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Targeting Soil Functions through Functional Microbiome Identification Tools

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Motivation

Intensive farming practices and ongoing climate change are threatening soil health and compromise its ability to provide key environmental services, including sustaining global food production. The soil microbiome play major roles in maintaining soil multifunctionality. Leveraging microbial sequencing data, agronomic history, and soil physicochemical properties offers opportunities to classify microbial communities into function-related groups and to develop predictive tools linking specific microbiomes to defined soil functions.

Technological challenge

Artificial intelligence (AI), such as multimodal deep learning models, provides powerful frameworks for extracting knowledge from such complex, high-dimensional biological data. There are key challenges that may arise:

1. Collection and generation of high-quality microbiome data and its associated metadata to train and build the AI models.
2. Development of robust and predictive AI models to establish reliable links between soil microbiome and soil functions.
3. Interpretability and identification of functional keystones species to be used as bioindicators for developing soil functions assessment tools.

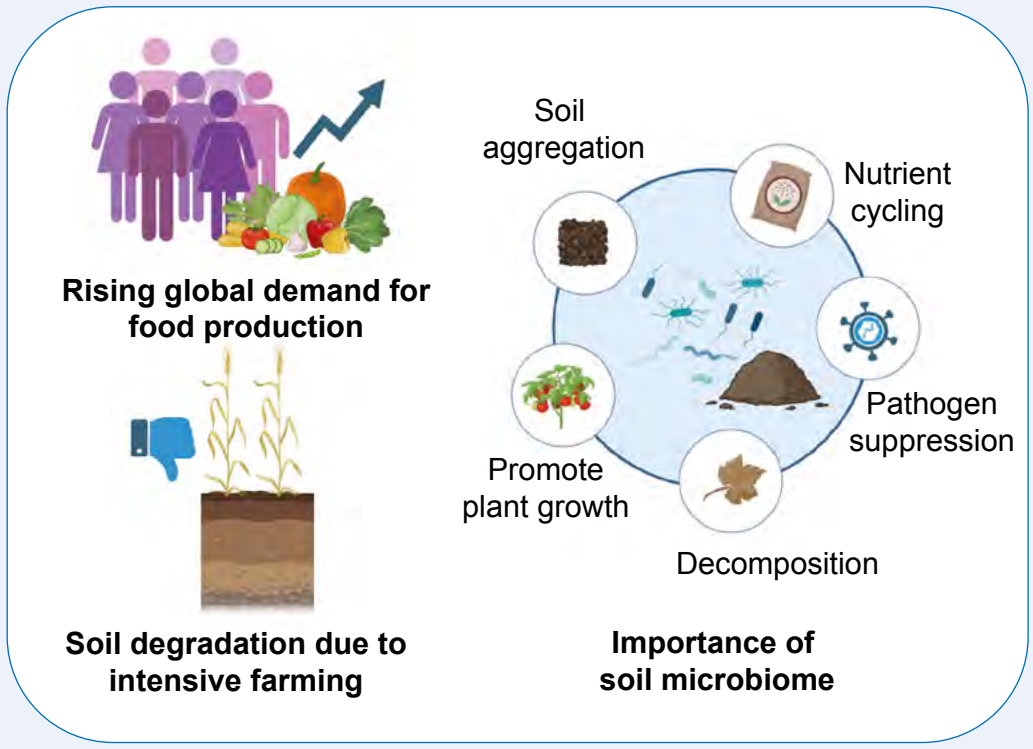

Fig 1. Project background. Rising global demand for food production leads to soil degradation due to intensive farming. Soil microbiome could give insight to the quality of soil functionality.

Research goals

1. Classify soil microbial communities into function-related groups that are essential for optimal soil performance.
2. Develop robust and predictive AI models that link soil microbiome composition to key soil function.
3. Identify microbial bioindicators (e.g., taxa and functional groups) that are responsible for specific soil functions.
4. Design and develop new soil function assessment methods that leverage indicator microorganisms to evaluate the functional quality of soils.

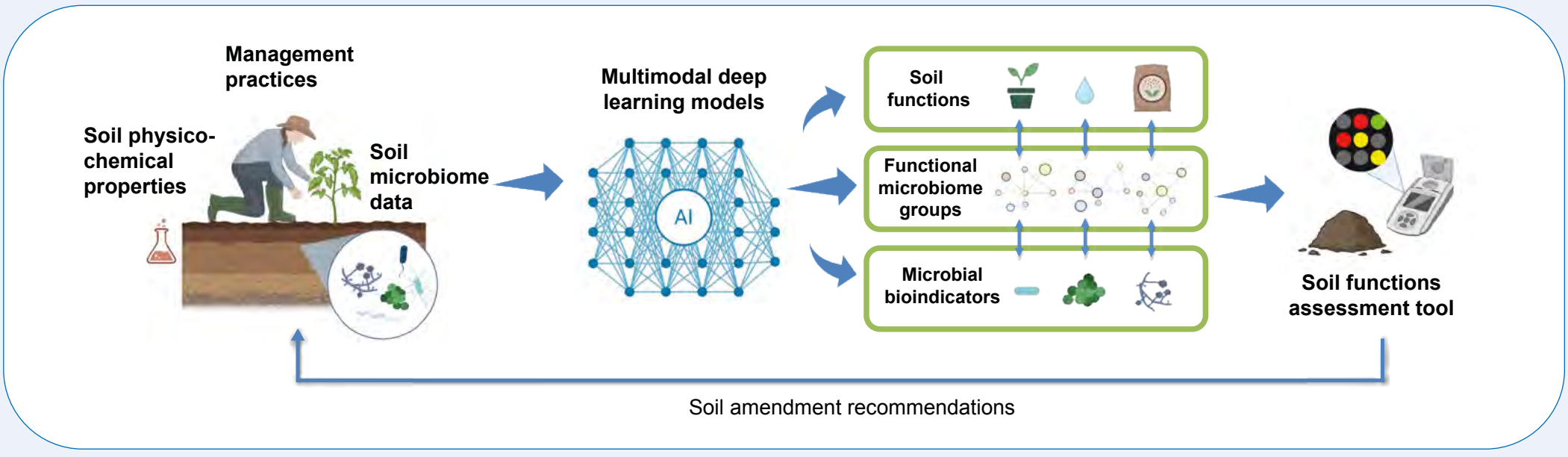

Fig 2. Project overview. Microbial sequencing data, soil physicochemical properties, and agricultural management practices are integrated as inputs into a deep learning framework to predict soil functions. Keystone microbial species associated with each soil function are subsequently identified and used as bioindicators for a microbiome-based soil function assessment tool.

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