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1S1a Models and tools for estimating circularity of alternative food and agricultural systems

PROSPECTIVE ANALYSIS OF THE EVOLUTION OF AGRONOMIC, ENVIRONMENTAL AND NUTRITIONAL PERFORMANCES OF CONTRASTING CROP ROTATIONS WHEN FACING CLIMATE CHANGE

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Food systems are at the core of severe environmental, sanitary and socioeconomic impacts (De Schutter et al., 2019). To address part of these problems, the EAT-Lancet commission described a reference diet which would be healthy and conform with planetary boundaries (Willett et al., 2019).

The EcoFoodSystem trial, hosted at the University of Liege (Belgium) since 2020, consists of a long-term experiment implemented in a 30-ha plot, in the pedoclimatic context of the Hesbaye area (Gembloux, Belgium) characterised by deep loamy soil and temperate climatic conditions. The experiment aims at testing innovative zero-pesticides agroecological cropping systems (8-year rotations) tailored to feed people according to EAT-Lancet dietary requirements and with contrasting expectations (business-as-usual vs. vegan vs. integrated crop-livestock). In particular, the business-as-usual rotation includes the main cultures of the Walloon region and uses manure; the Vegan rotation simulates an agriculture without crops used as feed, without consumption of animal products and therefore without animal manure; finally the Integrated Crop-Livestock System (ICLS) uses integrated livestock, temporary grasslands and forage cover crop.

The STICS soil-crop model was used to compare the agronomic and environmental performances of the three cropping systems. Simulations were run under historic climatic conditions (1985-2009) and when facing climate change impacts, i.e. under future climatic conditions covering the 2045-2069 and 2075-2099 timeframe and under RCP4.5 and RCP8.5 emission scenarios. The 24-year simulated periods correspond to 3 successive crop rotations. Nutritional performances were derived from simulated outputs. The performances of the three cropping systems were then evaluated using a multicriteria approach, including yield, vegetative cover, soil organic carbon and nitrogen

plant stresses, greenhouse gas emissions, number of people fed by the rotation and self-sufficiency.

Main results show that the BAU system is relatively competitive in terms of yield but weak as for thermic and water stresses and highly dependent on external products imports. The ICLS system provides a slightly weaker relative yield but with a much higher self-sufficiency, a great stress resistance and a very high organic carbon storage. When facing climate change impacts, all systems would increase their total yield but in contrasted ways.

This study exemplifies the power of modelling tools to predict the potential impacts of climate change and compare different agricultural systems over longer periods of time. It also emphasizes the need of modelling tools, complementary to field experiments, to design innovative cropping systems and highlights the pertinence of analyzing farming systems with the broadest possible perspective.

De Schutter, O. et al., 2019. Report of the IPES-FOOD panel.

Willett, W., et al. 2019. The Lancet, 393(10170), 447-492.

Keywords: Agroecology, Climate change, Integrated crop-livestock systems, Crop modelling, STICS