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Automated data acquisition for carbon footprints of arable farms in Germany

Background

The commitment of the German government to reduce greenhouse gas emissions to net zero by 2045 (1), requires far-reaching transformation of the agricultural sector. Arable farming contributes 5 % to the total greenhouse gases emitted in Germany (2). While there is a negative trend, further and faster reductions are needed to reach the net zero target (3).

Farmers have many opportunities to reduce GHG emissions associated to their management practices (3). Readily available environmental performance data empowers the farmer to actively shape the transformations of the agricultural sector.

The methods to calculate farm- or field-level CO₂ emissions with Life Cycle Assessment (LCA) have been developed over the past 20 years (4, 5, 6). While LCA has high access barriers (i.e. cost, knowledge, data availability), the increasing digitalization of agricultural enterprises could be leveraged to lower these access barriers and provide farmers with automated LCA results (7). The goal of this research was to identify available data sources within the documentation requirements of arable farms in Germany and discuss their suitability for automated farm LCA.

Methods

To identify available data streams, mandatory and voluntary documentation requirements have been reviewed. This includes EU and German laws and regulations, farm assurance programs and field documentation software. The identified data streams were categorized into the dichotomy of life cycle inventories: Inputs and outputs. The findings are compared to the data requirements of LCA for arable farms, considering the impact category climate change.

Results

Table 1 shows selected mandatory and voluntary documentation requirements in the context of data requirements for carbon footprints of arable farms. Beside the legal requirements for conventional and organic farming, exemplarily for voluntary documentation schemes the farm assurance program "GlobalG.A.P." and the field documentation software "Ackerchef" are presented. While the legal requirements focus on the fertilizer and pesticide use of the farming operation, voluntary documentation schemes require a more detailed documentation, including the crop management with machinery use, irrigation, and post-harvest treatments.

Table 1: Selected mandatory and voluntary documentation requirements in the context of data requirements for carbon footprints of arable farms

	Legal requirements (conventional)	Legal requirements (organic)	Farm assurance program (GlobalG.A.P.)	Documentation software (HELM - Ackerchef)
Inputs				
Soil preparation			Checklist: Combinable crops (11)	Ackerchef Web-App (12)
Seeds / Propagation material: Type and quantity			Checklist: Combinable crops (11)	Ackerchef Web-App (12)
Seeds / Propagation material: Pretreatment			Checklist: Combinable crops (11)	Ackerchef Web-App (12)
Fertilizer: Type and quantity	DüV §10 (8)	EC Reg. 889/2008 Article 72 (10)	Checklist: Combinable crops (11)	Ackerchef Web-App (12)
Fertilizer: Application method			Checklist: Combinable crops (11)	
Chemical plant protection: Type and quantity	PflSchG §11 (9)	EC Reg. 889/2008 Article 72 (10)	Checklist: Combinable crops (11)	Ackerchef Web-App (12)
Chemical plant protection: Application method			Checklist: Combinable crops (11)	
Mechanical plant protection: Type and quantity			Checklist: Combinable crops (11)	Ackerchef Web-App (12)
Irrigation: Water use			Checklist: Combinable crops (11)	
Harvest: Machinery				Ackerchef Web-App (12)
Post-harvest treatment: Type and quantity			Checklist: Combinable crops (11)	
Diesel use (total)			Checklist: Combinable crops (11)	
Outputs				
Yield: Main crop		EC Reg. 889/2008 Article 72 (10)	Checklist: Combinable crops (11)	Ackerchef Web-App (12)
Yield: Co-products		EC Reg. 889/2008 Article 72 (10)	Checklist: Combinable crops (11)	

Discussion and Conclusion

With initiatives like PEF (13) and a recent petition for CO₂e-labelling (14), it is anticipated that LCA results will play a larger role in the agricultural sector. The review results show, that farmers who voluntarily document their activities have a good starting point for creating a LCA-based carbon footprint of their operation. However, the mandatory legal requirements are not sufficient to calculate a detailed carbon footprint.

Automating the calculation procedure would facilitate the use of LCA in the agricultural sector. Here, a farm documentation software is most suitable, since the data is already entered and stored within a database. A simple add-on to available field documentation applications, and some additional information or assumptions on diesel use could provide farmers with field-specific LCA results.

While the reviewed assurance program showed the highest reporting requirements that could result in a very detailed LCA, the data is not necessarily stored digitally and/or at the same place.

Automated carbon footprints of arable farms can be a powerful tool to educate producers and consumers regarding their contribution to climate change. In addition, the results can be used for internal benchmarking and reporting. Thinking ahead, if farmers contribute actively to climate change mitigation and take the risk of yield loss, a subsidy program based on CO₂e reductions at farm level should be investigated. Also, further research should extend the scope considering impact categories and include other farm units, i.e. livestock and bioenergy production to work towards automated organisational LCAs of farms.

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