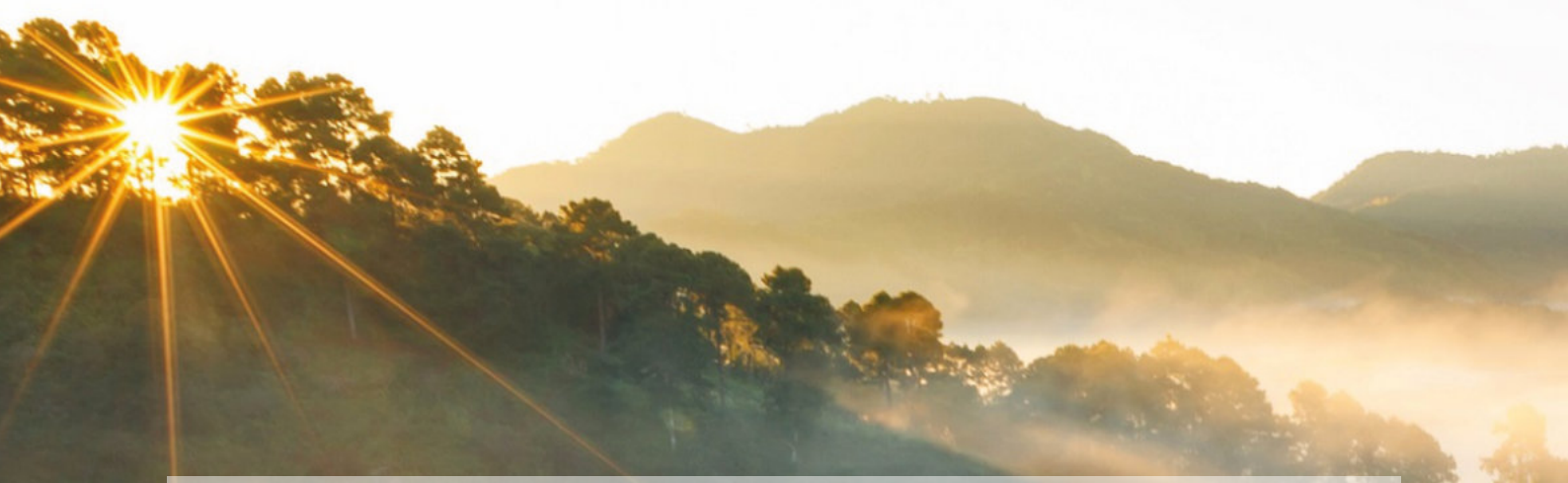
SMART FARMING
FUTURE OF AGRICULTURE
A Non-Profit Organization

The Future Begins in the Soil:

Growing Food. Foster Biodiversity. Stop Climate Change.



Something has changed

A new perspective on soil, nature, and the future

More and more people feel that we cannot go on like this. That we can no longer exploit the soil, from which all life originates.

But the answer does not lie in new genetic engineering, nor in even more technology. We cannot solve problems with the same tools that created them. Smart machines or AI alone will not save agriculture.

True innovation does not arise from optimizing the old, but from a completely different way of seeing and approaching things.

The old worldview is driven by profit and exploitation of the soil: monocultures, synthetic fertilizers, pesticides, ever higher yields – without giving back what we take. The result: depleted soils, declining biodiversity, and climate change. This has brought the Earth to the brink of catastrophe.

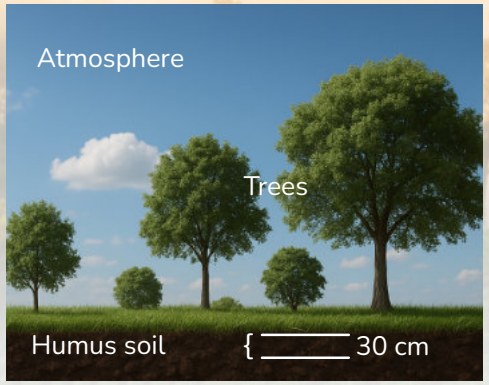
The new worldview recognizes that soils are alive with processes: they build humus, store water, create nutrient cycles carried by billions of soil organisms. If we support these processes, we keep soils healthy and fertile – for ourselves and for generations to come.

Our soil monitoring device makes visible what happens underground and helps us act in time, so that we work with nature, not against it – and learn from it together. It is a tool for observing, listening, and understanding. It is not meant to manipulate nature, but to give it a voice.

The time to act is now.

Not tomorrow. Not in ten years. Today.

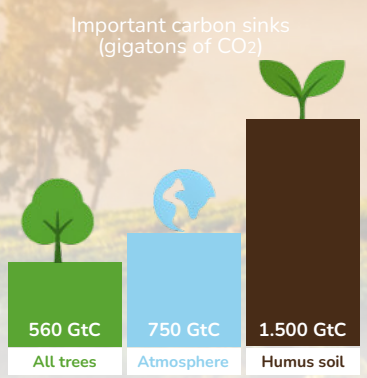
Humus Soils – The Earth's Largest Carbon Sink



Carbon sink: atmosphere, trees, and humus layer

The top 30 cm of soil – the humus layer – stores more carbon than all the world's trees combined. More than twice as much as the entire atmosphere. Within this thin, living layer lies the greatest natural potential for carbon sequestration – right beneath our feet. Protecting and rebuilding humus is therefore one of the most effective climate actions we

Source: IPCC 2019; FAO 2017; UNEP 2017



Source: IPCC AR6, FAO Soil Organic Carbon Reports, UNEP

But this foundation of life is disappearing at a rapid pace.

Soil destruction – an invisible catastrophe.

Up to 40% of soils worldwide are already moderately to severely degraded.

Source: UNCCD/UN-Bericht 2022; UNESCO 2023

Every minute, 23 hectares of fertile soil are lost forever.

Source: UNCCD 2022

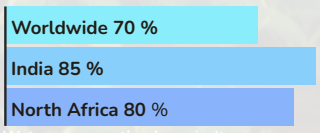
What do these numbers mean for us?

The consequences are declining harvests, rising food prices, and growing hunger. We are losing not only arable land, but also habitats, biodiversity, and one of the Earth's most important carbon sinks. More CO2 escapes into the atmosphere, further accelerating climate change. Conflicts over food and water intensify. More people are forced to leave their homes. Refugee movements will reach significant dimensions worldwide.

No water, no life – agriculture at the limit

Agriculture is by far the largest consumer of freshwater worldwide – already using around 70% of available resources. In water-scarce regions such as India, North Africa, or Ethiopia, the figure rises to as much as 85%.

This makes agriculture the epicenter of the global water crisis: unless we change course urgently, food security, biodiversity, and the very survival of many regions are at risk.



Water consumption in agriculture

Source: FAO (Food and Agriculture Organization of the United Nations), „The State of the World's Land and Water Resources for Food and Agriculture", 2021

From squeezing the soil to building it up:

Only living soils can secure our future.

Our soil monitoring device helps to detect early when soils fall out of balance, enabling natural processes to be supported. At the same time, it measures soil moisture so that irrigation can be precisely adapted to the plants – saving valuable water.

This allows farmers to cultivate their fields sustainably, strengthen biodiversity, and counteract the impacts of climate change – in harmony with nature, not against it.

Never before has understanding the soil been so important

This device is the result of a simple idea: we can only protect what we understand.

It regularly measures key soil parameters – moisture, nutrient levels, pH, and temperature – exactly where they matter: at root depth, directly in the field. Small, yet robust. Energy-autonomous through solar power and a supercapacitor. Flexible and expandable through modular connections and open interfaces.

Designed equally for smallholder farmers, research institutions, and educational projects. Usable worldwide – and open to local adaptations and further developments.

A tool to observe and understand the soil – so that we can create opportunities from which the intelligence of nature chooses its path.

1 Weatherproof Housing

- **Manufactured using 3D** printing with eco-friendly PHA filament. 100% biodegradable, fully compostable, and leaves no microplastic residues..
- **Can be printed** on any standard 3D printer – no heated bed required.
- **Ideal for decentralized** production on-site – for example in schools, workshops, or FabLabs.

Outer Shell – Protection and Climate Buffer

The outer shell reliably protects the internal electronics from rain and direct sunlight.

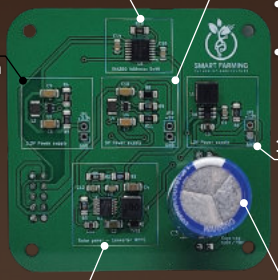
Between the shell and the inner housing, air circulates to create a balanced microclimate that safeguards the electronics

Module Mounts
Simple slide-in system for additional modules such as sensors, antennas, or actuators – no tools required

2 Power Supply

Energy Monitoring
- **Graphical logging in** the dashboard.

3.3 V Power Supply
- **Constant and efficient** – even with highly fluctuating energy sources.
- **Buck-boost converter** provides a stable 3.3 V output, even when supercapacitor voltage is below or above 3.3 V.
- **Extremely low quiescent** current (typ. 15 µA), ideal for low-power environments.



5 V Power Supply
- **Stable 5 V** output even with fluctuating solar/ supercapacitor voltage.
- **High efficiency, low** power loss.
- **Can be activated** in software at runtime – saving energy when not needed.

12 V Power Supply
- **Provides 12 V,** 1.2 A
- **Software-switchable to** save energy.

MPP Controller
- **Integrated Maximum Power** Point Tracker (MPPT) optimizes solar cell output by automatically adjusting to light conditions.
- **Particularly effective under** variable irradiation and with small solar module surfaces.

Energy Storage
- **Hybrid supercapacitor, 3.8 V**, 500 F.
- **Stores up to** 2,048 joules of energy.
- **Robust alternative to** batteries – long-lasting even under many charge cycles.
- **No batteries required.**

3 Communication and Control Center

LoRa-Module – SX1262
- **Enables energy-efficient,** wireless communication up to 2 km – ideal for remote fields without internet access.
- **Control of actuators:** irrigation (pumps, solenoid valves), shading systems, fans, dosing pumps or valves in fertigation systems, acoustic or optical alarms for specific measurements.

ESP32 – Control Center
- **The ESP32 dual**-core 32-bit microcontroller forms the "brain" of the system. It coordinates all sensors, collects measurements, processes them, and decides how they are transmitted.
- **Integrated WiFi (2.**4 GHz, 802.11 b/g/n) and Bluetooth.
- **Interfaces:**
  - **I²C (for sensors** such as BME280, energy monitoring).
  - **SPI (for sensors,** displays, storage).
  - **UART (for GSM** module and RS485).
  - **ADC (integrated, 10**-bit – for external voltage measurement).
- **Supports energy-efficient** operation through multiple sleep modes.
- **Large community, open**-source support (Arduino, PlatformIO).

Front Side

GSM-Module – SIM800
- **Wireless module for** data transmission to the cloud.
- **GPRS – for small** data packets (sensor readings).
- **Serial UART interface** to ESP32.
- **Supports SMS and** TCP/IP over mobile networks.
- **Onboard SIM card** slot, supports 2G networks (widely available in many countries).
- **Tested with a** "10 years – 10 euros" IoT SIM card for international use.

Industrial Interface – RS485
- **Connection for sensors** and devices for data acquisition or control.
- **Fully compatible with** the Modbus RTU protocol.
- **Enables robust data** transmission up to 1000 meters.
- **Supports multiple slaves** on a single bus.

High interference resistance (EMC-friendly) through differential signaling.

Ideal for professional soil and other environmental sensors.

Reverse Side

The soil speaks – the dashboard translates

Understanding the Soil – in Real

The dashboard translates the language of the soil into clear, accessible indicators. Instead of abstract numbers, farmers see at once what is happening in their fields – whether nutrients are lacking, the soil is drying out, or temperatures are shifting. In this way, the soil monitoring device supports resilient agriculture.

Line charts make developments visible over time. Farmers can take action early – using water more efficiently, maintaining soil fertility, and farming in balance with natural cycles. When nutrients are missing, they can be replenished through compost, manure, or cover crops – instead of burdening the soil with chemicals.

Resilience does not mean resisting a changing environment, but adapting to it. Agriculture is resilient when it can respond to droughts or heavy rainfall without further exhausting the soil. It is about understanding the language of the soil and working with natural processes, not against them.

Current Measurements – Nutrients at a Glance

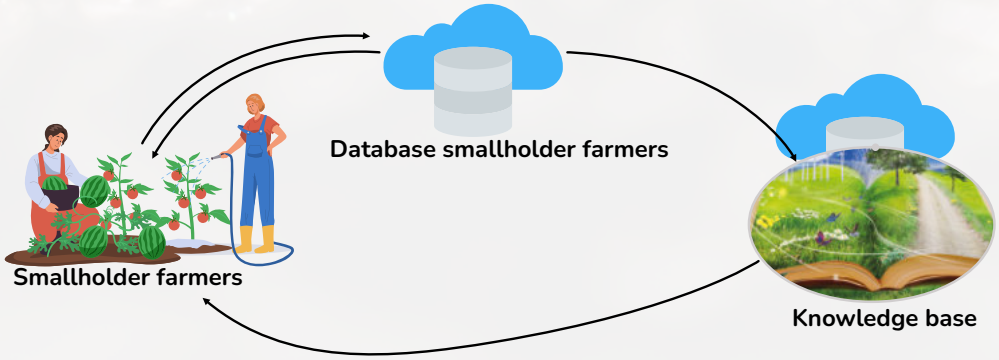
Displays for nitrogen, phosphorus, potassium, pH, moisture, electrical conductivity, and temperature. Simple gauges immediately show current and critical values.

Long-term trends and measures – line charts make developments visible, green vertical lines show when and which measures were taken.

From Data to Knowledge – by Farmers, for Farmers

All measurements are stored in a database, individually assigned to each farmer. Beyond that, a shared knowledge system emerges, where the observations of many smallholders come together. This system grows with every measurement and every entry – becoming a guide by farmers, for farmers.

It does not provide recipes for manipulating nature, but rather guidance on how to better understand natural processes and work with them. In this way, everyone benefits: farmers through concrete support, soils through better care, and the climate through the protection of the humus layer.



Smallholder Farmers or Industrial Agriculture

Industrial agriculture today is one of the main drivers of soil degradation and biodiversity loss – primarily through monocultures, pesticides, and massive land consumption. According to UN reports, it also contributes significantly to global greenhouse gas emissions.

Smallholder farmers, on the other hand, often cultivate their land for generations with methods deeply rooted in local ecology. Within their knowledge lies the intelligence of nature – something no technology can replace. If they are overlooked, we lose centuries of invaluable experience essential for maintaining soil fertility and biodiversity.

At the same time, smallholder farming holds enormous potential: worldwide, despite difficult conditions, smallholders produce around 70% of our food. If they can recognize early when soils fall out of balance, they can respond with simple means – protecting fertility, biodiversity, and the climate.

This is where our soil monitoring device comes in: as a tool to understand the soil and to work with the intelligence of nature.

70% of the world's food comes from smallholder farms.
(FAO, „State of Food and Agriculture", 2014; UNEP, 2021)

80% of agricultural land in Asia and Africa is managed by smallholder farmers.
(FAO, 2018: Smallholders and Family Farms)

Local knowledge: Generations of invaluable experience are deeply embedded in the regional ecology – which technology cannot replace.
(FAO & IFAD, 2019: The State of the World's Biodiversity for Food and Agriculture)

Industrial agriculture is one of the main drivers of soil degradation, biodiversity loss, and greenhouse gas emissions.
(IPBES Global Assessment, 2019; IPCC Special Report on Climate Change and Land, 2019)

From One Device to a Shared Commons – Scaling through Openness

Decentralized Manufacturing

Commons means a shared good – freely accessible, supported and maintained by many. This is exactly how the soil monitoring device is understood: open, decentralized, and replicable.

A single soil monitoring device will not change the world. But its strength lies in its replicability and openness: every farmer, every community, every NGO can build, adapt, and further develop the device themselves.

- **Circuit boards:** freely available layouts, orderable from any PCB manufacturer, assembled or unassembled.
- **Modules:** standard components, CE-certified1 and manufactured according to RoHS.
- **Housing:** locally producible via 3D printing – also with sustainable, biodegradable filaments, leaving no microplastic residues.
- **Sensors:** freely selectable, combinable through many open interfaces.

Decentralized, open, replicable – technology in the hands of the people

The device is not produced in central factories, but right where it is needed – directly on site. In this way, knowledge and skills remain in the hands of local people, creating independence instead of dependence.

Open Licenses as the Key

To ensure the idea can spread without barriers, all design files and software are released under open licenses:

- **GPL v2 for** software
- **CERN OHL for** Hardware

This means: anyone may replicate, improve, and share the soil monitoring device – as long as the results remain freely accessible in turn.

In this way, there is no dependency, but rather a commons of knowledge and tools.

Scaling through sharing

With every replicated device, the impact grows:

- **More farmers understand** their soils
- **More data flows** into the shared knowledge system
- **More room for** action emerges to protect soils, biodiversity, and the climate.

Scaling does not happen through central production, but through sharing, replication, and collective learning.

Photo: Achim Giebler, Indien, Odisha, Oct. 2023

Protecting Soil and Water – Securing the Future

Soil and water are the key elements of agriculture – they are essential for food, biodiversity, and the climate. The future of our children and grandchildren depends on them.

A new worldview recognizes the intelligence of nature and does not seek to exploit it.

Our soil monitoring device is a small tool in this great transformation – helping us to better understand soil and water, and thus preserve what our shared future depends on. It is **freely available**, because we believe that knowledge and tools should belong to everyone – not just a few.

Your donation directly supports the implementation of our projects – from the development of the soil monitoring device to the training and support of smallholder farmers on the ground.

This farmer in India represents the people at the heart of our mission: smallholders who secure our food supply.

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Smart Farming gGmbH · Flurweg 18 · 89250 Senden · Germany
E-Mail: info@Smart-Farming.org · Web: www.Smart-Farming.org
Registry Court: Amtsgericht Memmingen · Registration number: HRB 20626
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