A SOIL ENZYMATIC ACTIVITY READER TO ASSESS SOIL ORGANIC NITROGEN MINERALIZATION

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Measure

enzymatic activity with a new device and compare it with mineralized nitrogen

Why measure soil enzymatic activity?

The primary process driving soil nutrient release is the enzyme-catalyzed decomposition of organic matter. Still, when assessing the risk of nitrogen losses and excess nutrients from fields, we remain reliant on measuring highly variable nutrient content at single time points and creating thresholds. This approach misses the dynamic nature of nutrient fluxes needed to create actionable soil quality management strategies.

Our goal
By combining a single measurement of soil enzymatic activity with a predictive model that integrates real-time weather data, we can accurately forecast the rate of nitrogen mineralization throughout the crop's growing season. This allows for precise adjustments to fertilization needs for specific crops and a reduction in nutrient losses.

To achieve this goal
We are calibrating several soil nutrient cycling submodels, with a particular focus on the mineralization model.

We hypothesize that by measuring the initial extracellular enzyme activity (EEA) we can accurately predict the total amount of nitrate released in an agricultural soil sample under controlled laboratory conditions.

Experimental set-up

- Total 187 field samples (x3 – in triplicates)
- C_{tot} range: 0.85–8.5 kg C/kg soil
- Soil C:N ratios: 6 to 33
- Pre-incubation: 7 days
- Measurements at day 7 and day 56: β-glucosidase + Nmin
- Incubation at 25°C for 56 days, weekly rewatering.
- Co-incubation in field of 24 samples from lab incubation in water tight, air permeable plastic bags (buried for 49 days).

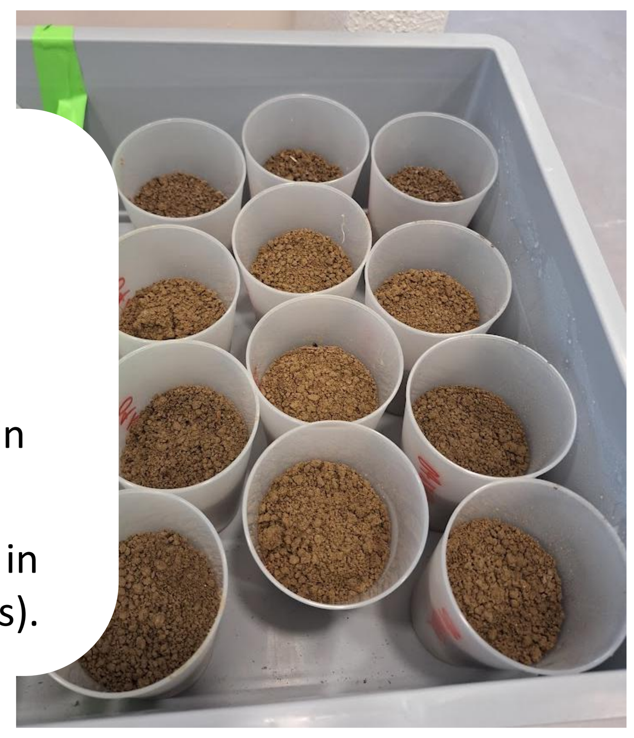
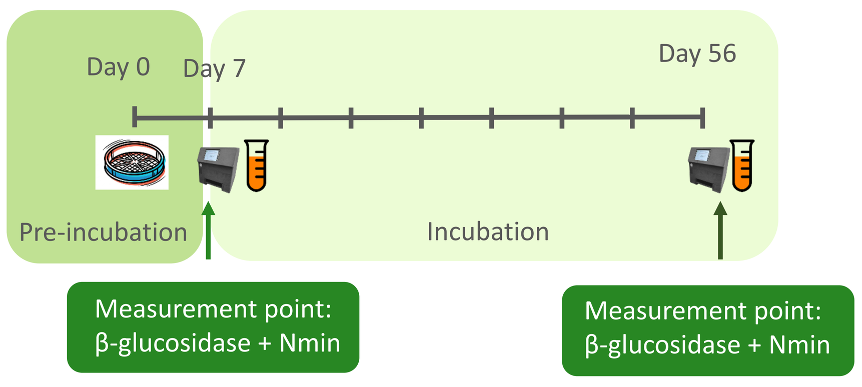


Fig.1 Soil samples were sieved to 4 mm and incubated in cups (in triplicates) in controlled conditions.



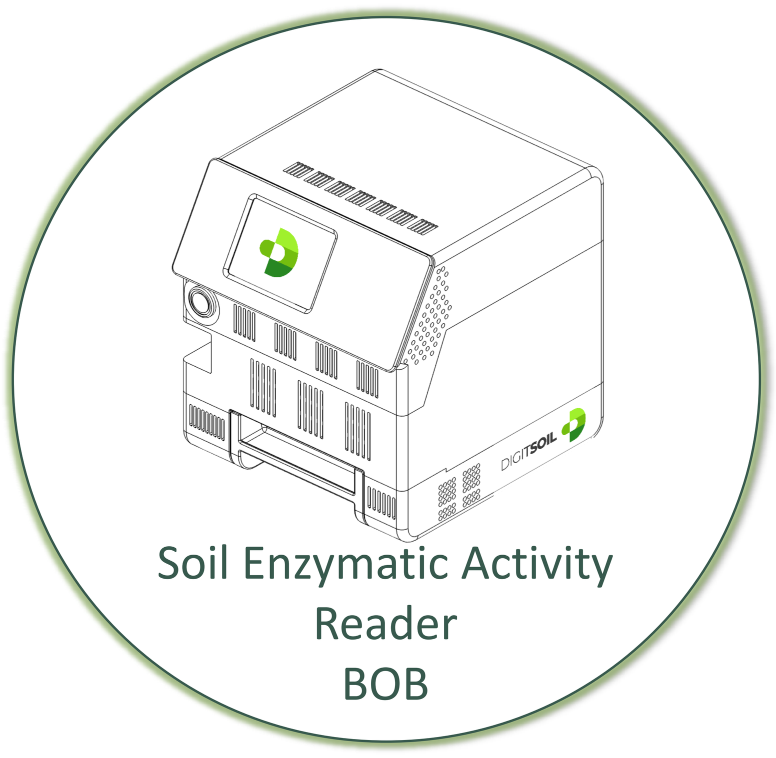


Fig. 2 Soil samples were measured at both time points with SEAR (soil enzymatic activity reader for fast assessment of EEA).

Fig. 3 Soil samples (187) for the incubation experiment were collected mainly in Switzerland with some additional locations in Germany, France and the Netherlands.

Model

nitrate released by soil enzymatic activity over time

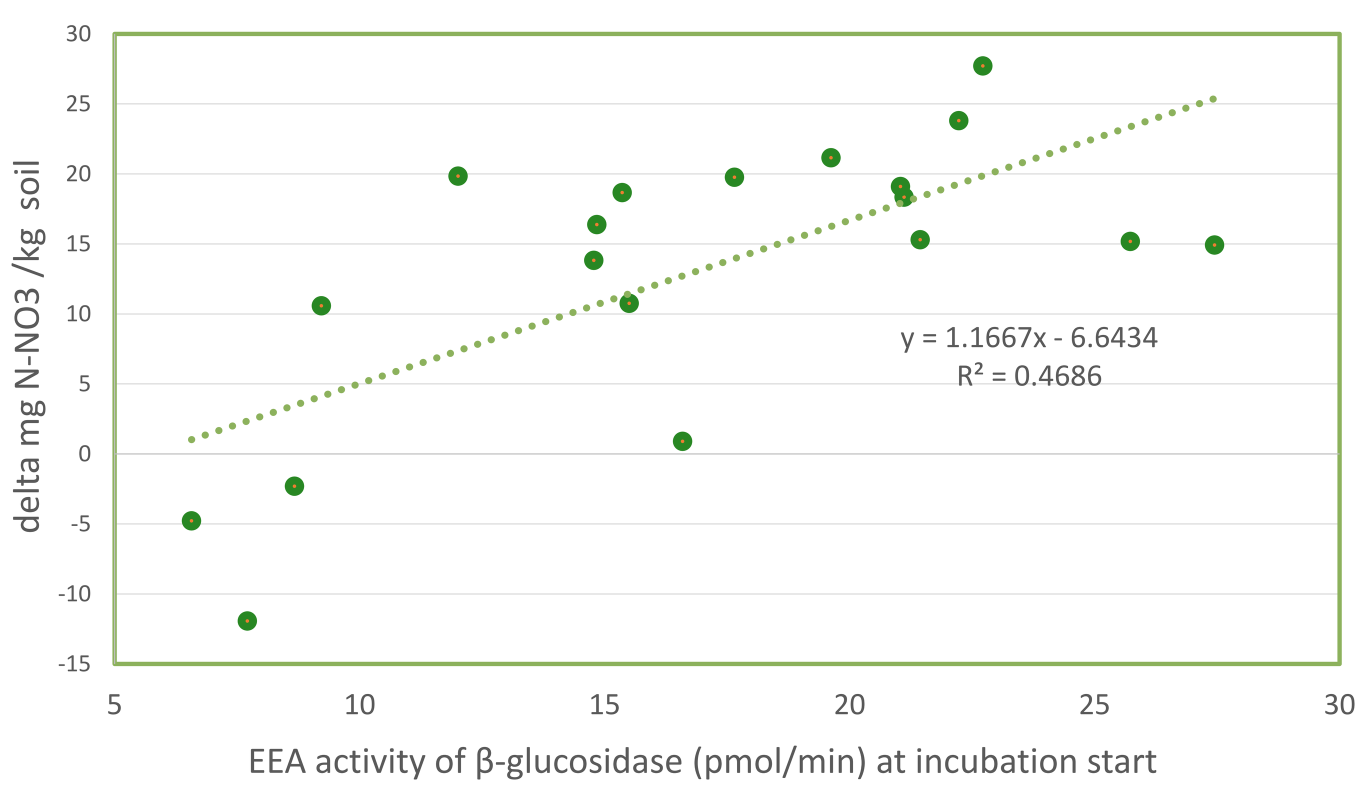


Fig. 4 A correlation between difference of nitrate content in incubated soil samples (from t7 to t56) and soil β-glucosidase activity measured at the t7.

We found a good correlation between soil enzymatic activity and nitrate released during the incubation period with the first subset of samples. With more samples undergoing the analysis, we will be able to validate this correlation and identify confounding factors or any clustering.

Act

to make an efficient nutrient management a reality

What is our way forward

With the biggest known EEA database, we are combining satellite data with plant needs and management practices. This ensures crops receive sufficient nutrients at the right time, which allows us to reduce both nutrient loss and its associated environmental and financial costs.

Next steps:
- More data!
- Integration of satellite crop and soil data
- Integration of crop needs and management
- Interface (an app) giving answers when needed (almost there!)

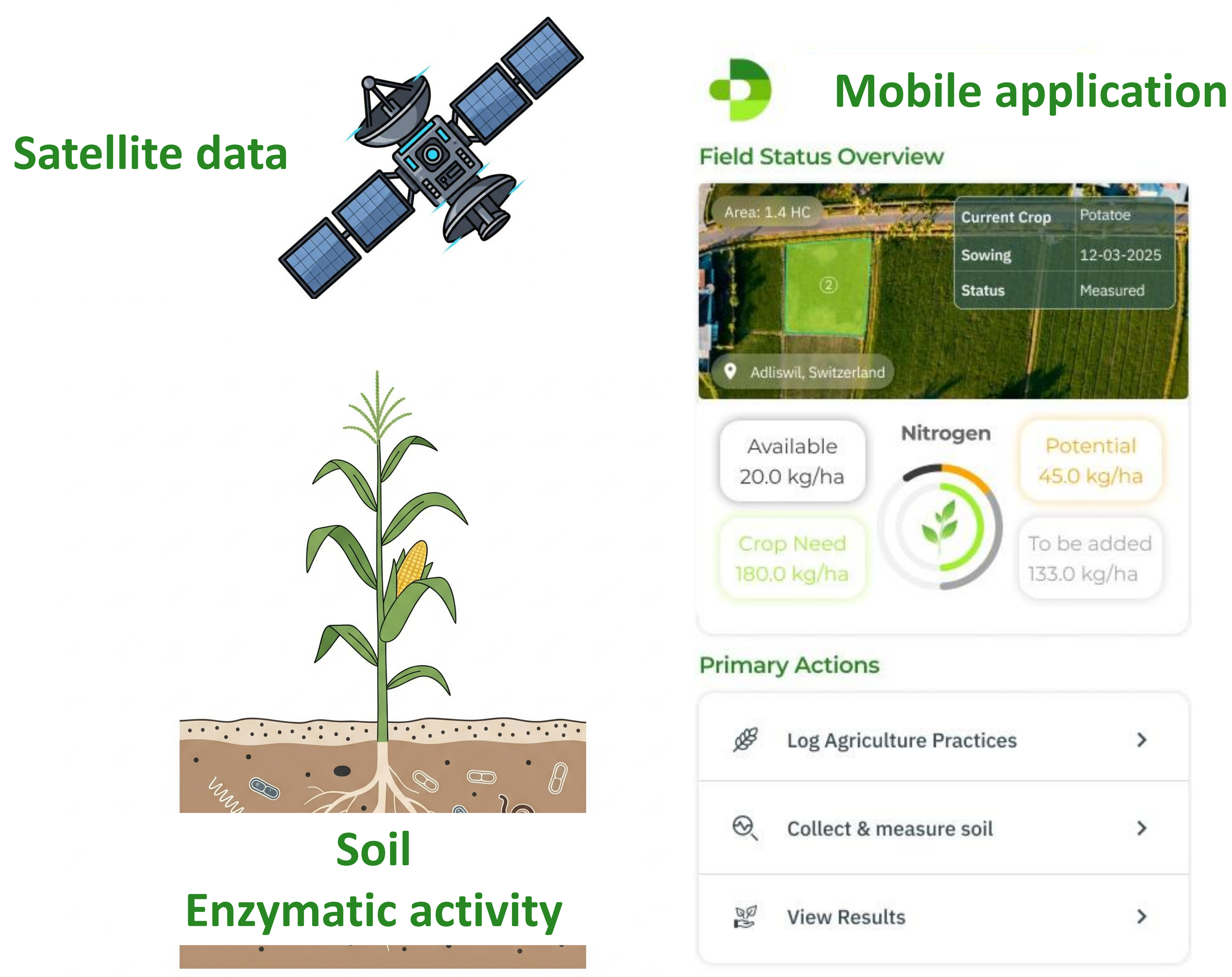


Fig. 5 Merging soil enzymatic activity data with satellite imagery and farming practices into an easy-to-use app will help farmers make quick fertilization decisions.

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