



From Sample to Species List

How environmental DNA (eDNA)
metabarcoding makes biodiversity visible

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Three scales to monitor biodiversity

Satellites tell us where to sample – only samples tell us what lives there



MACRO • LANDSCAPE

Earth observation

- Sentinel-2: 10 m, ~5-day revisit, free
- Commercial very-high-res: down to 30 cm
- Copernicus Hyperspectral Imaging Mission (CHIME): 30 m, from 2028

Sees: land cover, habitat structure, crop and bare-soil patterns – ideal for **sampling design**



MESO • FIELD

Proximal sensing

- Drones, tractor- and hand-held sensors
- Light detection and ranging (LiDAR): 3D structure in cm
- Hedges, margins, canopy, soil surface

Sees: habitat quality at field level – still structure, **not species**



MICRO • SAMPLE

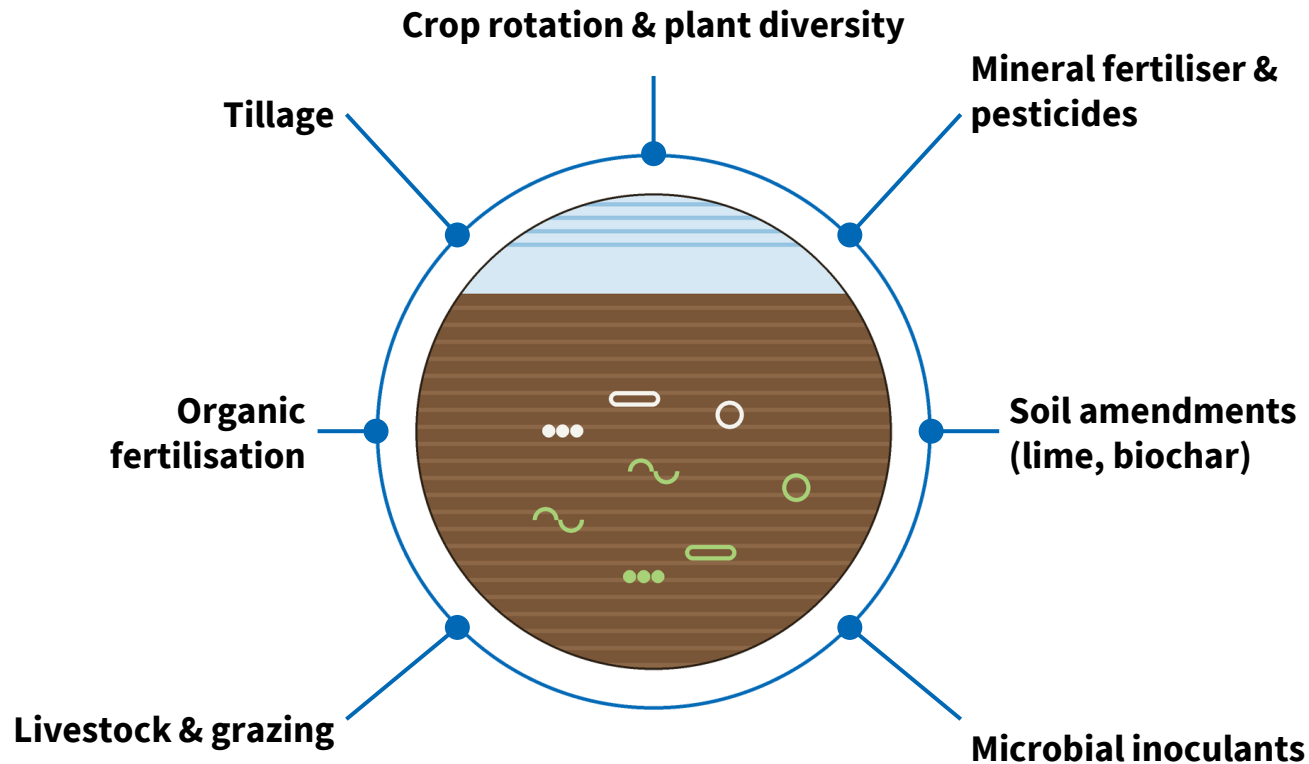
Ground truthing

- eDNA metabarcoding
- Bioacoustics
- Classic surveys and traps

Sees: species and communities – **including below ground**

Soil life is shaped by farm management

Almost every driver of the soil microbiome is a decision on the farm



Who lives there

Only ~1 % identified so far

Microbiome

bacteria, fungi, algae



Microfauna 0.002–0.2 mm

amoebae, flagellates, ciliates



Mesofauna 0.2–2 mm

mites, springtails, nematodes



Macrofauna 1–20 mm

beetle larvae, woodlice, millipedes



Megafauna > 20 mm

earthworms, moles



Measuring soil biodiversity: four methods

Environmental DNA (eDNA) is the only method that resolves species richness at scale

	TRADITIONAL		MODERN METHODS	
	PHYSICAL Counting	PHYSICAL Soil organic carbon (SOC) as proxy	BIOCHEMICAL Community-level physiological profiling (CLPP)	BIOTECHNICAL Environmental DNA (eDNA) metabarcoding
	Collect worms and springtails from soil  Count individual specimens	Measure soil organic carbon content  Use soil health as proxy for biodiversity	Add soil microbiome to different nutrient sources  Colour change shows metabolism rate	Extract environmental DNA from a soil sample  Analyse DNA to get the genetic barcode of the soil
MEASURES ...				
Species richness	 Only worms & springtails	 Not possible	 Limited to metabolism types	 Most species
Evenness of distribution	 Only worms & springtails	 Not possible	 Limited to metabolism types	 Rough distribution
Organism abundance	 For a few groups	 Limited, via SOC–microbiome correlation	 Metabolism as proxy	 Live and dead not separated

From sample to species list in five steps

A standardised lab workflow – results in about 4–6 weeks

1

Sample

Sampling plan from vegetation index (NDVI), bare-soil or yield maps; GPS-tagged points

2

Extract

Isolate all DNA in the soil – from living cells, traces and dead material

3

One barcode per group

- **16S** bacteria & archaea
- **Internal transcribed spacer (ITS)** fungi
- **18S** nematodes & arthropods
- Earthworm-specific markers

4

Sequence

High-throughput sequencing of millions of DNA fragments

5

Match

Compare with reference databases: species list, ratios, indices

KNOW THE LIMITS

Snapshot: one moment in time, not a trend

Gaps: reference databases are incomplete, many reads stay unnamed

Live or dead? DNA of dead organisms is counted too

Patchy soil: the sampling design decides data quality

Data for the field, not only for the report

Who uses soil biodiversity data – and for which decision?



REPORTING LOGIC

What the company needs

- Reporting under European Sustainability Reporting Standards (ESRS), E4 biodiversity
- Supplier scorecards and KPIs
- Once a year, aggregated
- Looks back



FARM LOGIC

What the farmer can decide

- **Test on strips:** cover crop, product or variety – before and after
- **Read the balance:** fungi-to-bacteria ratio, nematode indices
- **Link to yield:** in one maize study, 26 bacterial genera explained ~65 % of local yield variation
- Field-specific, repeatable, looks ahead

If the farmer gets value first, the company gets better data as a result.

Why biodiversity credits are not carbon credits

Carbon is fungible – biodiversity is tied to place

CARBON IS FUNGIBLE

1 t CO₂ = 1 t CO₂

No matter where it is stored

BIODIVERSITY IS NOT

1 orangutan ≠ 1 red kite

“Biodiversity is location-specific and context-dependent.” – Bruegel, 2025

Unsolved before credits can work

- No common unit across ecosystems
- Local baselines and additionality
- Permanence: who secures the gain?
- Measurement noise – “commodifying noise”
- Stable demand beyond voluntary buyers

EU STATUS

Nature Credits Roadmap published July 2025. The Commission’s expert group was still in a “listening phase” in March 2026.