8	0,8	0,8

2023 with compost		A	B	C	D	E	F
N-Tot	mg N/kg	1270	920	1100	1100	1040	1050
C/N		8	12	11	11	11	12
N-PAE	kg N/jaar	100	55	70	70	65	60
S-tot	mg S/kg	545	515	515	465	535	505
C/S		19	22	23	26	21	24
S PAE	kg S/jaar	45	45	45	38	45	43
P-PAE	mg P/kg	1,6	1,6	2	2	1,5	2,2
P-AL	mg P2O5/100 gr	33	33	41	37	30	37
Pw	mg P2O5/l	29	29	35	33	27	34
K-PAE	mg K/kg	49	44	40	46	41	69
K-tot	mmol+/kg	4,5	2,2	2,2	3	2,7	2,7
K number		19	16	15	17	16	19
Ca-PAE	kg Ca/ha	30	545	720	420	210	570
Ca-tot	kg Ca/ha	6705	7255	7230	7020	6920	7360
Mg PAE	mg Mg/kg	37	35	33	36	32	38
Na PAE	mg Na/kg	12	11	10	13	10	9
Si -PAE	µg Si/kg	46400	54580	42750	40070	52720	49240
Fe -PAE	µg Fe/kg	< 2010	4290	< 2020	<2020	3140	3530
Zn -PAE	µg Zn/kg	280	< 100	100	<100	< 100	110
Mn-PAE	µg Mn/kg	430	410	490	520	400	530
Cu-PAE	µg Cu/kg	57	58	69	64	54	58
Co-PAE	µg Co/kg	2,6	3,8	3,1	2,7	3,5	4
B-PAE	µg B/kg	206	198	217	242	196	247
Mo-PAE	µg Mo/kg	14	12	15	17	10	16
Se-PAE	µg Se/kg	6,2	6,3	6,4	6,4	6,4	6,7
pH		7,1	7,3	7,4	7,4	7,5	7,4
C-org	%	1,1	1,1	1,2	1,2	1,1	1,2
O.M.	%	2,3	1,7	1,8	1,9	1,8	2,0
CaO	%	4,5	4,6	4,5	5,3	5,6	5,1
Lutum	%	11	12	12	12	12	11
Silt	%	31	32	31	26	28	34
Sand	%	51	50	51	55	53	48
CEC	mmol+/kg	99	103	104	102	100	106
CEC-occu	%	100	100	100	100	100	100
microb. activity	mg N/kg	41	38	39	26	30	42
microb.bm	mg C/kg	111	193	190	188	187	189
bact.bm	mg C/kg	45	64	71	68	71	72
fungal bm	mg C/kg	65	75	84	79	79	88
fung./bact.		1,4	1,2	1,2	1,2	1,1	1,2

2024 with compost		**A**	**B**	**C**	**D**	**E**	**F**
N-Tot	mg N/kg	1040	930	860	1200	1090	950
C/N		11	12	13	10	11	12
N-PAE	kg N/jaar	80	65	60	95	85	65
S-tot	mg S/kg	460	470	690	440	340	430
C/S		25	23	17	27	36	26
S PAE	kg S/jaar	45	45	45	44	31	43
P-PAE	mg P/kg	1,4	1,1	1,3	1,2	1,1	1,1
P-AL	mg P2O5/100 gr	40	38	47	40	35	37
Pw	mg P2O5/l	31	28	33	29	26	27
K-PAE	mg K/kg	53	33	39	38	38	38
K-tot	mmol+/kg	3,6	2,5	4	3,7	4,2	3,3
K number		18	15	17	17	17	16
Ca-PAE	kg Ca/ha	35	395	35	215	255	255
Ca-tot	kg Ca/ha	8645	8885	9180	9440	9100	8495
Mg PAE	mg Mg/kg	44	38	40	42	43	38
Na PAE	mg Na/kg	22	10	9	11	10	9
Si -PAE	µg Si/kg	43360	38550	40290	40110	39440	37500
Fe -PAE	µg Fe/kg	2930	< 2020	< 2020	< 2020	< 2020	< 2020
Zn -PAE	µg Zn/kg	< 100	< 100	140	< 100	< 100	100
Mn-PAE	µg Mn/kg	< 250	< 250	250	< 250	< 250	< 250
Cu-PAE	µg Cu/kg	30	31	38	26	46	29
Co-PAE	µg Co/kg	< 2,6	2,9	2,7	< 2,6	< 2,6	< 2,6
B-PAE	µg B/kg	167	179	197	216	205	177
Mo-PAE	µg Mo/kg	6	6	10	7	4	4
Se-PAE	µg Se/kg	3,1	2,8	3,8	3,2	3,4	3,2
pH		7,5	7,4	7,3	7,5	7,6	7,3
C-org	%	1,17	1,09	1,16	1,19	1,22	1,10
O.M.	%	2,1	2,1	2,1	2,3	2,1	2,1
CaO	%	5,7	6,5	5,4	6,7	5,9	5,3
Lutum	%	11	12	13	14	13	11
Silt	%	26	26	35	27	22	25
Sand	%	55	53	45	50	57	57
CEC	mmol+/kg	104	106	112	114	110	101
CEC-occu	%	93	100	100	100	100	100
microb. activity	mg N/kg	40	46	23	45	44	38
microb.bm	mg C/kg	182	178	192	234	216	197
bact.bm	mg C/kg	70	69	71	88	84	74
fungal bm	mg C/kg	73	55	80	79	83	76
fung./bact.		1,0	0,8	1,1	0,9	1,0	1,0