

# Relating N<sub>2</sub>O emissions from energy crops to the avoided fossil fuel-derived CO<sub>2</sub>

– a study on bioethanol and biogas produced from organically managed maize, rye, vetch and grass-clover

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# Combinations of energy crops and biofuels

## Energy crops



Rye straw



Vetch straw



Rye-vetch intercrop



Grass-clover



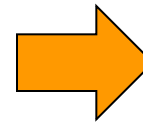
Maize

## Biofuel technologies

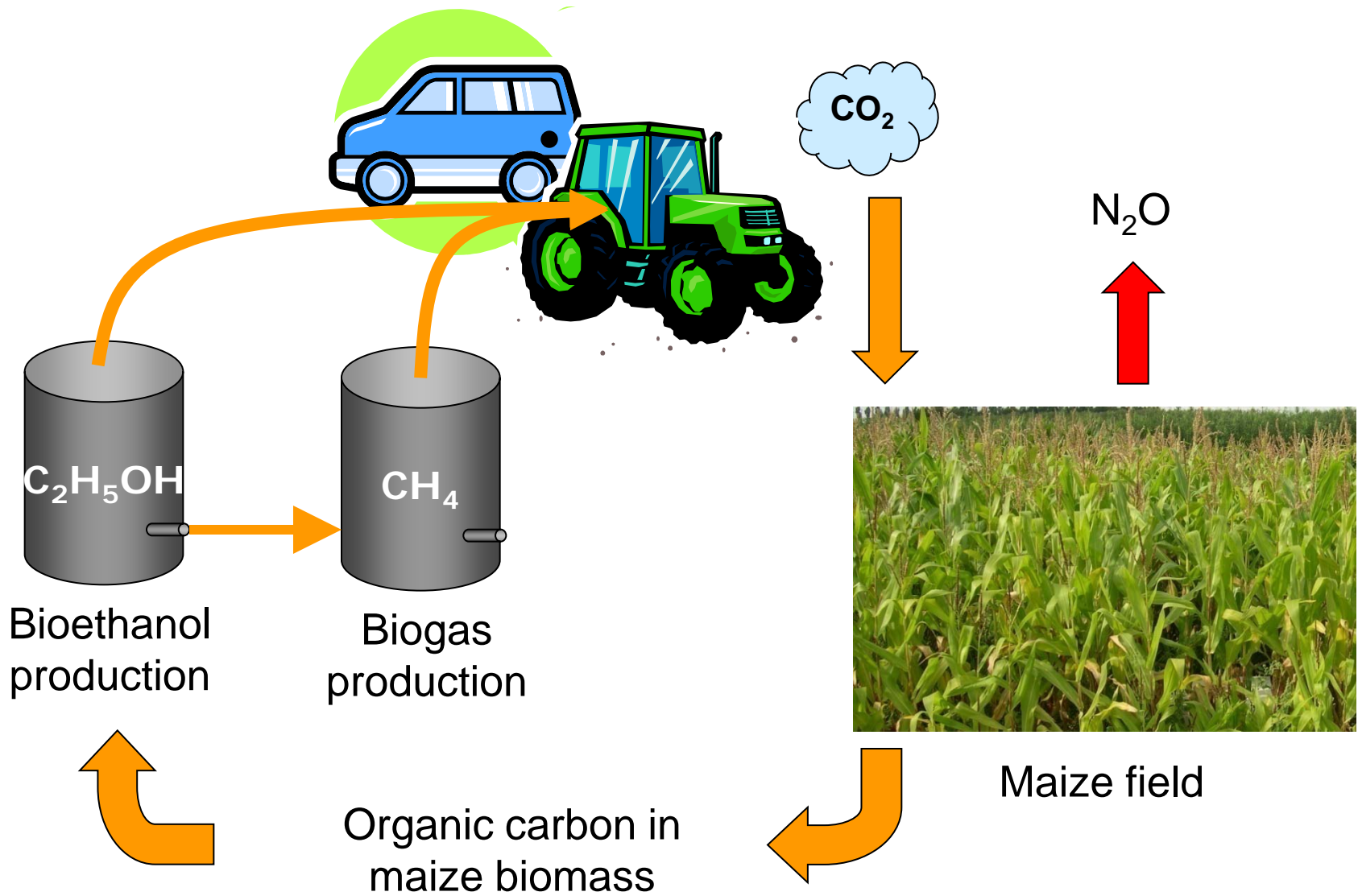
Bioethanol

Biogas

Combined bioethanol  
and biogas

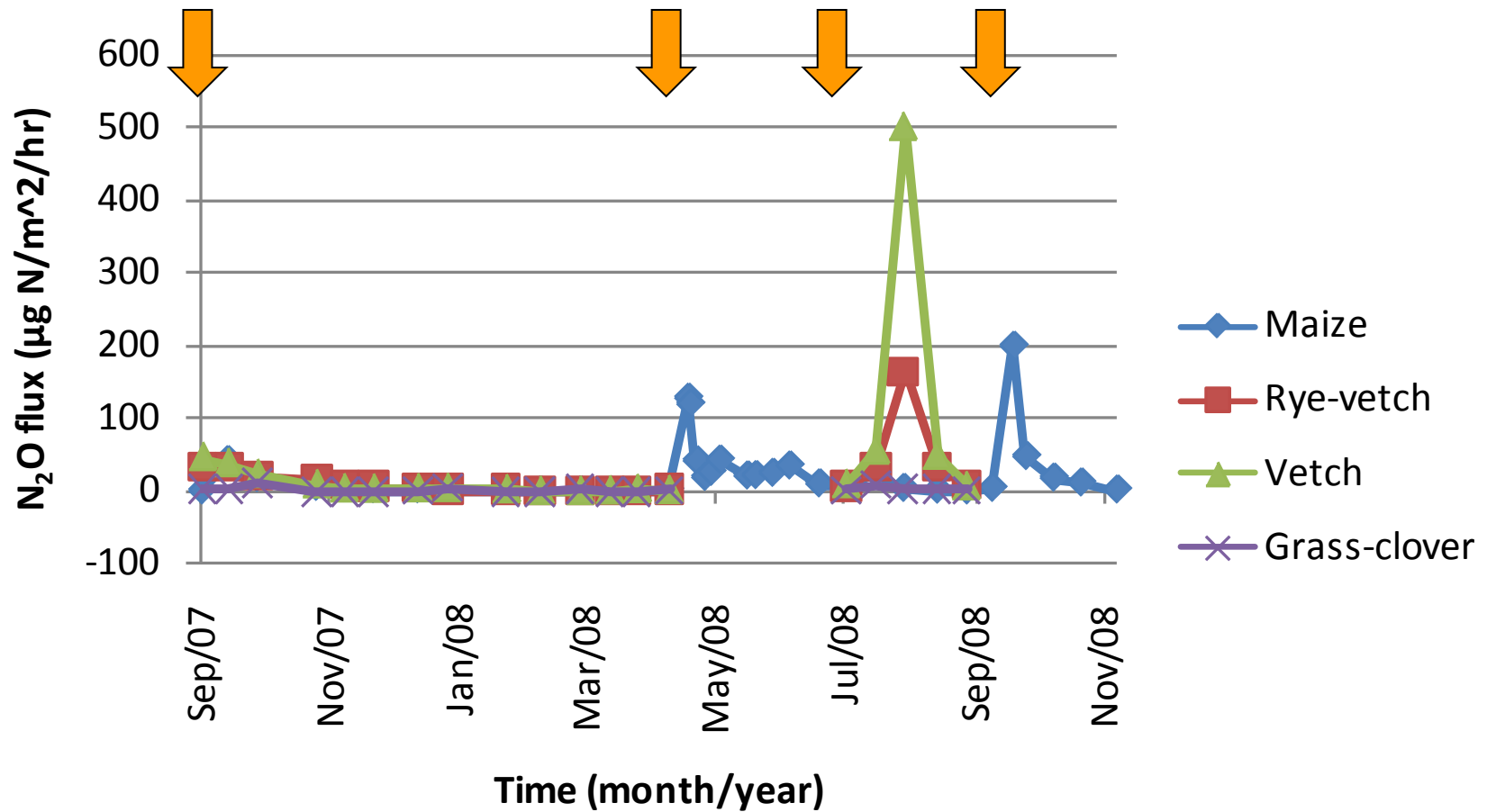


# Carbon cycling in biofuel production

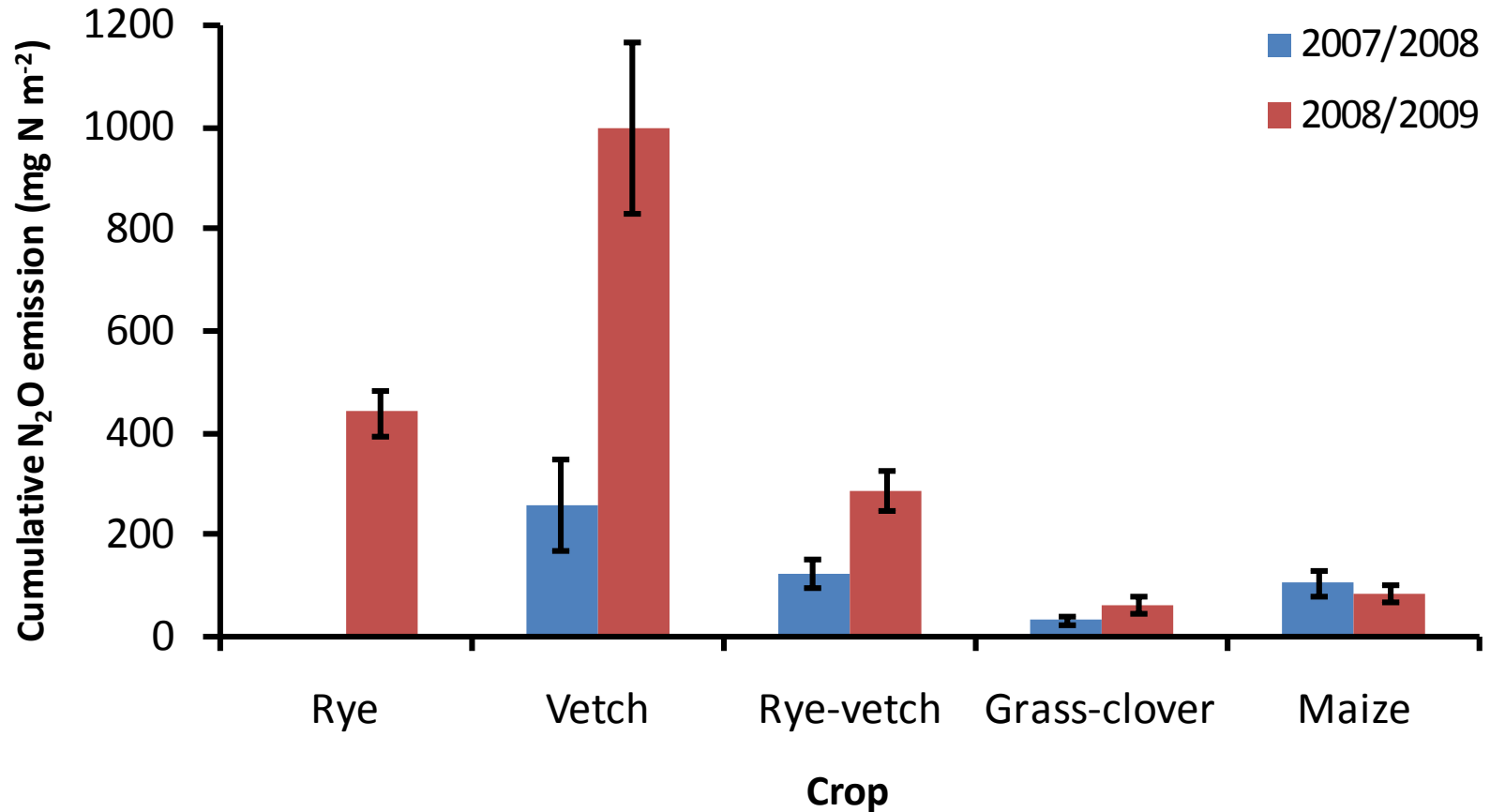


# Temporal variability in N<sub>2</sub>O fluxes

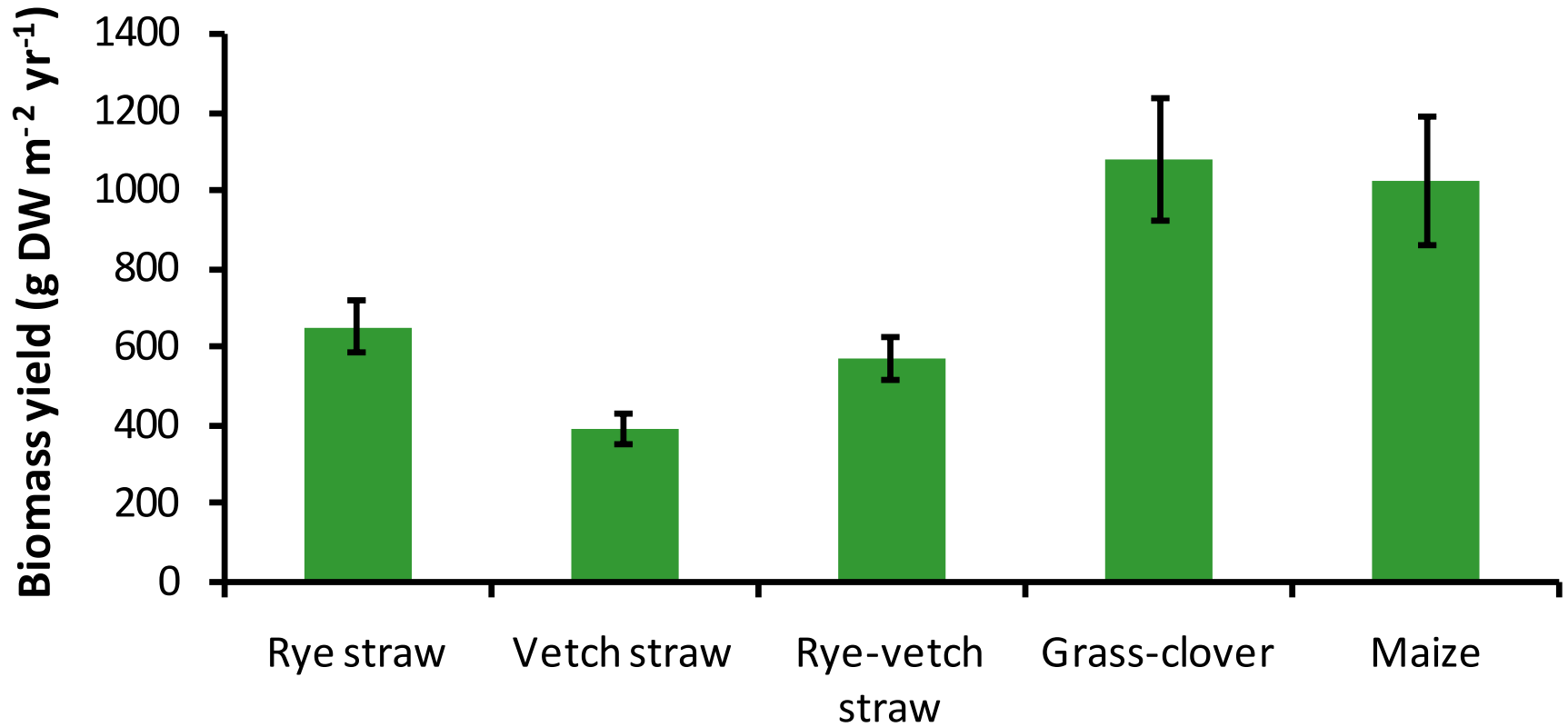
## Example from 2007/2008 for unfertilized crops



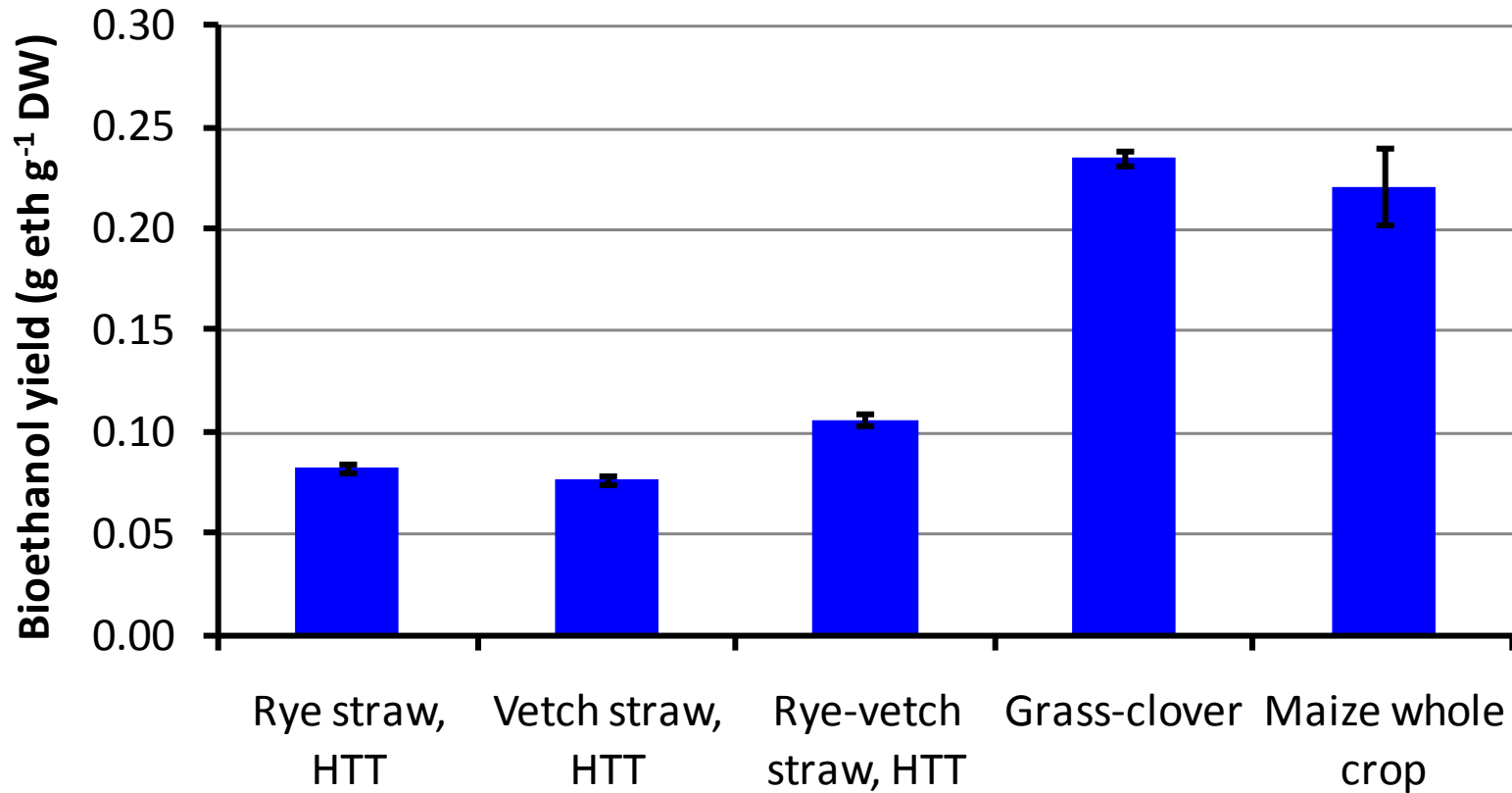
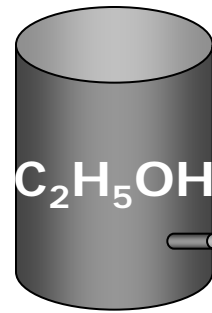
# Cumulative N<sub>2</sub>O emission, unfertilized crops



# Harvested biomass of unfertilized crops (2 yr)

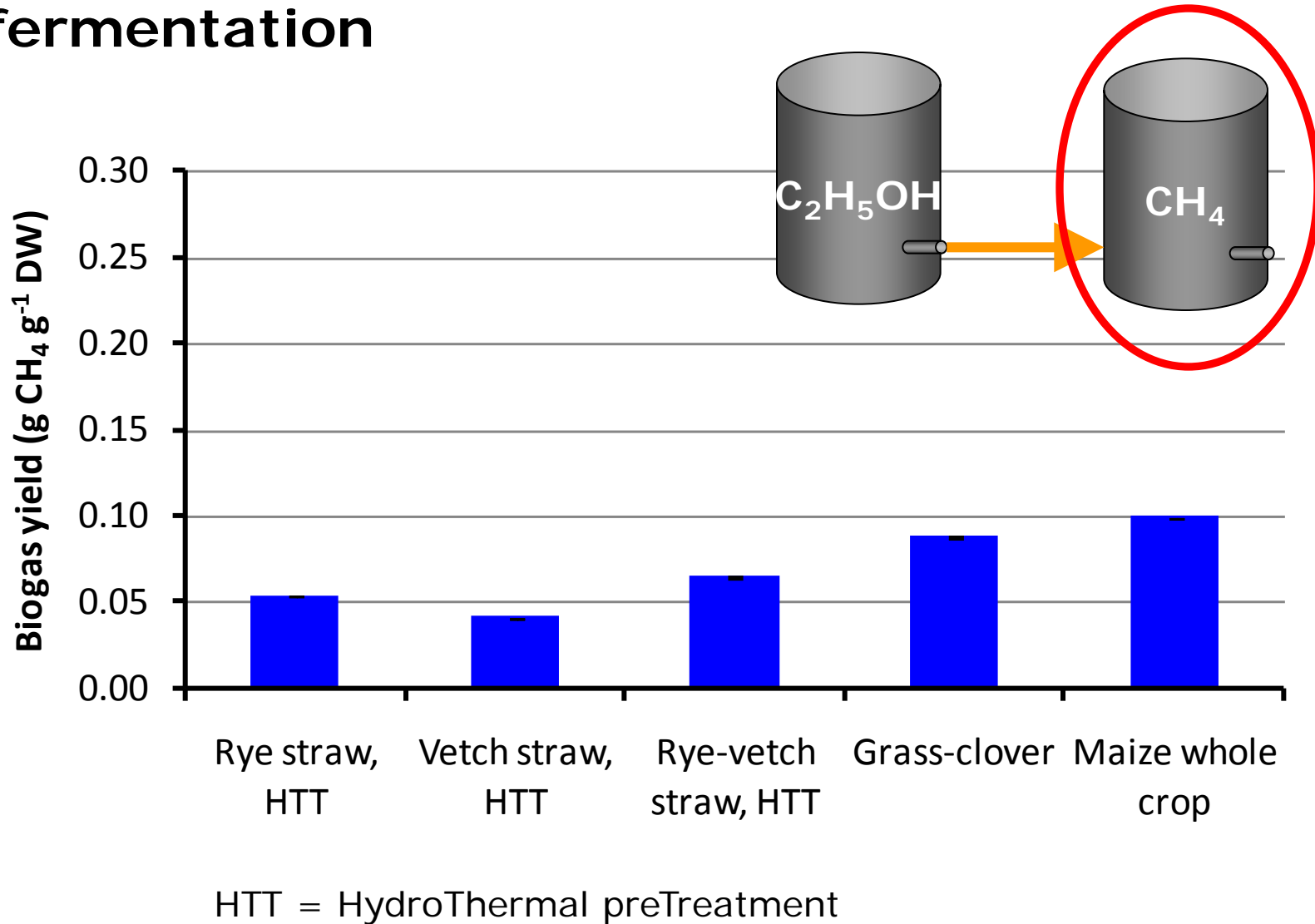


# Bioethanol yields



HTT = HydroThermal preTreatment

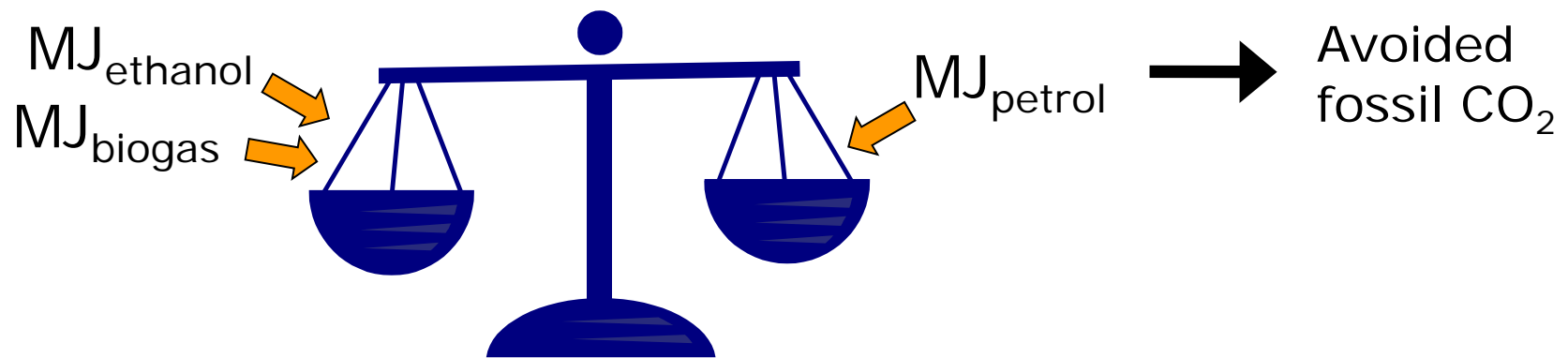
# Biogas yields on effluents from ethanol fermentation



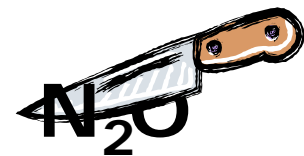


# Accounting methodology

- We assume that bioethanol and biogas replace petrol
- Avoided fossil CO<sub>2</sub> is obtained by calculating how much petrol the produced bioethanol and/or biogas corresponds to based on energy (LHV)

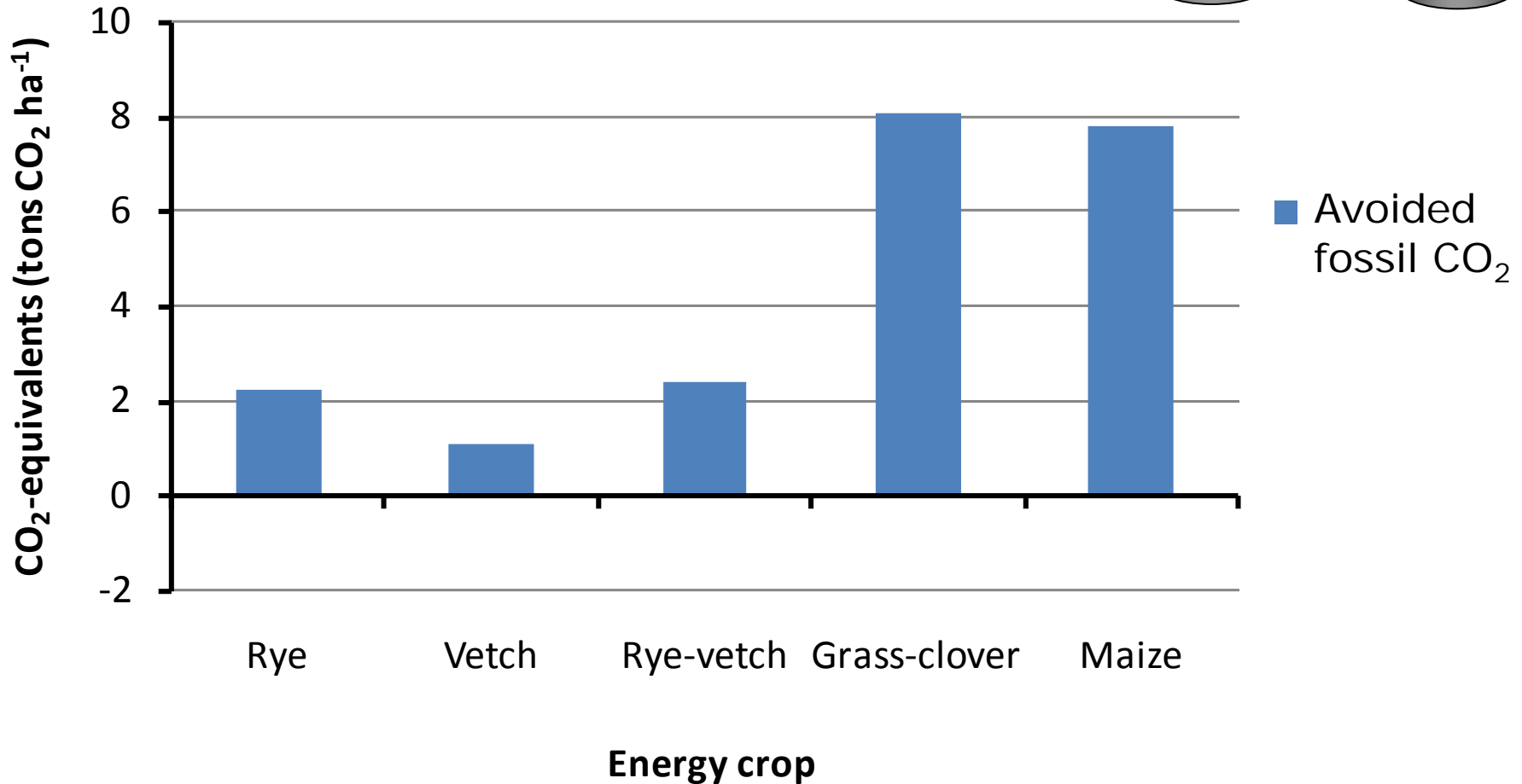
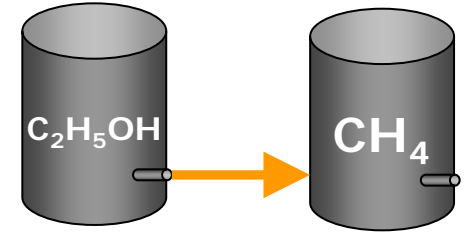


- Not accounted for: Fuel consumption by farm machinery and during biofuel production
- N<sub>2</sub>O emissions from rye, vetch and rye-vetch are allocated between straw and grain according to energy content



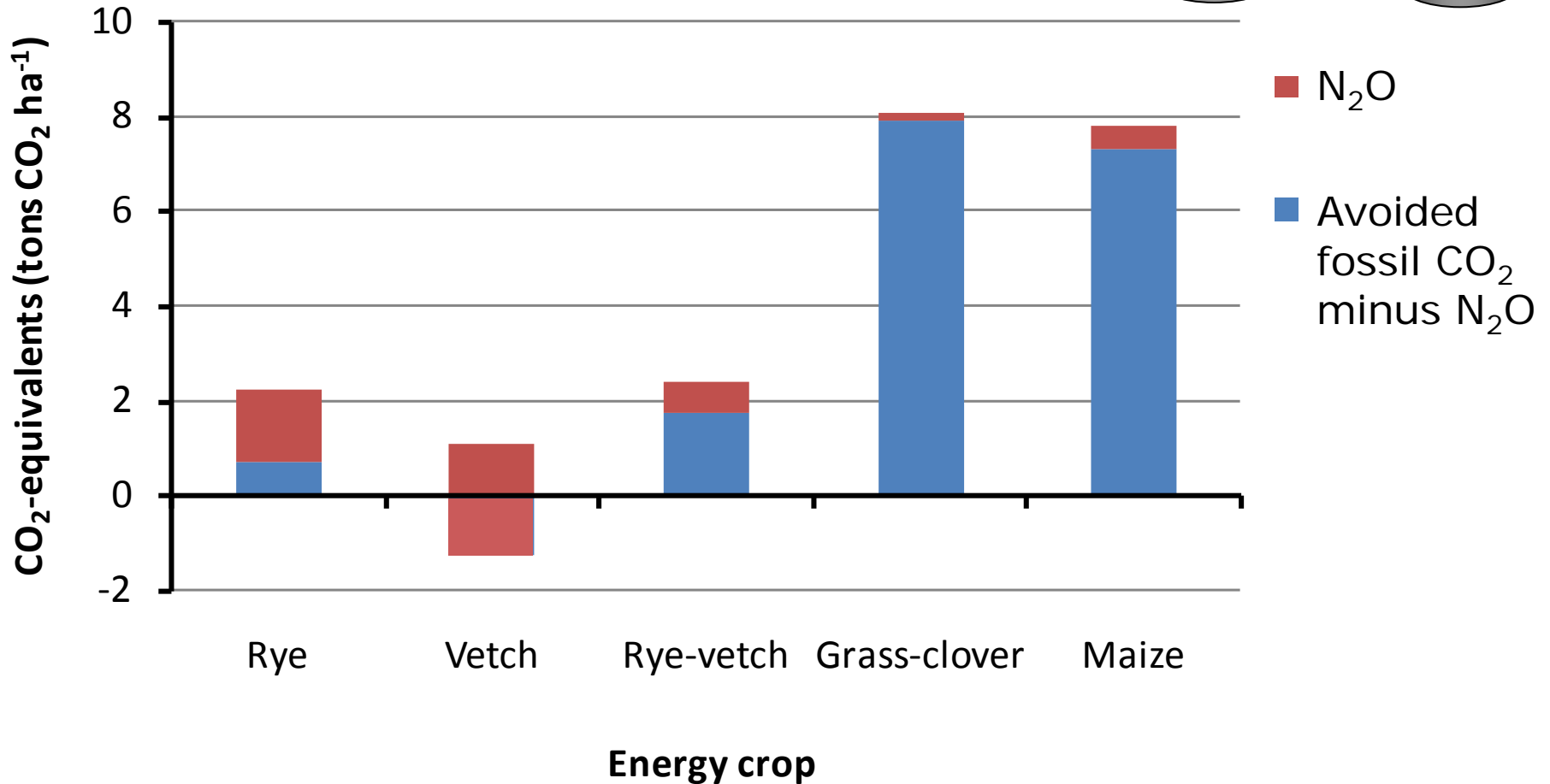
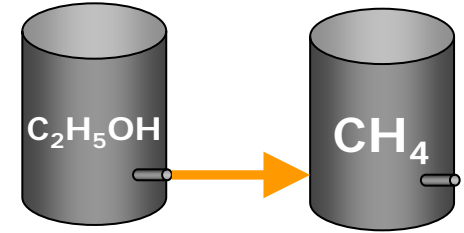
# N<sub>2</sub>O emissions related to avoided fossil CO<sub>2</sub>

## Co-production of bioethanol and biogas

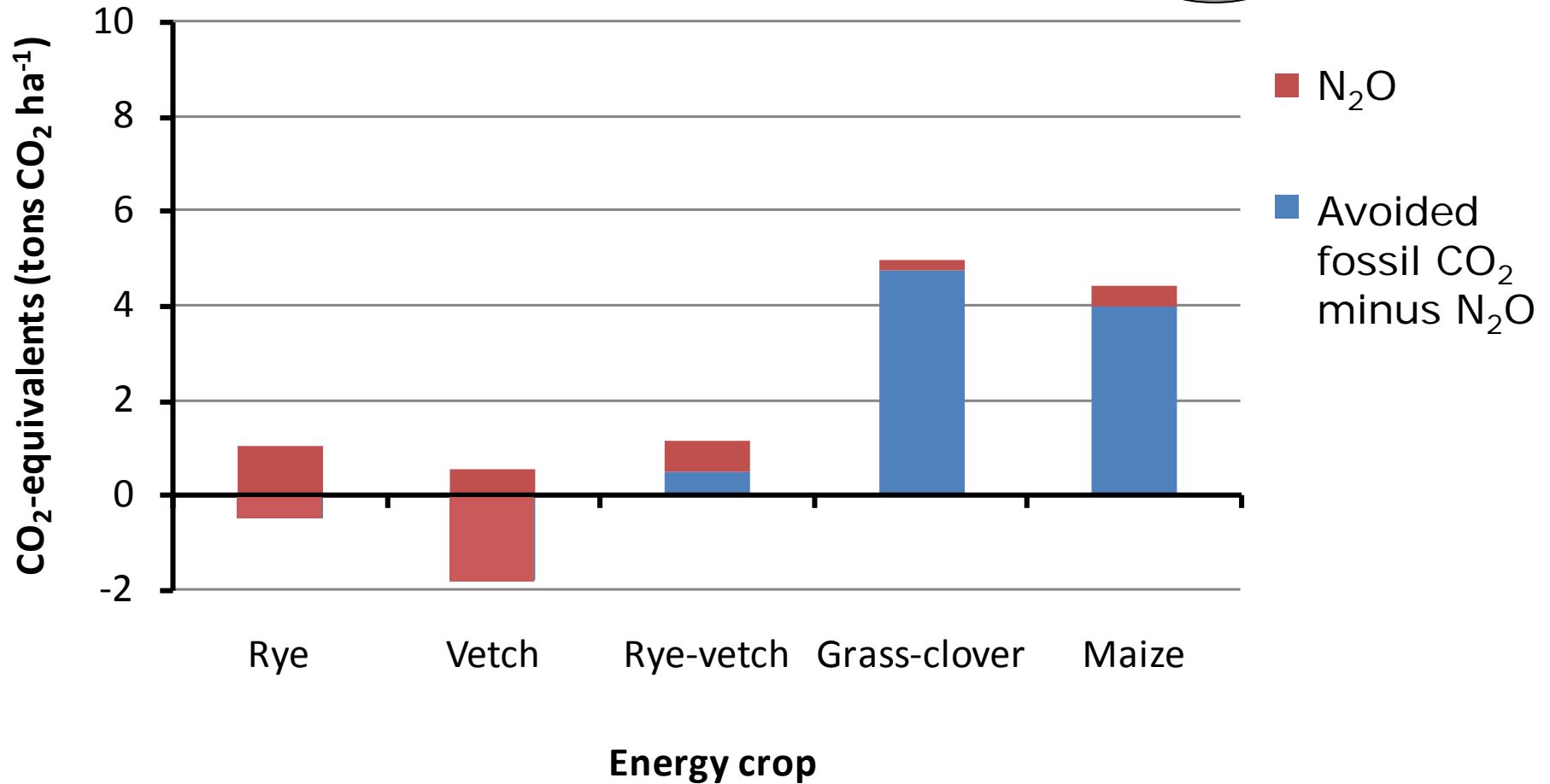
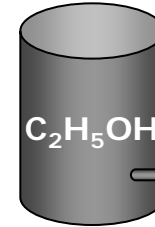


# N<sub>2</sub>O emissions related to avoided fossil CO<sub>2</sub>

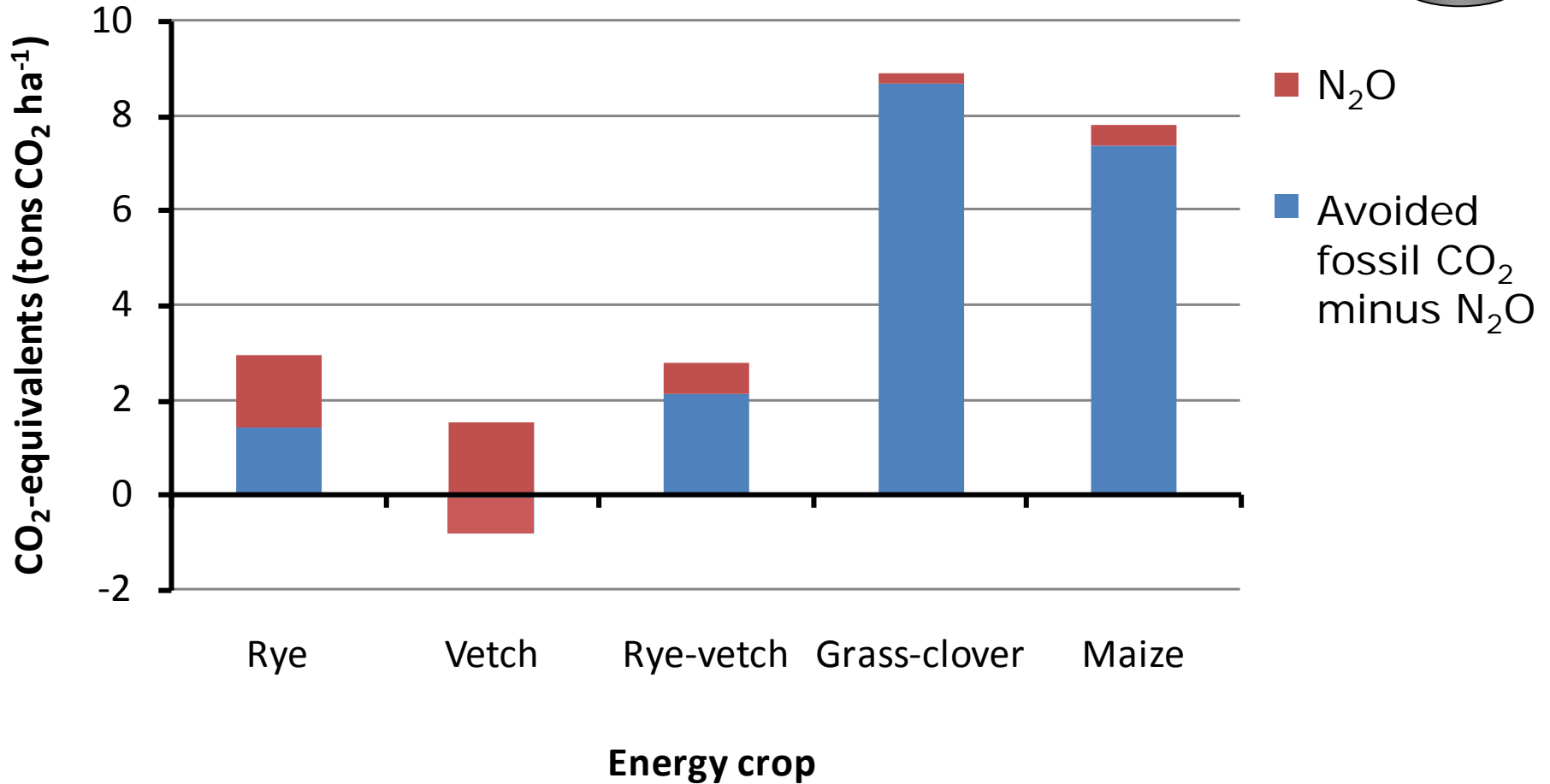
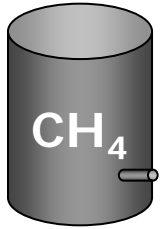
## Co-production of bioethanol and biogas



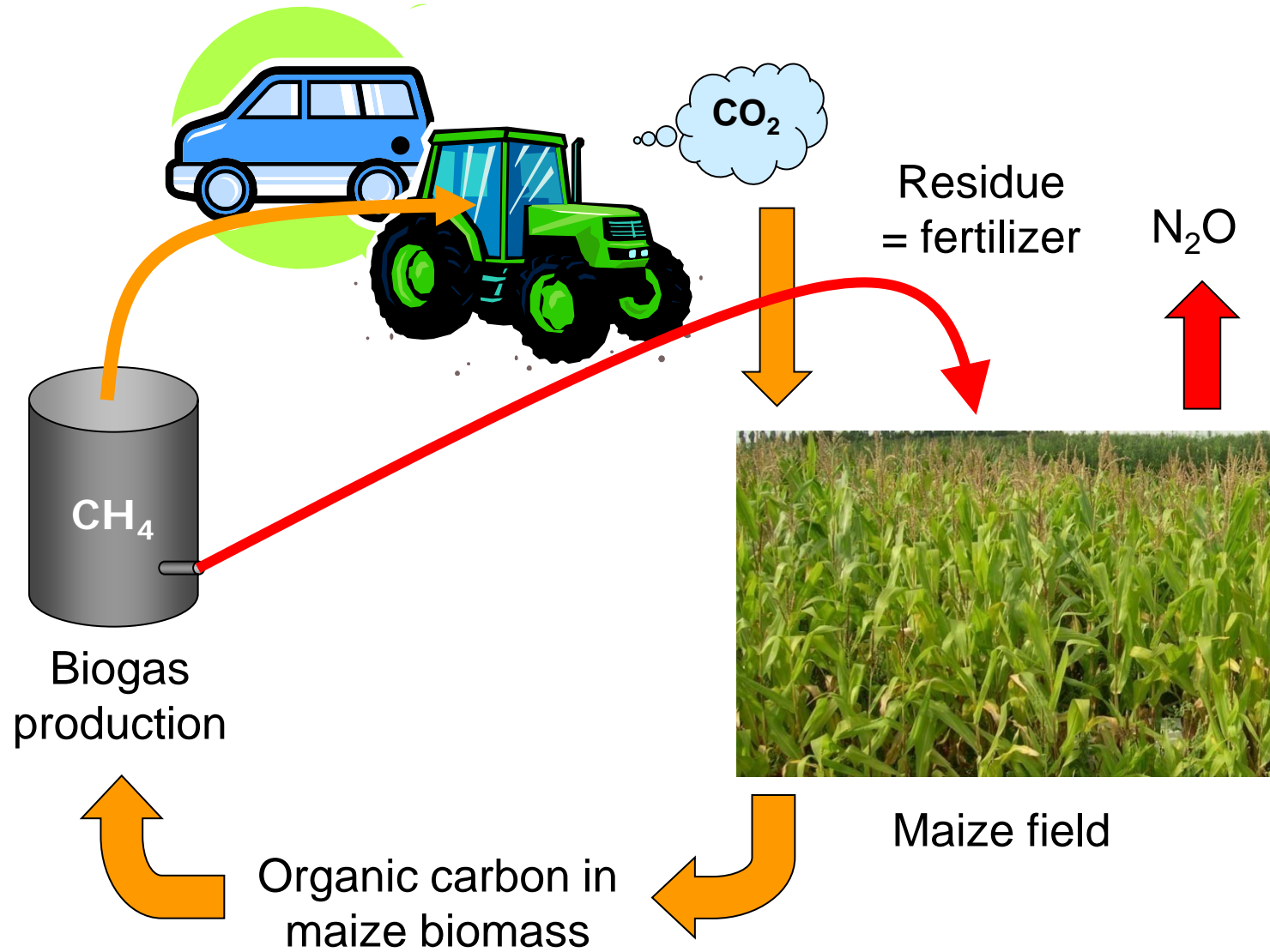
# Bioethanol



# Biogas



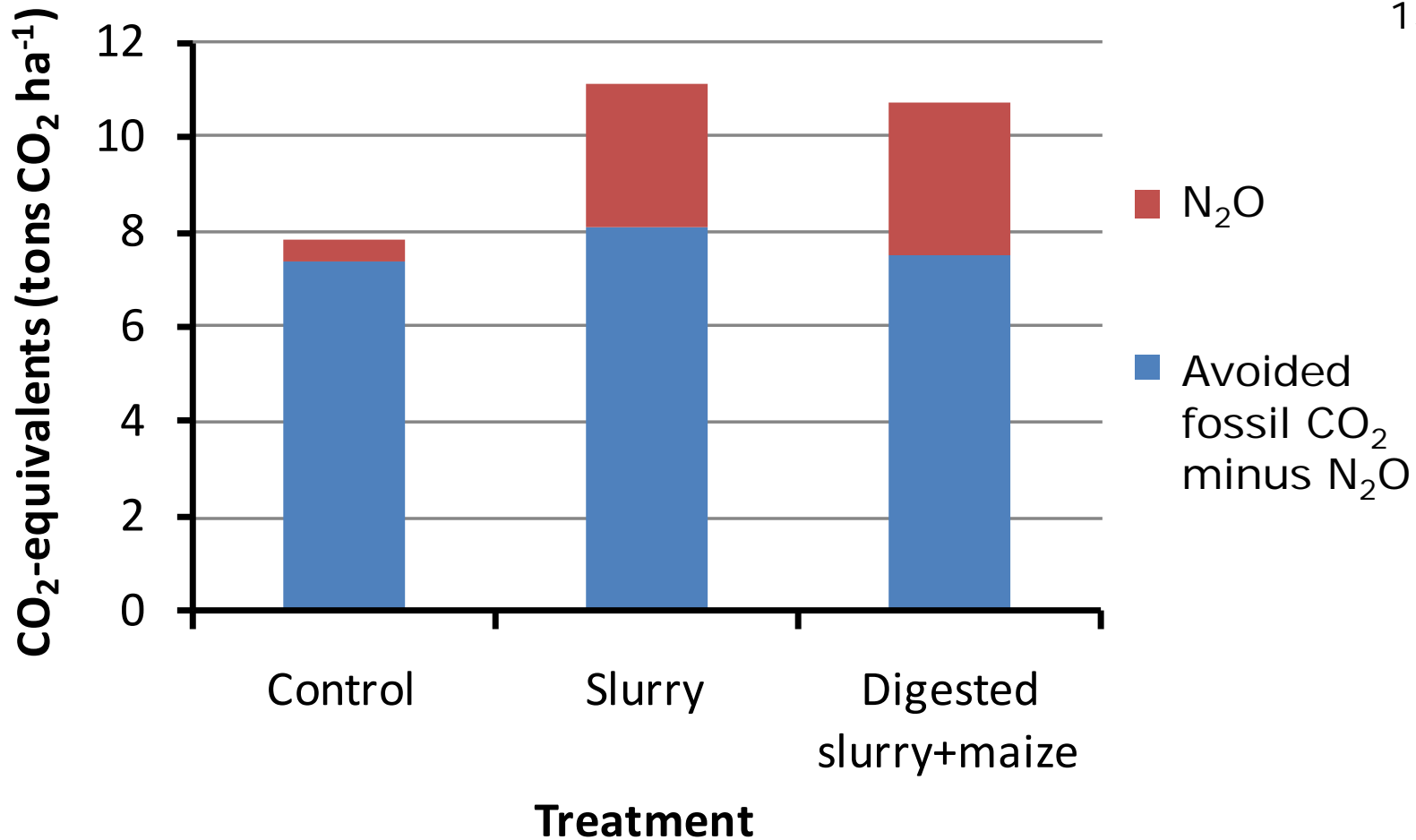
# Biogas residues are used as fertilizer



# Biogas produced on fertilized maize



150 kg N ha<sup>-1</sup>

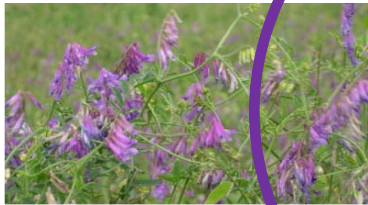


# Conclusions

## Energy crops



Rye straw



Vetch straw



Rye-vetch intercrop



Grass-clover



Maize

## Biofuel technologies

Bioethanol

Biogas

Combined bioethanol  
and biogas

No advantage to  
fertilize maize  
crop - extra crop  
yield offset by  
increased N<sub>2</sub>O  
emissions





# Thanks to all the people who contributed...

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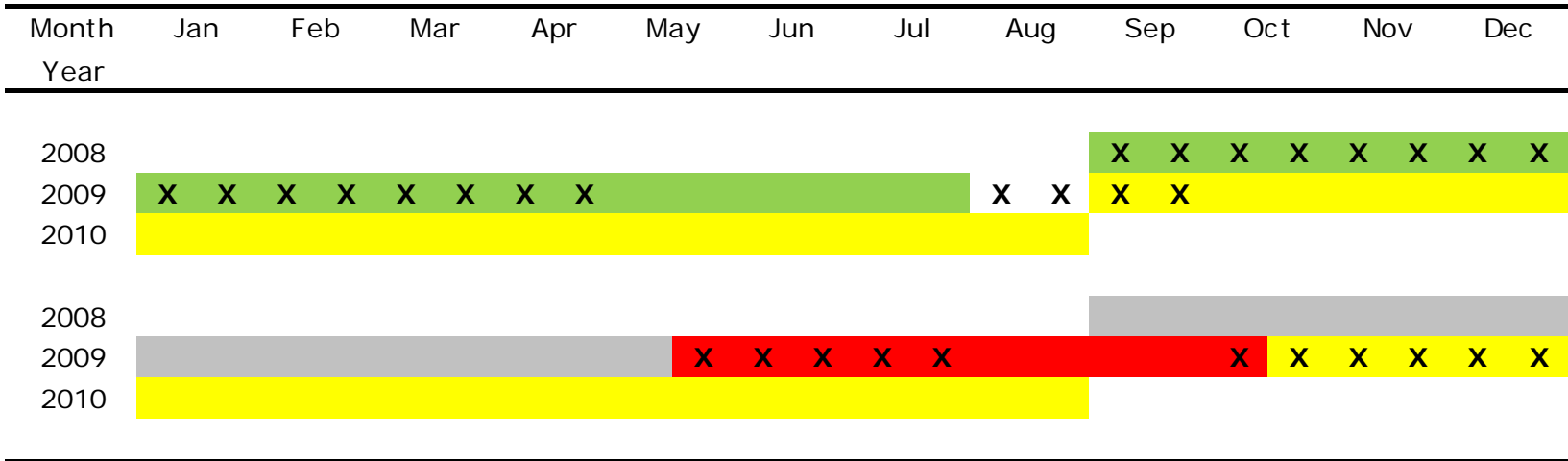
Hanne Østergård

**BioConcens:**



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



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# Cumulative N<sub>2</sub>O emissions



X Periods of N<sub>2</sub>O monitoring

 Rye, rye-vetch, vetch  
 Triticale  
 Total monitoring period = 300 days

 Maize  
 Triticale  
 Total monitoring period = 146 days