HAL 24K AGRI

Artificial Intelligence for Agriculture

The New Standard for **Functional Biodiversity** and **Ecosystem Services**

Bodembreed - March 25, 2025

Who we are

- We are a software company which builds **AI solutions** for (but not exclusive for) the agri-food sector
- We are based in **Giesbeek** (near Arnhem) and Amsterdam, the Netherlands
- We have a diverse background from **science, biology, data science and engineering**
- We want to contribute to **solve complex problems** the world faces, the more complex, the more interesting
- **Nematodes first** – Monitoring the most common animal species on earth

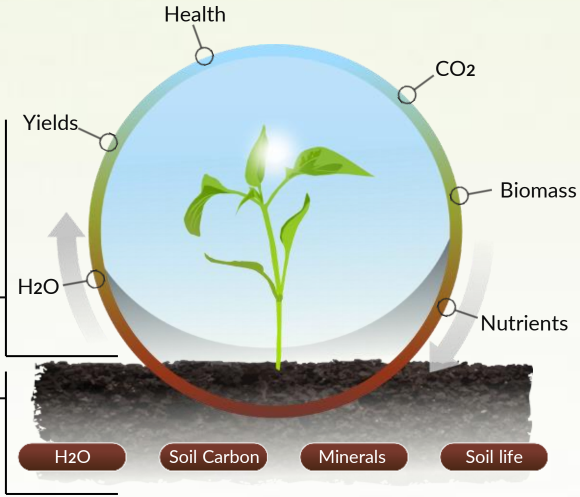
“Our goal is to create the method which will become the standard in assessing functional biodiversity and the ecosystem services provided”

Our services

Soil Health Suite™

Crop Monitor™

Life Monitor™



Crop Monitor

- Monitor and manage crop growth enabled by Artificial Intelligence

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

Soil Health Suite

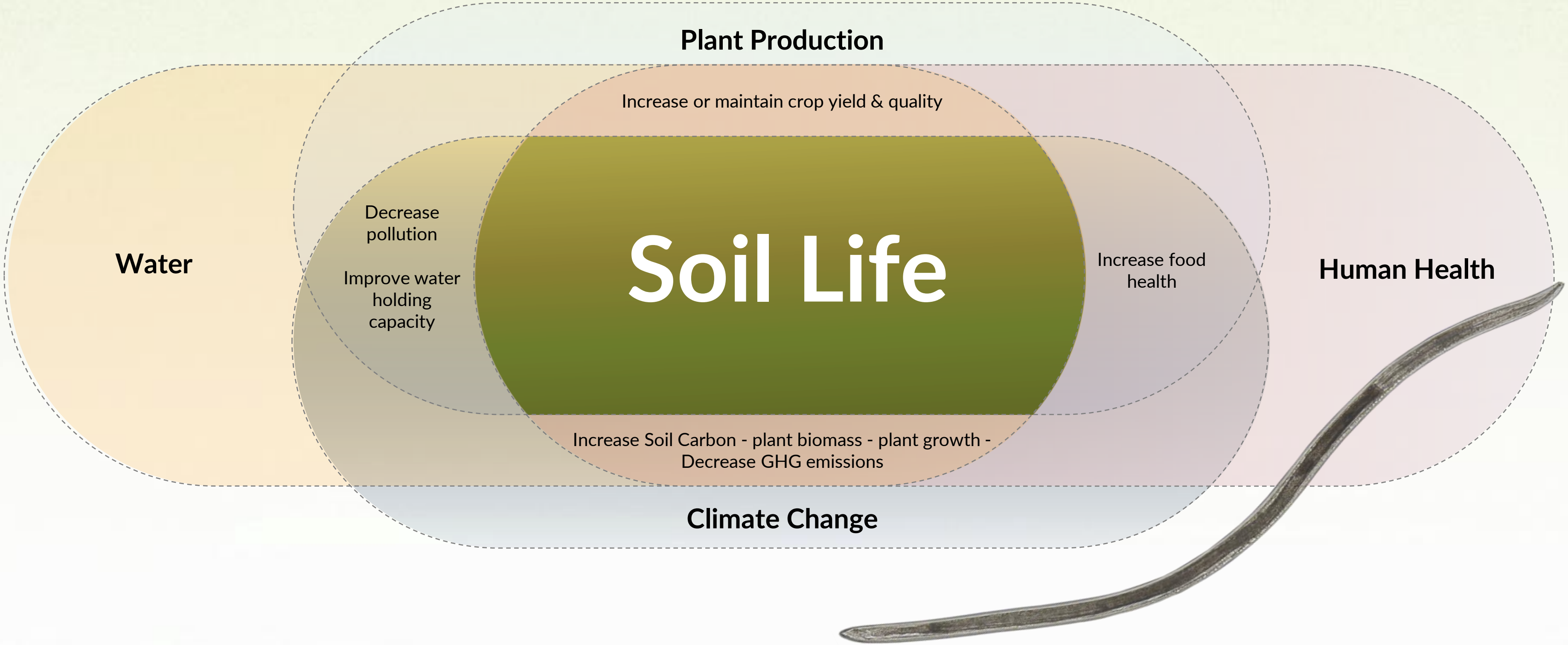
- Use unique combination of Life and Crop monitors
- Optimize Soil Asset Value
- Improve Human Health, Plant Growth, Climate, Water retention

Introducing *LIFE Monitor*

Method	Lab	Field	Life Quality	Life Quantity	Life Activity	Expert independent	Cost
PLFA	✔			✔		✔	✔
DNA	✔		✔	✓			⊖
PCR	✔		✓	✓			✔
Microscopy	✔	✓	✔	✓	✔		✖
LIFE Monitor	✔	✔	✓	✔	✔	✔	✔

- Chemical soil analyses don’t tell the whole story!
- Detailed biology analysis are slow, expert dependent and expensive
- LIFE Monitor enables to measure and track Functional biodiversity
- 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

Soil Life is the Core of Our Ecosystem



Optimizing the total Asset Value of Soil

Soil Asset Value

Water

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

Climate Change

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

Plant Production

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

Human Health

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

Soil Life is driving Soil Health

Monitoring Soil Life

TEN reasons to measure **nematodes**

Live everywhere

Very numerous

Key players in soil-food web

Do not migrate

Respond to changes in environment

Directly indicate soil circumstances

Easy to analyse

Very well studied

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.

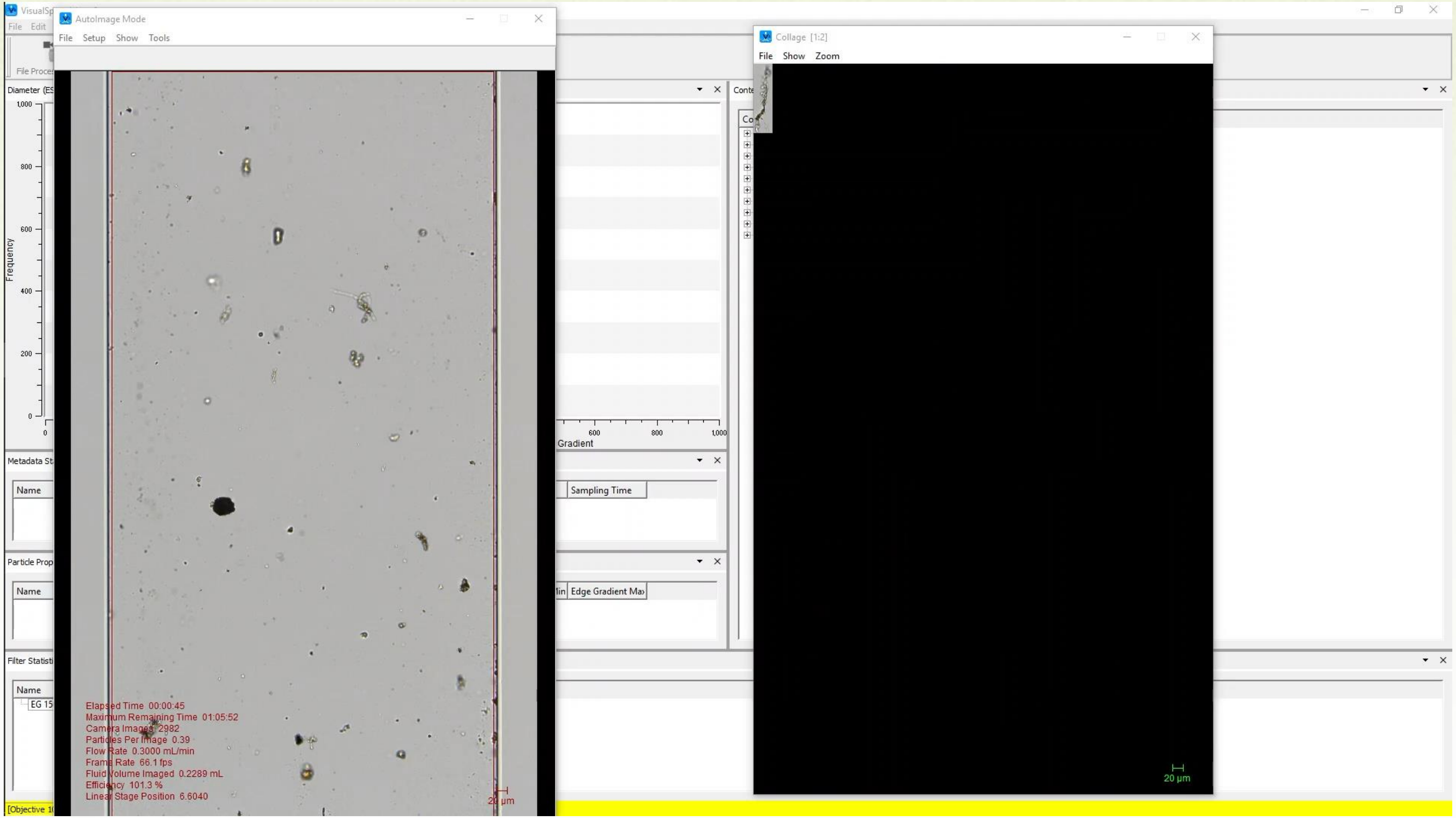
7. There is a clear connection between structure and function.

8. Nematodes respond quickly to disturbance and enrichment.

9. Nematodes are easy to sample and relatively easy to analyze.

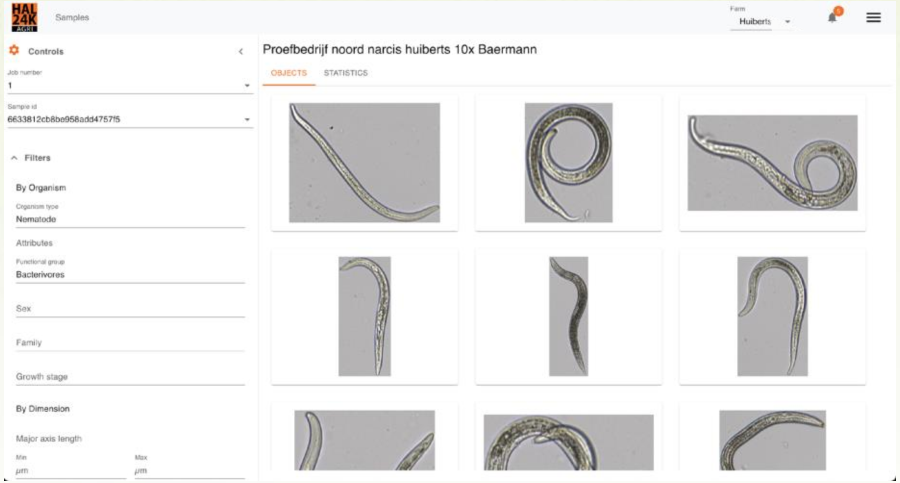
10. Advisory tools based on nematodes well studied in academia.

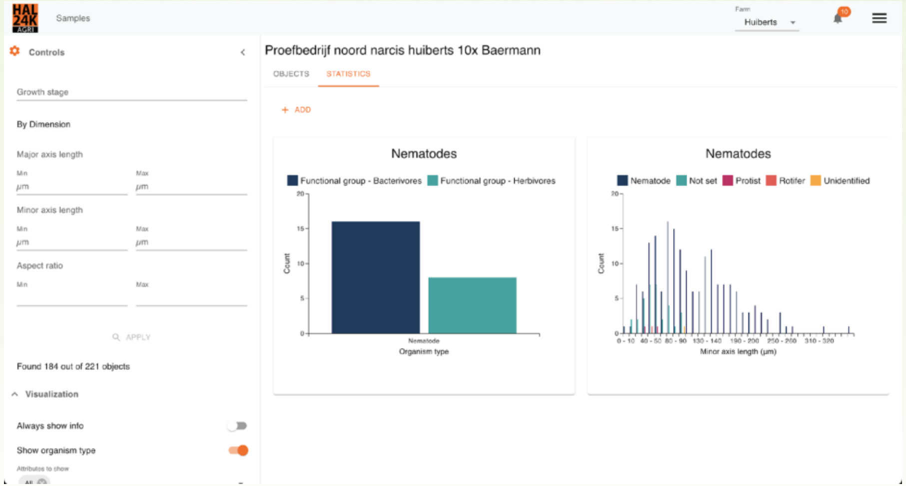
Analyse with the LIFE Monitor



Current standings

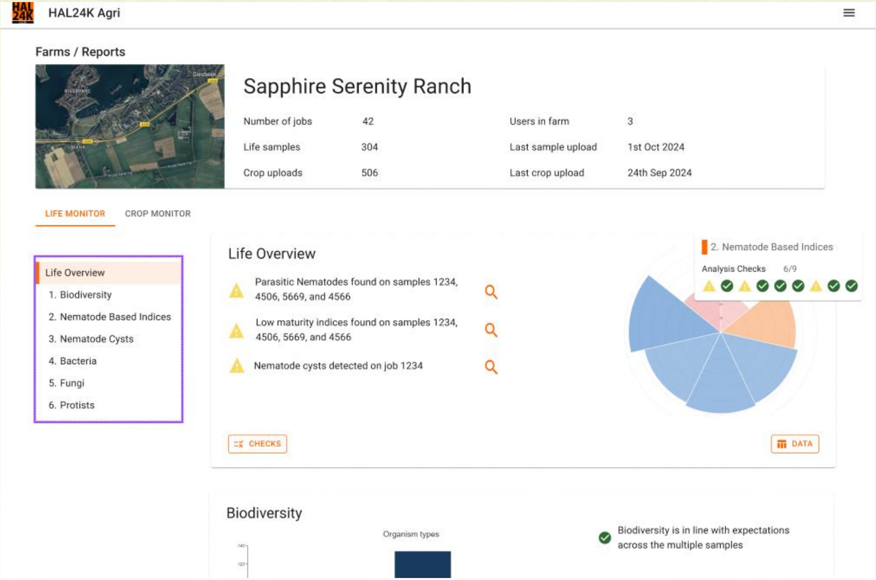
Interact with data in LIFE

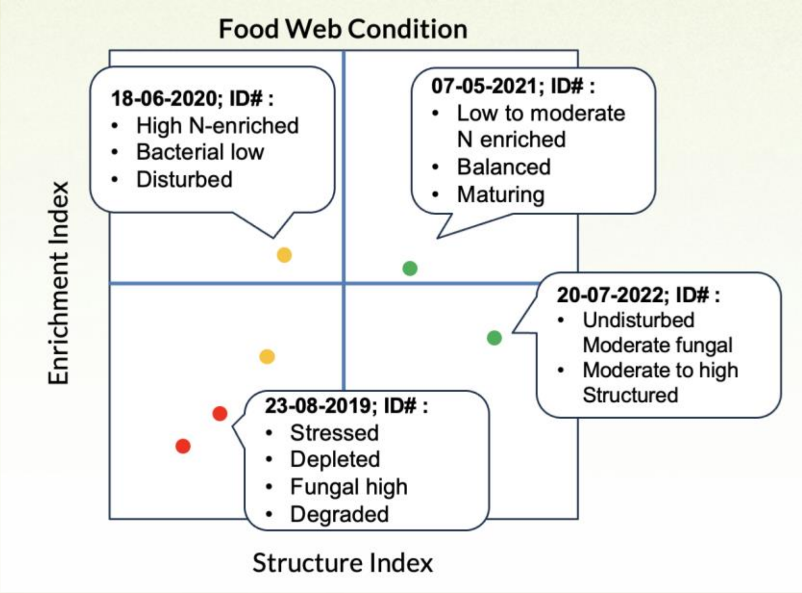


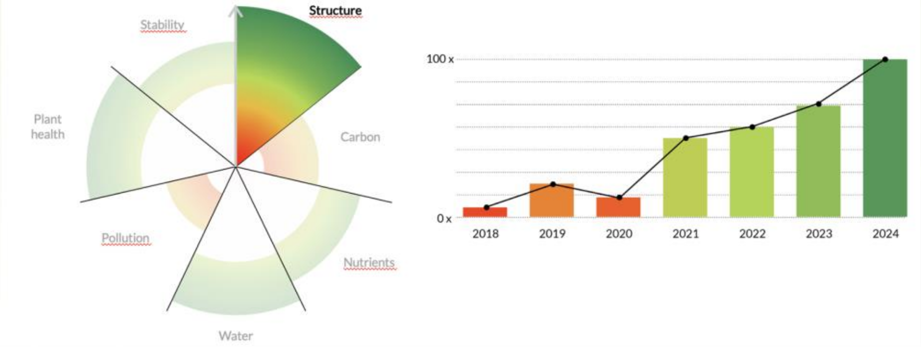


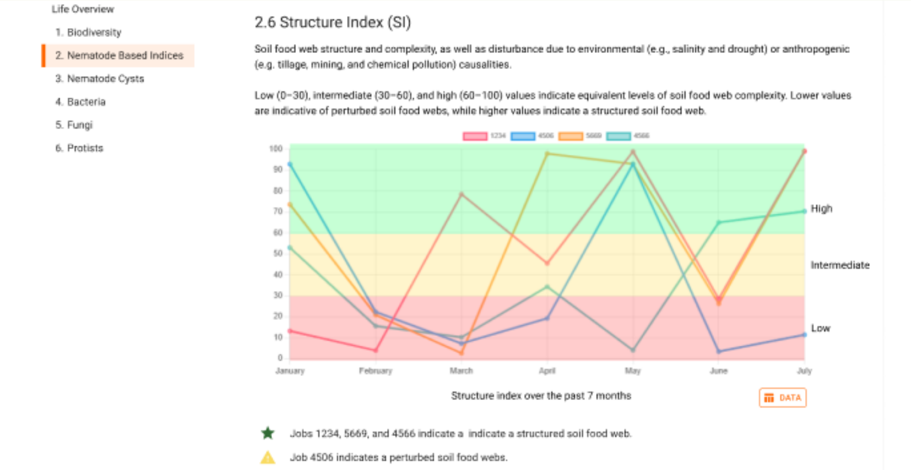
Run soil sample → Analyse soil content (AI) → Extract Nematodes (AI) → Identify Nematodes (AI) → Calculate NBIs → Soil & Farm management advice

Platform/Environment

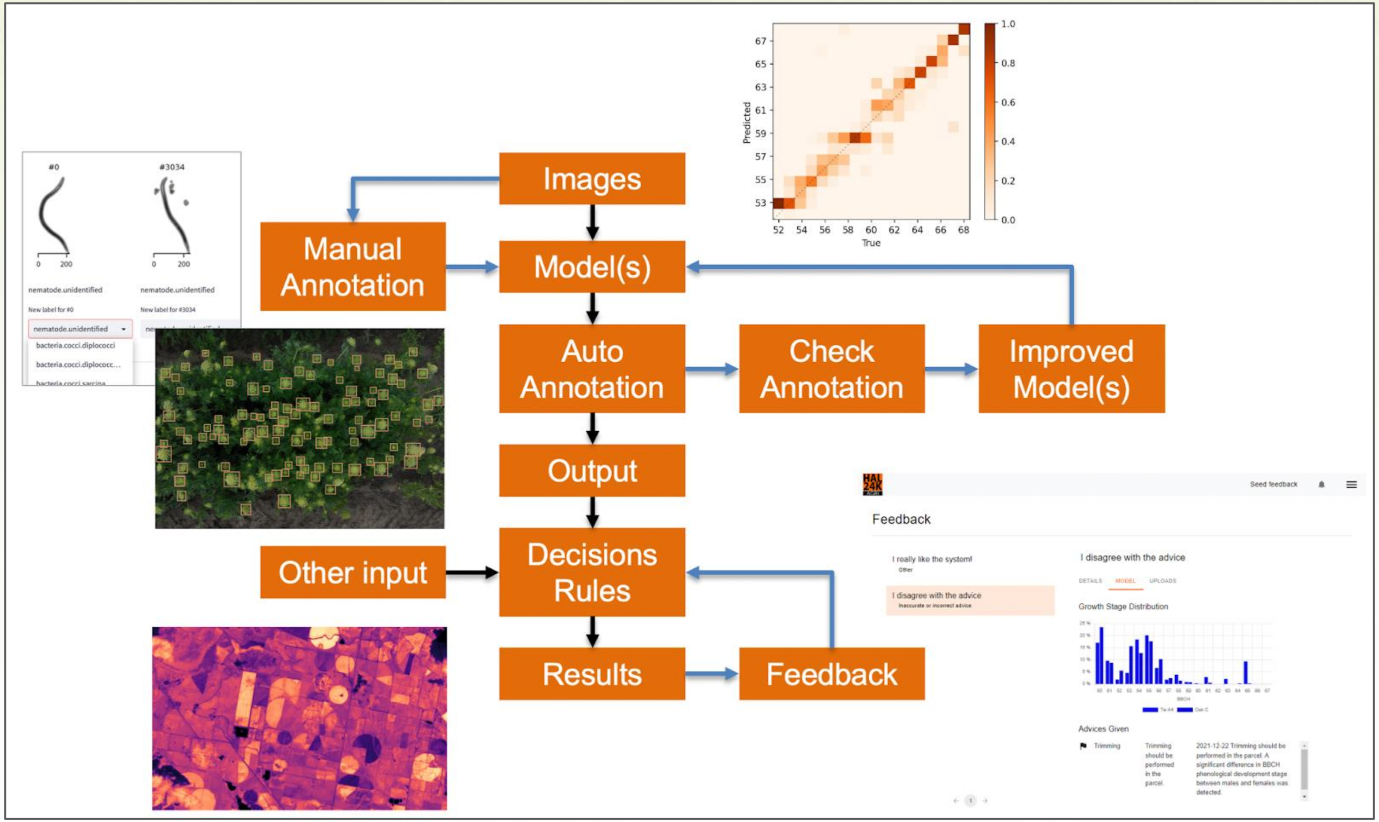








From images to results



Types of annotated data

a. Images from single-species cultures
   - E.g., specific nematodes/protists
   - High quality
   - Restricted to availability of cultures

b. Manually annotated images from soil samples
   - Good at higher taxonomic level
     - A nematode, a enchytraeidae or a microarthropod?
     - Nematode functional groups
   - Difficult at lower taxonomic levels
     - E.g. species, genus

c. Soil samples with DNA data
   - Useful if the number and variety of samples is large

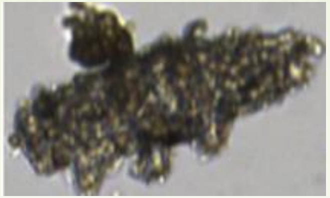
d. Images from soil samples without labels

Models and training approaches

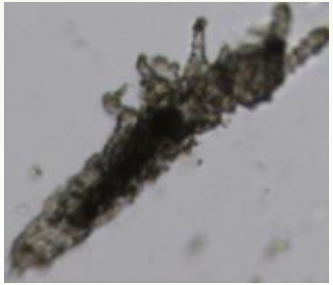
1. Classical supervised learning
    - Learning from data with available ground truth
        - Data: cultures, manually annotated images
    - Models for identifying:
        - Organism type
        - Nematode feeding groups
        - Nematode genera

Rotifer

Protist



Tardigrade

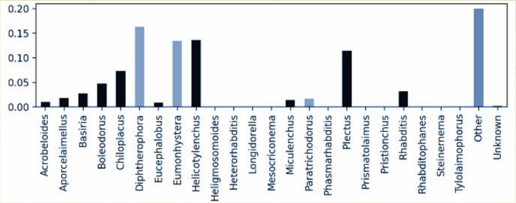


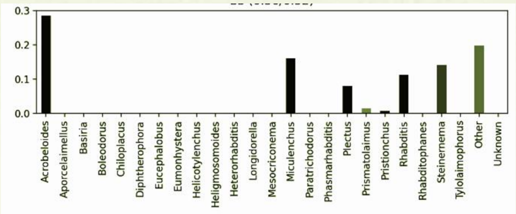
Microarthropod

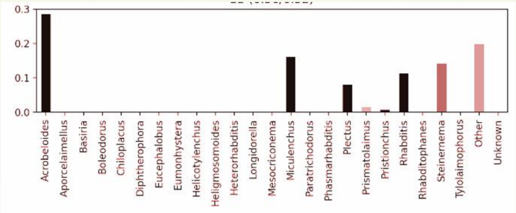
Enchytraeidae

Nematodes

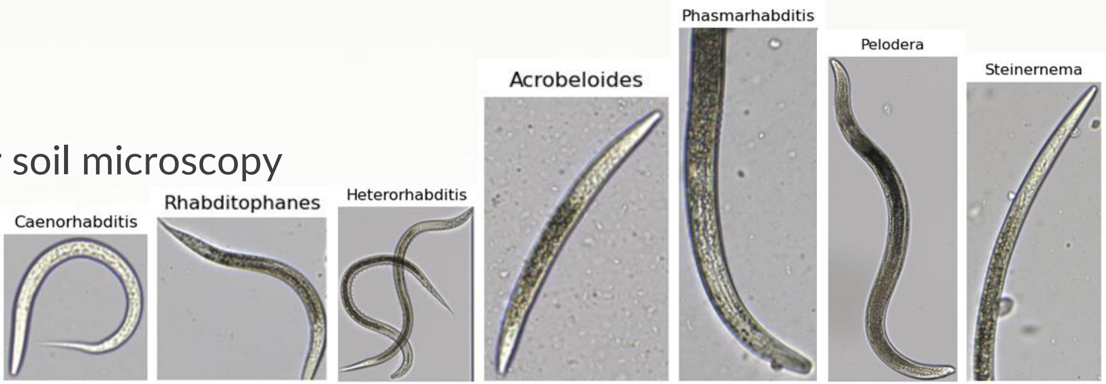
Models and training approaches





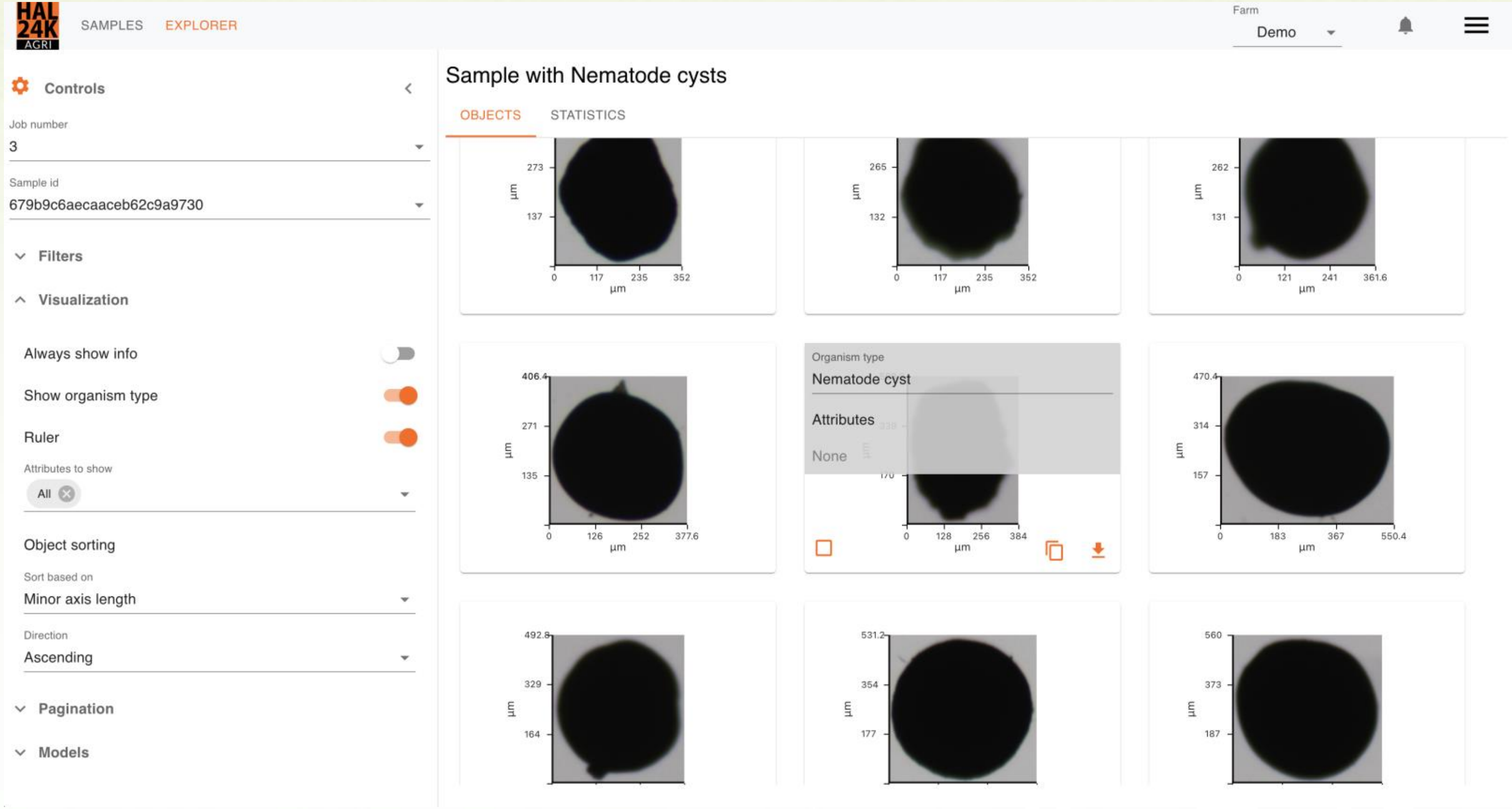


2. Learning from a mixed set of nematodes (weak supervision)
   - Models learn to classify individual images using image data *combined with DNA data*
     - Data:
       - large set of samples with DNA data
       - cultures (for learning monitoring and performance checks)
   - Model for identifying:
     - Nematode genera
3. Self-supervised learning
   - A large visual model (LVM) for soil microscopy
     - Planned



Specific applications

Cyst nematode detection



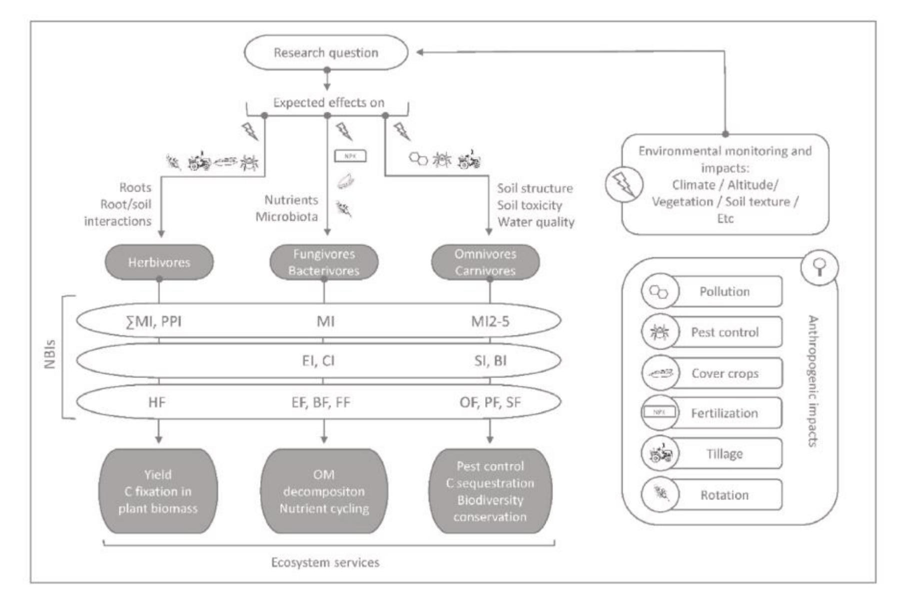
HAL 24K AGRI

Hartelijk Bedankt

Peter.denHartog@hal24k-agri.com

Future results

Nematode Based Indices (NBIs)



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

NBIs are well studied in academia, but are hard and expensive to determine with traditional analysis methods and hence not commercially interesting. Using our new technology NBIs will be faster and cheaper to determine. The use of NBIs will become increasingly important in providing valuable information on soil ecosystem health and functioning, especially considering the urgent need for more sustainable land use.