Proposal master thesis

Topic:

"Evaluating the economic potential of soil additives to reduce post-harvest nitrogen losses in agriculture"

Description:

One of the most pressing issues in intensive agriculture is how we can reduce post-harvest losses of nitrogen (N) on agricultural land. In terms of N use efficiency, the focus so far has been on optimizing the amount and timing of N fertilization, including spatially targeted application (precision agriculture). However, we must be aware that this will not be sufficient to solve the problem of N surplus. The mineralization of crop residues and soil organic matter, especially after harvest, can lead to very high mineral N concentrations in the soil, which ultimately result in high N losses, mainly in the form of nitrate leaching, but also as nitrous oxide (N_2O), if the excess N is not immobilized before winter. In crop rotations that do not allow the cultivation of a catch crops, e.g. before winter cereals, the N immobilization potential is by far not high enough to immobilize the available mineral N. In this case, a different approach than plant N immobilization is required to immobilize the excess N before winter.

Laboratory incubations and field trials with different soils under a wide range of conditions have shown that substantial nitrogen immobilization is possible through the stimulation of microbial biomass growth by readily available organic soil amendments. We have shown that effective immobilization of mineral N in large quantities (up to almost 100 % reduction of nitrate concentration in the soil) is possible for several months, even under winter conditions. A consistent picture emerges from the results, suggesting that the optimal and longest-lasting effect of N immobilization can be achieved with nitrogen-free organic compounds that are moderately available to microorganisms. However, the extent to which such management measures can be implemented in agricultural practices also depends on the economic feasibility of such measures.

The aim of this MSc topic is to assess the economic feasibility of applying nitrogen-free organic compounds to agricultural fields in sufficient quantities to reduce nitrate leaching from agricultural soils during the winter season, both under the current policy framework and for different hypothetical (push or pull) policy scenarios, using a bio-economic model.

Potential starting points in the literature are:

Kuhn, T., Enders, A., Gaiser, T., Schäfer, D., Srivastava, A. K., & Britz, W. (2020). Coupling crop and bio-economic farm modelling to evaluate the revised fertilization regulations in Germany. *Agricultural Systems*, *177*, 102687.

Li, Z., Reichel, R., Xu, Z., Vereecken, H., & Brüggemann, N. (2021). Return of crop residues to arable land stimulates N 2 O emission but mitigates NO 3− leaching: a meta-analysis. *Agronomy for Sustainable Development*, *41*, 1-17.

Chen, Z. X., Zhang, H. M., Tu, X. S., Sun, X., Wang, J., Cheng, Y., ... & Chang, S. X. (2021). Characteristics of organic material inputs affect soil microbial NO3− immobilization rates calculated using different methods. *European Journal of Soil Science*, *72*(1), 480-486.

Contact:

The master thesis will be jointly supervised by the chair groups of “Production Economics” at the ILR University of Bonn and “Plant-Soil-Atmosphere Exchange Processes” at the Forschungszentrum Jülich.

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