Leaf-Brix-Driven AI for Non-Invasive Soil-Carbon Monitoring

From one leaf’s sweetness we read the soil’s carbon health—in real time.

2025/04/25

Why it matters?

SOC = the hidden carbon bank

- Soil organic carbon (SOC) drives CO_2 sequestration & soil fertility.

- Current “dig & measure” methods is not good.

SLOW

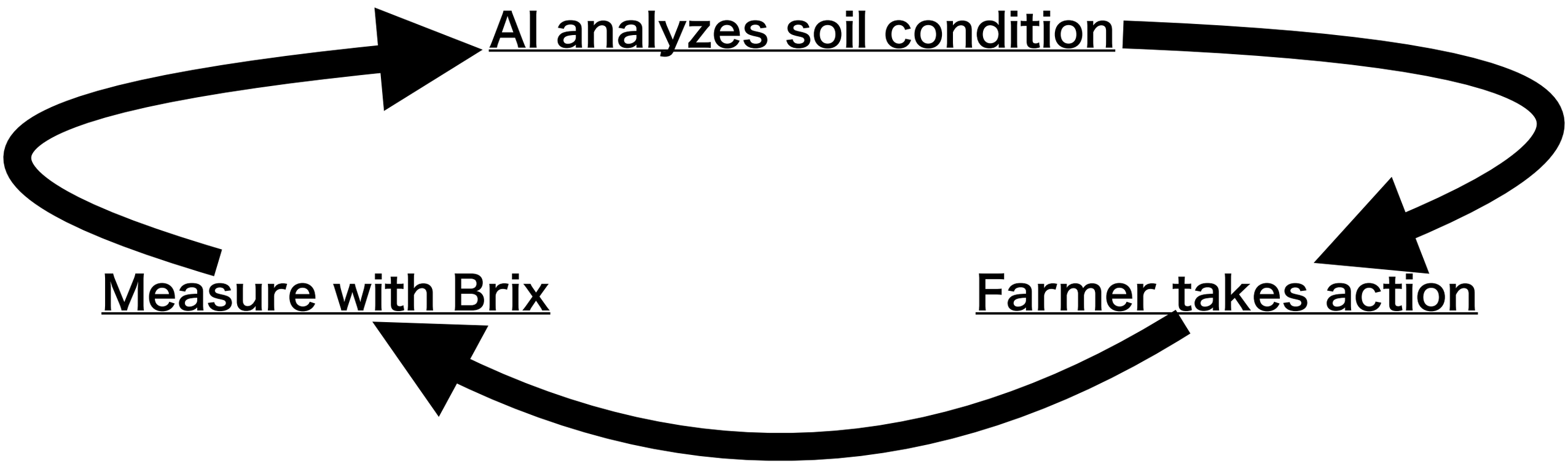
PRICEY

DESTRUCTIVE

Research Overview

Goal: Replace excavation with a leaf-Brix + AI workflow.

- Measure leaf sugar (Brix) using a handheld refractometer.
- **Map Brix → SOC** with a hybrid (physics + data) AI model.
- Deliver a farmer-friendly monitoring loop



Objectives

Hypothesis – Verification

- Demonstrate Hypothesis A(H-A)
  ”That SOC can be estimated from Brix values alone with a statistical accuracy within **±20%**.”

- Demonstrate Hypothesis B(H-B)
  “The increase in SOC in natural farming plots is significantly greater than in conventional plots (**p < 0.05, d ≥ 0.8**).”

- Build a database **integrating crop × cultivar × growth stage × farming method**, and generate a general-purpose AI model ("universal" AI usable across regions and crops without retraining).

Field Design & Sampling

How do you design the experiment? How many samples?

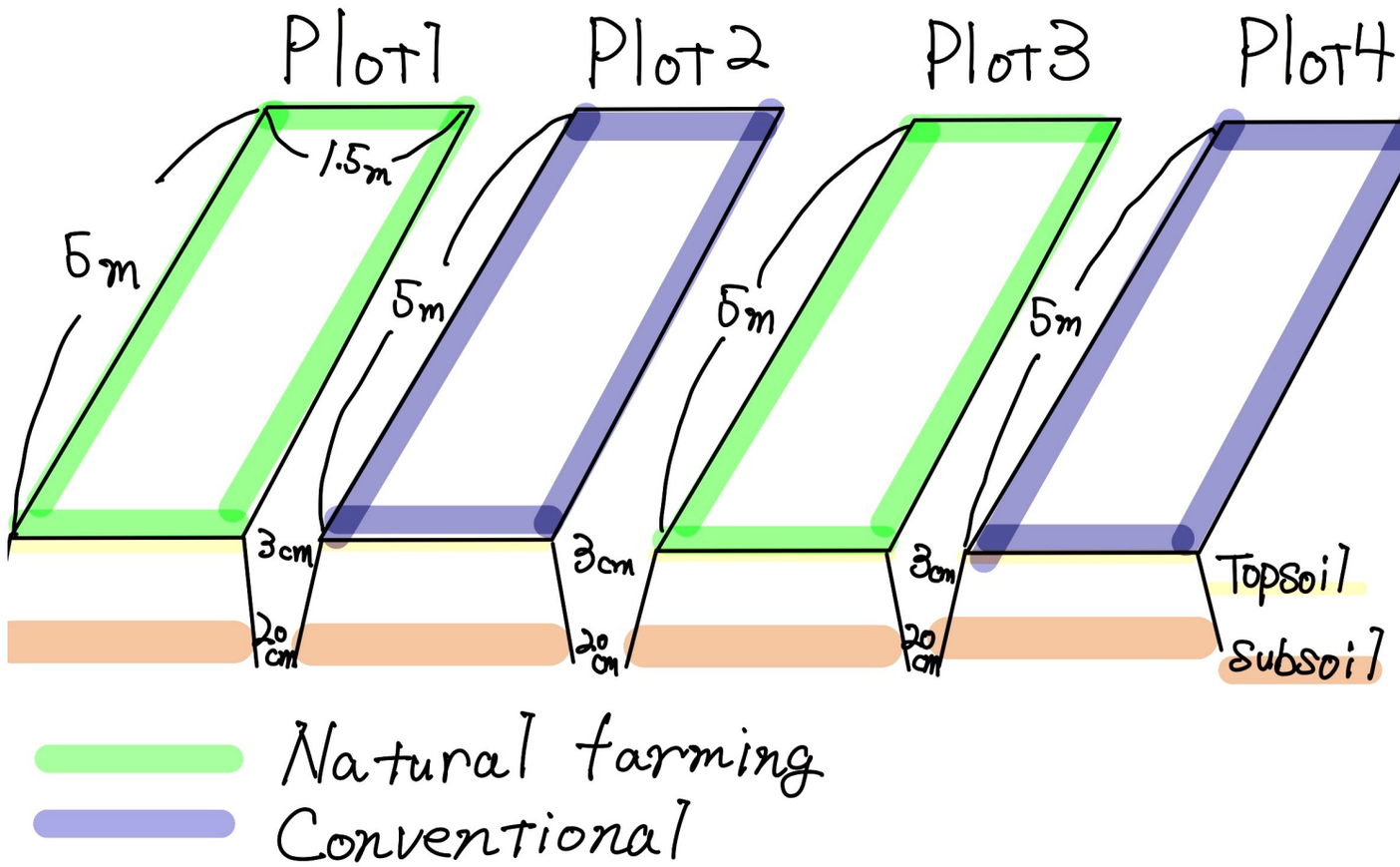
- 4 plots
  (**1.5 m × 5 m** each)
  Natural farming (1 & 3)/
  Conventional (2 & 4)

- Sampling months:
  June / Aug / Oct (3 times)

- Depths:
  topsoil 3 cm/subsoil 20 cm

→ 12 pts/plot

→ **48** samples / year



Data Collection

Primary Data	Instrument	Estimated price
SOC	Dry combustion (outsourced)	Approximately 10,000 yen / sample
Leaf Brix	Hand refractometer	Approximately 10,000 yen

Timeline & Milestones

Year	Key Outcomes
2025	50 baseline samples, prototype model, test H-B
2026	On-farm validation, model generalisation, verify H-A
2027	Publish “post-human-centred” ag-monitoring framework

Relevance & Impact

Towards Smarter and More Sustainable Farming

- **Originality**
  World's first non-invasive SOC estimation via Brix + AI.

- **Feasibility**
  The test site is ready.
  Preparation of equipment and establishment of a cooperative framework have already begun.

- **Societal Impact**
  Cuts monitoring cost
  → enables smarter, more sustainable farming.

Soil diagnosis with just a single leaf