DIMIVEA
Microbial and Plant Diversity in Multi-species Agroecosystems - Modeling of Relationships
Metaprogramme BIOSEFAIR

Projet Report: 2021 - 2024

December 2023

The DIMIVEA consortium (October 2021–September 2022), entitled "Microbial and Plant Diversity in Multi-species Agroecosystems – Modelling of Relationships", aimed to model community biodiversity dynamics to better simulate the provision of ecosystem services. The project sought to go beyond current simplified models by integrating biological diversity into explicit and dynamic simulators.

By focusing on the characteristics of plant and microbial communities in mixed plant covers, DIMIVEA aspires to provide a conceptual framework to extend model potential, allowing more reliable estimation of ecological processes supporting ecosystem services in agroecosystems.

Results

DIMIVEA, focused on understanding interactions between plant and microbial diversity in multi-species ecosystems, established conceptual bases by progressively integrating plant diversity dynamics into simulation models. Modeling relied on tools such as ModVege, CoSMo, DynaGram, and SYMPHONY, serving as the technical foundation for a new integrated prototype aiming to simulate interactions among C-N flows, climate, and agricultural practices, while introducing plant diversity into C-N flow models. The prototyping approach sought to develop a dynamic conceptual framework linking biological diversity and biogeochemical

fluxes, considering biomass, biogeochemical structure, and interactions with soil microorganisms.

The DIMIVEA consortium made significant progress in modelling multi-species agroecosystems with an emphasis on microbial and plant diversity.

The developed simulator offers a more accurate representation of C-N coupled cycles in agroecosystems, moving beyond usual simplified schemes by integrating explicit and dynamic biodiversity representation. Initially focused on carbon sequestration and biomass production, the project used coupled models ModVege (plant) and SYMPHONY (microbial). While oscillations between grasses and legumes were not fully reproduced, the model revealed coherent trends in carbon storage and release. Simulated annual biomass balances are consistent with real observations, despite overestimation of exuded carbon and gaps in some dynamics. Key points raised include nitrogen uptake, C/N ratio, biomass-to-carbon conversion, the physically unrepresented root compartment, the decomposition chain, pedoclimatic conditions, and plant interactions.

Identified gaps in root representation, phenological dynamics, C/N ratio, and other processes will require parameter calibration to improve model accuracy. The dynamics of the C-N ratio and allocation within plants also play a crucial role to be explored.

Scientific perspectives

The results and questions that emerged following the DIMIVEA project motivated the implementation of the exploratory MODIMIV project ("Modeling relationships between microbial and plant diversity in multi-species agroecosystems") to deepen particularly the following aspects:

- Dynamic and explicit representation of plant and microbial diversity,
- Understanding specific mechanisms by which microbial diversity influences plant diversity and vice versa, notably via the organic decomposition chain.

Valorisation

Bellocchi, G., 2023. Modelling microbial and plant diversity in multi-species agroecosystems: the DIMIVEA project. EJP SOIL, Annual Science Days 2023, 13/06/2023, Riga, Latvia (oral presentation)

Adam, L., 2023. Conception d'un modèle prototype pour l'étude de la productivité et de la séquestration du carbone en lien avec la diversité dans les prairies permanentes : le cas de la dynamique interannuelle légumineuses/graminées. Rapport de stage Master 2 MODE 2022 – 2023, Université de Rennes