Assessing environmental impacts of “Bioeconomy-oriented” cropping systems using Life Cycle Assessment (LCA) approach

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« Bioeconomy-oriented » cropping systems in Northern France

Cropping system

- **Bioeconomy**
  - each economical activity based on bio-resources (food AND non-food)

= « Bioeconomy-oriented » cropping systems
  - cropping systems that produce resources for the bioeconomy sectors

→ Great potential for bioeconomy development in Northern France
« Bioeconomy-oriented » cropping systems in Northern France

Introduction

Methods

Results

Conclusions
How to grow these crops in current cropping systems in Northern France to reach the best performances?
« Demonstrating sites network » project

2015-2020

Study and show the feasibility + performances + sustainability of “bioeconomy-oriented” cropping systems

Experimental site network

Environmental impacts of “bioeconomy-oriented” cropping systems compared to the current grown ones in the region

Agronomical keys to enhance the implementing of “bioeconomy oriented” cropping systems
Question and LCA methodology

What is the climate change impact of the “bioeconomy-oriented” cropping systems compared to the current grown ones in Northern France?

- Studied indicators:
  - Climate change impact using the ILCD method, Europe, JRC, 2012

- Functional units:
  - *Production function*: 1 ton of produced dry matter
  - *Land management function*: 1 hectare of field used to grow the cropping system

- Life cycle inventory:
  - Input and machinery production + fuel combustion: Ecoinvent v3.3 + Agribalyse databases
  - Direct and indirect N₂O in-field emissions: IPCC tier 1, 2006; using data collecting on field experiments
Studied system for the LCA

- Indirect GHG Emissions
- Combustion GHG Emissions
- Direct and indirect in-field emissions

System boundary:
- Machinery production
- Input production

Year 1 = Crop 1
Year 2 = Crop 2
Year 3 = Crop 3

Transport

Storage area
Comparing systems

Current cropping system
= Reference
100% food

« Bioeconomy-oriented »
cropping system
2/3 food + 1/3 non-food

Year 2

VS.

Year 2

Double cropping
Barley vs. Double cropping:

597 > 233 kg eq CO2 / tDM

Importance of direct and indirect in-field emissions of N₂O!

3.8 tDM/ha (grain) + 10.3 + 5.5 = 15.8 tDM/ha
Barley vs. Double cropping:

2267 < 3665 kg eq CO2 / ha

More sowing operations + More harvests

More N in residues (root + stubble + straw)
Cropping systems comparison

For 1 tDM of each system

1 tDM

GHG emissions (kg eq CO2/tDM)

Reference

Bioeconomy

Rapeseed
Wheat
Double cropping
Barley

Cropping systems comparison
Cropping systems comparison

For 1 ha of each system, over 3 years

<table>
<thead>
<tr>
<th>GHG emissions (kg eq CO2/ha)</th>
<th>Reference</th>
<th>Bioeconomy</th>
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<tbody>
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<td>Rapeseed</td>
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For 1 ha of each system, over 3 years
Cropping systems comparison

For 1 ha of each system, over 3 years

C storage\(^1\) in soil converted into avoided CO\(_2\) emissions

More crop residues returned to soil

Reference

Bioeconomy

Rapeseed
Wheat
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Barley

\(^1\) Calculated with AMG model (Saffih-Hdadi & Mary, 2008)
Cropping systems comparison

For 1 ha of each system, over 3 years

![Graph showing GHG emissions for different cropping systems](image)

- Reference
- Bioeconomy

**GHG emissions (kg eq CO2/ha)**

- **Rapeseed**
- **Wheat**
- **Double cropping**
- **Barley**
Conclusions and perspectives

- Different results obtained depending on the functional unit considered
- Nitrogen fertilization and N₂O emissions contribute a lot to GHG emissions
- These results can contribute to optimize environmental performances of the bioeconomy oriented systems
Thank you for your attention…

… and the whole project team!