Organic farming as a climate solution?

Professor Jørgen E. Olesen

Long-term experiment in arable organic farming

Started in 1997

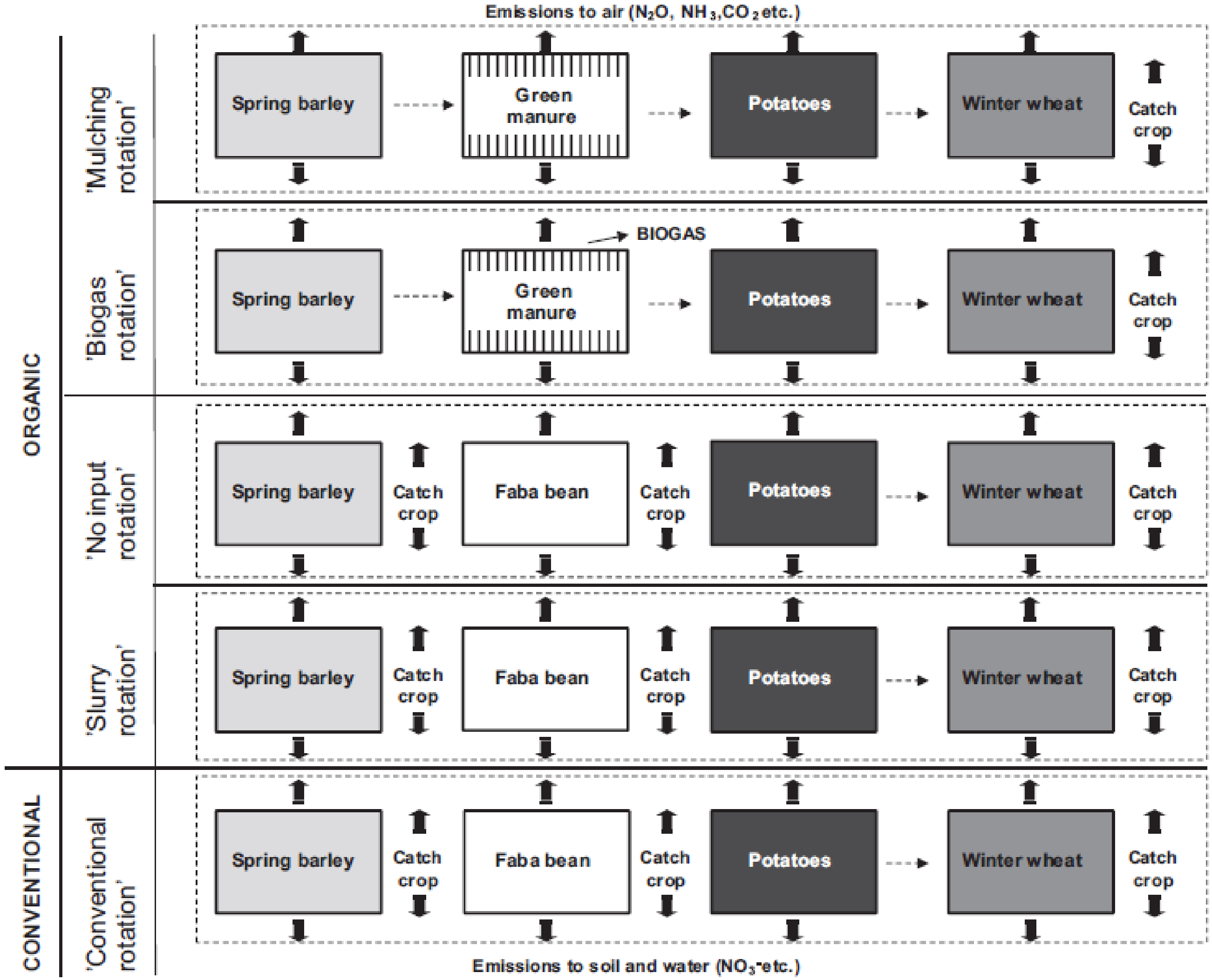
Three experimental (factorial) factors:

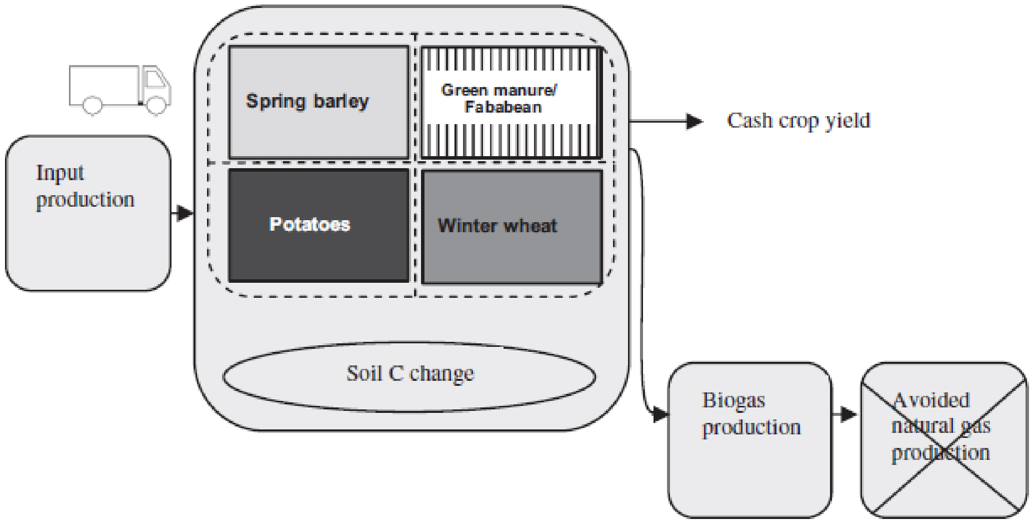
- Crop rotation (conventional/organic, proportion of legumes, cereals)
- Cover crops (with/without)
- Manure (with/without)

Crop rotation	Production system	-CC +M	+CC -M	+CC +M
O2	Green manure-cash crop-organic	X	X	X
O4	Cash crop-organic	X	X	X
C4	Cash crop-conventional	X		X

M: animal manure (organic) or mineral fertilizer (conventional).
CC: catch crop, '+' is with catch crop and '-' is without catch crop.

LCA based assessment of arable cropping systems





Knudsen al. (2014)

LCA based assessment of arable cropping systems

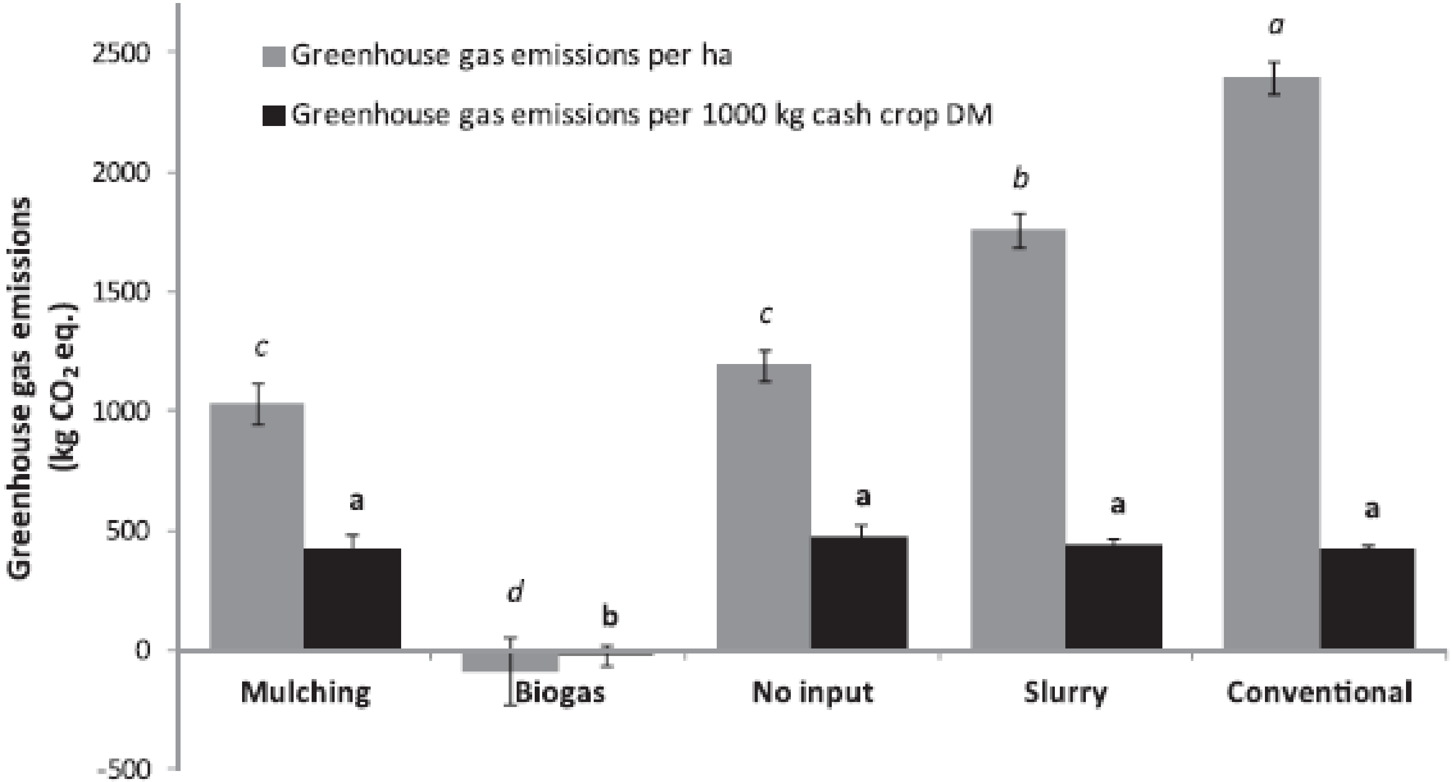


Fig. 3. Carbon footprints at farm gate from the full crop rotations 2006–8 per ha and t DM, respectively. The values are means over three years (2006–8), three locations and two replicates (±S.E.). Small letters denote significant differences between crop rotations at $p \leq 0.05$ and is only valid for the grey and black columns, separately.

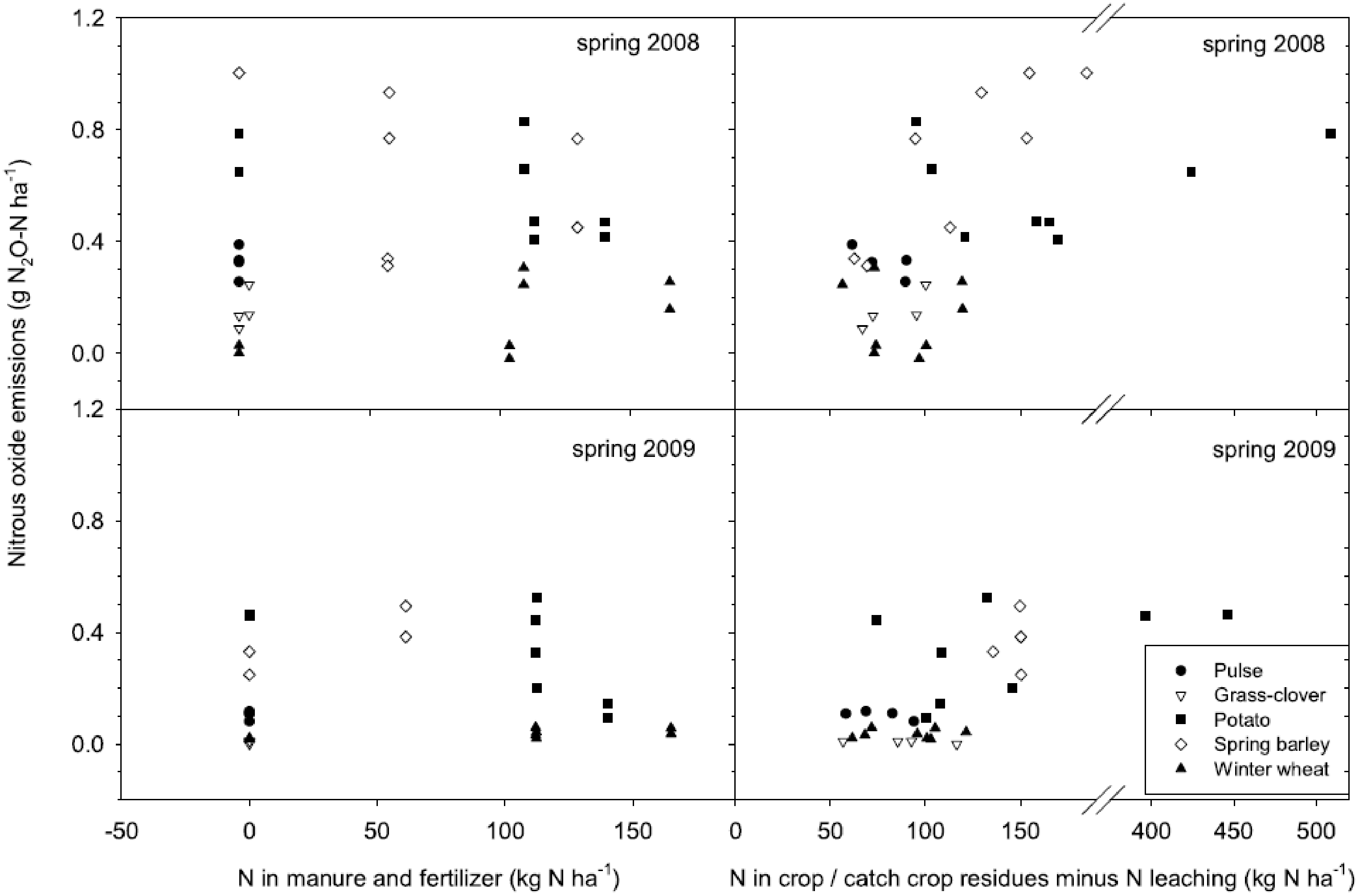
Knudsen al. (2014)

Crop residues drive N_2O emissions in complex systems

Data from 2008-2009

Cumulated spring time emissions

Linear response to N in crop residues, but not effect of N in manure or fertilizers



Pugesgaard et al. (2017)

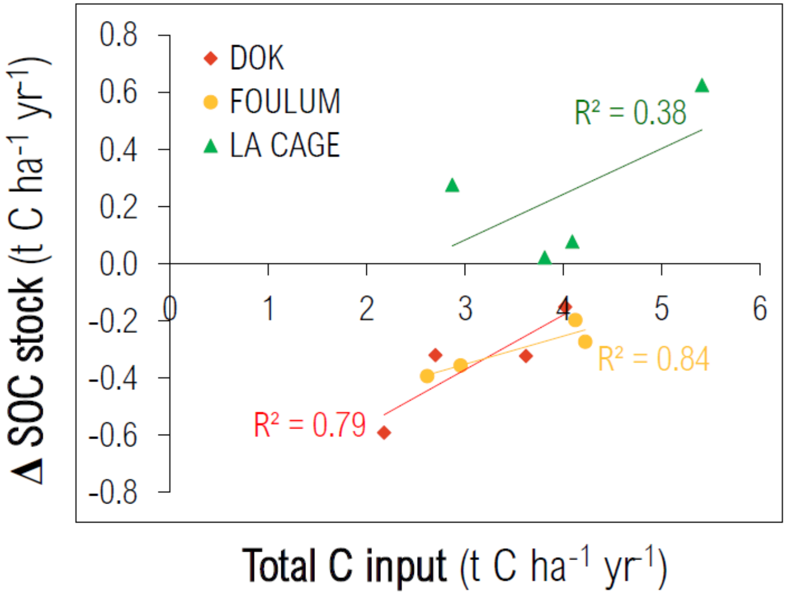
N surplus is linked to the soil carbon stock changes

Data from three European long-term experiments: DOK, Foulum, La Cage

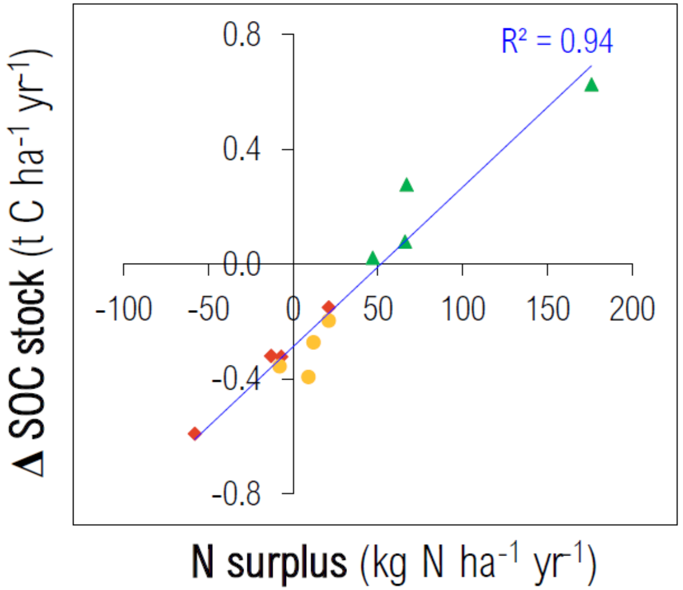
Enhancing soil carbon also stores N, P and S. The C:N:P:S ratio is almost constant (11:1:0.21:0.16) in SOM

Thus the slope of the relationship between SOC change and N surplus reveals two aspects:

- The C:N ratio of SOM
- The response of N losses to N surplus



- Contrasted relation between sites :
  - SOC storage controlled by C inputs
  - But also driven by N availability



- N required for C sequestration (Van Groenigen *et al.* 2017)

Benedict Autret, INRA

The greenhouse gas impacts of converting food production in England and Wales to organic methods

Laurence G. Smith [1,2], Guy J.D. Kirk [1*], Philip J. Jones [3] & Adrian G. Williams[1]

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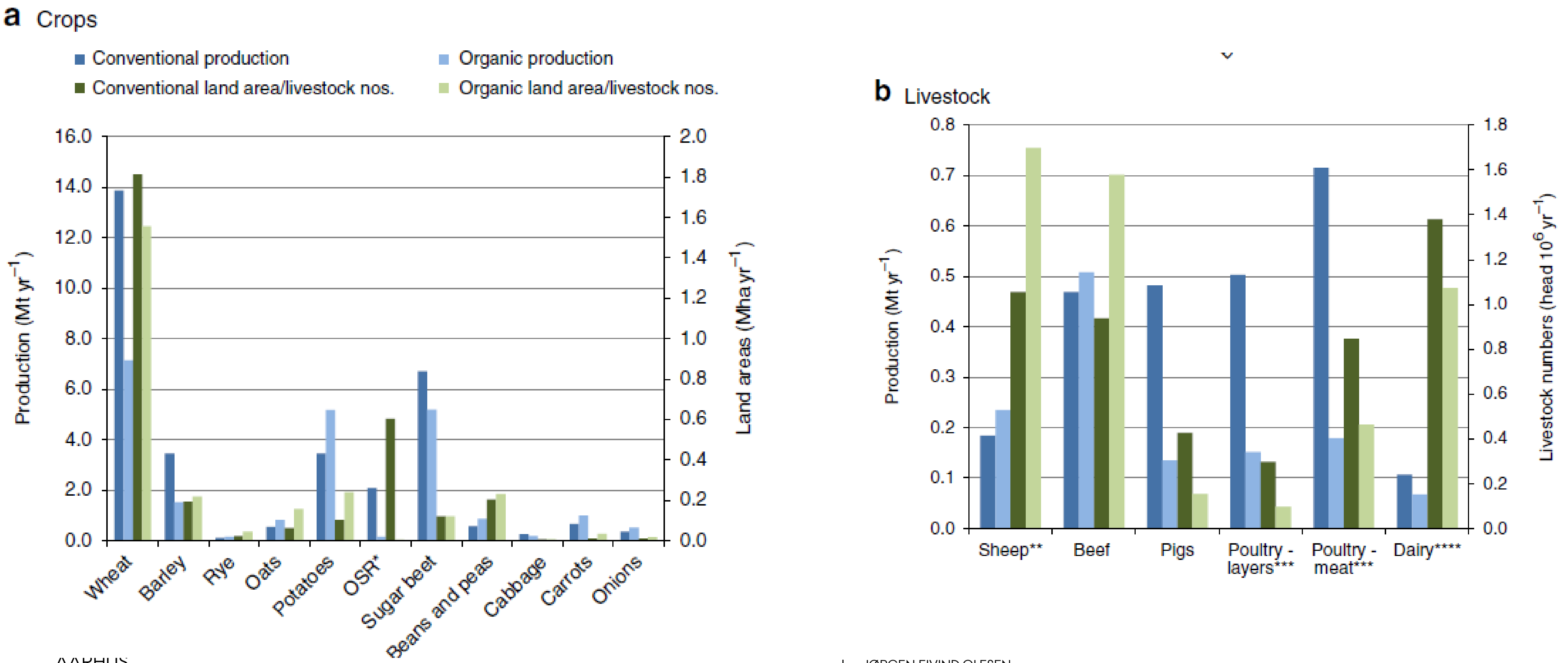
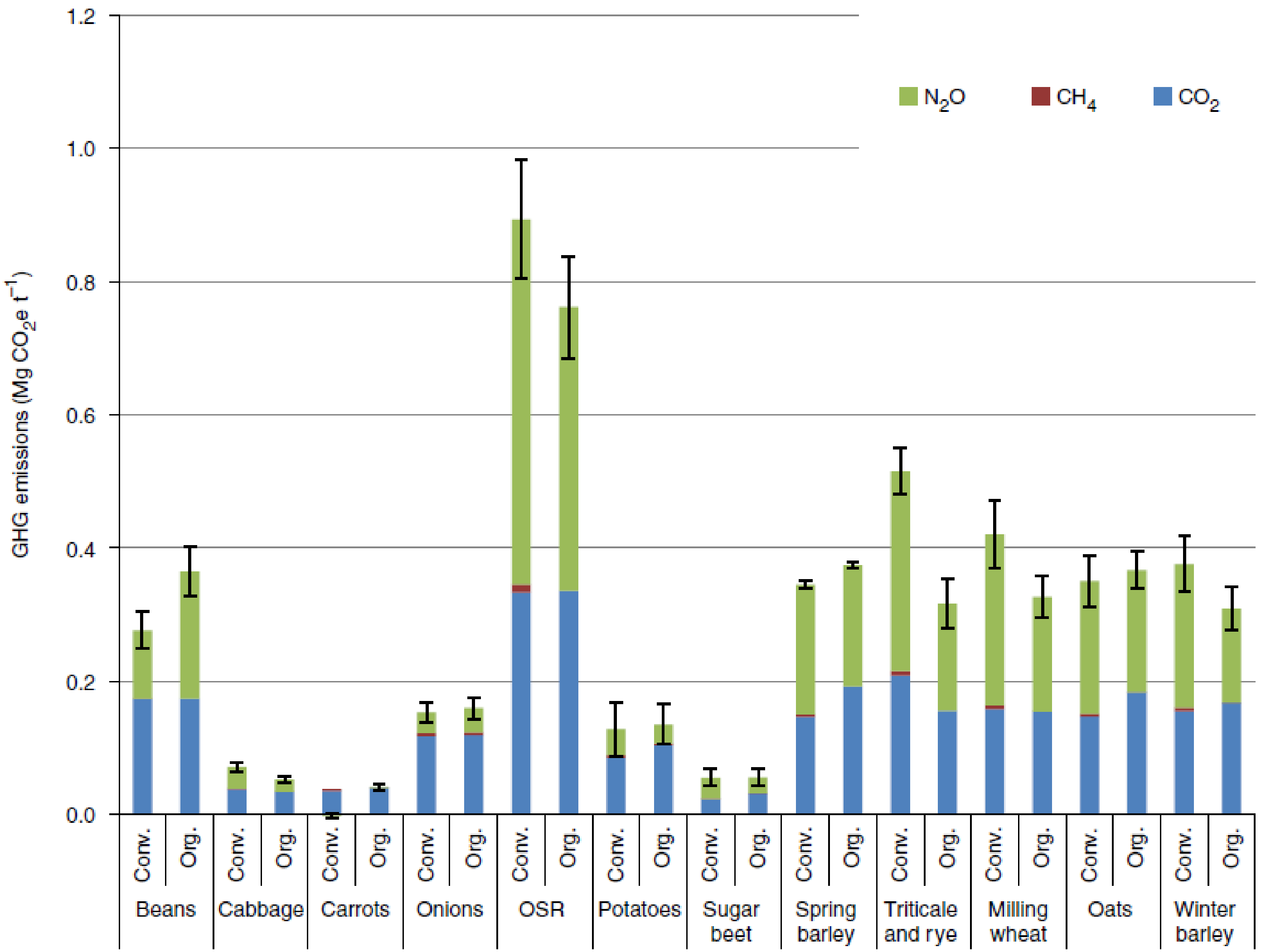
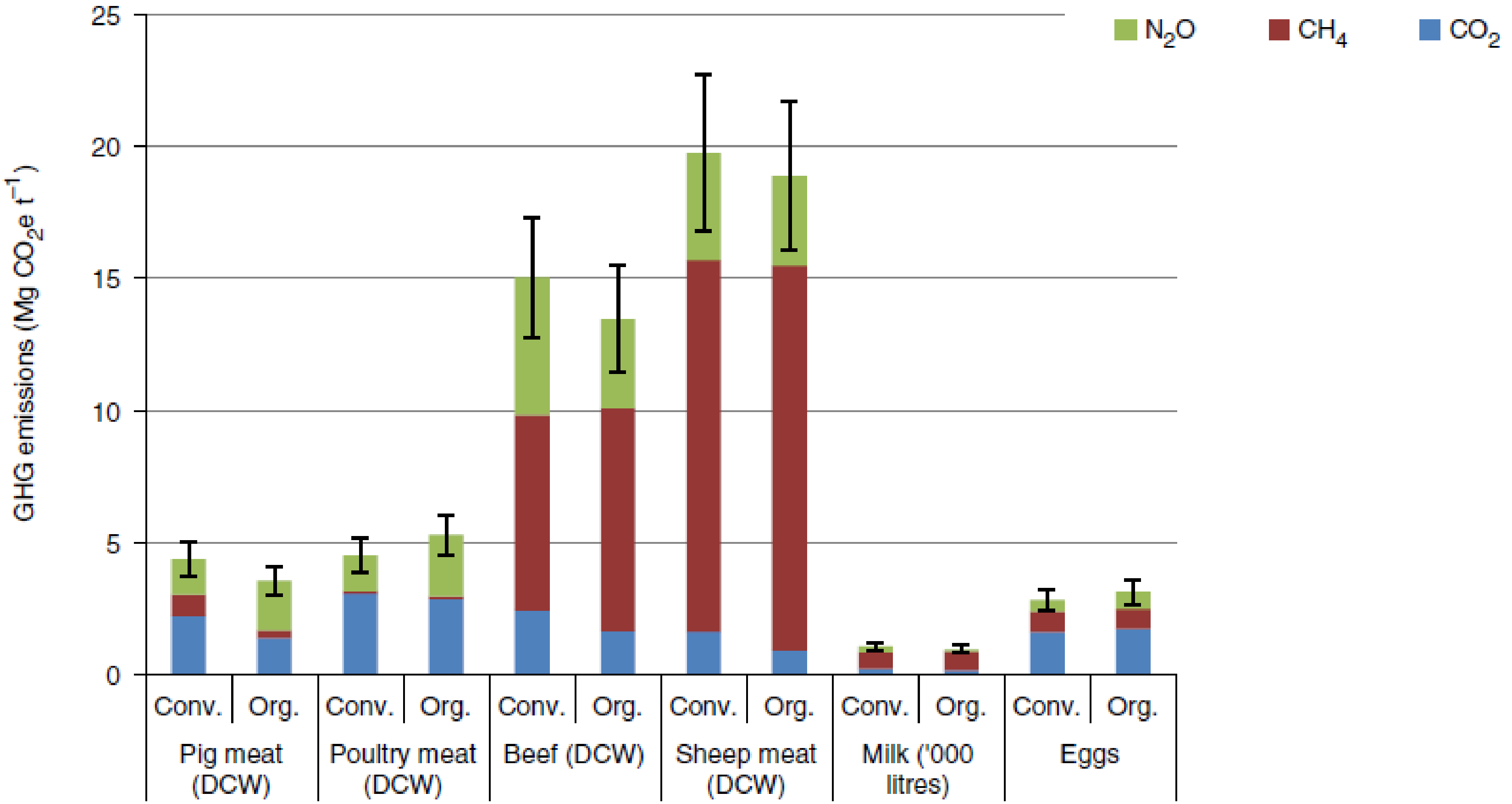
Projected food production under conventional and organic production



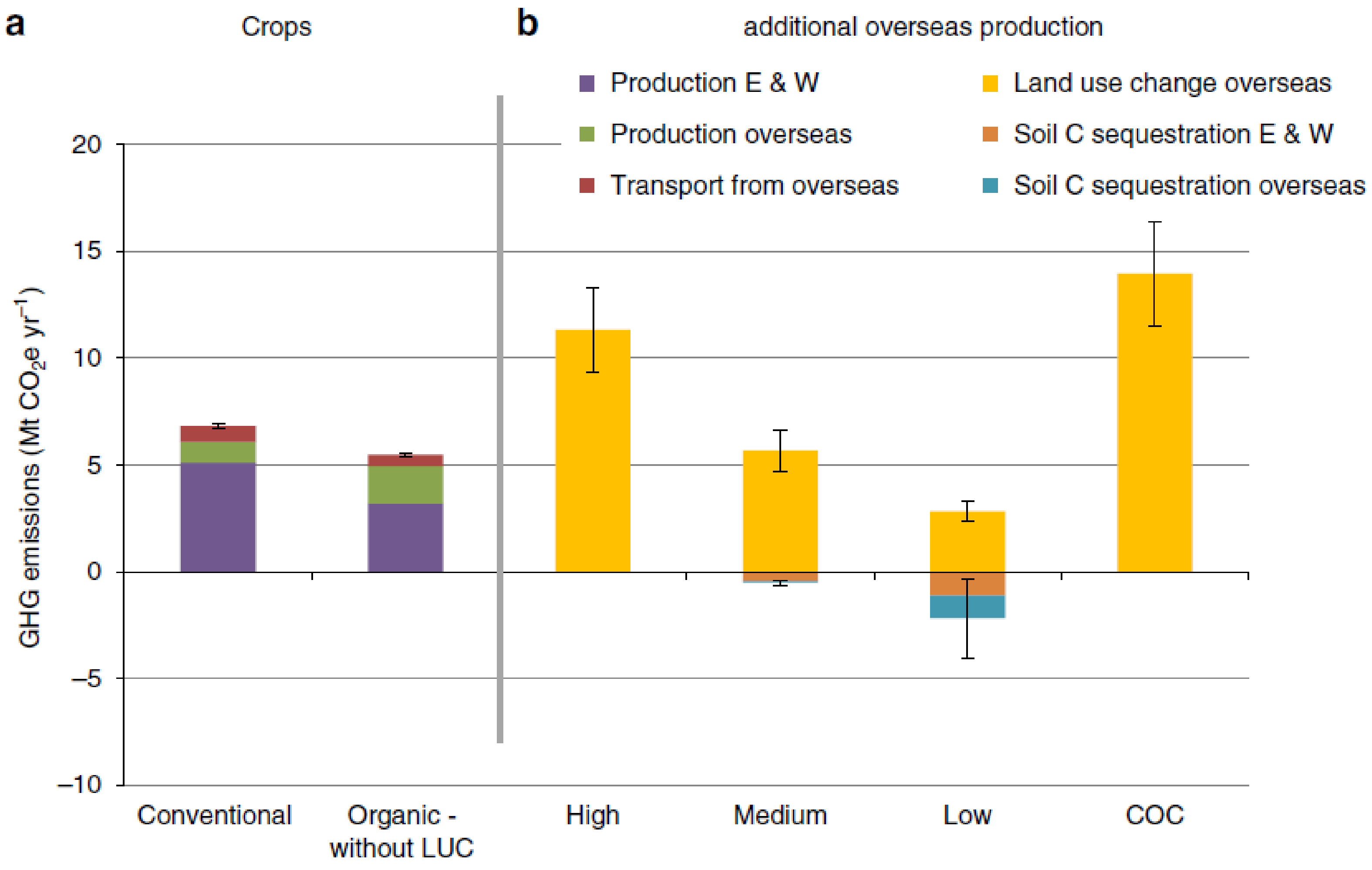
GHG emissions crops (Mg CO_2-eq/ton)



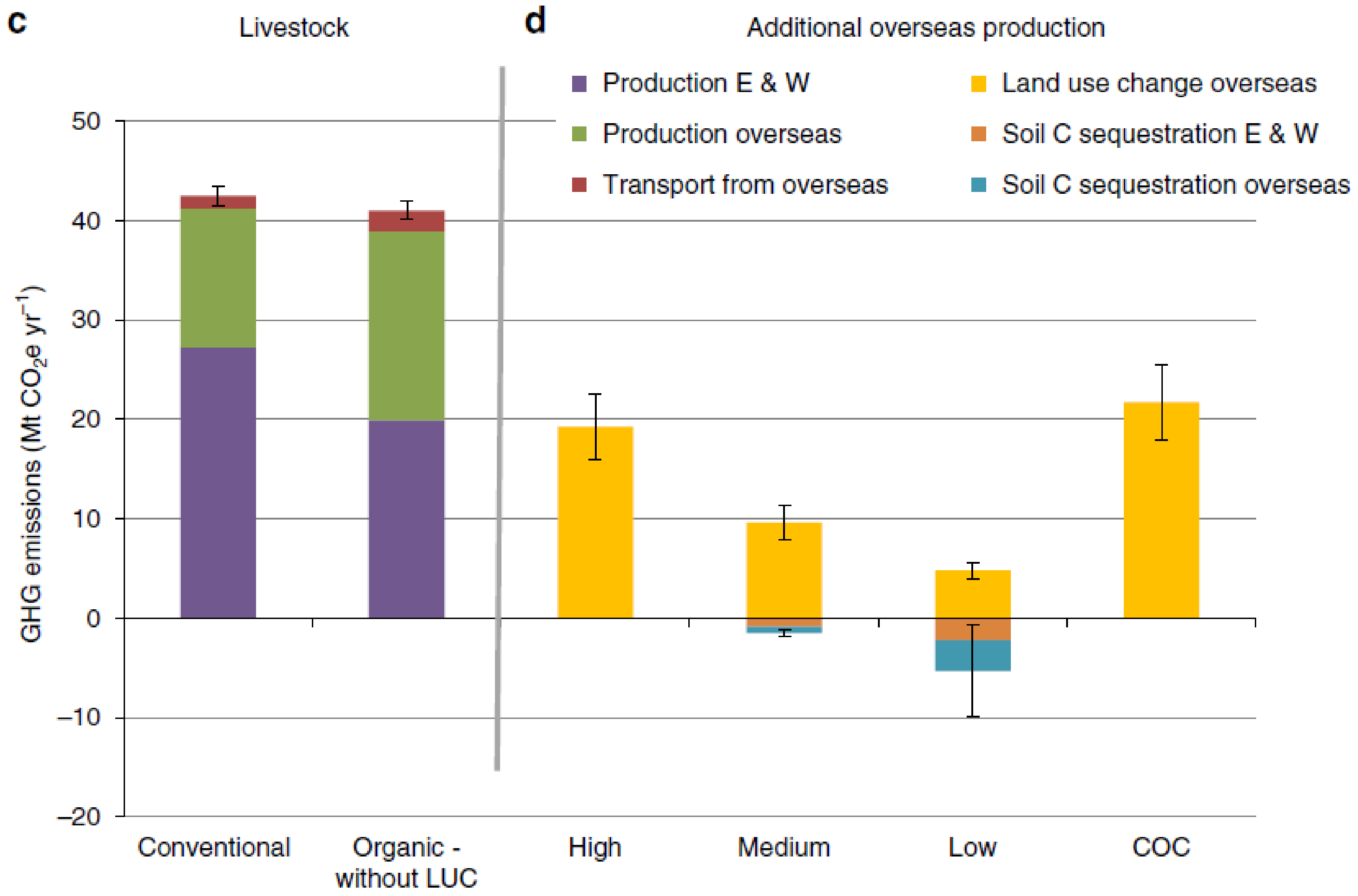
GHG emissions livestock (Mg CO2-eq/ton)



GHG emissions crops (Mt CO_2-eq) / E&W



GHG emissions livestock (Mt CO_2-eq) / E&W



Total GHG emissions and land use / E&W

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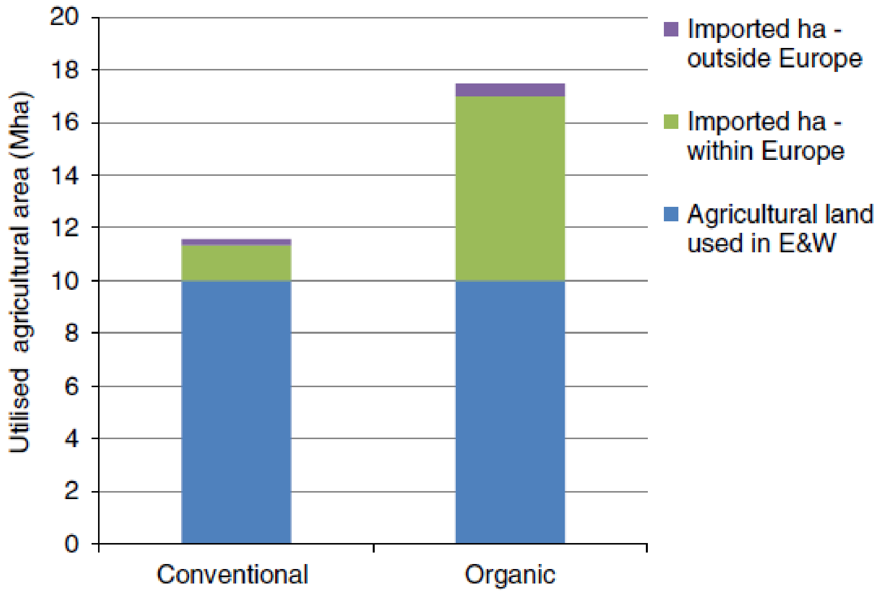

Table 1 Total GHG emissions from crop and livestock production under conventional and organic production allowing for High, Medium and Low levels of overseas LUC and soil C sequestration as in Fig. 3

	Conventional	Organic		
		High	Medium	Low
Emissions (Mt $CO_2e\ yr^{-1}$)	49.3 ± 2.1	77.1 ± 4.2	59.8 ± 2.7	46.6 ± 4.1
Fraction as CO_2 (%)	34	59	48	33
Fraction as CH_4 (%)	36	25	32	41
Fraction as N_2O (%)	29	16	21	26
Difference from conventional baseline		$p < 0.05$	NS	NS

*Data are means ± 1 std. dev

Challenges for organic farming as a climate solution

- GHG emissions per area is lower in organic compared to conventional farming due to lower inputs and lower livestock density
- Productivity is lower in organic compared to conventional farming:
  - GHG emissions per unit product is the same
  - Greater land area needed if similar food is produced (iLUC emissions)
- Organic farming is highly reliant on livestock (in particular ruminant animals)
- Some technological options for reducing specific GHG emissions is not available in organic farming
- For organic farming to contribute would require rethinking the farming system