Biodiversity-based cropping systems - and their long-term consequences for ecosystem services : a 50-year simulation in western France

Arnaud Delbaere*[1], Matthieu Carof[2], Olivier Godinot[3], and Edith Le Cadre[4]

[1]Sol Agro et hydrosystème Spatialisation – Institut National de Recherche pour l'Agriculture, l'Alimentation et l'Environnement, Institut Agro Rennes ANgers – France

[2]Sol Agro et hydrosystème Spatialisation (SAS) – Agrocampus Ouest, Institut national de la recherche agronomique (INRA) : UMR1069 – 65 Rue de Saint Brieuc, 35042 Rennes cedex, France

[3]Sol Agro et hydrosystème Spatialisation (SAS) – Agrocampus Ouest, Institut national de la recherche agronomique (INRA) : UMR1069 – 65 Rue de Saint Brieuc, 35042 Rennes cedex, France

[4]AGROCAMPUS OUEST – Agrocampus Ouest UMR SAS – Institut Supérieur des Sciences Agronomiques, Agroalimentaires, Horticoles et du Paysage - 65, rue de St Brieuc - CS 84215 - 35042 Rennes cedex, France

Résumé

Biodiversity-based cropping systems (BBCS) represent a promising nature-based solution for agriculture, offering a potential avenue for addressing socio-environmental issues under climate change pressure. Mechanisms that could be harnessed for the implementation of such a system, like crop diversification, necessitate a certain level of synchronization with the underlying agroecosystem processes and the specific needs of agricultural practitioners. The enduring repercussions of diversified systems present a particular challenge given the current inadequacies in design and evaluation methodologies. We suggest that integrating crop models with innovative design and complementary assessment tools could facilitate the evaluation of BBCS impacts on the provision and stability of ecosystem services across time horizons.

To deal with our hypothesis, we relied on STICS model V10.1.0 (Brisson et al., 2010) to simulate the long-term functioning of an agroecosystem under a BBCS. The BBCS was co-designed with agricultural experts and includes 16 crop species in a 6-year rotation cycle. Two reference cropping systems were also simulated, (i) a conventional two-species rotation (corn-wheat) commonly found in western France, and an agroecological diversified rotation tested in Kerguennec site (Central Brittany, France). The simulations incorporated historical climate data from 1973 to 2023 (SAFRAN) and projected data from 2023 to 2073, from three climatic models (CRNM-ALADIN63, CRNM-RACMO22, EARTH-RACMO22) under 4.5 and 8.5 IPCC scenarios. STICS outputs such as nitrogen and carbon dynamics are then introduced as indicator components in a decision model informed by expert opinion, built on DEXI (Bohanec, 2008) to assess compromise between services over time.

Preliminary findings indicate a positive evolution of the soil quality maintenance service over time while the regulation of water quality service deteriorates for the BBCS compared to the other systems. It can be explained, by the higher annual quantity of nitrates resulting from

*Intervenant

mineralization and the fastest stabilization of organic carbon stocks in the soil where the BBCS is implemented compared to the two additional systems. One possible explanation for this phenomenon is the supply of N-rich residues by leguminous plants introduced through the BBCS. But this higher quantity of nitrates is accompanied by more frequent and intense nitrates leaching events, degrading water quality service for BBCS system. The very next phase of this research will involve the study of other variables from STICS simulation to assess the contribution of BBCS on the provision of other ecosystem services and their stabilityover time (e.g. crop yields for the provisioning service, greenhouse gas emissions for climate regulation).

Mots-Clés: Agroecology, Crop diversification, Long term, Cropping system, Crop model, STICS model, Co, design, Nature based, solution