Reducing Excess Nitrogen Through Sustainable Farming Systems in Danish Agricultural Catchments

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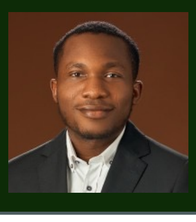

Background & Aim

- Nitrogen pollution from fertilizer in agriculture has emerged as an escalating global concern. Hence, it is imperative to assess the farming system that will facilitate the optimal utilization of livestock manure while minimizing environmental impact. In pursuit of sustainable nitrogen practices, the implementation of a farming system incorporating crop residues and catch crops has been identified as a promising strategy.
- Crop residue incorporation is a carbon farming practice that can have significant implications for both soil organic carbon (SOC) and nitrous oxide (N_2O) emissions while catch crops have been an important tool for the reduction of nitrogen leaching in the Danish legislation since 1998 (Sommer and Knudsen, 2021).
- **The aim of this study** is to assess the environmental performances of twelve (12) different farming systems integrating crop residues and catch crops across six representative Danish agricultural catchments.

Method

- This study utilizes a process-based model called LandscapeDNDC (Haas et al. 2013) to assess the environmental performances of twelve (12) different farming systems in six Danish representative agricultural catchments (LOOPs).
- Fields are categorized based on their management between 2013-19, distinguishing between those dominated by organic manure, chemical fertilizer, or a blend of both.
- The label (OMD) stands for Organic Manure Dominated fields, (SMD) represents Synthetic Fertilizer Dominated fields, and (BLN) signifies Blending fields.
- The illustration in Figure 1, indicated by the + and - signs, represent the inclusion or exclusion of Catch Crop or Crop Residues in each field, resulting in a total of 12 cropping systems for modeling.

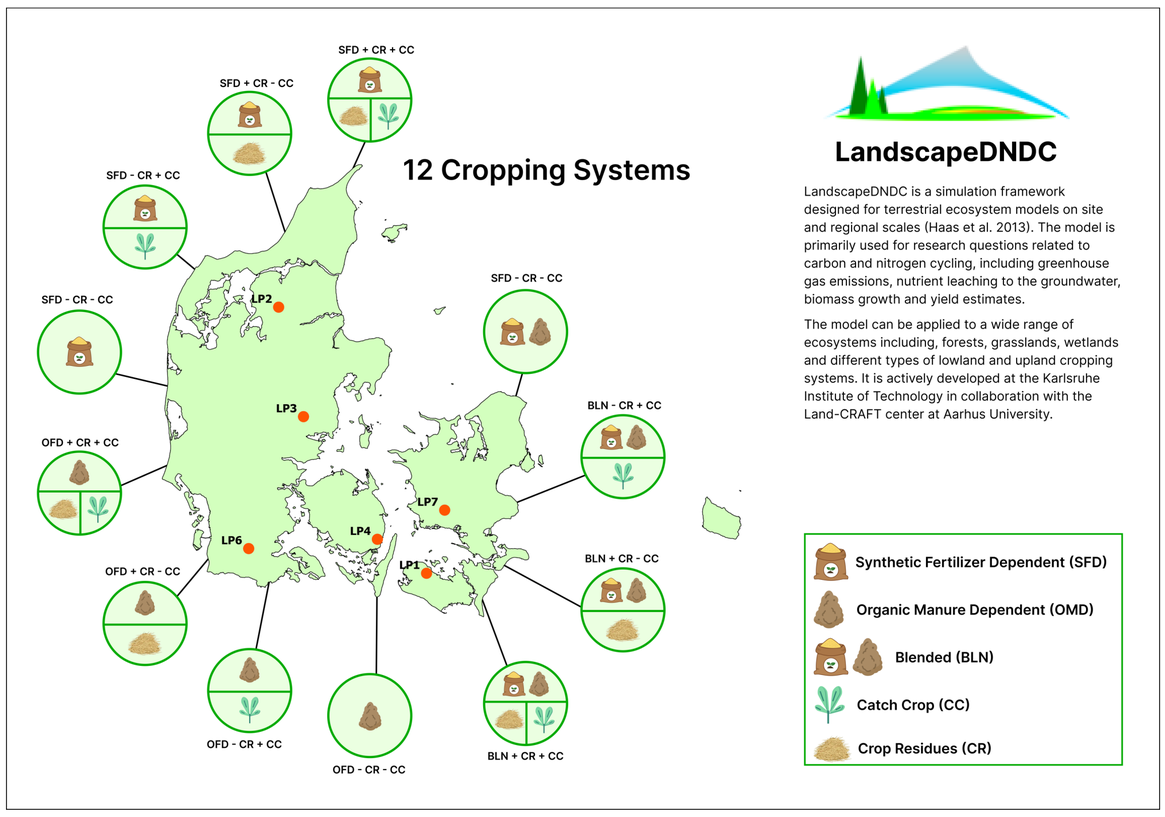

Figure 1: Illustration of the 12 Cropping System Combinations

Results

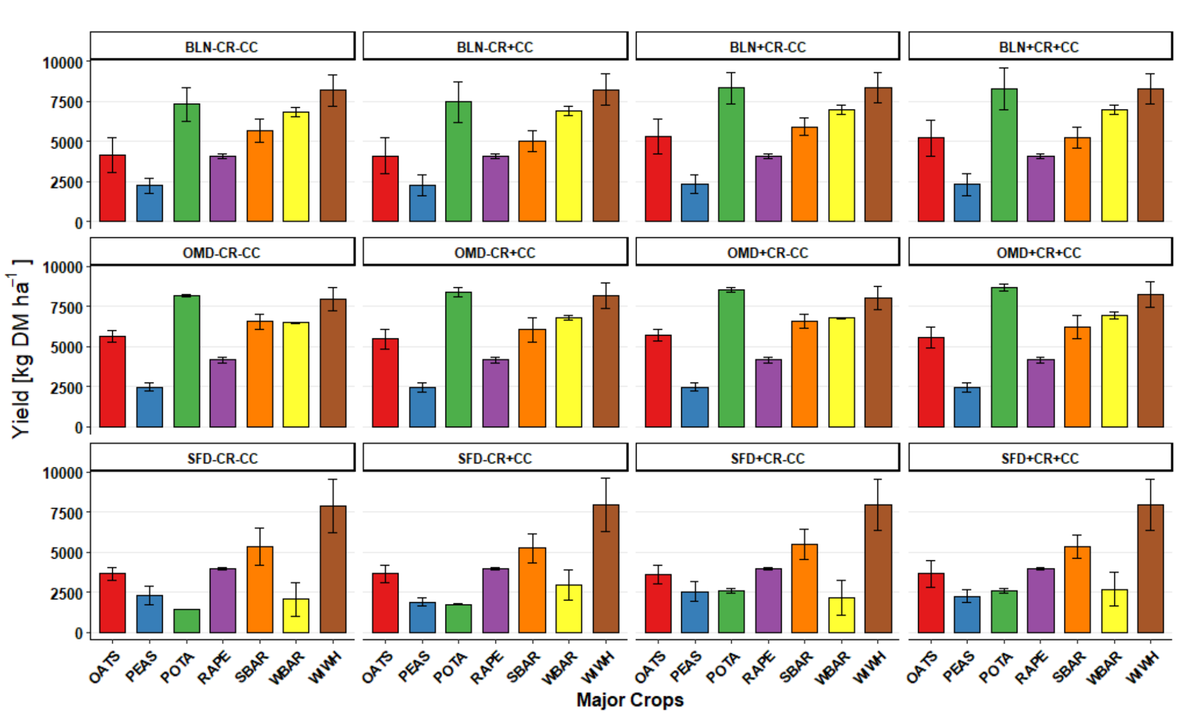

Figure 2. Yield [kg DM ha^{-1}] of each cropping system

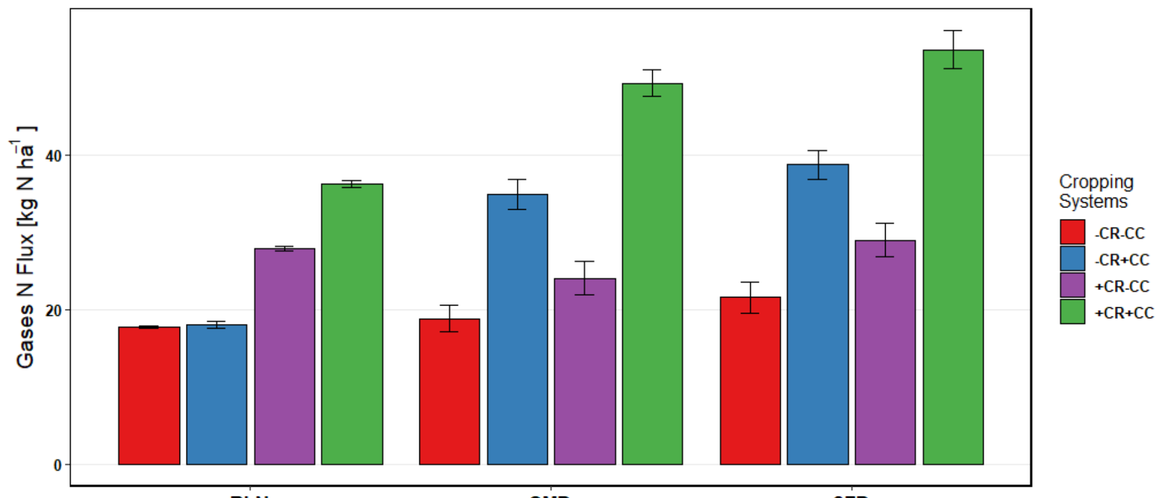

Figure 3. Gases N Flux of each cropping system

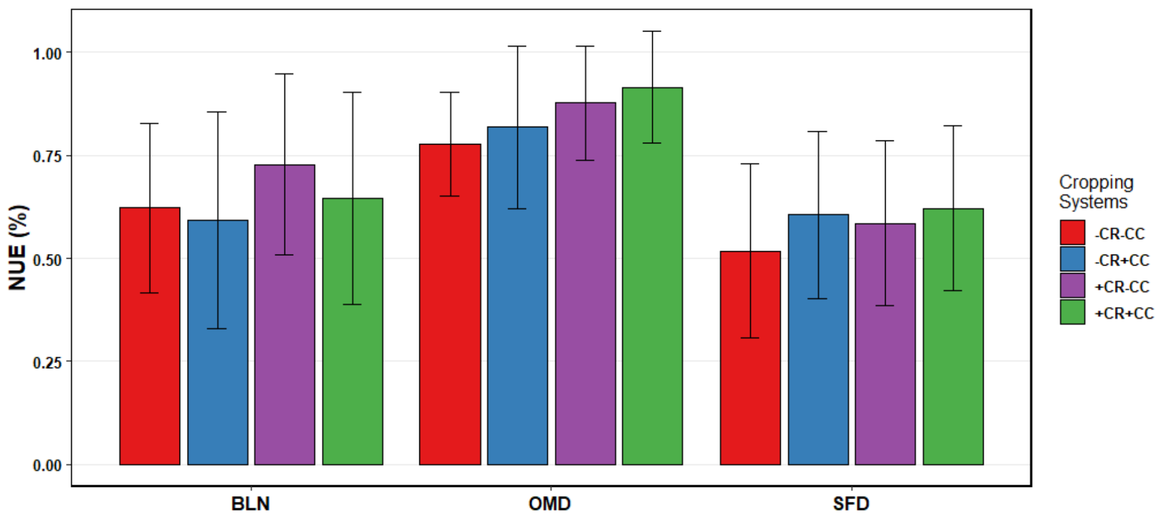

Figure 4. Nitrogen Use Efficiency (NUE) of each cropping system

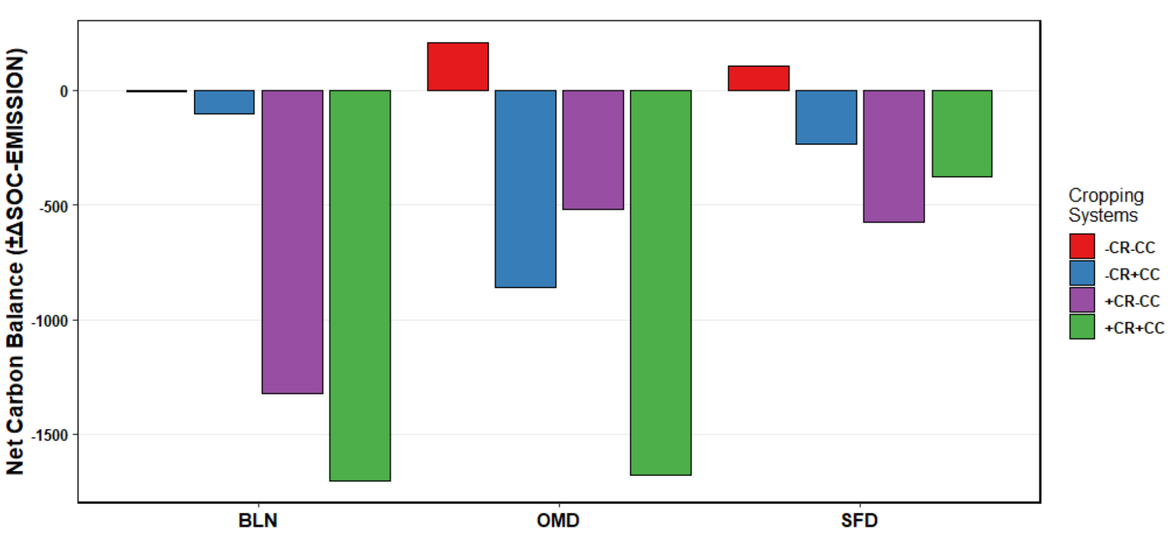

Figure 5. Net Carbon Balance (±ΔSOC-EMISSION) of each cropping system

Key Findings & Conclusion

- The more crop residue and catch crop in each cropping system, the more Net Carbon Balance with respect to sequestration (Figure 5). Additionally, there is an observed increase in Nitrogen Use Efficiency (NUE), as shown in Figure 4.
- Figures 2 and 3 reveal substantial advantages in terms of yield and reduction in nitrogen gas flux when transitioning Synthetic Fertilizer Dependent (SFD) fields to Blended (BLN) fields. This transition also involves the conversion of Organic Manure Dependent (OMD) fields to BLN, resulting in comparable yields and nitrogen gas flux.
- As shown in Figure 5, OMD systems integrated with crop residue and catch crop practices exhibit a comparable net carbon balance regarding carbon sequestration to BLN systems with similar practices.
- Strategic manure distribution will contribute significantly to the reduction of nitrogen gas flux while concurrently enhancing yield.

References & Affiliations

- Haas, E., Klatt, S., Fröhlich, A., Kraft, P., Werner, C., Kiese, R., ... & Butterbach-Bahl, K. (2013). LandscapeDNDC: a process model for simulation of biosphere–atmosphere–hydrosphere exchange processes at site and regional scale. Landscape ecology, 28(4), 615-636.
- Sommer, S. G., & Knudsen, L. (2021). Impact of Danish livestock and manure management regulations on nitrogen pollution, crop production, and economy. Frontiers in Sustainability, 2, 658231.

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