Session Economy: April 13th 09.00 hrs

3s2 Monitoring and modelling the transition from linear to circular production chain in the bio-economy

A cost minimization model for bio-based fertilizer prosumers

De Keyser E 1), Mathijs E 1), Vranken L 1)

1) Division of Bio-economics, Department of Earth and Environmental Sciences, KU Leuven, Belgium

---

Today's crop production is heavily dependent on mineral fertilizers. However, excessive use of mineral fertilizer can be linked to environmental threats such as global warming and nutrient pollution. At the same time, there are huge nutrient losses along the food chain as a consequence of food waste. Bio-based fertilizers can address imbalances in regional nutrient cycles and simultaneously reduce environmental harm related to fertilizer use. However, from a farmer's perspective, an optimization problem arises: the farmer wants to minimize costs while safeguarding nutrient uptake of his crops. Optimization research in the fertilizer domain mainly focuses on scheduling fertilizer application or minimizing manure management costs. The Linear Programming (LP) model developed in this study intends to minimize fertilizer costs for an individual vegetable farmer by taking into account the possibility of simultaneous production and consumption of bio-based fertilizers. Bio-based fertilizer prosumption is accounted for by considering conversion of crop residues through composting and anaerobic fermentation, or leaving crop residues on the field after harvest. These options are compared to purchasing mineral fertilizer, commercial compost or pig slurry. Based on the cost estimations for each of these fertilizers, total fertilizer costs are minimized while taking into account the nutrient requirements of the crop as well as the availability of organic waste. In addition, a distinction is made between different sustainable business models and value chains related to bio-based fertilizer prosumption. These business models influence average costs of bio-based fertilizers as well as the organic waste availability. The LP model is tested for the case of a representative Flemish leek farmer. Sensitivity analyses are carried out with respect to changing cost parameters. The results confirm that, given the baseline parameters, it is unlikely for a Flemish vegetable farmer to fulfill his nutrient and organic carbon needs solely with bio-based fertilizer. Nevertheless, the study shows that it can be interesting to consider value chains involving regional cooperation between stakeholders. There is abundant room for progress in determining how to efficiently collect and convert a sufficient amount of organic waste in order to fulfill a larger part of the fertilizer need.

Keywords: optimization, linear programming, sustainable business models, bio-based fertilizers