Umweltwirkungen der Energieerzeugung aus Pappel-KUP unter Einbeziehung von pflanzen- und bodenbiologischen sowie technischen Prozessen

dargestellt am Beispiel eines landwirtschaftlichen Marginalstandorts in Südwestdeutschland

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Short rotation coppice (SRC)

Are SRC a good strategy to save CO_2-emissions?

How are the environmental impacts …

- of technological processes?

- of soil- and plant biological processes?

We conducted an integrated analysis of the *Global Warming Potential* (*GWP)* related to energy produced from wood chips from a hybrid poplar SRC.

Method and Materials

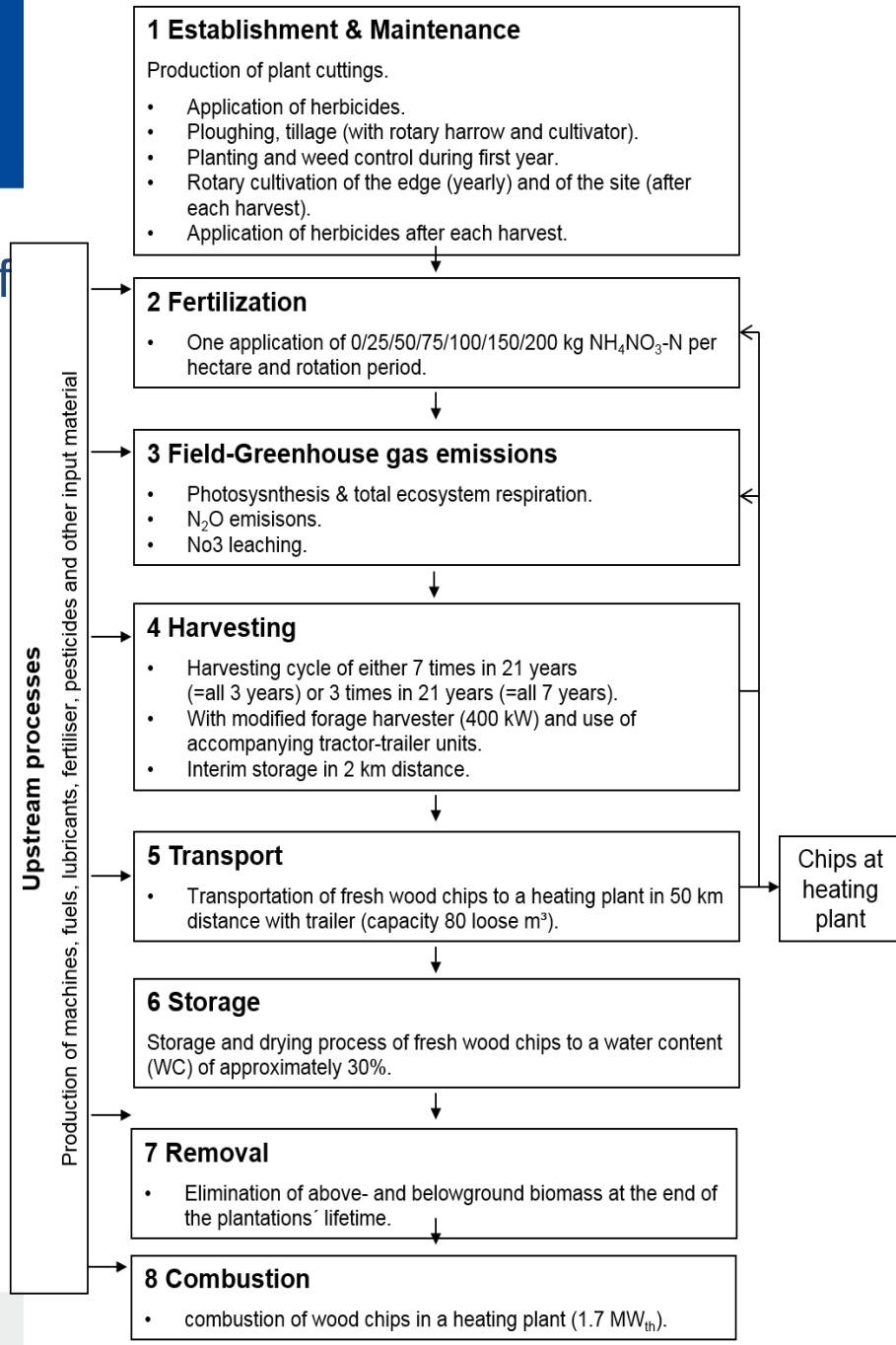
Scope definition

- All processes over a full rotation cycle of 21 years were included, also removal.
- 2 alternative harvesting rotation cycles were analyzed:

  3-year cycle = 7 harvests in 21y;

  7-year cycle = 3 harvests in 21y.
- 7 different nitrogen fertilization rates (0/25/50/75/100/150/200 kg NH_4NO_3-N per hectare & rotation) were analyzed.

→ In total 14 production chains.



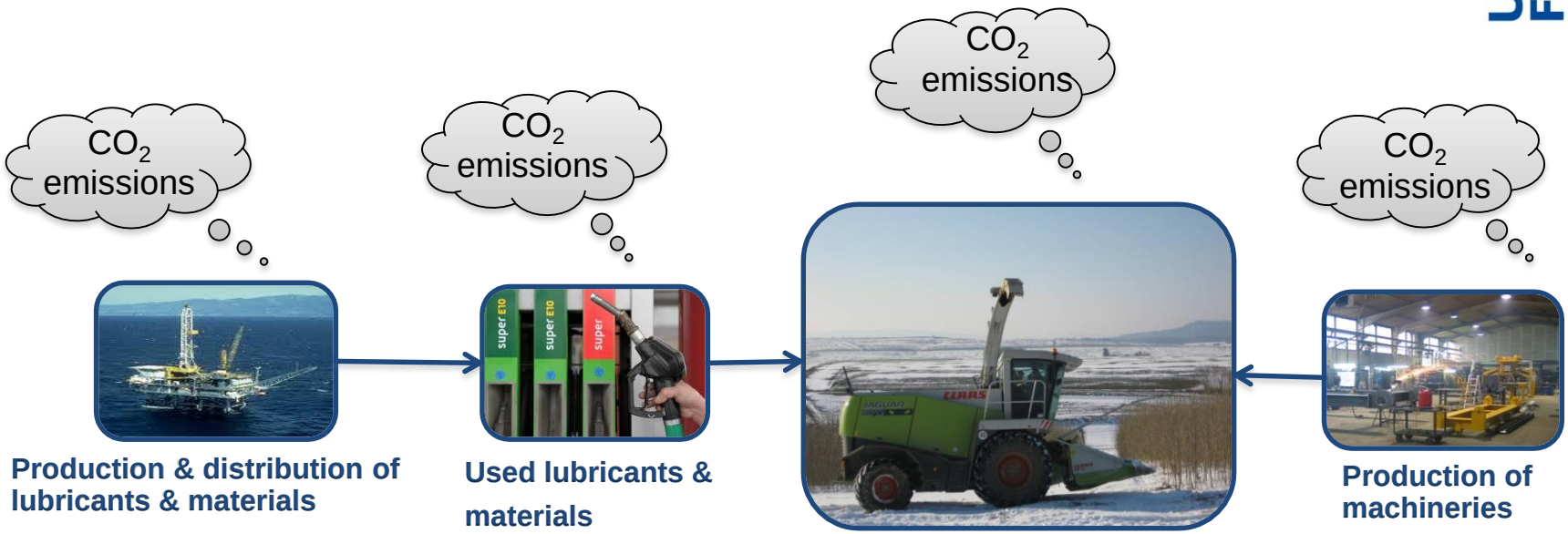
Method: Life Cycle Analysis

„***Potential environmental impacts*** and ***environmental aspects*** which are ***related to a product*** are estimated using the method of Life Cycle Analysis“.

source: DIN EN ISO 14040

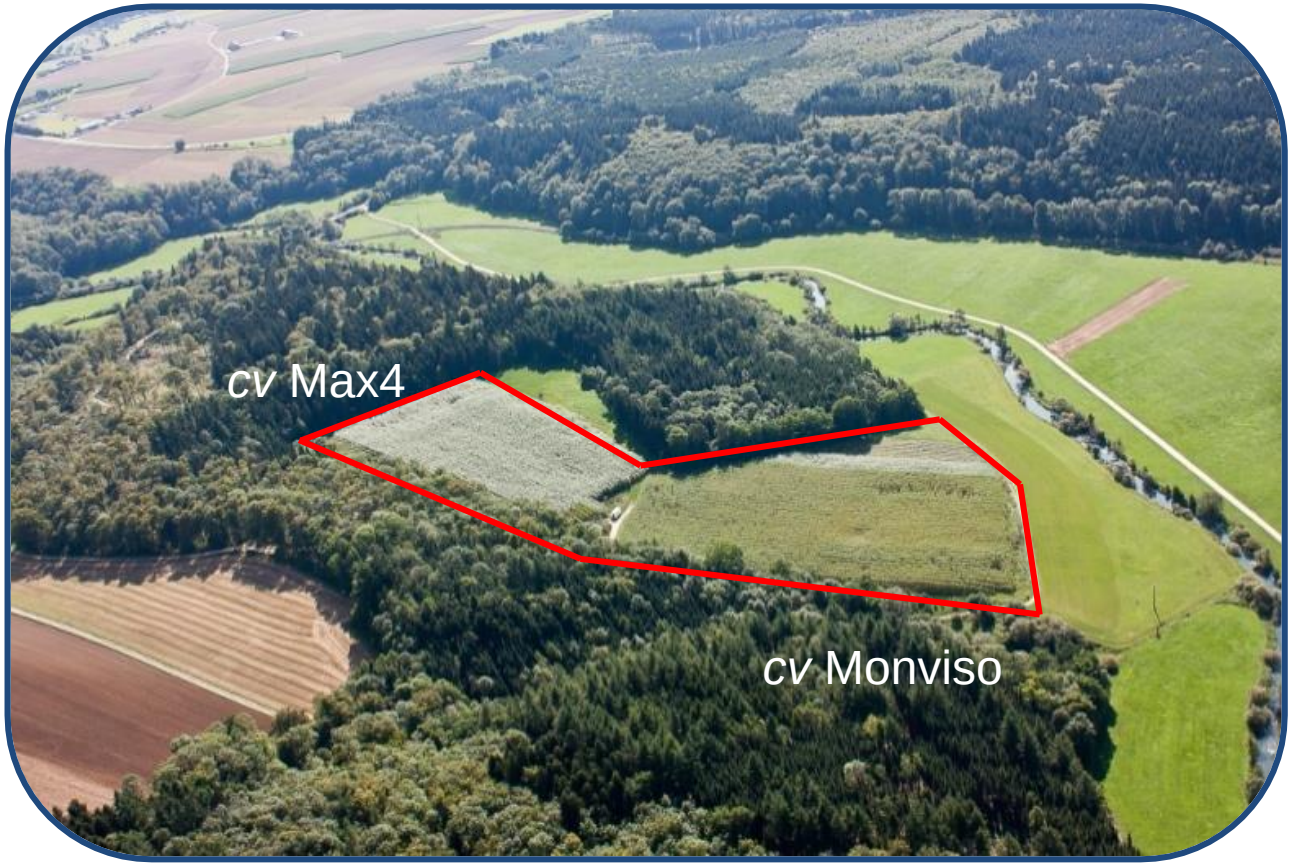
In a Life Cycle Analysis (LCA), **all material- and energy flows** along the **overall** supply chain are taken into account.

Implementation of a Life Cycle Analysis



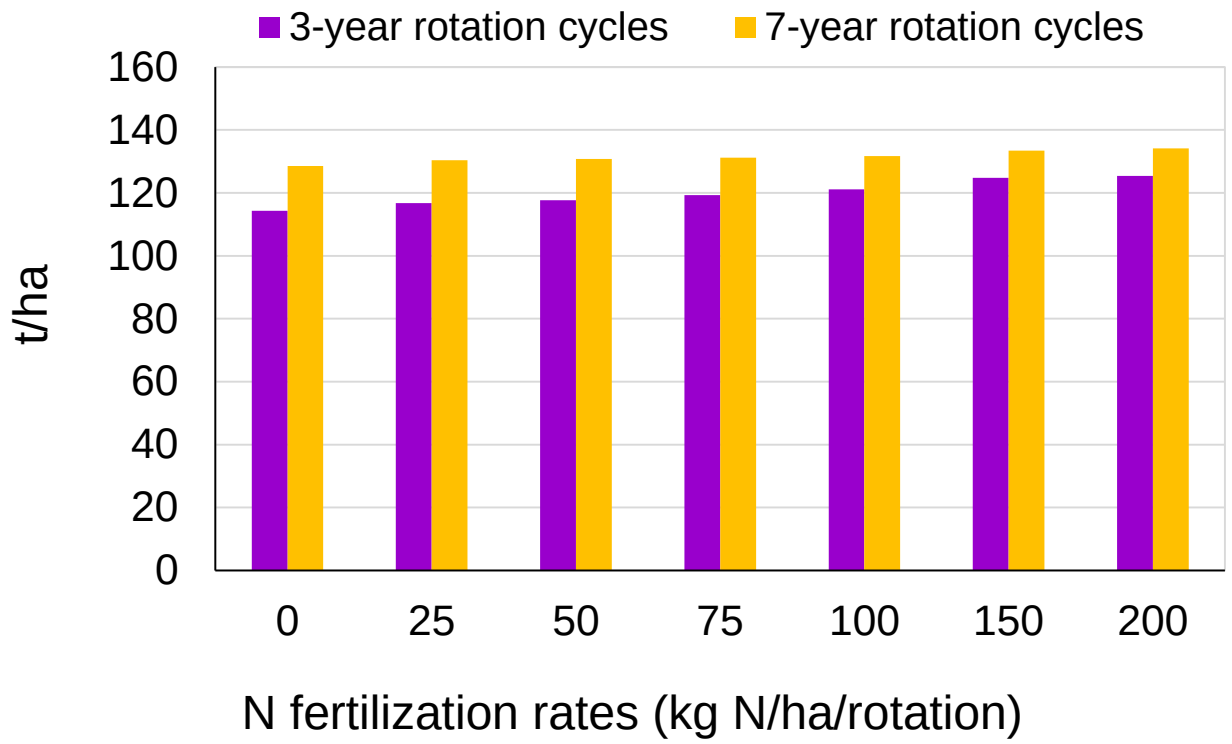
System boundary

- ✓ southwest Germany
- ✓ uplands
- ✓ marginal sites



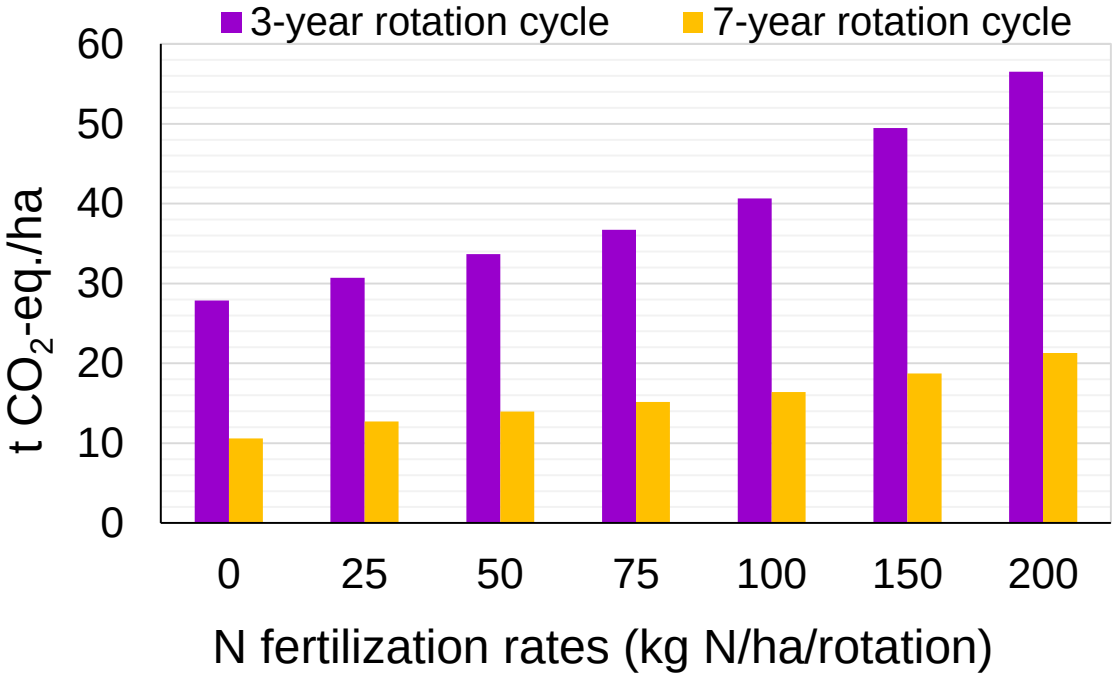
Results

Biomass production



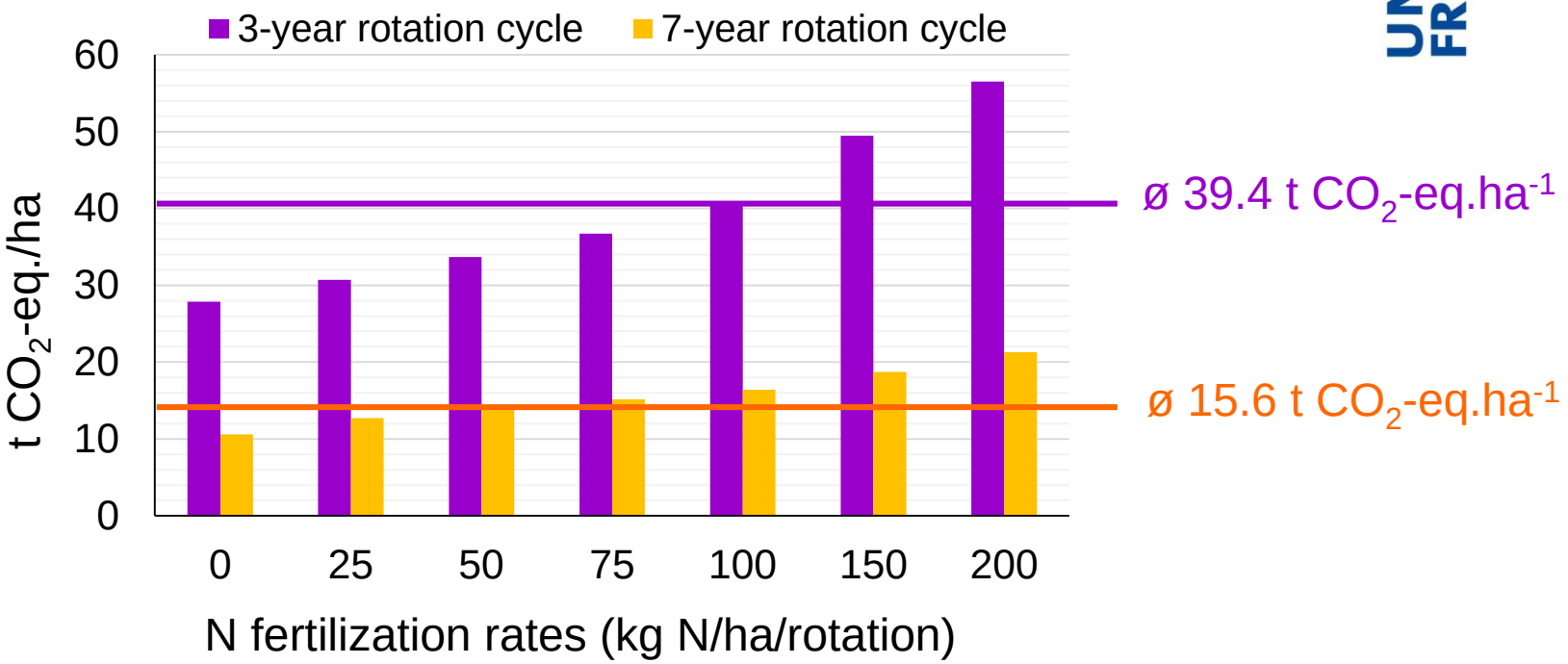
- Yield of aboveground biomass ranged from 5.4 to 6.4 t y^{-1} ha^{-1}.
- Plant productivity with 7-year rotations was 10% higher than with 3-years.
- Highest biomass productivities were reached with highest fertilization rates.

GWP: Influence of fertilization



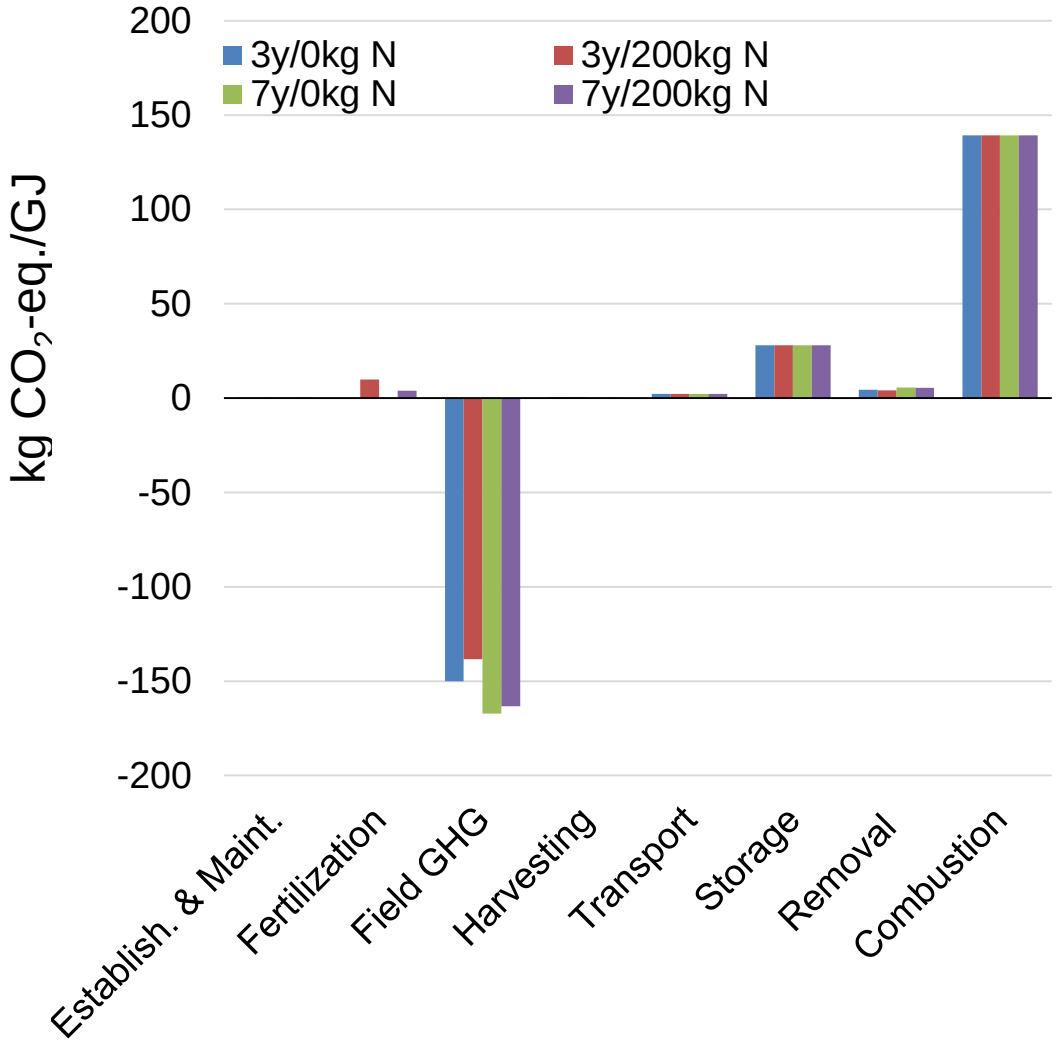
- Resulting GWP was positively correlated with the fertilization rates within each rotation cycle length.
- The use of the 7-year rotation cycles decrease yield scaled emissions by a factor of 2.2 compared to 3-year rotation cycles.

GWP: Influence of rotation cycle length



Dependency of the GWP on rotation cycle length was found highly significant: cases with 7-year rotation cycles resulted in a lower GWP than 3-year cycles.

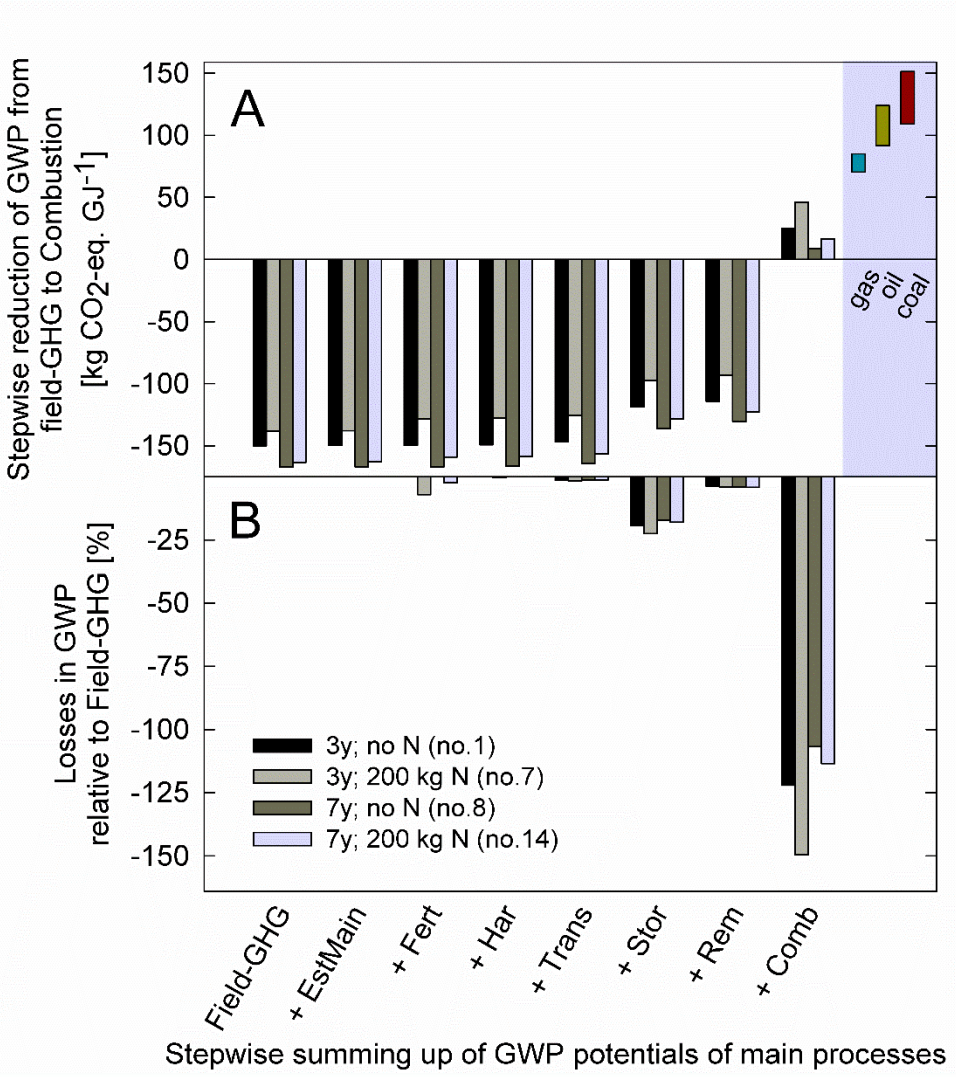
Environmental impacts per process step (I)



- In all cases heat production from poplar SRC resulted in a moderate C release varying between **8-46 kg CO_2-eq.GJ^{-1}**.
- Combustion is the major contributor for increasing the *GWP* by causing 75-79% of total emissions.

Environmental impacts per process step (II)

- All process steps up- and downstream of *Field-GHG* released CO_2 to the atmosphere.
- Each process declines the CO_2-saving potential.
- The use of poplar wood chips for bioenergy production is more favorable compared to fossil fuels.



Conclusion

- In all cases, heat production from SRC was more favourable compared to heat from fossils.
- Field-GHG, combustion and storage were main carbon sink and sources.
- Results showed that the main factor controlling the biomass production and the environmental impact was the rotation cycle length.
- Biomass was highest in 7-year rotation cycles, conversely to the impacts on GWP, which decrease by increasing the rotation cycle length.
- Fertilization treatments affect the SRC biomass production while negatively impacts the environment.

Thanks for your attention

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This study is currently under review in GCB Bioenergy

Related papers:

• Molina-Herrera et al. (2016) A modeling study on mitigation of N_2O emissions and NO_3 leaching at different agricultural sites across Europe using LandscapeDNDC. *Science of the Total Environment,* in press.

• Díaz-Pinés et al. (2016) Nitrate leaching and soil nitrous oxide emissions diminish with time in a hybrid poplar short-rotation coppice in southern Germany. *GCB Bioenergy*, published online.

• Schweier et al. (2016) Life cycle analysis of the technological production of wood chips from poplar short rotation coppice plantations on marginal land in Germany. *Biomass and Bioenergy* 85, 235-242.

• Aust et al. (2014) Land availability and potential biomass production with poplar and willow short rotation coppices in Germany. *GCB Bioenergy*, 6, 521-533.

• Grote et al. (2011) Modelling forest carbon balances considering tree mortality and removal. *Agricultural and Forest Meteorology* 151, 179-190.