

# From Aspiration to Implementation

## “Building Hubble/James Webb for the Soil Universe”



BodemBreed – Themabijeenkomst Bodem en Data – 8 mei 2025  
Bob Klein Lankhorst

# Bob Klein Lankhorst – Chief Soil Officer at HAL24K AGRI



**Mission to establish the global standard for measuring functional biodiversity enabling better decisions for soil health, restoring biodiversity, and improving human well-being on Earth.**



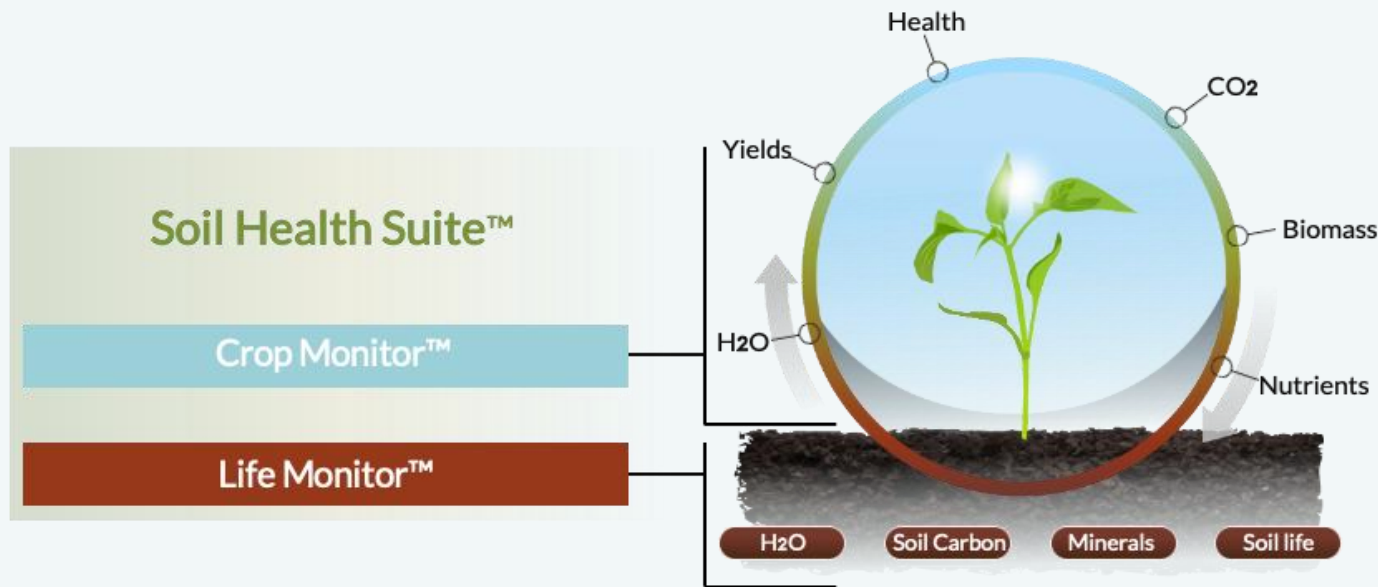
**Co-Founder HAL24K Agri - Pioneering AI-driven soil intelligence, combining expertise in soil science, functional biodiversity, and ecosystem services to revolutionize soil health monitoring.**



**Setting a Global Standard – A member of several Standards Committees shaping new guidelines for soil health assessments**



# Introducing Soil Health Suite



## Life Monitor

- A new technology to observe soil life enabled by Artificial Intelligence
- Measure and track functional soil biology
- Transform data to information and advice

## Crop Monitor

- Monitor and manage crop growth enabled by Artificial Intelligence

## Soil Health Suite

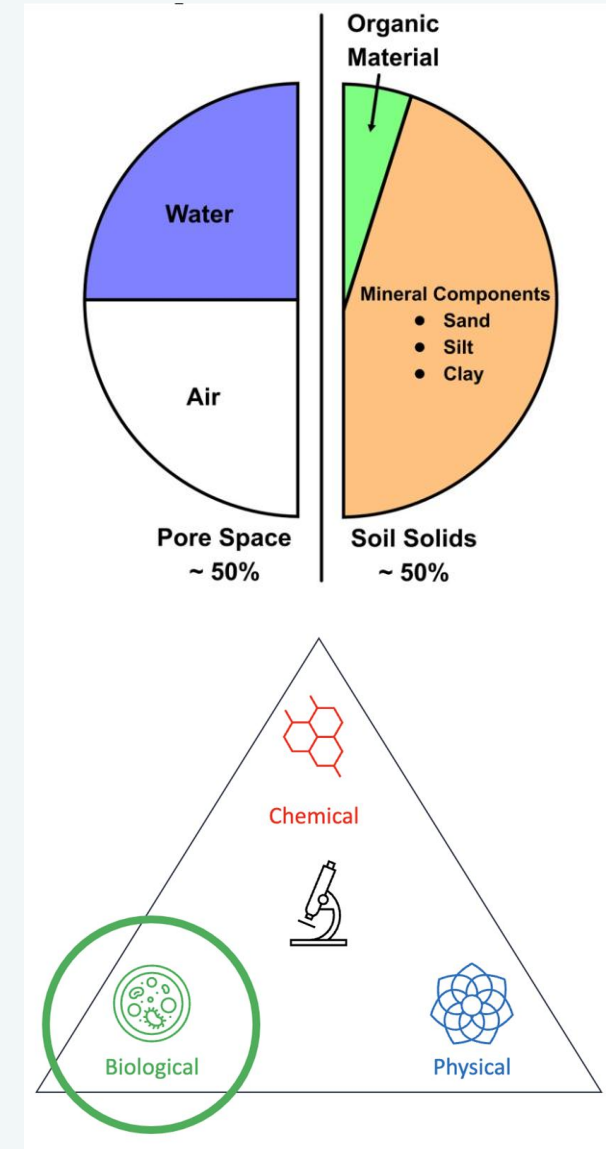
- Use unique combination of Life and Crop monitors
- Optimize Soil Asset Value
- Improve Human Health, Plant Growth, Climate, Water retention

# From Aspiration to Implementation

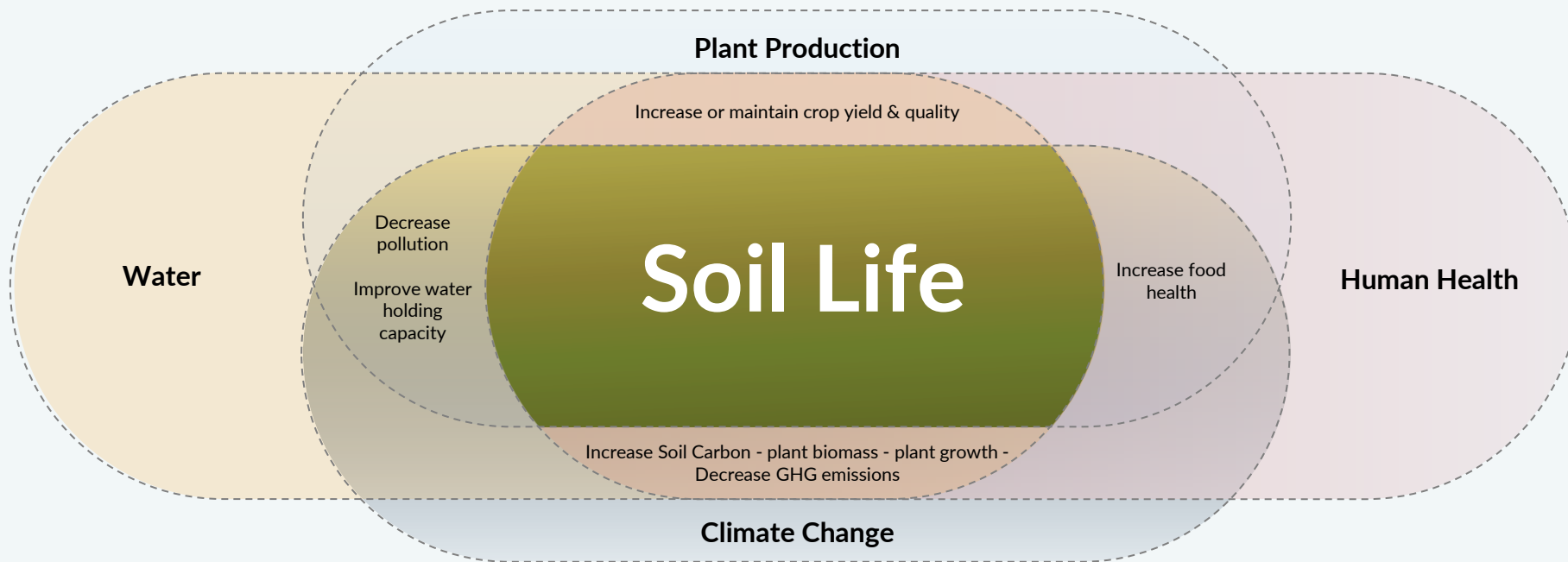
## “Building Hubble/James Webb for the Soil Universe”

# Soil is a Complex Universe

- **Bacteria:** Total weight of 5 cows per hectare!
- **Fungi:** 100,000 species known, there may be a million
- **Protists:** Thousands in a teaspoon of soil
- **Nematodes:** Most common animal on earth ( $\pm 80\%$ )



# Soil Life is the Core of Our Ecosystem



# Optimizing the total Asset Value of Soil

## Soil Asset Value

- *Improve holding capacity*
- *Effective usage*
- *Decrease pollution*
- *Reduce eutrophication*



Water

- *Increase soil carbon*
- *Better microclimate*
- *Climate adaptation*
- *Lower inputs*
- *Decrease GHG emissions*



Climate Change

- *Optimize yield*
- *Increase resilience*
- *Higher quality*
- *Minimize inputs*
- *Reduce cost*



Plant Production

- *Increase food quality*
- *More nutrients*
- *Better taste*
- *Less disease*



Human Health

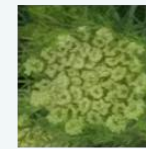
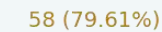
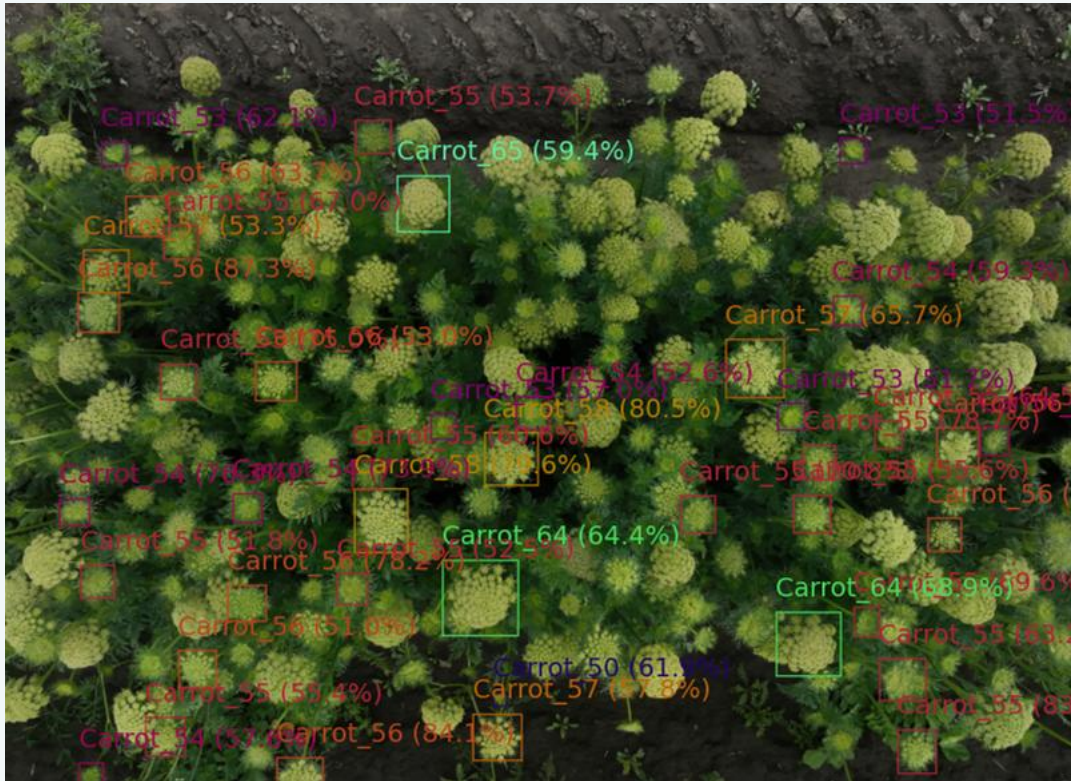
Soil Life is driving Soil Health

Monitoring Soil Life

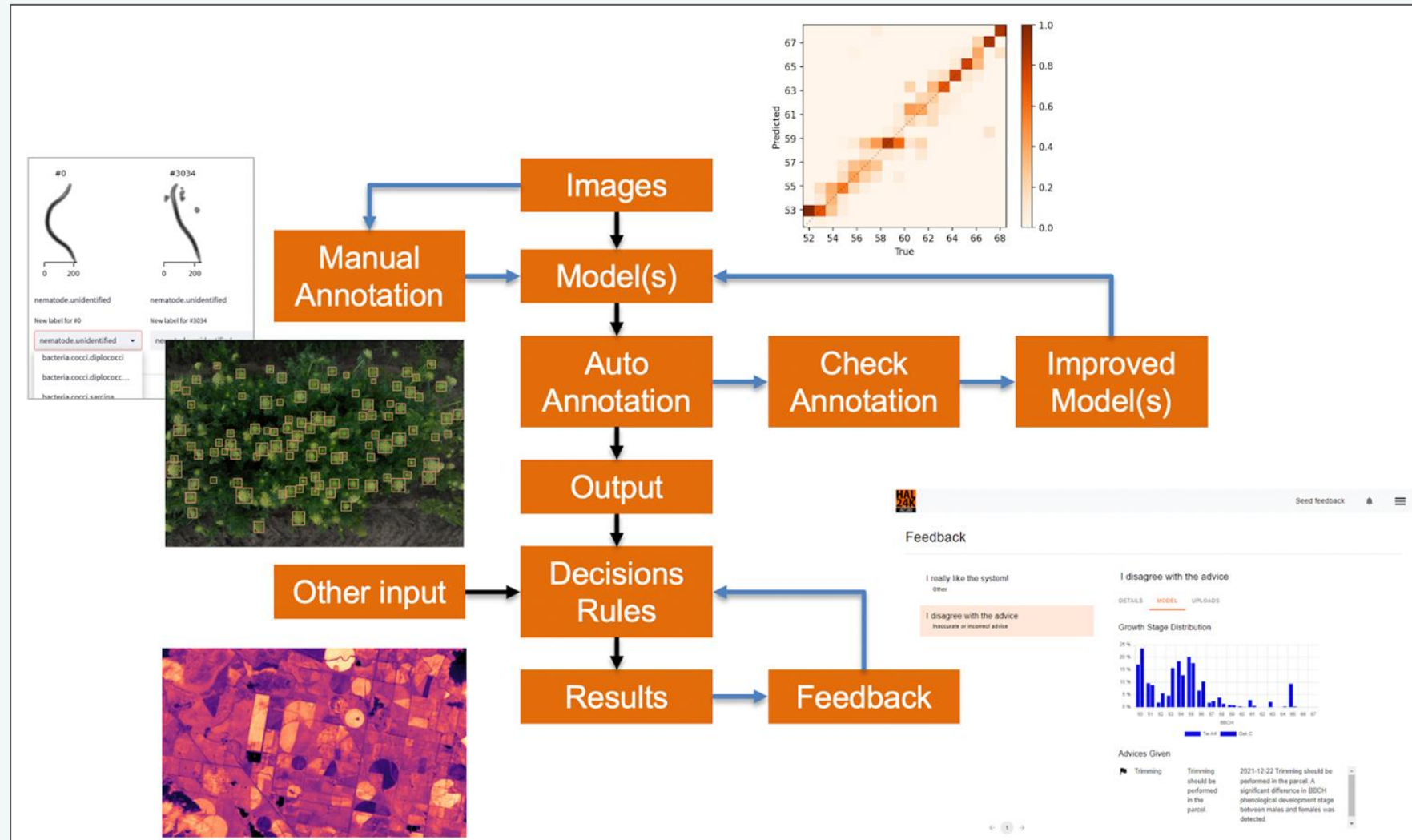
**“To Make Sense of this Universe and  
to Value it, we Need to Observe it”**



# Computer Vision Aboveground has Proven to be a Useful Tool



# From Images to Results





# A New Era in Soil Life Measurement: Faster, Smarter, Deeper



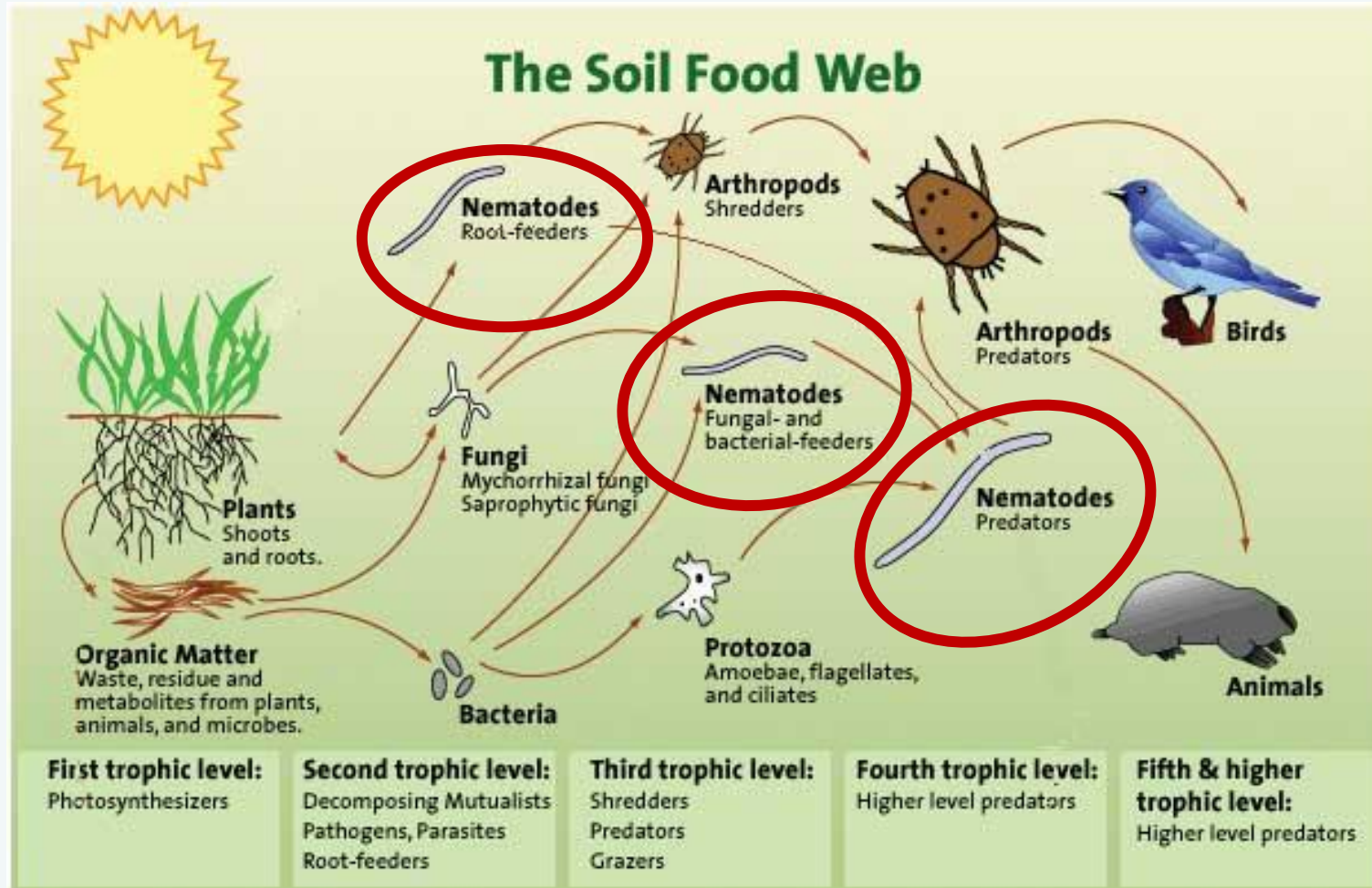
Method	Lab	Field	Life Quality	Life Quantity	Life Activity	Expert independent	Cost
	PLFA	✓		✓		✓	✓
	DNA	✓	✓	✓			—
	PCR	✓	✓	✓			✓
	Microscopy	✓	✓	✓	✓		✗
	<b>Life</b>	✓	✓	✓	✓	✓	✓

- Functional biodiversity finally measurable and trackable
- Unique hardware + unique software
- System gets better, more-inclusive and faster over lifetime
- 6 orders of magnitude amount of soil measured than the traditional soil food web analysis with microscopy

*Life* can take up to **1 million times** the amount of data compared to traditional microscopy in direct counting methods



# Where to start: Nematodes First!



**±80% of all animals are nematodes!**



# Ten Reasons to Measure Nematodes

1. Nematodes are among the simplest multicellular soil organisms found in any soil type, under all climatic conditions and in habitats ranging from pristine to very polluted.
2. Nematodes are by far the most numerous group of multicellular organisms in the soil.
3. In the soil, nematodes live in capillary water and have direct contact with their environment.
4. They do not migrate quickly from stressful conditions and many species survive desiccation, frostbite or oxygen stress.
5. The structure of the communities is an indication of the circumstances in the soil they inhabit.
6. Nematodes occupy key positions in soil food webs. They feed on most soil organisms and are food for many others.
7. There is a clear connection between structure and function.
8. Nematodes respond quickly to disturbance and enrichment.
9. Nematodes are easy to sample and relatively easy to analyse.
10. Advisory tools based on nematodes well studied in academia.

Live everywhere

Very numerous

Key players in soil-food web

Hardly migrate

Respond to changes in environment

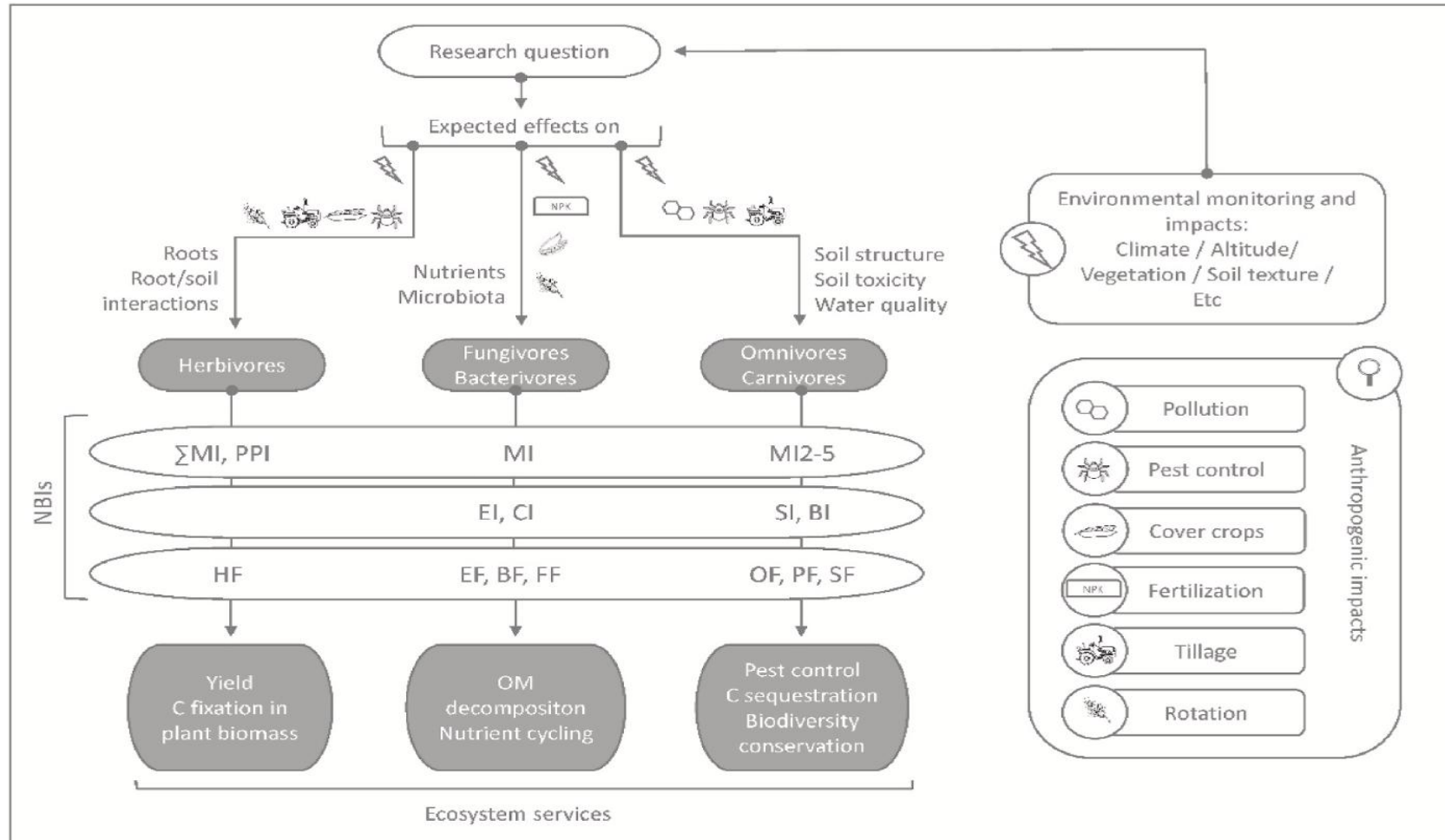
Directly indicate soil circumstances

Very well studied

Easy to analyse



# Nematode Based Indices (NBIs) – Insights in Soil Status



## Examples of NBIs

- Maturity Index
- Maturity Index 2–5
- Plant Parasitic Index
- Enrichment Index
- Channel Index
- Basal Index
- Structure Index
- Metabolic Footprints

# How NBIs Help You Make Smarter Soil Decisions

## Early warning system

Detects soil stress, compaction, proneness to disease, or degradation.

## Ecosystem function insight

Reveals nutrient cycling, pest pressure, and microbial activity.

## Targeted management

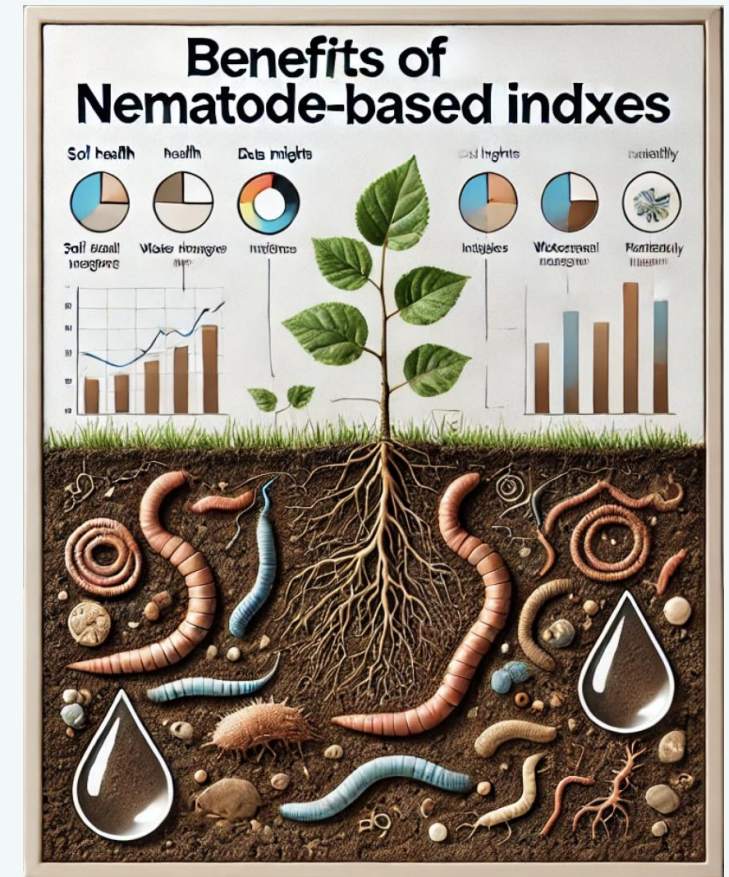
Helps farmers adjust inputs like fertilizer, compost, or biological control with more precision.

## Standardized and scalable

Offers a reliable metric for comparing soil health across time, fields, and regions.

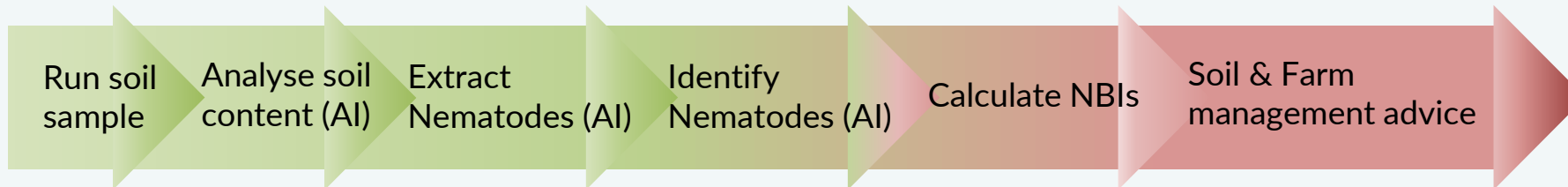
## Tracks improvement

Measures the biological impact of soil regeneration practices and amendments over time.



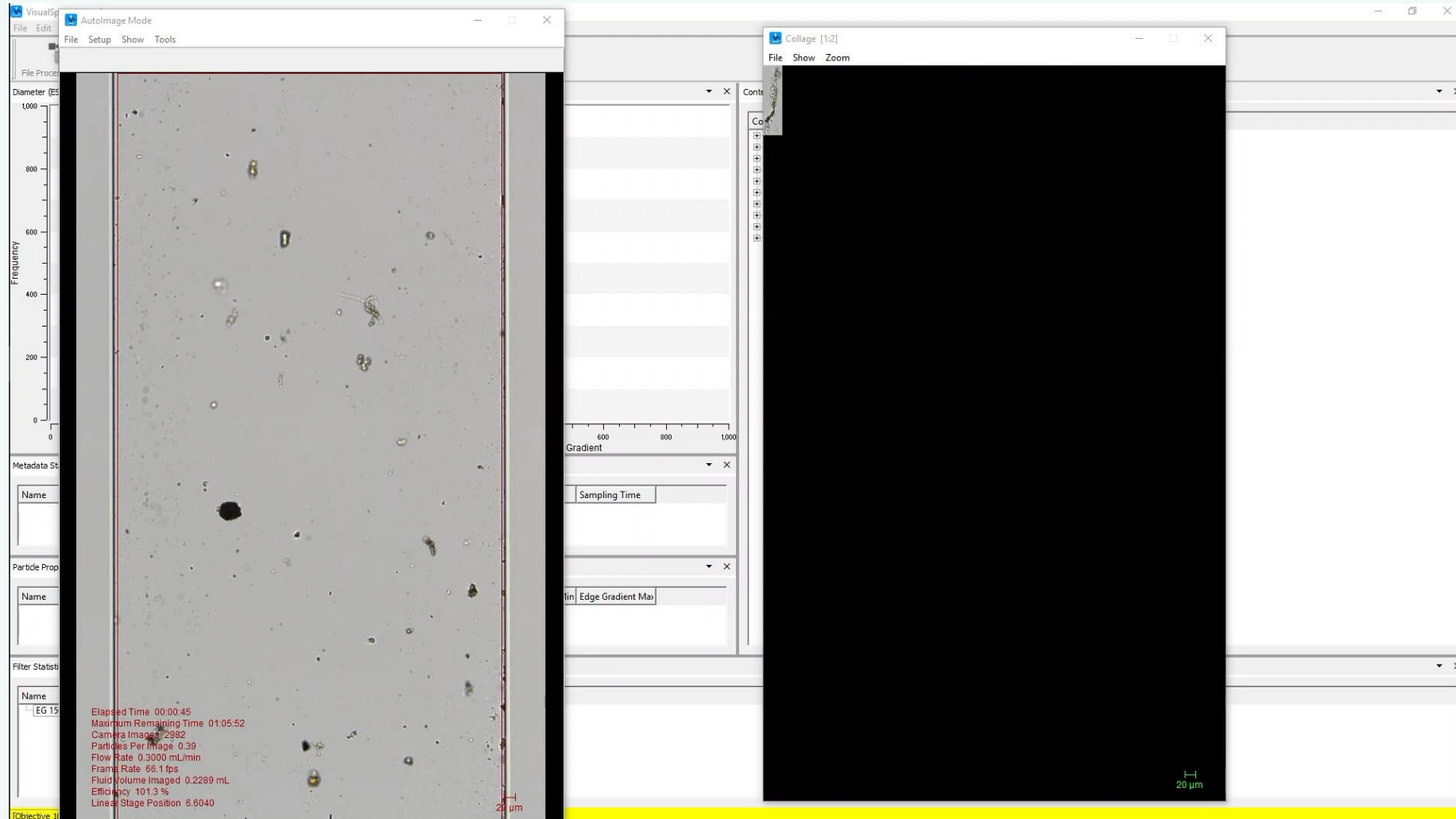


# How does it work?




Field to Lab (current) in the future possibly also Lab to Field



# LIFE Monitor




# Platform Demo – Sample view

SAMPLESEXPLORER

Farm  
Demo



## Samples

 SEARCH

New Sample

	Sample ID	Name	Sample Date ↓	Device	Uploaded By	Job Number	
▼	67cefce6e198b9d0f25dcc19	Cool sample	Sunday, March 9, 2025 at 3:26:08 PM GMT+1	Life Monitor	fmendez	4	...
▼	679b9c6aecaaceb62c9a9730	Sample with Nematode cysts	Wednesday, January 29, 2025 at 3:26:08 PM GMT+1	Life Monitor	fmendez	3	...
▼	65df4281c57da7afb5e01035		Wednesday, February 28, 2024 at 3:26:08 PM GMT+1	Life Monitor	fmendez	2	...
▼	65d4ad431728b314172b2a17		Wednesday, July 19, 2023 at 2:01:00 PM GMT+2	Life Monitor	fmendez	1	...

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# Detailed insights to Assess and Value Soil

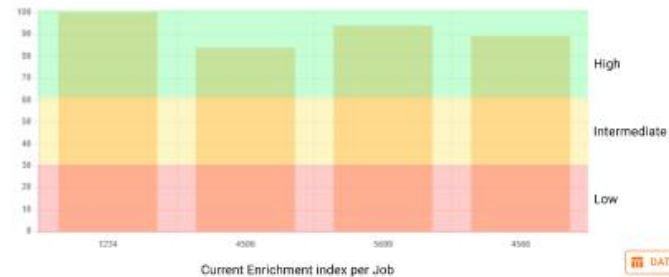
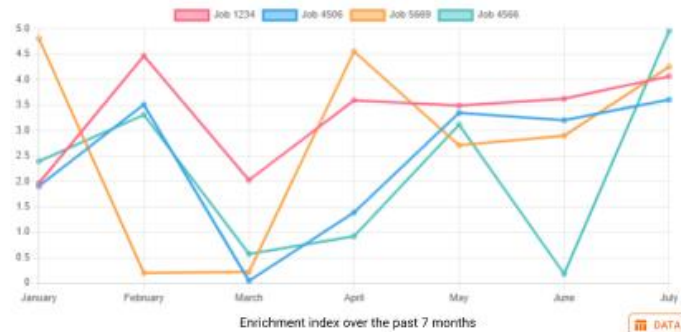
## Life Overview

1. Biodiversity
2. Nematode Based Indices
3. Nematode Cysts
4. Bacteria
5. Fungi
6. Protists

## 2.5 Enrichment Index (EI)

Food availability and nutrient enrichment.

Low (0–30), intermediate (30–60), and high (60–100) values indicate equivalent levels of food availability (e.g., labile organic carbon) and nutrient enrichment.



★ All jobs have a high enrichment index indicating equivalent levels of food availability

## Life Overview

1. Biodiversity
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## 2.6 Structure Index (SI)

Soil food web structure and complexity, as well as disturbance due to environmental (e.g., salinity and drought) or anthropogenic (e.g., tillage, mining, and chemical pollution) causalities.

Low (0–30), intermediate (30–60), and high (60–100) values indicate equivalent levels of soil food web complexity. Lower values are indicative of perturbed soil food webs, while higher values indicate a structured soil food web.



★ Jobs 1234, 5669, and 4566 indicate a structured soil food web.

▲ Job 4506 indicates a perturbed soil food webs.

## 2.7 Channel Index (CI)

Predominant decomposition pathway of organic matter.

Lower values (<50) indicate increasing decomposition dominance by bacteria, while higher values (>50) indicate increasing decomposition dominance by fungi. Bacterial dominance indicates the presence of rapidly decomposed organic matter, while fungal dominated decomposition indicates the slow breakdown of more complex organic matter. The focus on opportunistic bacterial and fungal feeders makes this a highly responsive index, which can be used to detect alternating decomposition pathways over time.



# We now have the tools to paint the full picture

Open Journal of Soil Science > Vol.10 No.12, December 2020

Check for updates

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## Soil Nematodes as Indicators of Heavy Metal Pollution: A Meta-Analysis

Camille Chauvin<sup>1</sup>, Manon Trambolho<sup>1</sup>, Mickael Hedde<sup>2</sup>, David Makowski<sup>3</sup>, H  l  ne C  r  monie<sup>1</sup>, Anne Jimenez<sup>1</sup>, C  cile Villenave<sup>1\*</sup>

<sup>1</sup>ELISOL environnement, Cong  nies, France.  
<sup>2</sup>INRAE, UMR Eco & Sols, Montpellier, France.  
<sup>3</sup>INRAE, UMR Agronomie, Thiverval-Grignon, France.

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RIVM De zorg voor morgen begint vandaag

🏠 Onderwerpen Over RIVM Publicaties Internationaal Contact Agenda



Home > Publicaties > Nematodengemeenschappen als potentieel diagnostisch instrument voor chemische verontreinigingen

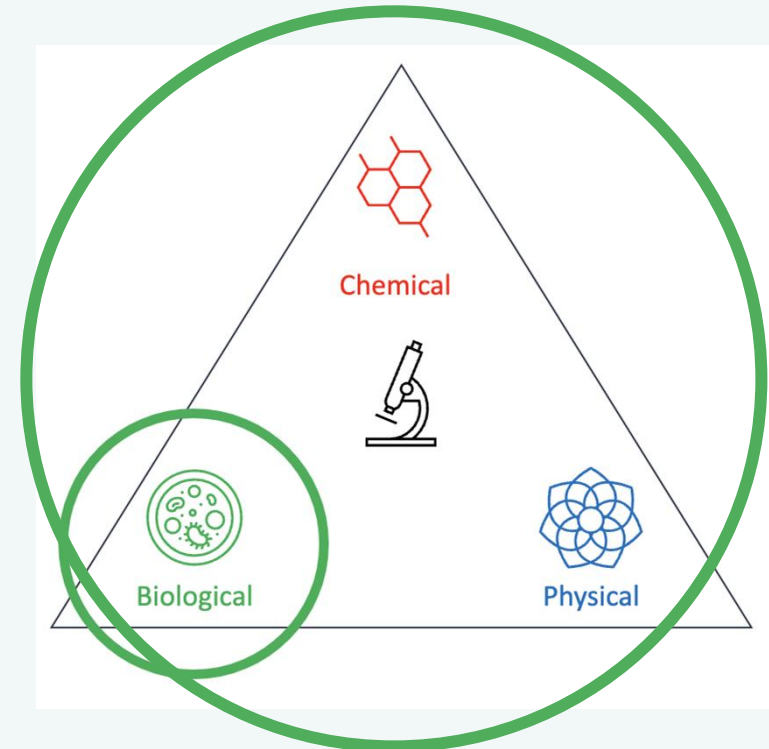
## Nematodengemeenschappen als potentieel diagnostisch instrument voor chemische verontreinigingen

Publicatiedatum 11/02/1992

Auteurs

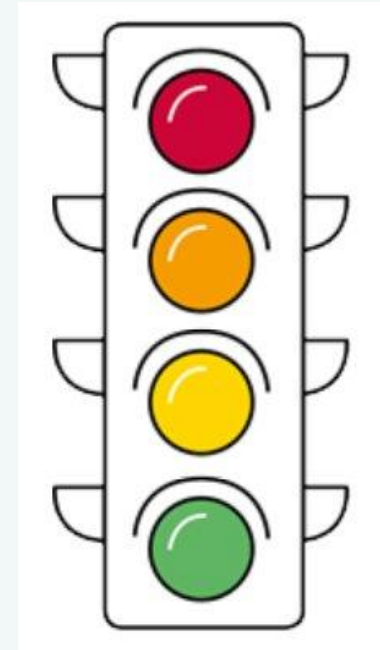
# Nematode-based indices in soil ecology: Application, utility, and future directions

Gerhard Du Preez <sup>a</sup>  , Mieke Daneel <sup>b</sup>, Ron De Goede <sup>c</sup>  , Marié Joey Du Toit <sup>a</sup>,  
Howard Ferris <sup>d</sup>, Hendrika Fourie <sup>a</sup>, Stefan Geisen <sup>e</sup>, Thomais Kakouli-Duarte <sup>f</sup>, Gerard Korthals <sup>g</sup>,  
Sara Sánchez-Moreno <sup>h</sup>, Jan Henrik Schmidt <sup>i</sup>



# New way of gauging soil quality or soil health

- Legislation based on chemistry
- Soil life more resilient than previously thought
- Illogical laws
- Soil life as agricultural guide
- Soil life for remediation purposes
- Soil life as an environmental proxy
- Soil life as a proxy for polluting elements
- Soil life as a "policy advisor"







Thank you

## Implementation - Project Overview



SoilProS - The Netherlands Organisation for Scientific Research



Regenerative Agriculture - Dutch National Growth Fund



SHAPE - Soil Health Check and Practices



Soil Valley - Soil Health & Agroecology Living Lab



Linking to HE & Soil Mission - e.g. SOLO, PREPSOIL, BioMonitor4CAP





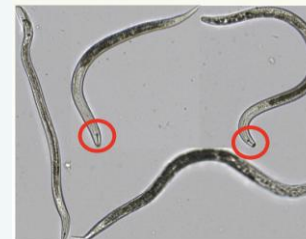
Use Case Examples  
LIFE Monitor™  
Huiberts Biologische Bloembollen

# LIFE Monitor - Parasitic Pressure and Green Manures

- 4 fields - 2 strategies
- The efficacy of inundation as anti-parasitic strategy
- The (possible) benefits of growing a green manure crop
- Expected outcome: detailed information on: 1) the efficacy of inundation as anti-parasitic strategy; 2) the benefits of green manure



Herbivoren



Niet Herbivoren



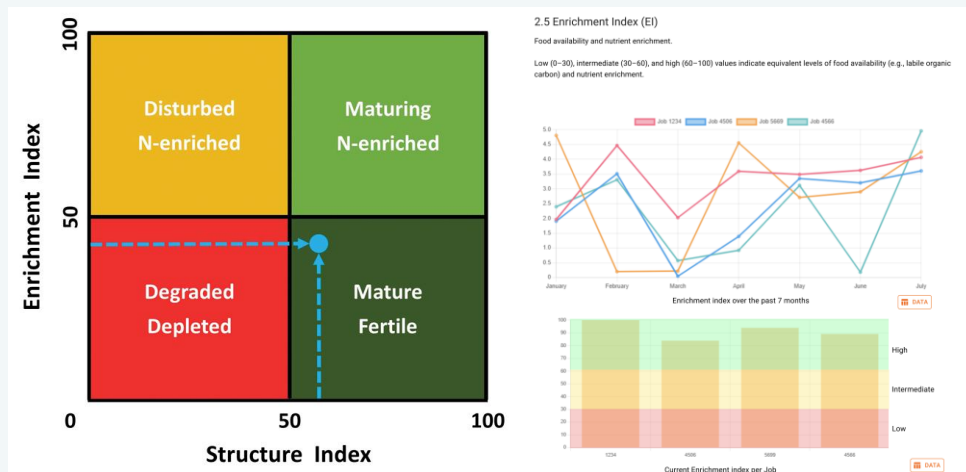




Use Case Examples  
LIFE Monitor™  
Agrifirm

# LIFE Monitor - Nitrogen Efficiencies

- Nitrogen efficiencies - 4 intensity steps
- Nitrogen steps in relation to practical fertilization
- Not fertilized towards fully fertilized
- To what extent does the Plant activate the Microbiome?
- Follow the different intensity steps through time
- Expected outcome: detailed information on nitrogen efficiencies in relation to plant-soil life interactions





Use Case Examples  
LIFE Monitor™  
Gebroeders Ham



# LIFE Monitor - Conventional & Regenerative Practices

- 4 fields with different farming approaches
- Field 1: Conventional
- Field 2: Conventional to Regenerative
- Field 3: Regenerative (3 years)
- Field 4: CSA Vegetable garden
- Expected outcome: detailed information soil life pattern evolution, food quality and yields





Thank you