ENVIRONMENTAL LIFE CYCLE ASSESSMENT OF VARIABLE RATE NITROGEN APPLICATION USING A GROUND-BASED OPTICAL CROP SENSOR

DILAAG
DIGITALIZATION AND INNOVATION

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Introduction

Greenhouse gas emissions related to crop production are projected to reach 6.3 Gt CO_2 eq./year by 2050 (Food and Agriculture Organization of the United Nations, 2020). The use of crop sensors for variable rate nitrogen application (VRNA) can make crop production more efficient, sustainable and profitable.

In this poster our aims are:

- To show key results of an LCA of winter wheat production with and without using an optical crop sensor for VRNA.
- To show key results of using the DeNitrification-DeComposition (DNDC) model together with the LCA methodology to quantify soil emissions.

Picture 1. Winter wheat production

Picture 2. Crop sensor used for VRNA

Pictures: (Barta, N., 2020)

Methods

- A Life Cycle Assessment (LCA) analysis was perfomed in acordance to ISO 14040 standards.
- The DNDC model was used to simulate soil emissions.
- N_2O, NO, N_2, NH_3, NO_3 and P soil emissions coming from the DNDC model were integrated into the LCA.

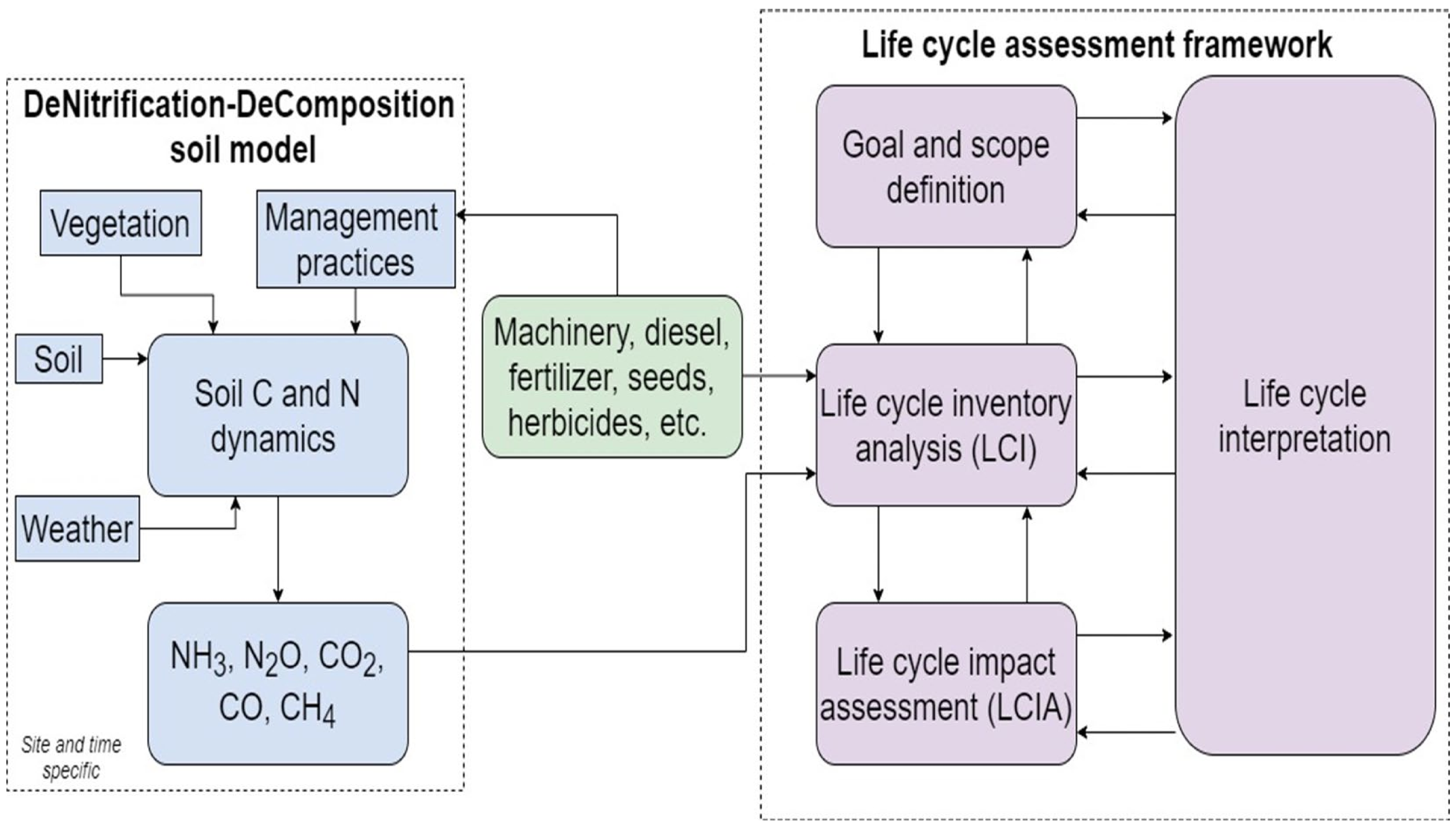

Figure 1. Framework of the DNDC model integration into the LCA phases based on ISO 14040 standards (ISO, 2006)

Results

- Three nitrogen fertilization scenarios –one conventional and two VRNA scenarios using the sensor– were modeled. The best scenario showed a GWP reduction of 8.80% when using the sensor.
- The Information and communication technology (ICT) components contributed less than 1% to the overall GWP.
- Soil fluxes simulated by the DNDC model were lower than those from the ecoinvent life cycle inventory (LCI) background database.

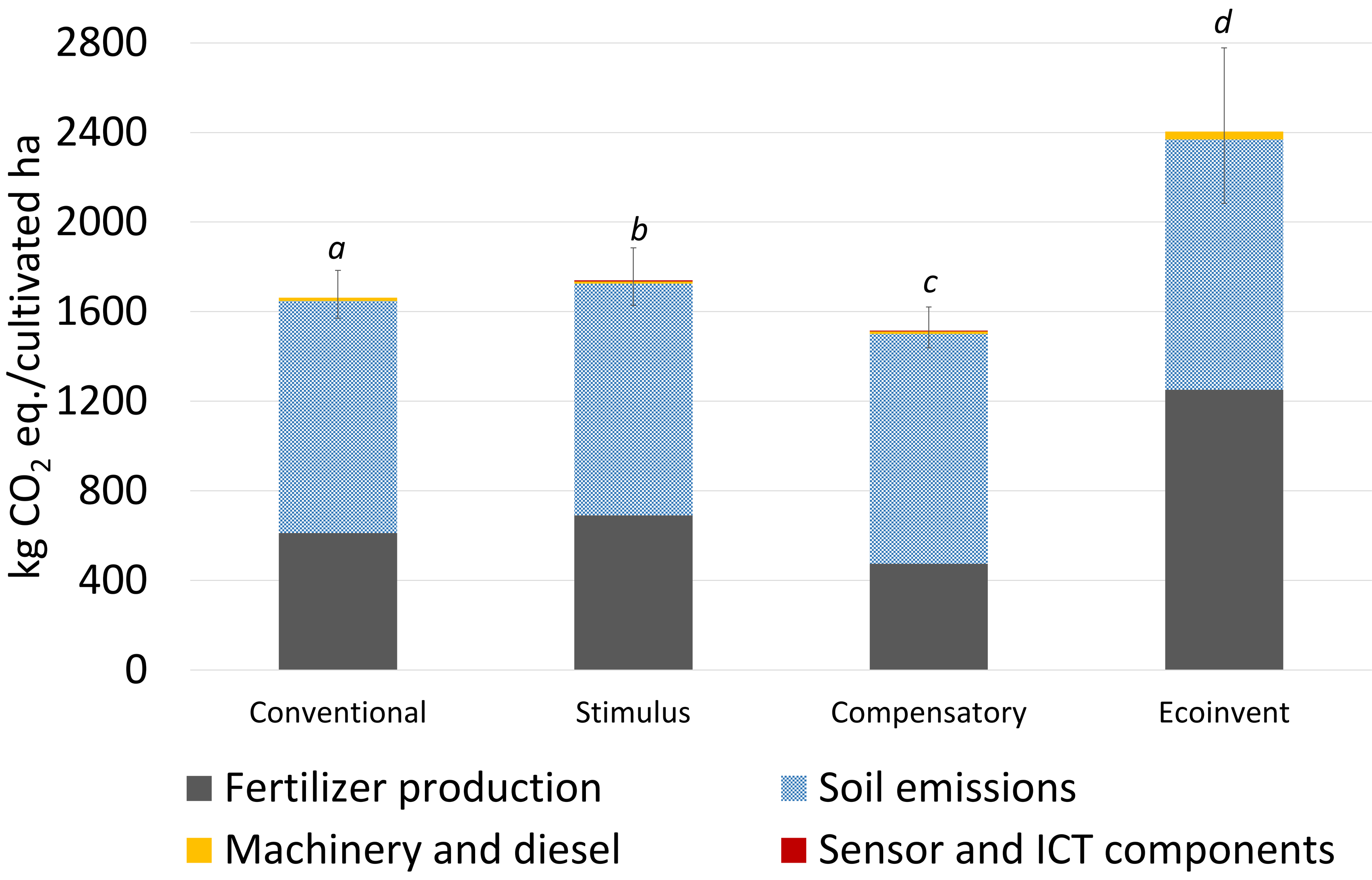

Figure 2. GWP of fertilization by different scenarios using the crop sensor along with the ecoinvent bar representing fertilization of winter wheat (Swiss integrated production, cut-off). Error bars show the 5% and 95% interpercentile range probability distribution of results based on a 1000 iterations Monte Carlo simulation. Different letters on bars indicate significant difference ($p \leq 0.05$).

Conclusion

- Using optical crop sensors for VRNA could have a limited, but a positive environmental impact.
- Information and communication technology (ICT) components have a minimal contribution to GWP.
- Environmental, ecological and agricultural management drivers have a great influence over soil emissions.

References

Barta, N., 2020. Picture of crop sensor and winter wheat production in the field experiment.

Food and Agriculture Organization of the United Nations, S.D., 2020. Food and Agriculture Data, Feb 9, 2021 ed., Rome, Italy.

ISO, 2006. ISO 14040:2006 Environmental management - Life cycle assessment - Principles and framework. International Organization for Standardization, Geneva, Switzerland.

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