Session Biosphere: April 11th 13.45 hrs

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

Connecting cropping system design with food diet requirement through the development of an innovative conceptual model

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Nowadays, agriculture has to face the great challenge of balancing the social expectations and environmental costs of food production with the nutritional requirement of a growing population, in the greater context of climate change. In this context, the modification of our eating habits towards more environmentally-friendly and healthy -diets is a key lever. In 2019, the EAT-Lancet commission defined a universal guideline diet that should allow 9 billion people across the globe to be fed healthily while respecting our planet boundaries. In parallel it remains of primary importance to design innovative cropping systems, where agroecological processes are at play, to provide resilience and sustainability to our agroecosystems.

We conceived an innovative approach and conceptualize a decisional model to optimize the use of cropping systems and determine how they could support the eating patterns proposed by the EAT-Lancet commission. The approach was designed to remain generic and deployable at the global scale, while offering the potential to be contextualized and applied for any specific agro-pedo-climatic context.

More specifically, our conceptual model allows optimizing the direct (food) or indirect (feed) contribution of the different commodities produced within the crop rotation to each category of food items defined by the targeted diet. To do so, an inner process of the model allows to feed different category of animals, including dairy cow, meat beef, lamb, pork, chicken or hens. Therefore, depending upon the rotation assessed, the model allows produce different categories of animal derived products (milks, eggs, red meat, white meat).

Multicriteria optimization targets where defined to reach the required amount of daily calories and fall within the boundaries of each food category. A specific attention was also

devoted to determine which food category appeared in excess or in deficit, in order to minimize the exports and imports of food and feed commodities.

We demonstrated in silico the potential of our approach by applying it to the Belgian Hesbaye context (loamy region and temperate climate). Results show that longer and more diverse rotations are more likely to comply with food requirements, especially if animal-based foods are allowed in the diet. In addition, rotations must usually include rapeseed to supply oil for humans and oilseed meals for livestock, one legume crop for protein and pulses and several cereals. In particular, integrated crop livestock systems (hosting temporary pasture and forage cover crop) are the one minimizing the excess and deficit of all commodities.

Keywords: Cropping system design, sustainable food system, EAT Lancet die