



BETER  
BODEMBEHEER

# SOIL INDICATORS FOR AGRICULTURAL FIELDS IN THE NETHERLANDS (BLN VERSION 1.1)

Measuring the soil quality of agricultural fields in a uniform and integral manner is possible with the set of indicators 'Soil indicators for agricultural fields in the Netherlands' (Bodemindicatoren voor Landbouwgronden in Nederland, BLN for short). Measuring the soil quality is important for the sustainable management of agricultural soils.

## WHY MEASURE SOIL QUALITY?

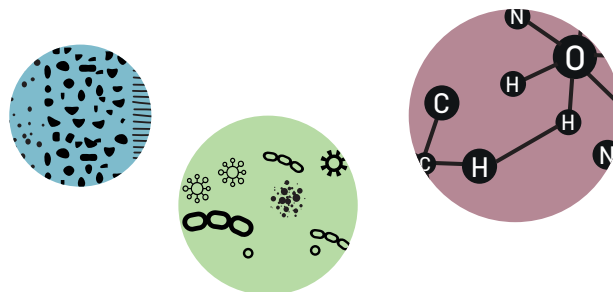
The Netherlands aims for a sustainable management of agricultural soils by 2030 and additionally a yearly storage of 0.5 Mton carbon in the soils to mitigate the negative effects of climate change. To realise this, it is necessary to measure changes in soil quality, including the carbon content. With these measurements, the soil quality can be assessed and the necessary measures to maintain or improve the soil quality can be defined. When measuring soil quality, it is important to use a common and clear approach. Measuring soil quality in a uniform and integral manner is important for:

1. National and regional monitoring of soil quality at a selection of fields or points.
2. Application by farmers to monitor the soil quality on their fields and improve their management.

## DEVELOPMENT OF THE BLN FROM VERSION 1.0 TO VERSION 1.1

WUR developed the BLN set of indicators in 2019, commissioned by the Dutch Ministry of Agriculture, Nature and Food Quality (version 1.0, Hanegraaf et al., 2019). In 2021, the set was adapted (version 1.1, de Haan et al., 2021). In version 1.1 a few improvements were made on the indicator categories and measuring methods. Moreover, some target values and reference values were updated.

The BLN has been endorsed by parties of the Dutch national program on agricultural soils (Nationaal Programma Landbouwbodems). This marked an important step towards a uniform way of defining the soil quality of agricultural soils and reaching to a sustainable management of these soils.



## BLN, VERSION 1.1

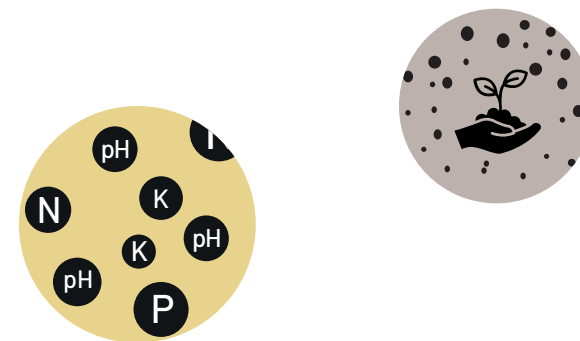
In the BLN, version 1.1, a selection of 18 important indicators was made, to give a reliable representation of integral soil quality, see the infographic at page three, and the table at the back of this brochure. This includes classical, reliable, but sometimes expensive and slow measuring methods, as well as alternative, quick and cheaper methods. The BLN, version 1.1, can be used for all combinations of soil types and land use in the Netherlands. For four combinations, target values and/or reference values are given.

## TARGET VALUES AND REFERENCE VALUES

In the BLN, version 1.1, the definitions used for target value and reference value are as follows:

- **Target value:** The value of an indicator above and/or below which the target can be reached for a given combination of land use type and soil type. The target value can also be a specified range. As an example, the optimal pH level for an optimal crop yield is pH 5.5 or higher.
- **Reference value:** A specified value or range that can be used to compare a measured value for a given combination of land use type and soil type, without mentioning whether this is good or bad.

Reference values are not 'optimal' values for a specific target and are only used when target values are not available. The presented target and reference values are based on the current available knowledge on arable and dairy farming on clay as well as sandy soils in the Netherlands. Overviews of target and reference values for other soil types and land use types are not yet available.



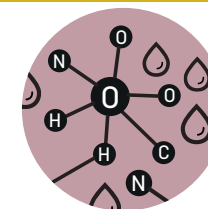
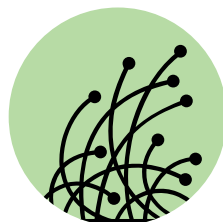
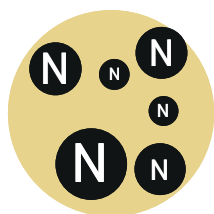
## SOIL QUALITY AND SOIL MANAGEMENT

When using the BLN, version 1.1, it is important to differentiate between soil quality and soil management. A good soil quality does not necessarily mean there is a good soil management and vice versa. Changes in the soil occur slowly, and therefore a change in soil management does not directly result in a measurable change in soil quality.

## SELECTION CRITERIA FOR INDICATORS

The indicators of the BLN list were selected by experts as being the most relevant characteristics for agricultural soil quality, regarding carbon, soil physics, soil chemistry and soil biology. The methods to measure and define these indicators have to be:

1. Sufficiently accurate and precise to be able to detect changes of the indicator caused by management of the farmer.
2. As cheap as possible within the requirements for accuracy and precision as named in point 1.
3. Quick and practically executable (in field or lab).
4. As robust as possible: independent of influences of other circumstances.



Because many measuring methods do not fulfil all criteria at the same time, a distinction was made between classical methods (usually accurate and precise) and alternative methods (usually quick and cheap). The classical methods usually measure the indicator directly, while the alternative methods are mostly based on indirect measurements. For some of the indicators no alternative methods are necessary, as the classical method is already quick and cheap. For some other indicators no alternative methods are available.

## TESTING AND DEVELOPING THE SET OF INDICATORS

The BLN, version 1.1, is mostly suitable for research purposes and monitoring and is not yet suitable for the use by farmers and advisers. In the coming years, the BLN will be further developed to a version 2.0 that will be suitable for monitoring as well as use by farmers. This research is executed within the PPS Beter Bodembeheer (*public private collaboration on better soil management*) and the program Slim Landgebruik (*Smart Land use, focused on carbon sequestration and soil quality*).

## COLOPHON

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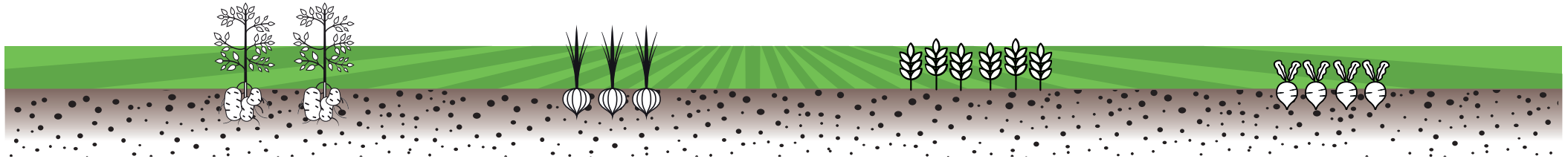
Further information (in Dutch): [www.beterbodembeheer.nl](http://www.beterbodembeheer.nl)

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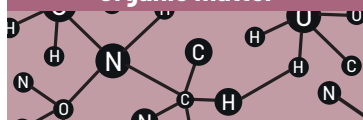
The BLN, version 1.1, is described in (in Dutch): J.J. de Haan, H.G.M. van den Elsen, M. Hanegraaf, S.M. Visser, 2021. Evaluatie van de BLN, versie 1.1; Voorstel voor BLN, versie 1.1 en schets van een ontwikkelpad naar een BLN, versie 2.0. Wageningen Research, Rapport WPR-883.

The BLN, version 1.0, is described in (in Dutch): M. C. Hanegraaf, H.G.M. van den Elsen, J.J. de Haan and S.M. Visser. 2019. Systematiek voor bodemkwaliteitsbeoordeling van landbouwgronden in Nederland. Wageningen Research, Rapport WPR-795.

For a uniform assessment of soil quality and sustainable soil management




### Organic matter



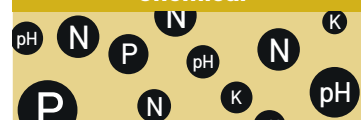
- Soil organic matter content
- Soil organic carbon content
- Easily degradable organic matter

### Physical




- Water holding capacity
- Aggregate stability
- Penetration resistance
- Dry bulk density

### Chemical




- Acidity (pH)
- Total nitrogen
- Potentially mineralisable nitrogen
- Total soil phosphate stock and availability
- Total soil potassium stock and availability

### Biological



- Nematodes, amount and diversity
- Plant parasitic nematodes
- Bacterial biomass
- Fungal biomass
- Earthworms, amount and diversity

### Visual



Visual assessment:

- Soil structure
- Soil life
- Rooting

**TARGETING SOIL FUNCTIONS BY MEASURING SOIL QUALITY**  
**PRODUCTION • WATER REGULATION • CARBON STORAGE • NUTRIENT CYCLING • BIODIVERSITY**

BLN, VERSION 1.1					Target and reference values				
Nr	Indicator	Classical method	Quick and cheap method <sup>1</sup>	Measuring unit	Type of value	Arable farming on clay	Arable farming on sand	Dairy farming on clay	Dairy farming on sand
<b>Soil organic matter indicators</b>									
1	Soil organic matter content	Loss on ignition 550 °C	NIRS*	%	Ref	2.5 - 7.6	1.6 - 10.9	3.5 - 19.9	2.6 - 9.6
2	Soil organic carbon content	Carbon, 550 °C	NIRS*	%	Ref	0.9 - 2.8	0.7 - 6.2	1.3 - 8.8	1.3 - 5.4
3	Easily degradable organic matter	Hot water extraction (HWC)	n.a.	mg kg <sup>-1</sup>	Ref	500	500-2000	n.a.	700 - 2300
<b>Physical indicators</b>									
4	Water holding capacity	Sandbox/pressure plate	PTF: textuur + OS%	m <sup>3</sup> m <sup>-3</sup>	Ref	0.24	0.19	0.24	0.19
5	Aggregate stability	Wet sieving method	n.a.	%	n.a.	n.a.	n.a.	n.a.	n.a.
6	Penetration resistance	Penetrometer	n.a.	MPa	Target	< 3	< 3	< 3	< 3
7	Dry bulk density	Mass after drying 105 °C	PTF: OS%	kg m <sup>-3</sup>	Target	1.15 - 1.41	1.20 - 1.51	0.76 - 1.38	1.17 - 1.47
<b>Chemical indicators</b>									
8	Acidity (pH)	Extraction in CaCl <sub>2</sub>	NIRS	-	Target	Dependent on lutum%, SOM% and crop rotation		Dependent on lutum% and SOM%	
					Ref	6.4 - 7.6	4.5 - 7.4	5.5 - 7.6	4.4 - 6.4
9	Total nitrogen (N-totaal)	DUMAS	NIRS*	g kg <sup>-1</sup>	Ref	0.9 - 2.8	0.7 - 2.9	1.3 - 8.1	0.9 - 3.3
10	Potentially mineralisable nitrogen (PMN)	Anaerobic incubation	n.a.	mg kg <sup>-1</sup>	Ref	21 - 93	20 - 79	33 - 209	23 - 113
11	Total soil phosphate stock (P-AI) and phosphate availability (P-CaCl <sub>2</sub> )	Extraction in ammonium lactate-acetic acid	NIRS	g P <sub>2</sub> O <sub>5</sub> 100 g <sup>-1</sup>	Target	Tables Handboek Bodem & Bemesting Phosphate <sup>2,3</sup>		Tables Adviesbasis Bemesting p. 2.1.3.3/3.3.2 <sup>3</sup>	
					Ref	27 - 92	18 - 98	10 - 52	11 - 95
					Ref	0.6 - 4.8	0.6 - 8.7	0.3 - 3.3	0.3 - 6.5
12	Total soil potassium stock (K-CEC) and potassium availability (K-CaCl <sub>2</sub> )	Co-hexamine	NIRS	mmol+ kg <sup>-1</sup>	Target	Tables Handboek Bodem & Bemesting Potassium <sup>2,3</sup>		Tables Adviesbasis Bemesting p. 2.1.4.3/3.3.3 <sup>3</sup>	
					Ref				
13	Nematodes, amount and diversity	Microscopy	PCR <sup>3</sup>	# 100 ml <sup>-1</sup> fresh soil	Ref	660 - 2190	1475 - 6331	2170 - 7260	2450 - 7760
				# taxa 100 ml <sup>-1</sup> fresh soil	Ref	25 - 44	19 - 32	21 - 36	27 - 42
14	Plant parasitic nematodes	Microscopy	PCR <sup>3</sup>	# 100 ml <sup>-1</sup> fresh soil	Target	Dependent on soil type, crop and nematode species <a href="http://www.aaltjesschema.nl">www.aaltjesschema.nl</a> / <a href="http://best4soil.eu">best4soil.eu</a>			
15	Bacterial biomass	Microscopy	PLFA	µg C g <sup>-1</sup> dry soil	Ref	7.5 - 162	25 - 145	38 - 844	40 - 293
16	Fungal biomass	Microscopy	PLFA	µg C g <sup>-1</sup> dry soil	n.a.	n.a.	n.a.	n.a.	n.a.
17	Earthworms, amount and diversity	Mustard extraction	n.a.	# m <sup>-2</sup>	Ref	12 - 440	0 - 118	126 - 804	24 - 388
				# taxa m <sup>-2</sup>	Ref	1.3 - 7.9	0.0 - 4.7	5.0 - 9.0	3.0 - 7.0
<b>Other indicators</b>									
18	Visual assessment	Soil structure Soil life Rooting	n.a.	-		<a href="https://www.goedbodembeheer.nl/graaf-eeen-kuil">https://www.goedbodembeheer.nl/graaf-eeen-kuil</a> , <a href="https://www.cosunleden.nl/unitip/handleiding-bodemconditie">https://www.cosunleden.nl/unitip/handleiding-bodemconditie</a> , <a href="http://mijnbodemconditie.nl/">http://mijnbodemconditie.nl/</a> <sup>5</sup>			

n.a. = not available

Ref = reference value for land use on this soil type

Target = target value

PTF = Pedotransfer function, estimation of the indicator based on easily measurable indicator

1 Quick and cheap methods with a \* are accredited

2 Dutch fertilization advice: arable farming:

[www.handboekbodemembemesting.nl](http://www.handboekbodemembemesting.nl),

dairy farming: [www.bemestingsadvies.nl](http://www.bemestingsadvies.nl) (in Dutch)

3 Target values for phosphate and potassium in arable farming, based on the named indicators, will be taken up in the Handboek Bodem en Bemesting in 2021

4 Only available for specific nematode species

5 References to visual soil assessments (in Dutch)