Greenhouse gas emissions from cultivation of energy crops may affect the sustainability of biofuels

Risø International Energy Conference
11 May 2011

Mette S. Carter
Henrik Haugaard-Nielsen
Stefan Heiske
Sune T. Thomsen
Morten Jensen
Jens Ejbye Schmidt
Anders Johansen
Per Ambus

Risø DTU
National Laboratory for Sustainable Energy

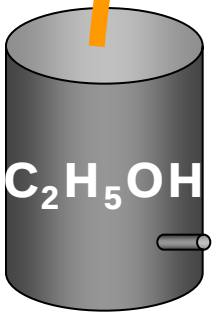
Combinations of biomasses and biofuels

Biomass		Biofuel technology
	Rye straw	Bioethanol
	Vetch straw	Biogas
	Rye-vetch intercrop	Combined bioethanol and biogas
	Grass-clover	
	Maize	

Carbon cycling in biofuel production

CO_2

N_2O

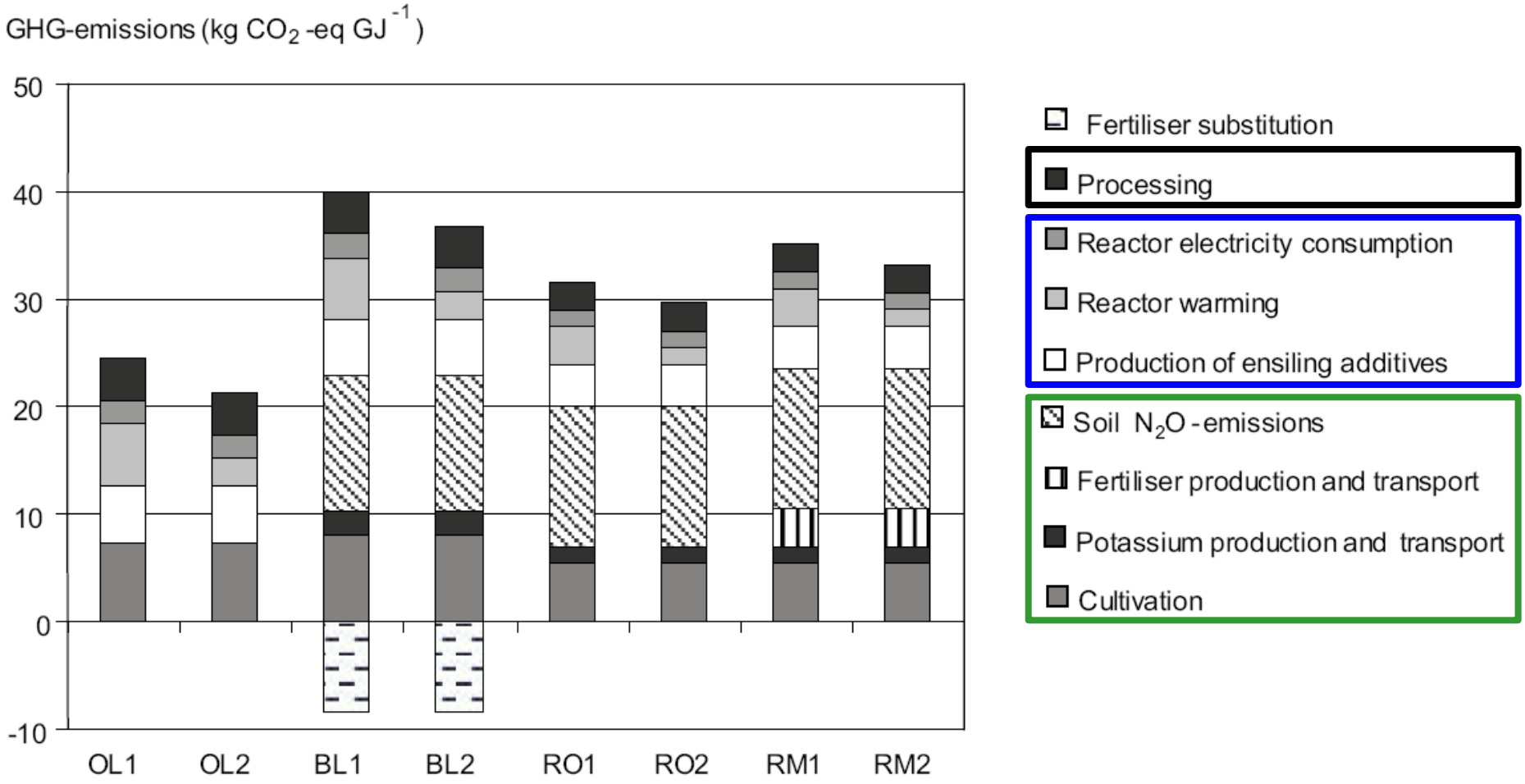


Bioethanol production

Maize field

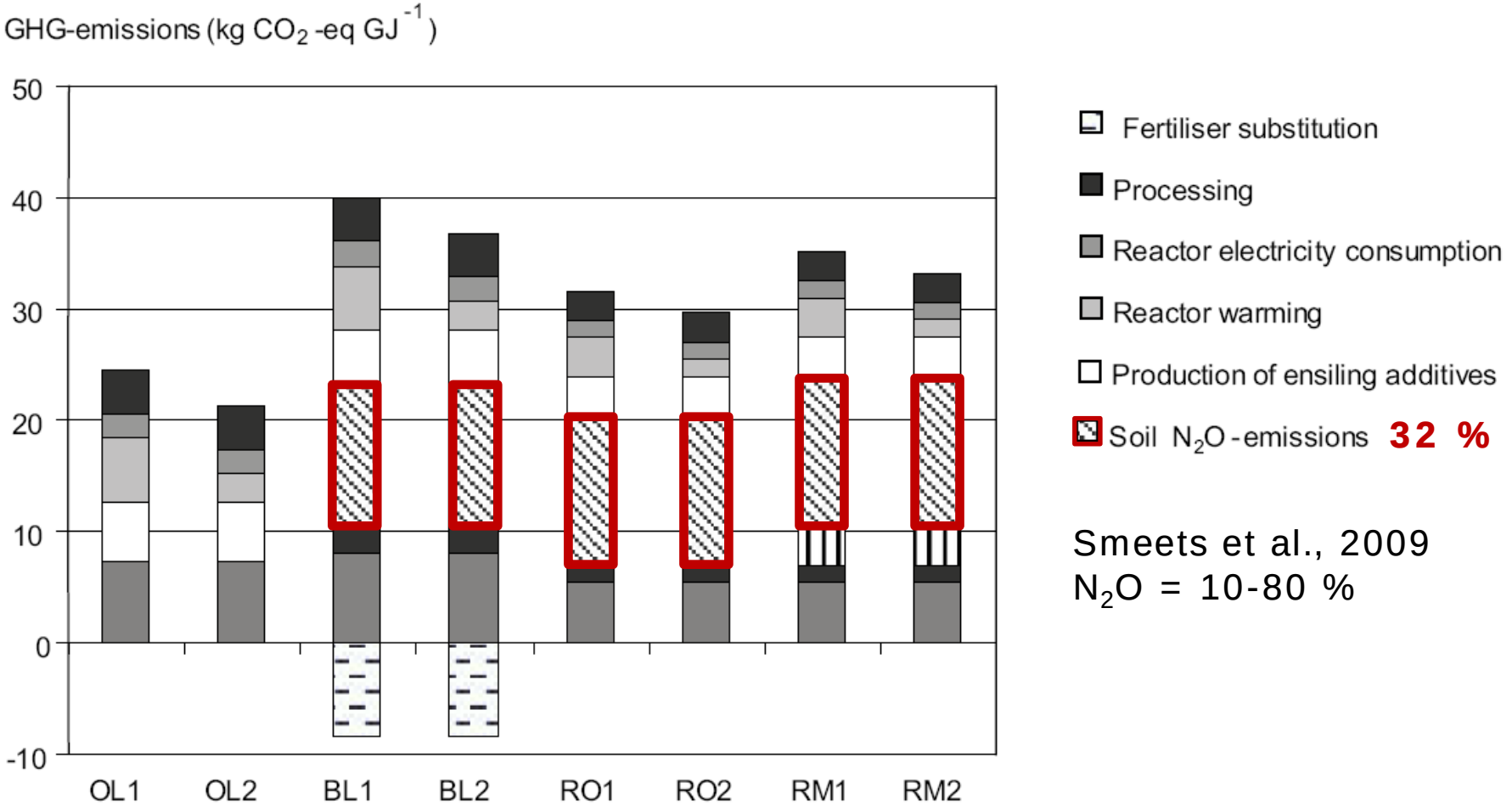
Organic carbon in maize biomass

Contribution of soil N_2O emissions to total GHG emissions during biofuel production



Tuomisto and Helenius, 2008

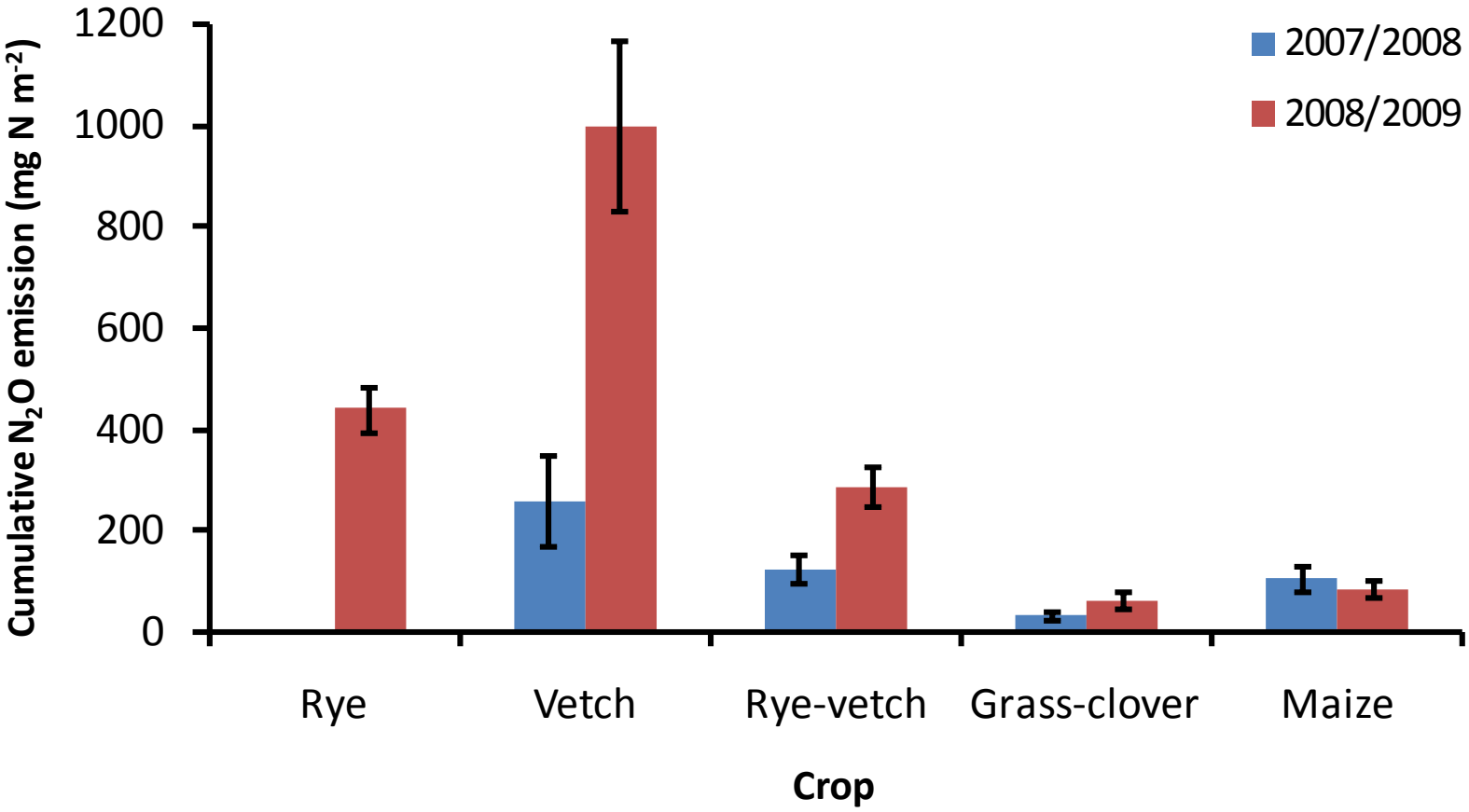
Contribution of soil N_2O emissions to total GHG emissions during biofuel production



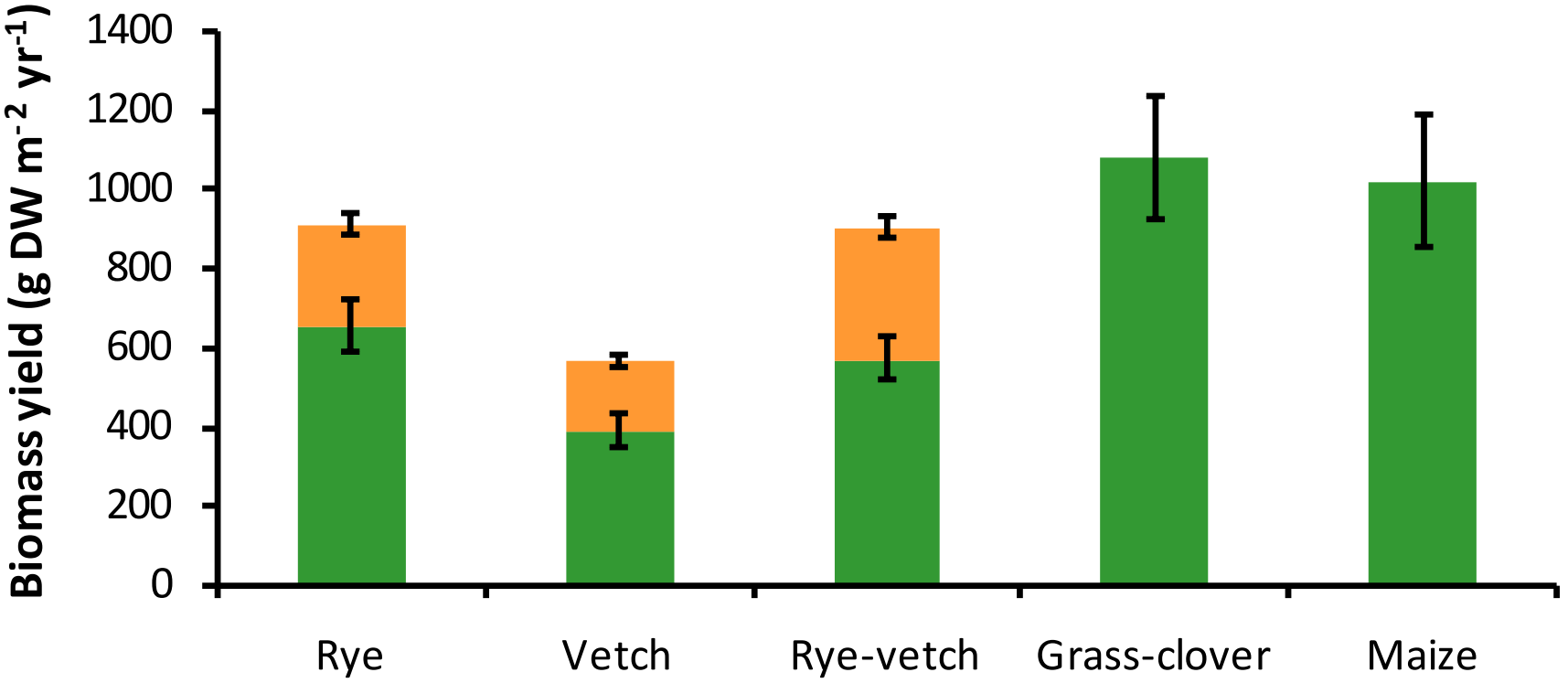
Smeets et al., 2009
N_2O = 10-80 %

Tuomisto and Helenius, 2008

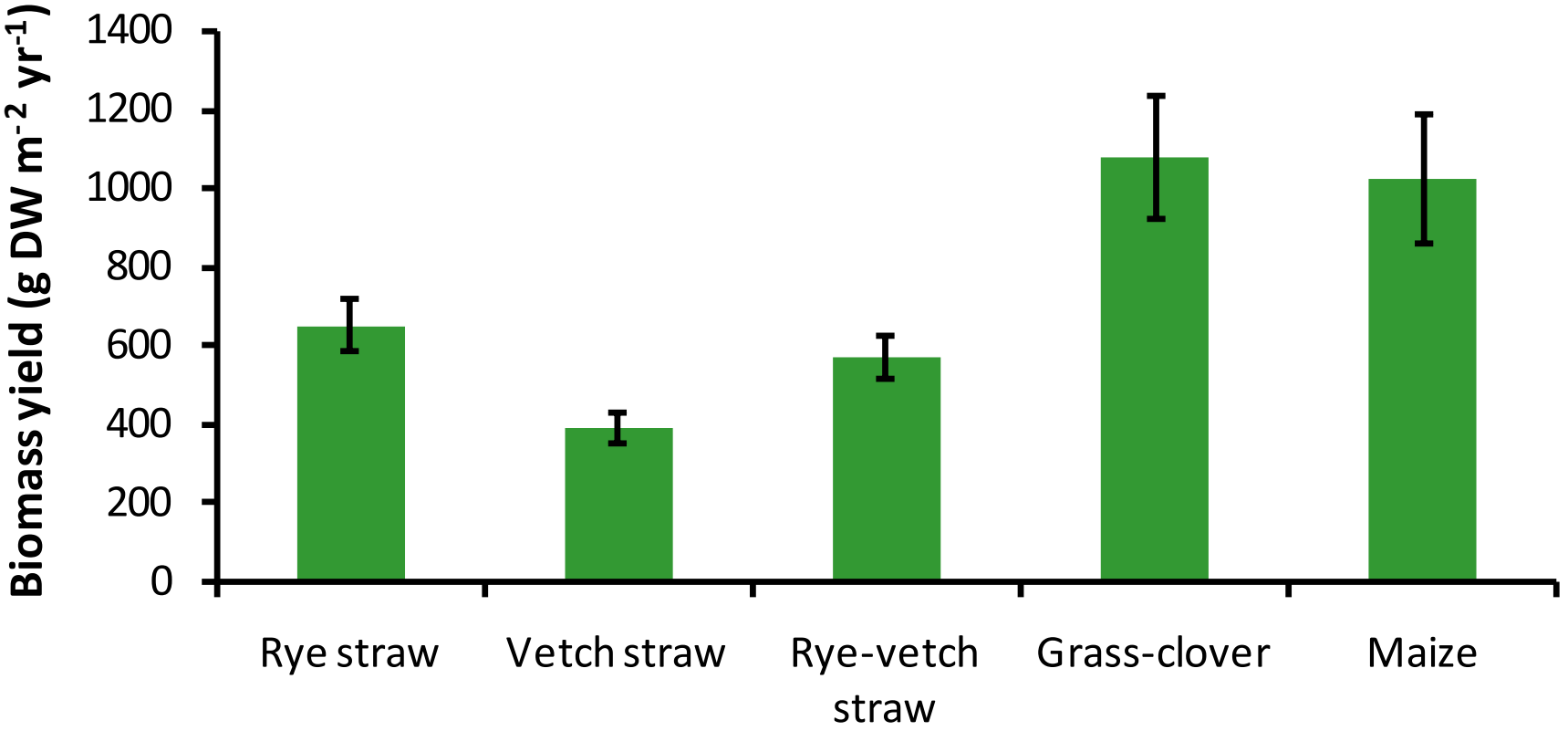
Cumulative N_2O emission, unfertilized crops



Harvested biomass of unfertilized crops (2 yr)



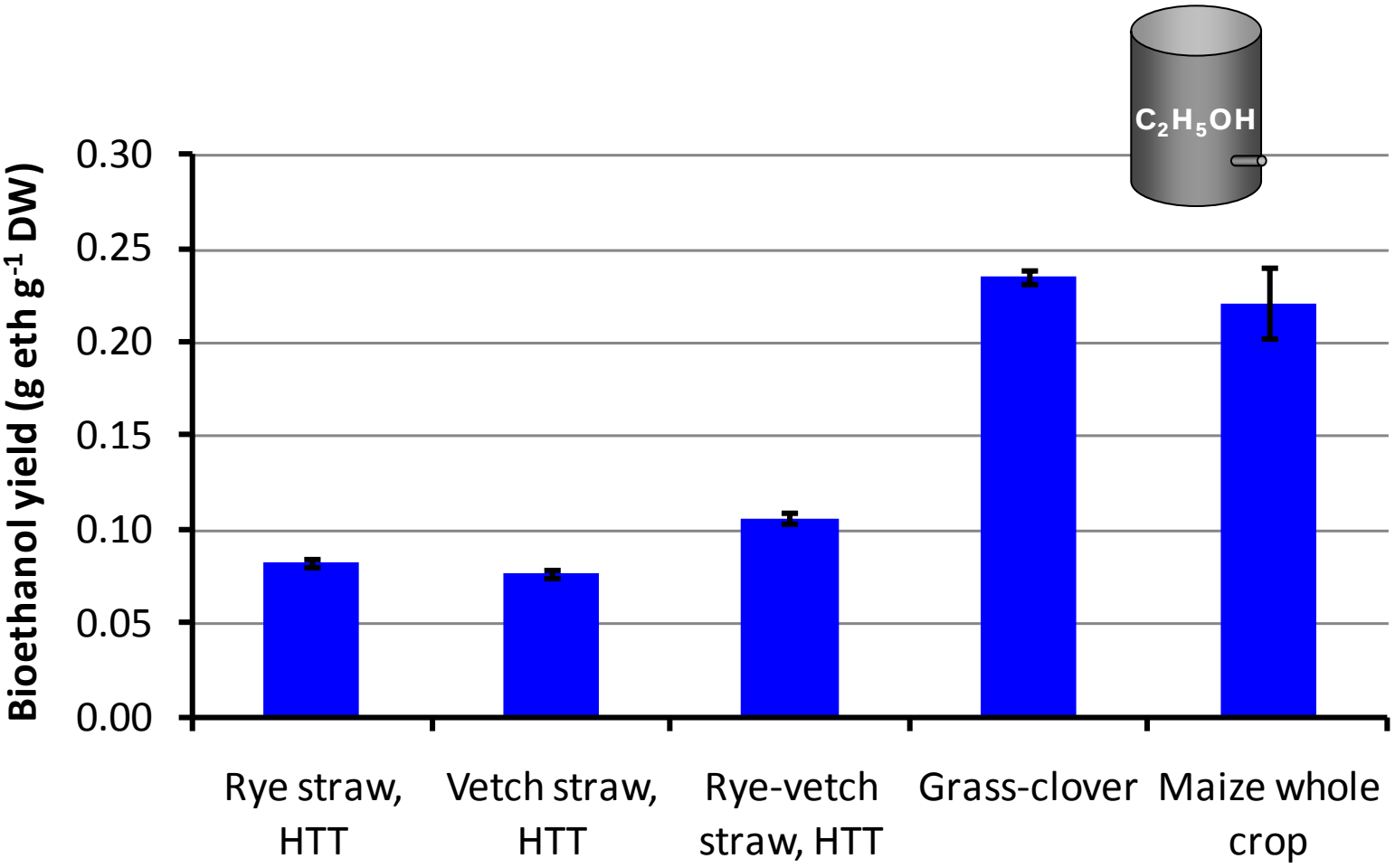
Harvested biomass of unfertilized crops (2 yr)





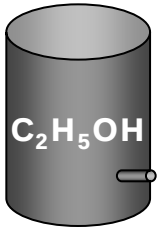


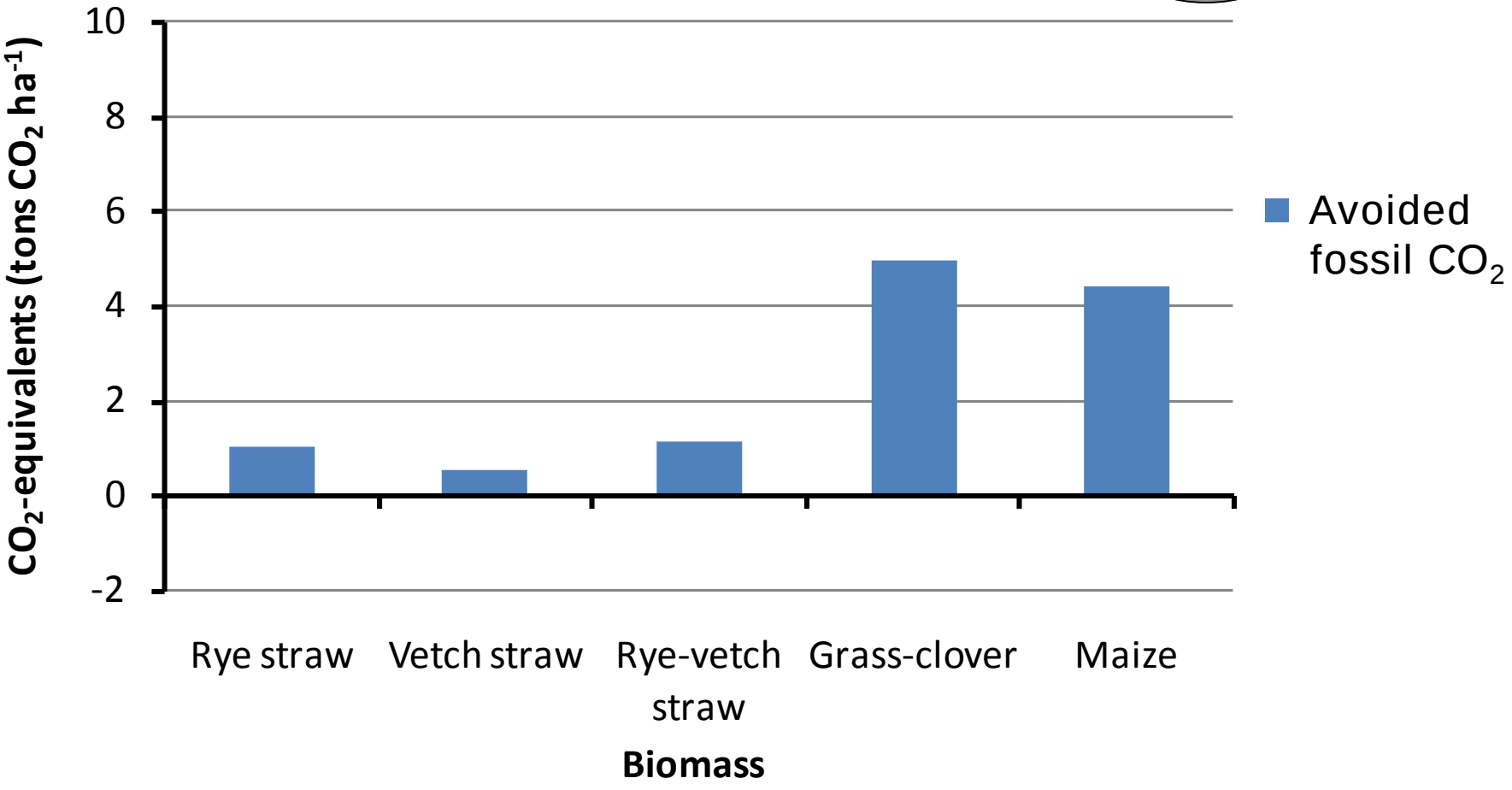
Bioethanol yields



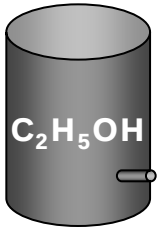
HTT = HydroThermal preTreatment

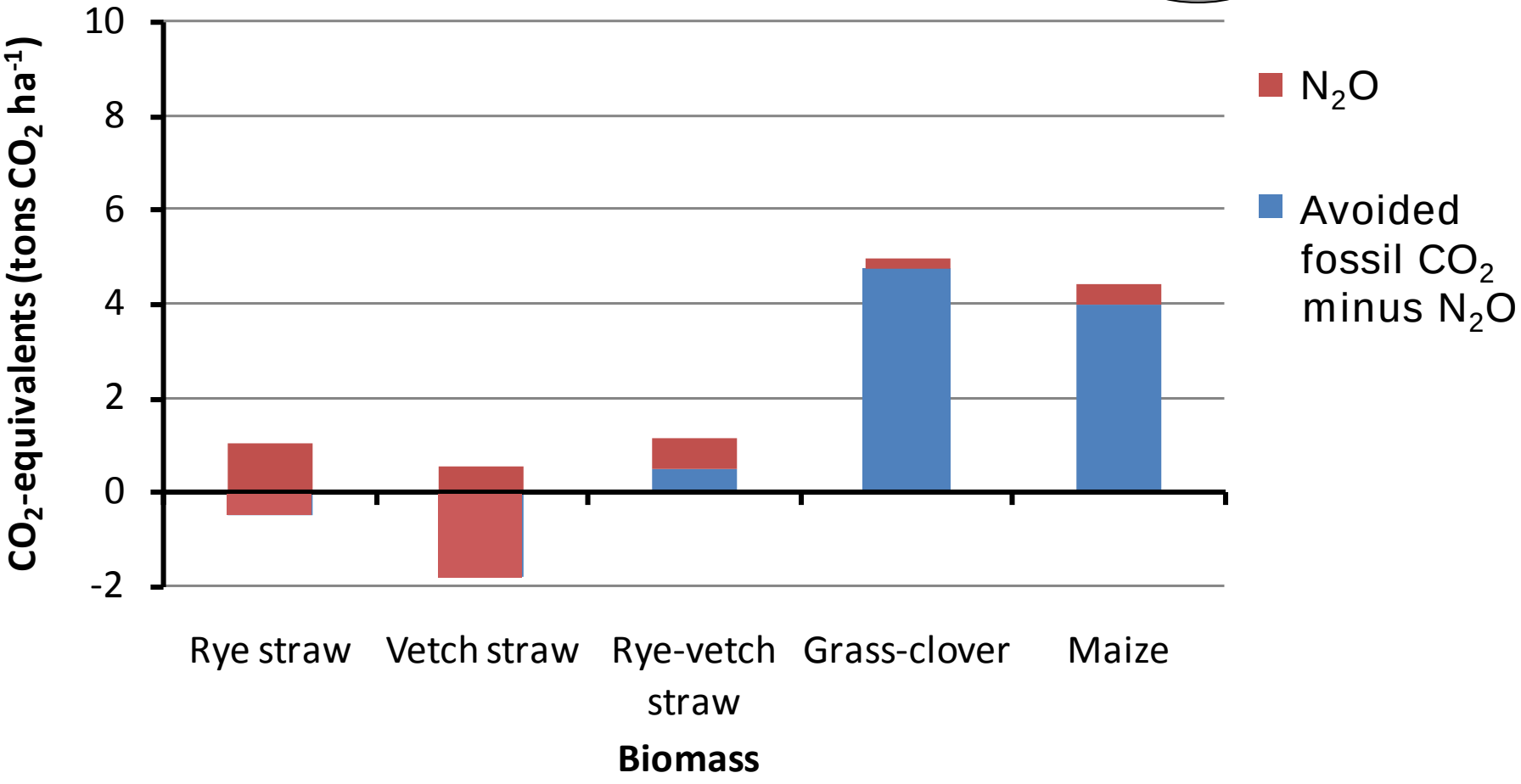
N_2O emissions related to avoided fossil CO_2
Bioethanol



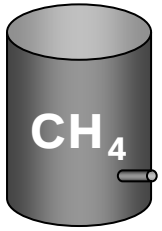


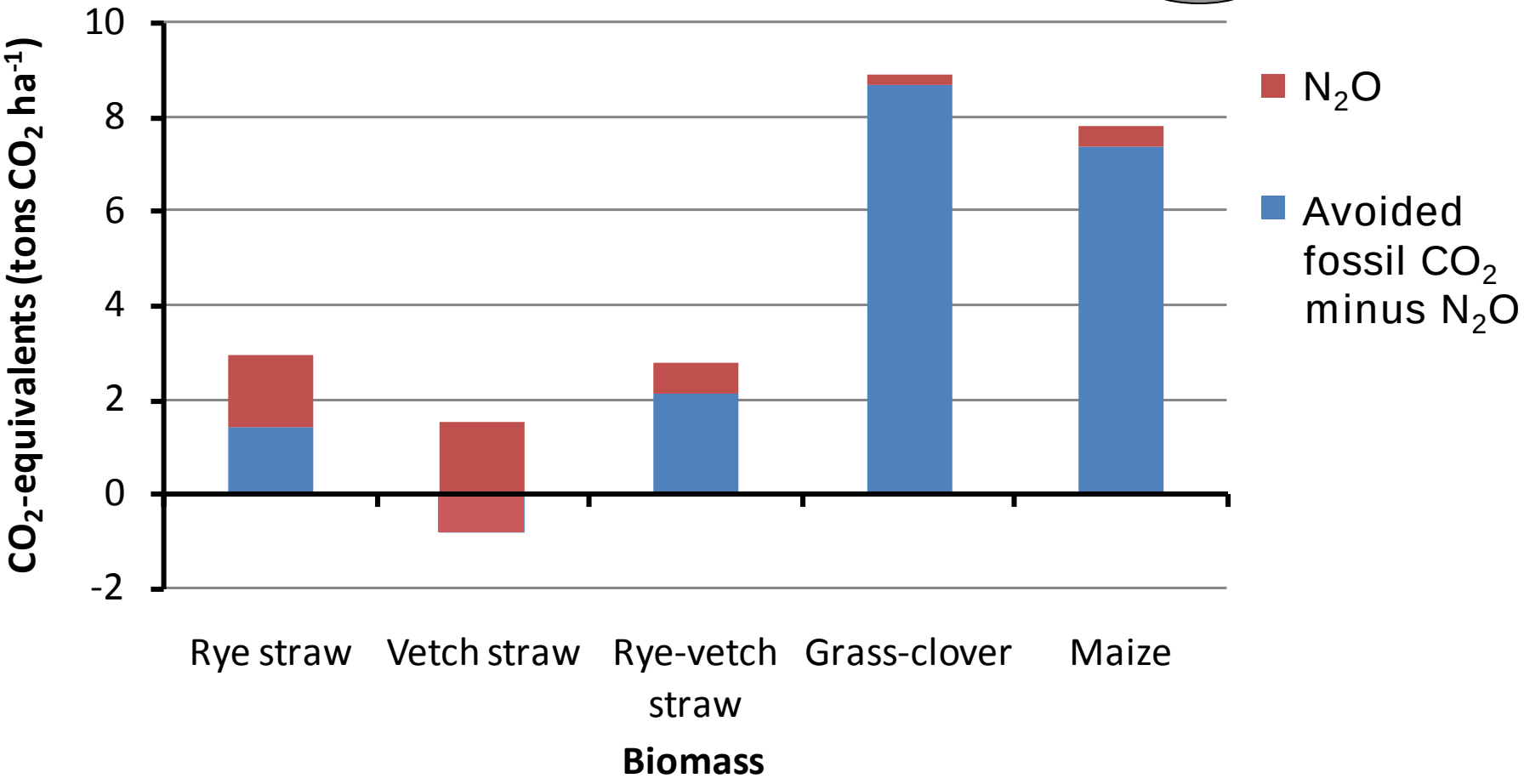
N_2O emissions related to avoided fossil CO_2
Bioethanol



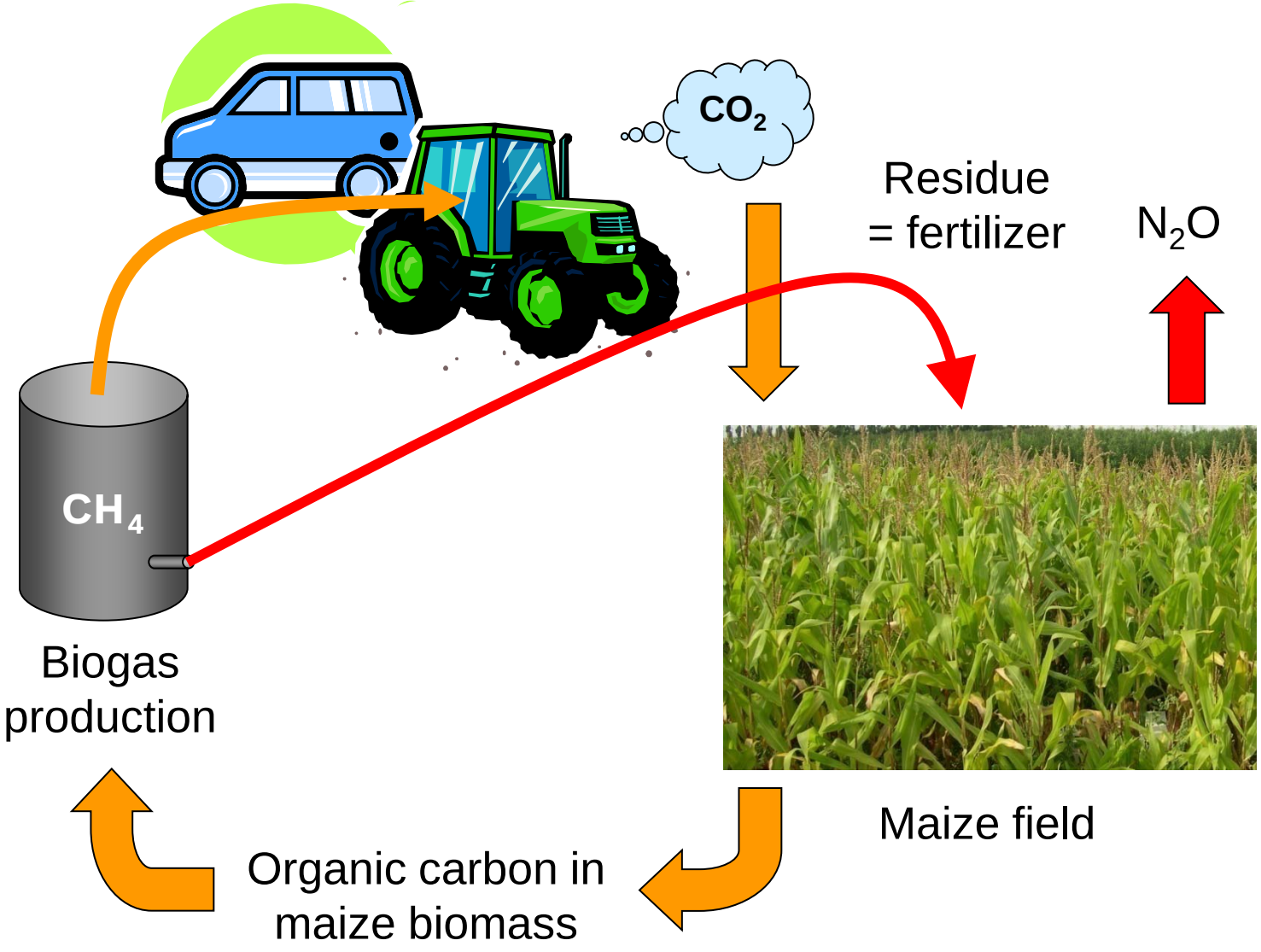


N_2O emissions related to avoided fossil CO_2
Biogas



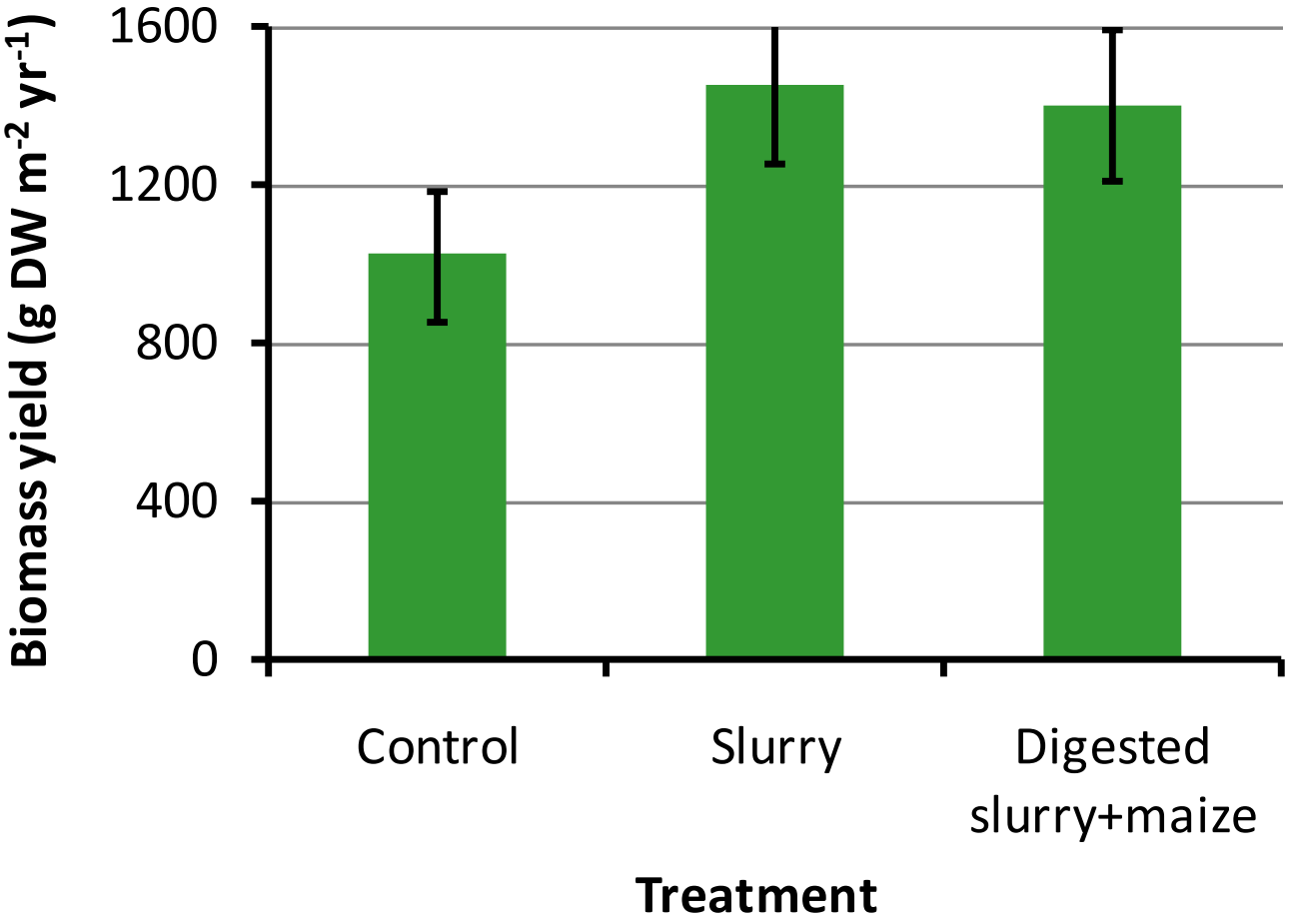


Biogas residues are used as fertilizer



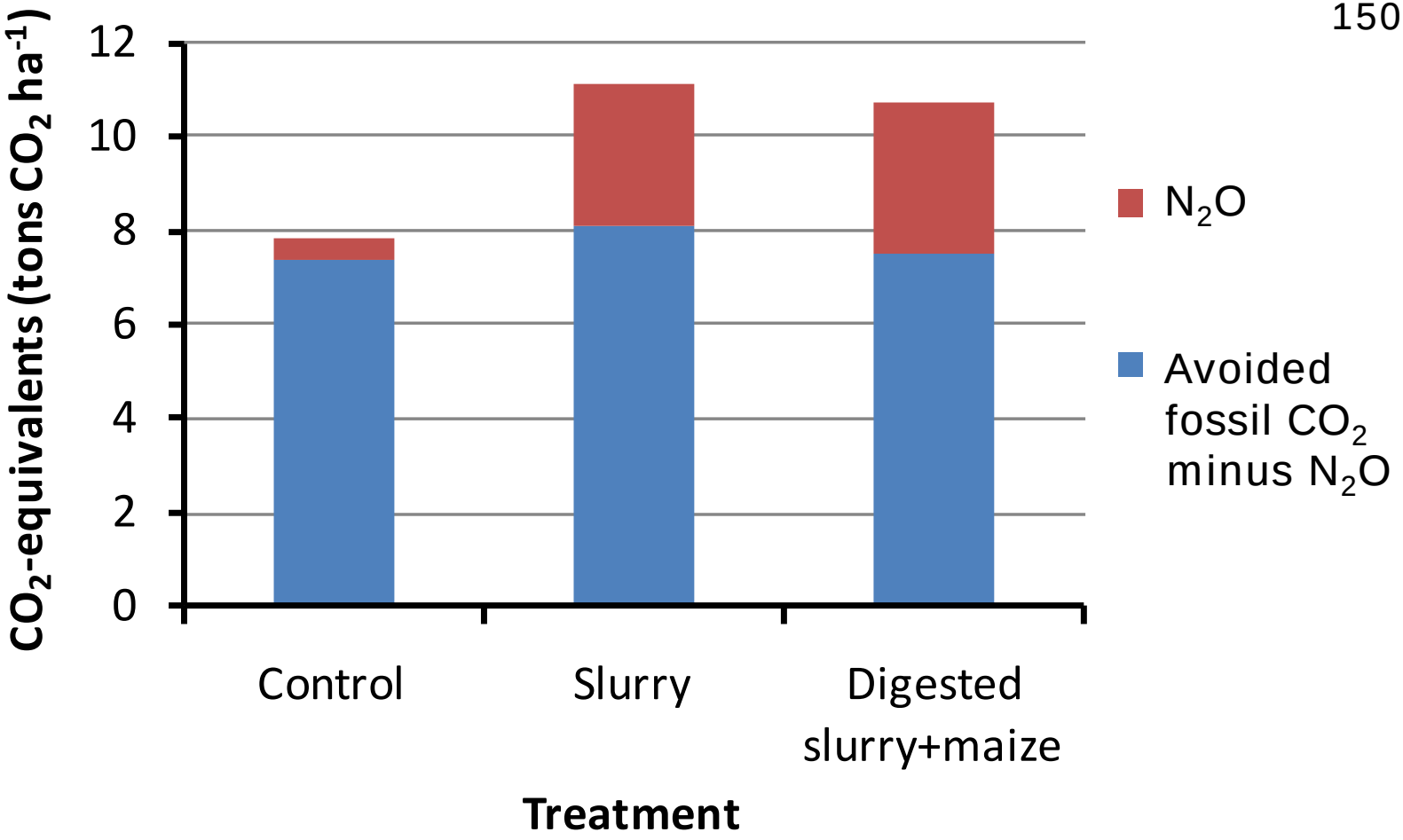
Biogas produced on fertilized maize

150 kg N ha^{-1}



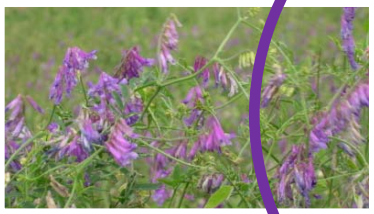
Biogas produced on fertilized maize

150 kg N ha^{-1}



Conclusions

Biomass



Rye straw

Vetch straw

Rye-vetch intercrop

Grass-clover

Maize

Biofuel technology

Bioethanol

Biogas

Combined bioethanol and biogas

No advantage to fertilize maize crop - extra crop yield offset by increased N_2O emissions

Thanks to all the people who contributed…

Mette Hedegaard
Christel Barker
Nina Wiese Thomsen
Liselotte Meltofte
Anja Nielsen
Marianne Munck
Kristian Albert
Poul Sørensen
Anne Belinda Thomsen
Mette Hedegaard Thomsen
Piotr Oleskowicz-Popiel
Henrik Bangsø Nielsen
Steffen Blume
Ingelis Larsen
Erik Steen Jensen
Hanne Østergård

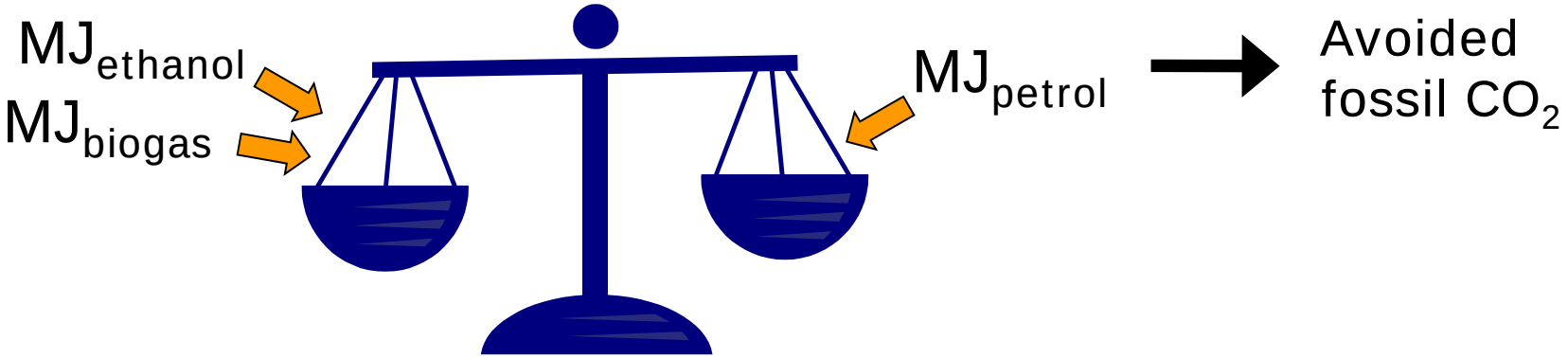
BioConcens:
Biomass and bioenergy production in organic agriculture – consequences for soil fertility, environment, spread of animal parasites and socio-economy

www.bioconcens.elr.dk

Accounting methodology

- We assume that bioethanol and biogas replace petrol

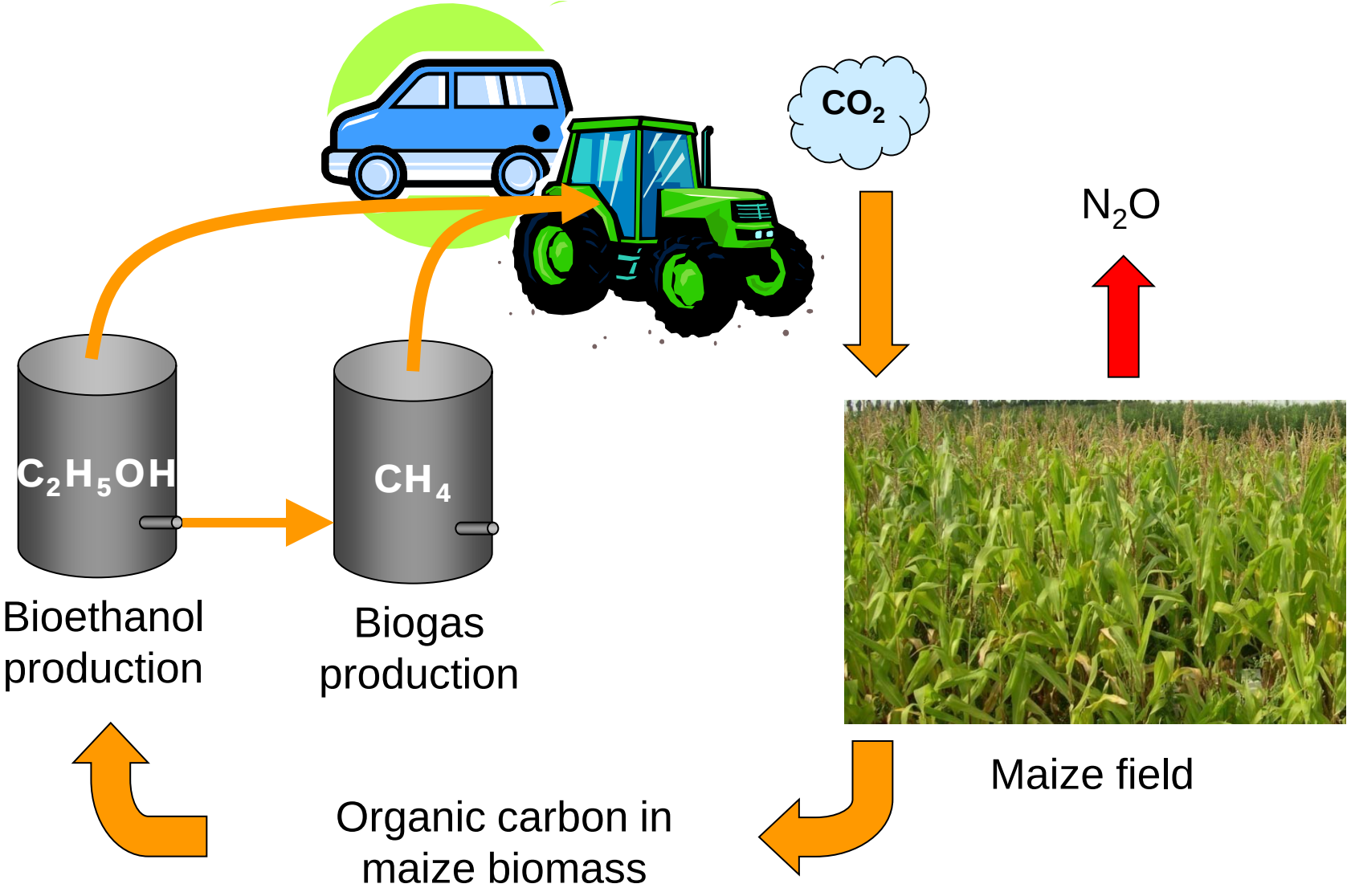
- Avoided fossil CO_2 is obtained by calculating how much petrol the produced bioethanol and/or biogas corresponds to based on energy (LHV)



- Not accounted for: Fuel consumption by farm machinery and during biofuel production

- N_2O emissions from rye, vetch and rye-vetch are allocated between straw and grain according to energy content

Carbon cycling in biofuel production



N_2O emissions related to avoided fossil CO_2

Co-production of bioethanol and biogas