Greenhouse gas emissions from feed production and enteric fermentation of rations for dairy cows

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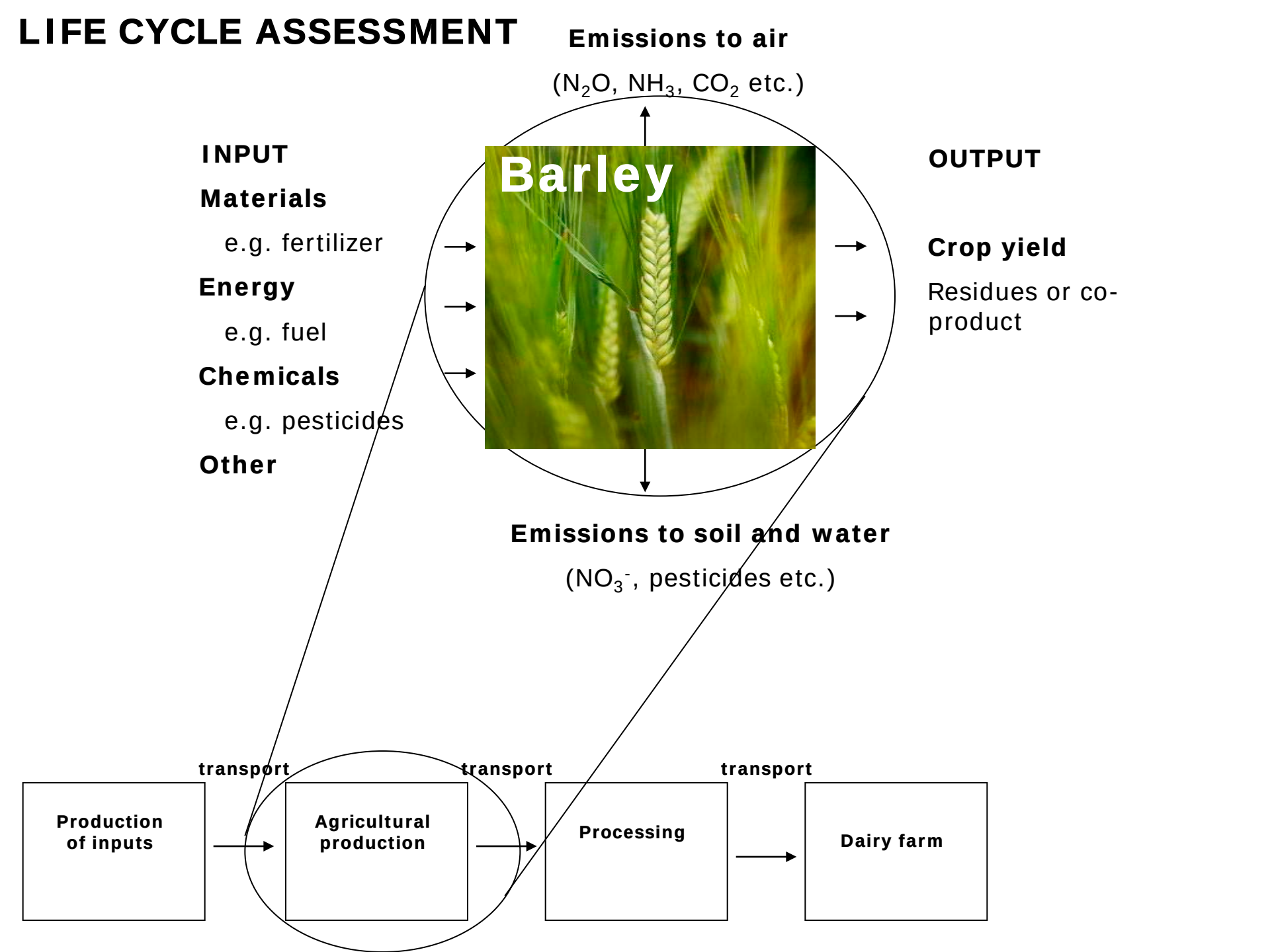
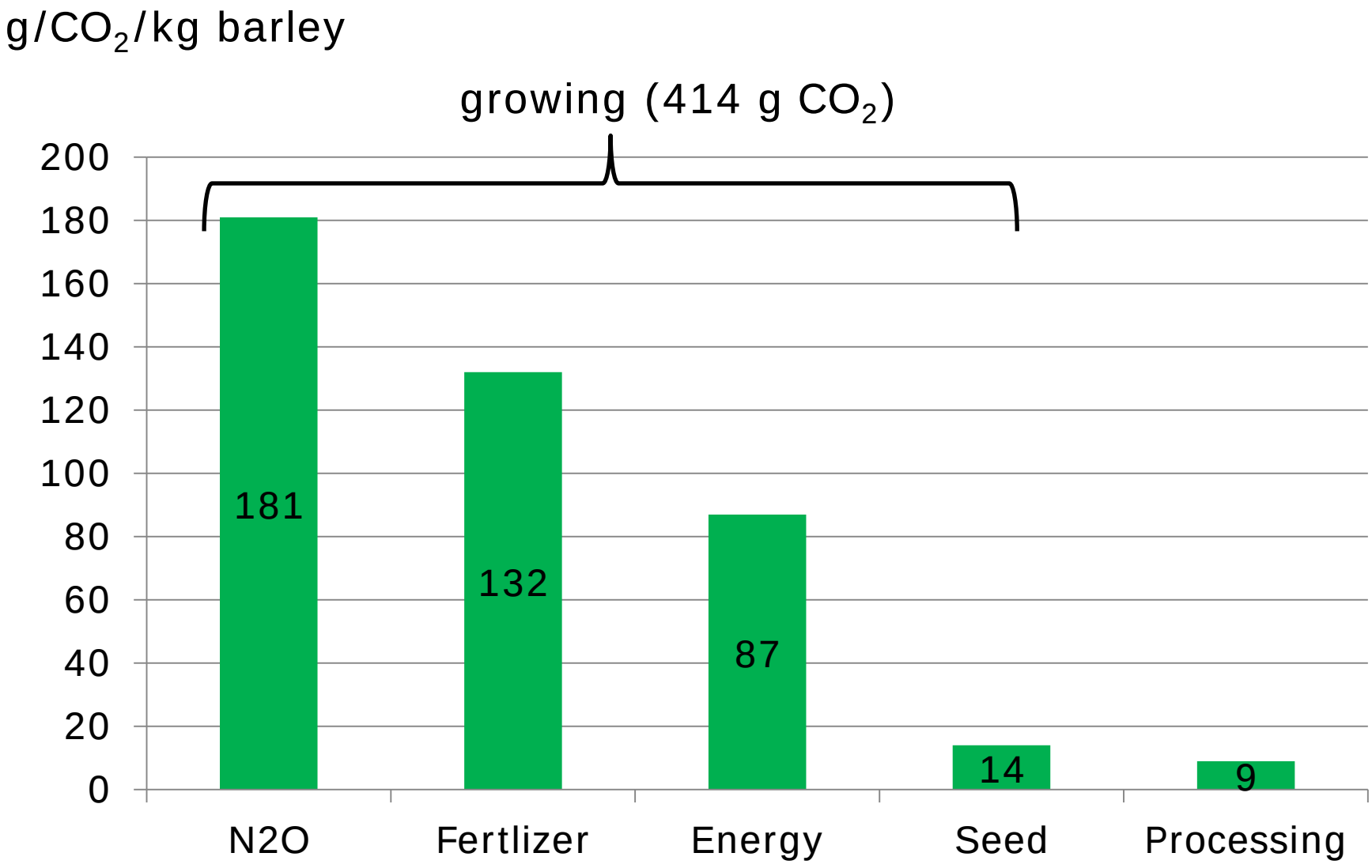
Outline

- Carbon footprint (CF) of feed by LCA
  - Growing and processing
  - Transport
  - Land Use Change (LUC) – deforestation
  - CF from carbon (C) changes in soil
- Effect of different feeding strategies
  - CF from feed combined with
  - CH_4 from enteric fermentation

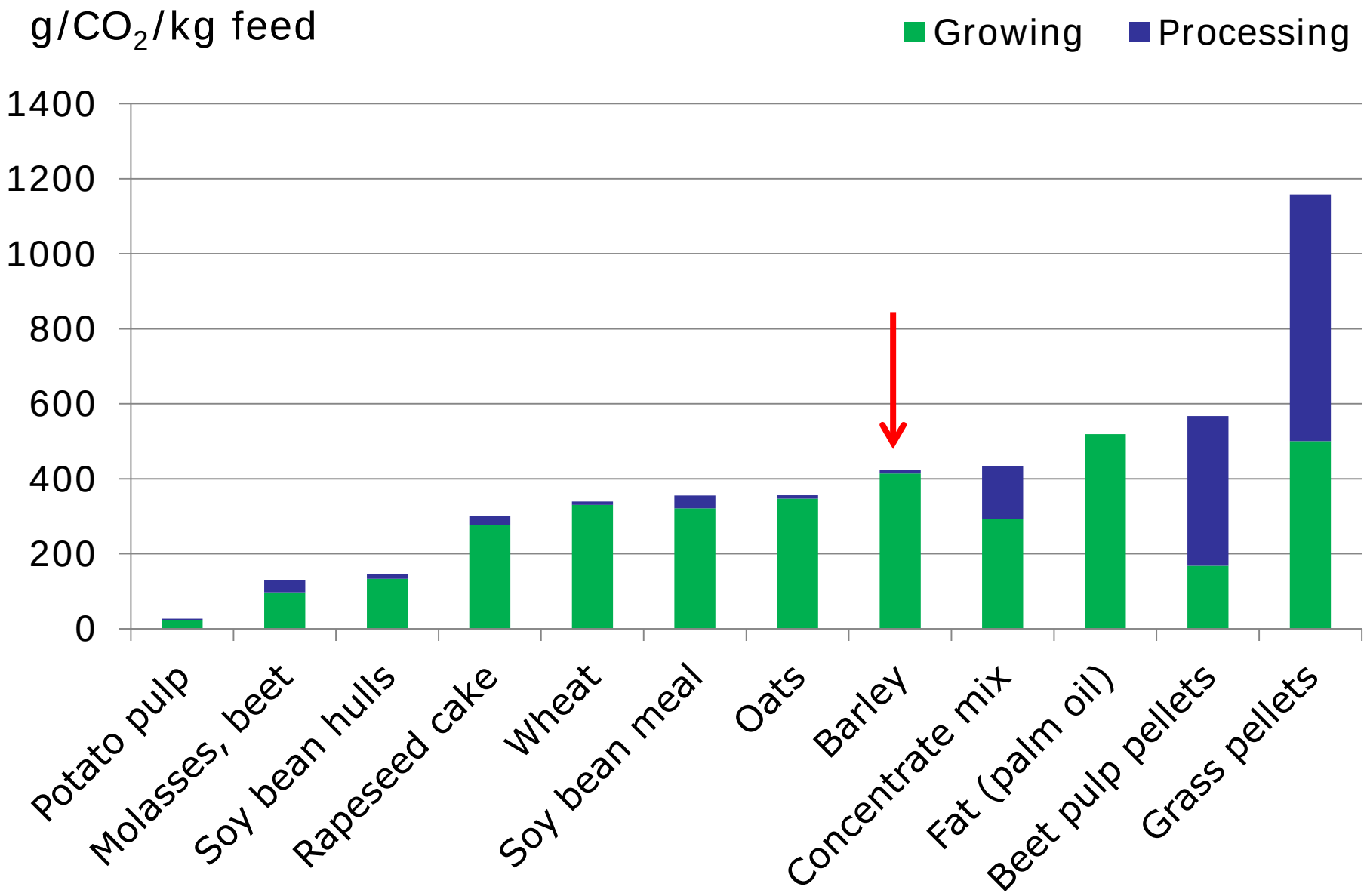
LIFE CYCLE ASSESSMENT



Carbon footprint of barley
- from growing and processing



Carbon Footprint of feed

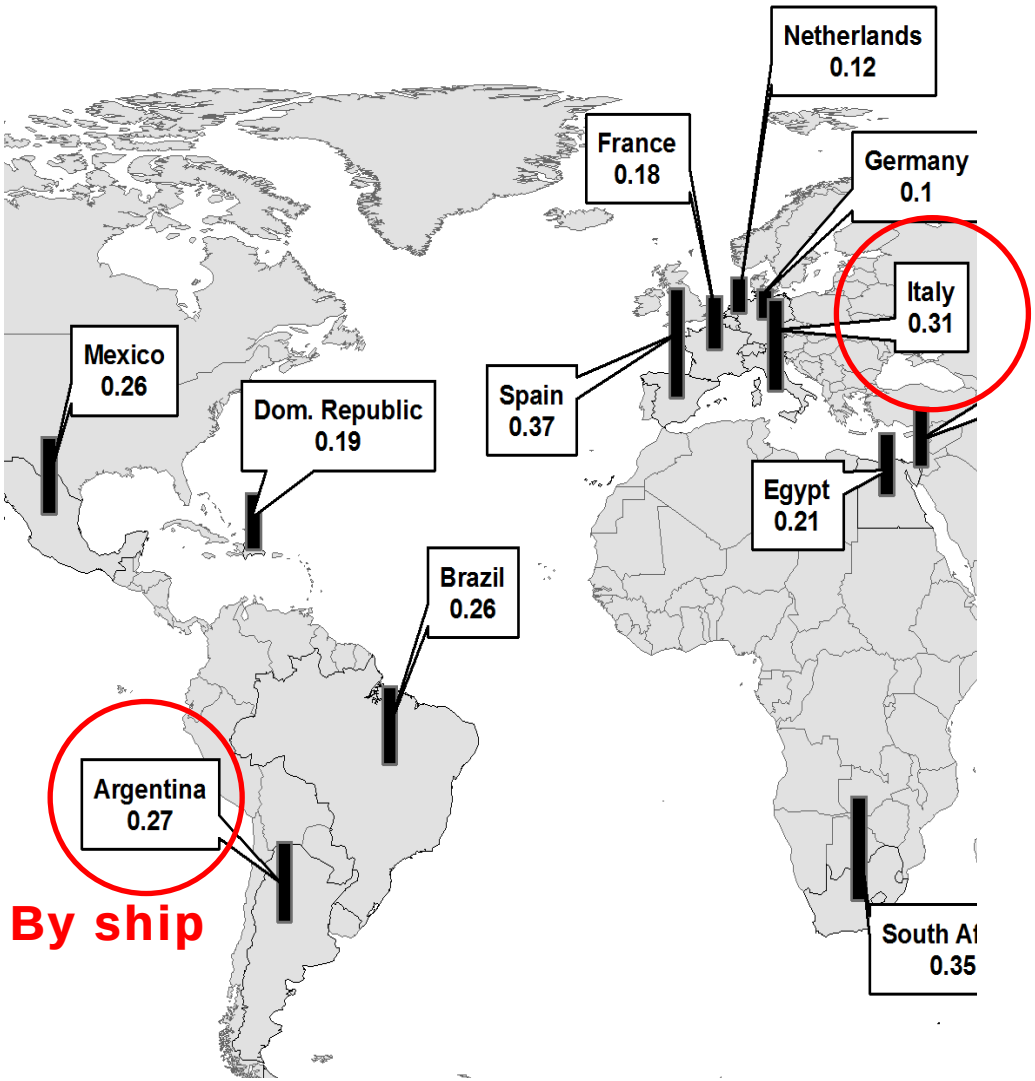


Emission of CO_2 from transport

	CO_2-eq, *g per tkm*
Ship	9
Lorry (40 t)	150
Lorry (28 t)	227
Lorry (16 t)	375
Train	40
Plane	1080

Transport of 1 kg product,

kg CO_2 eq /kg product



By lorry

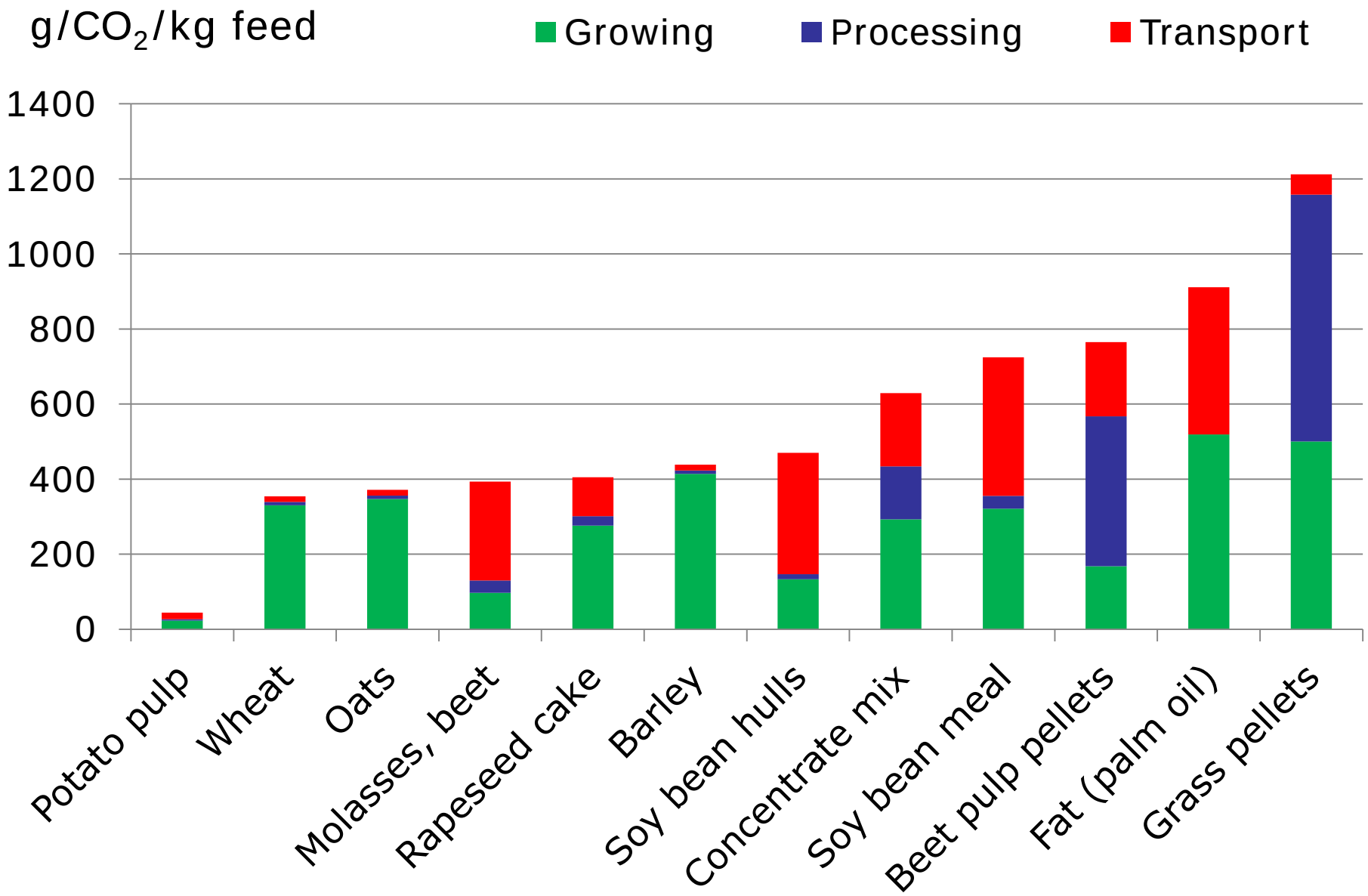
By ship

(Knudsen, M.T. 2011)

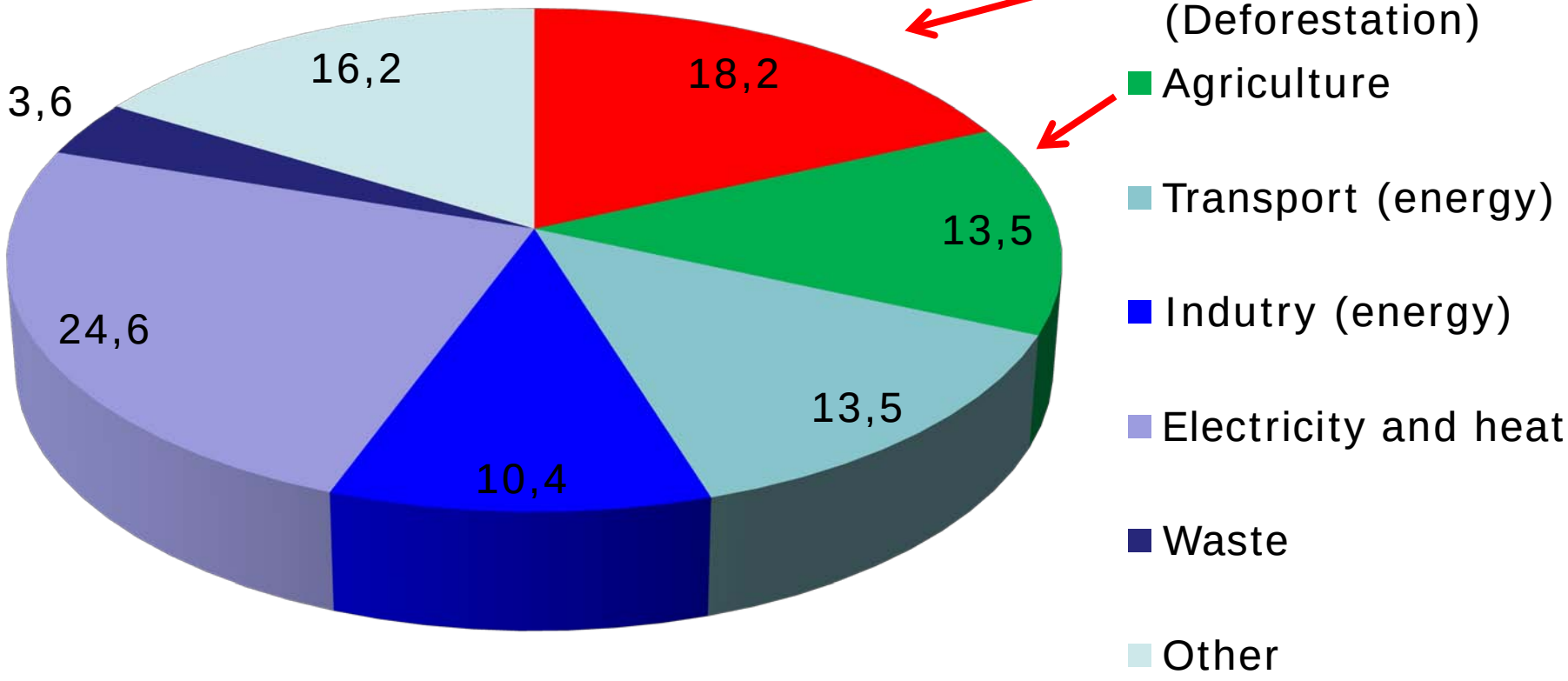
Transport of feed

Feed	Land of origin	To DK	To factory	To farm	Total
		CO_2/kg feed, g			
Barley	Denmark	0	9	6	15
Rapeseed cake	Denmark 47% Germany 53%	61	9	34	104
Soy bean meal	Argentina 73% Brazil 27%	342	0	27	369

Carbon Footprint of feed



World GHG emissions

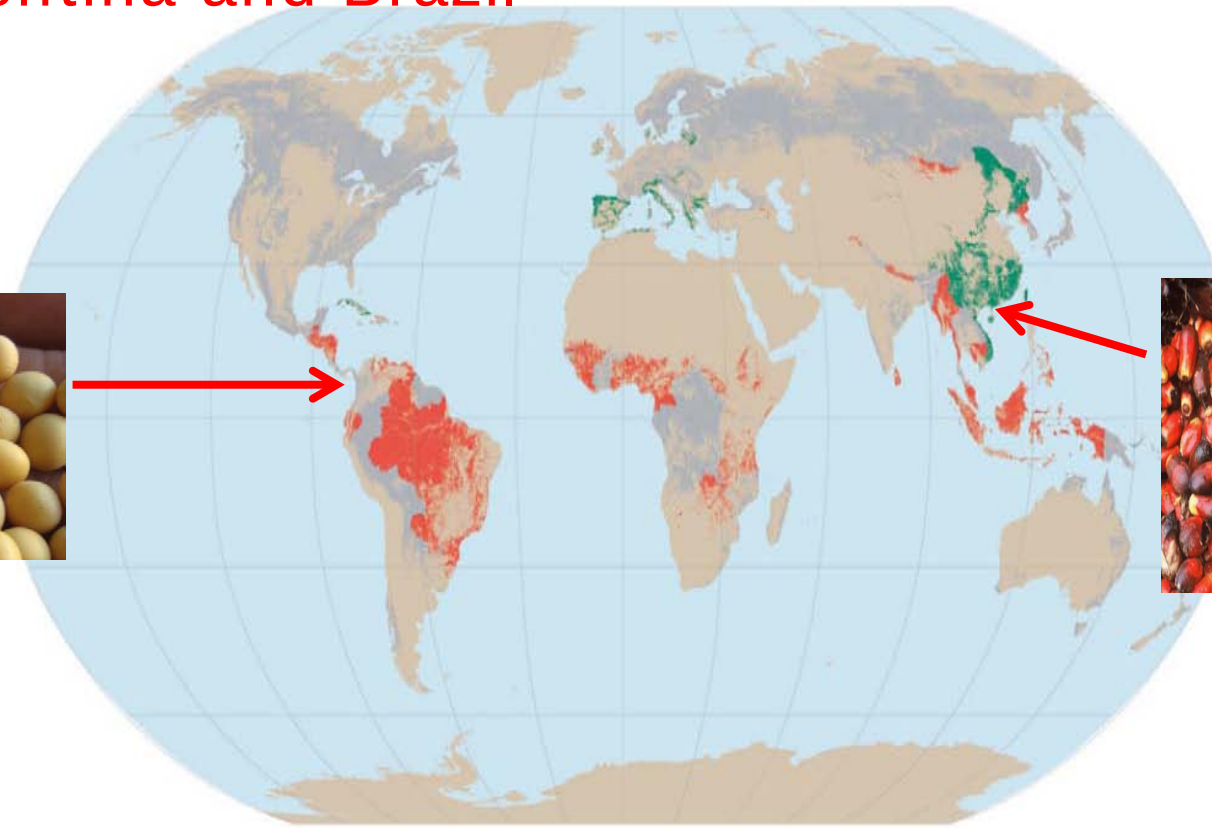


(Baumert et al., 2005. World Resources Institute)

Direct LUC

Soy bean meal
from Argentina and Brazil

Palm oil from Malaysia

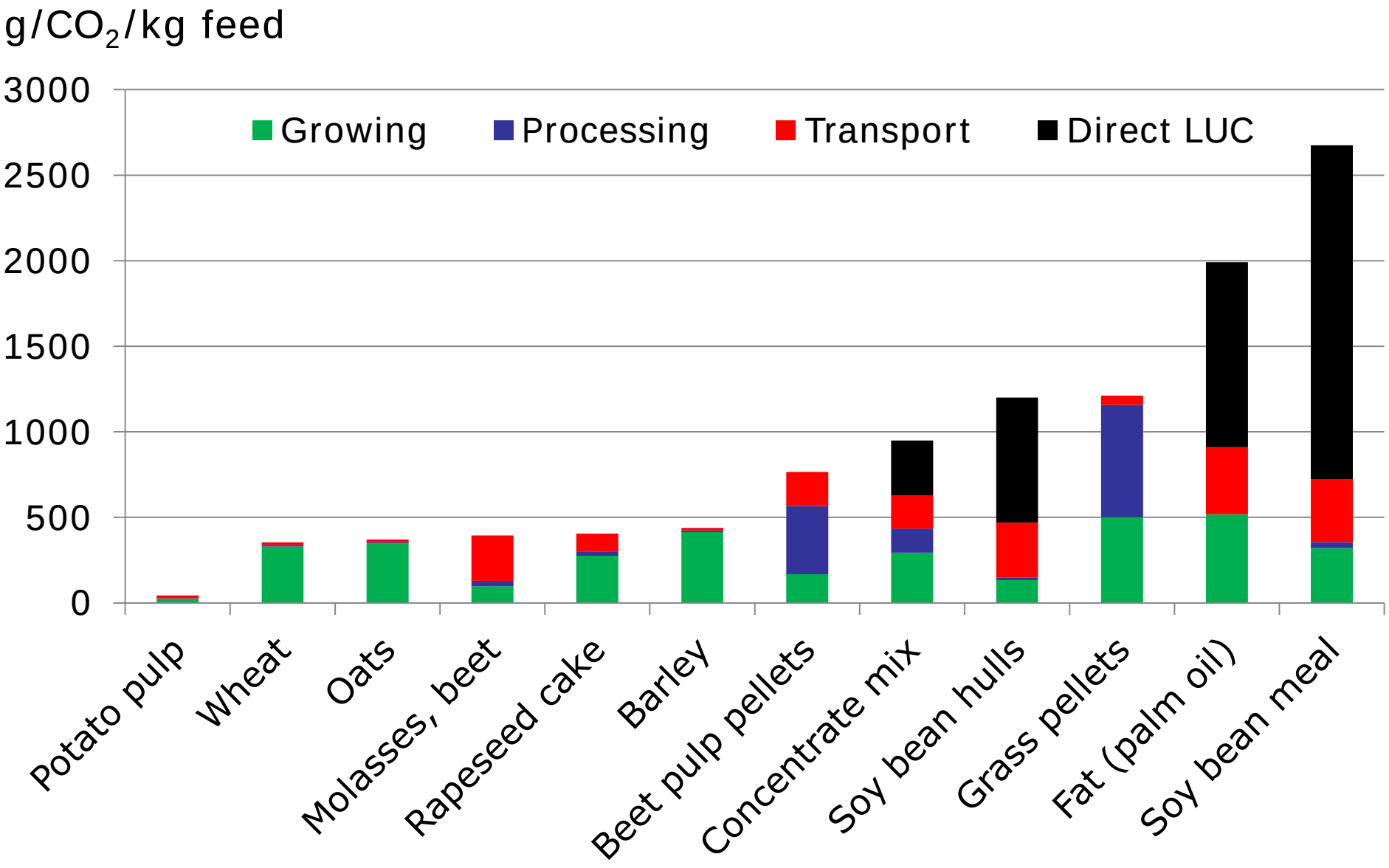


Direct LUC

Soy bean meal	
Direct LUC	$g\ CO_2/kg$
Argentina	930
Brazil	7690

(PAS2050, BSI, 2008)

CF of feed – incl. direct LUC



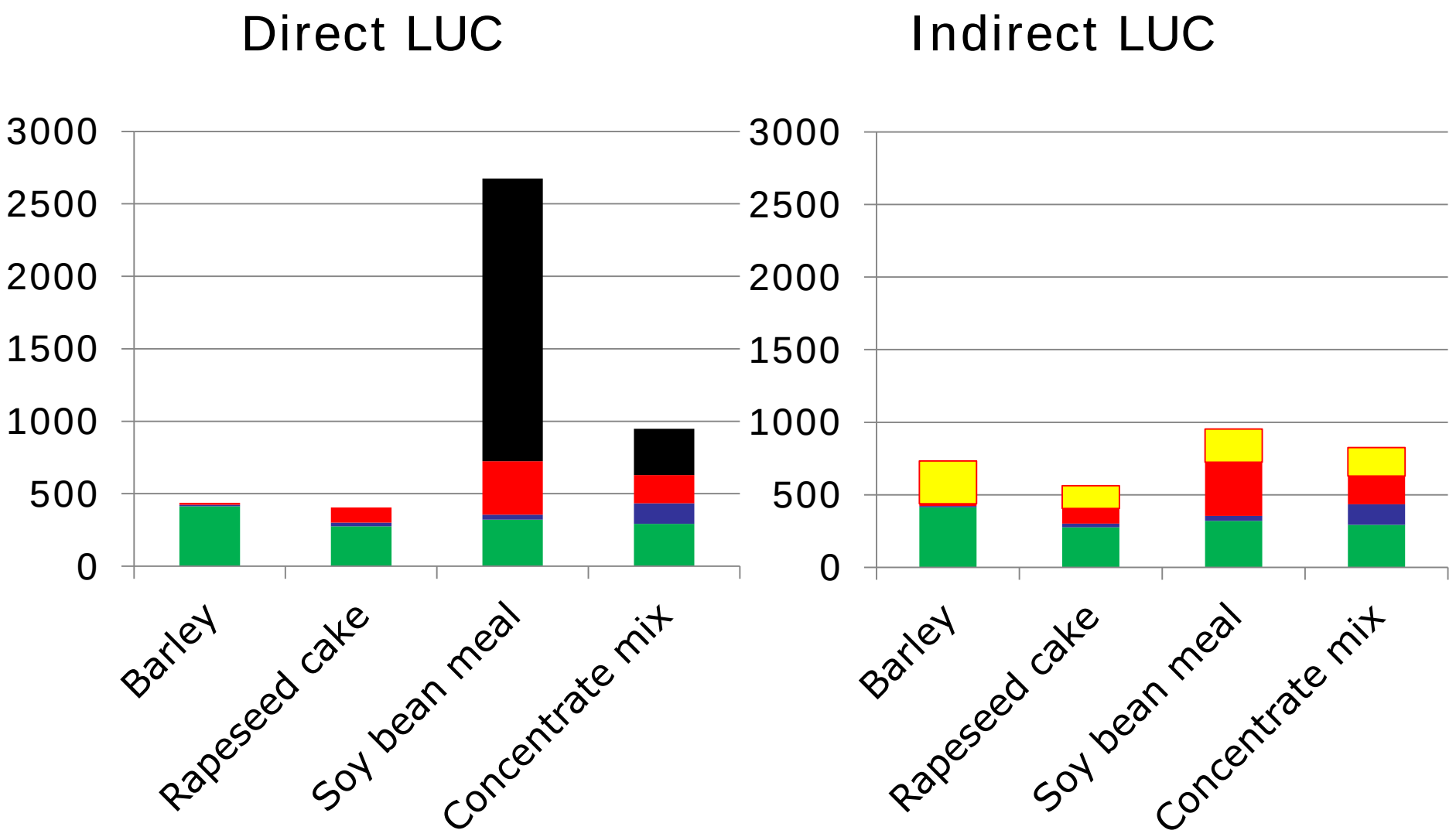
Method II: Indirect LUC

The burden of deforestation caused by food production is shared by all feed production (indirect LUC)

As the global demand for food increases, there will be increased pressure on land and thereby land use change somewhere in the world.

(Audsley et al., 2009)

Including LUC – which method?

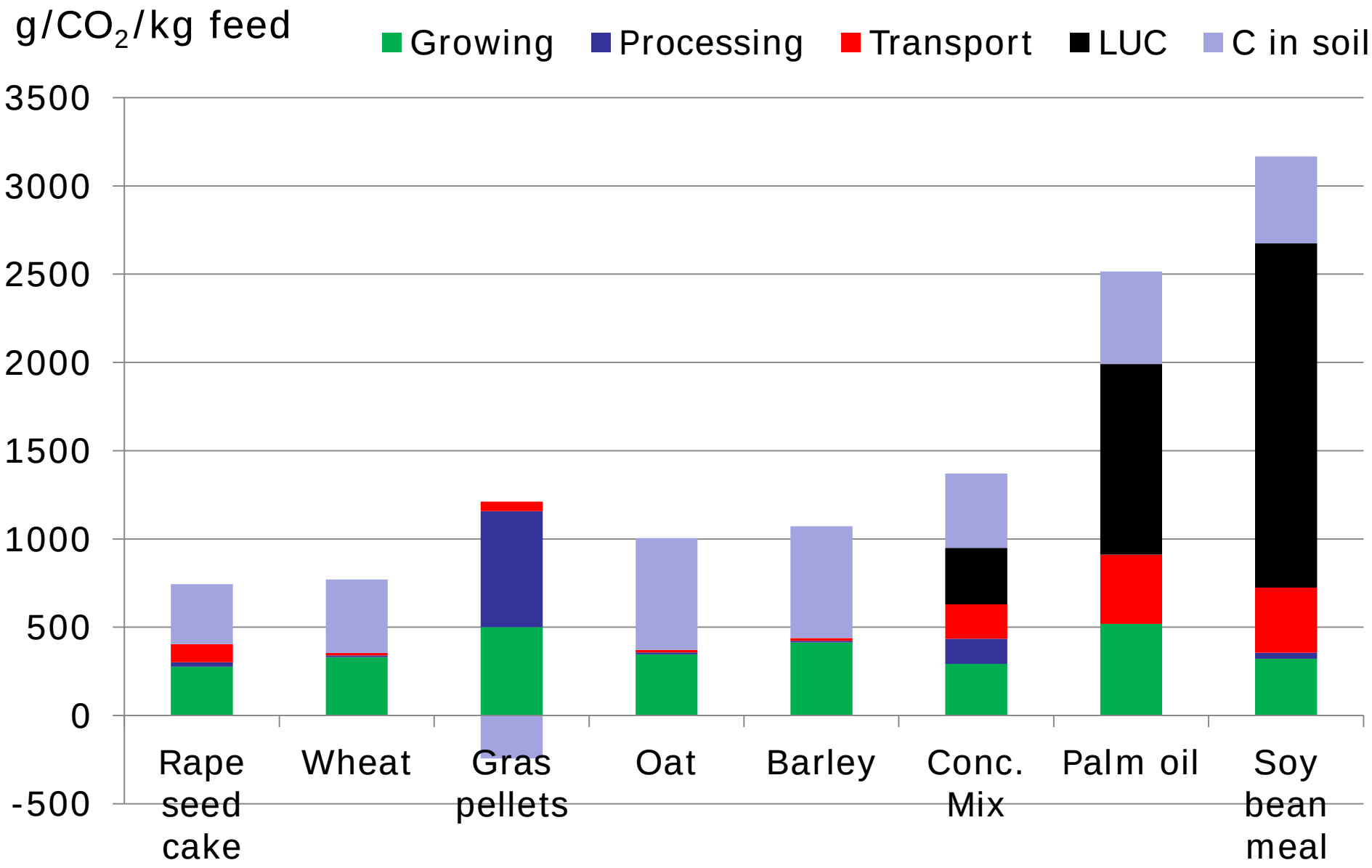


Impact of changes in soil carbon

	C in soil	kg CO_2eq/ha/year
Grass	sink	- 1910
Other crops	release	+ 3080

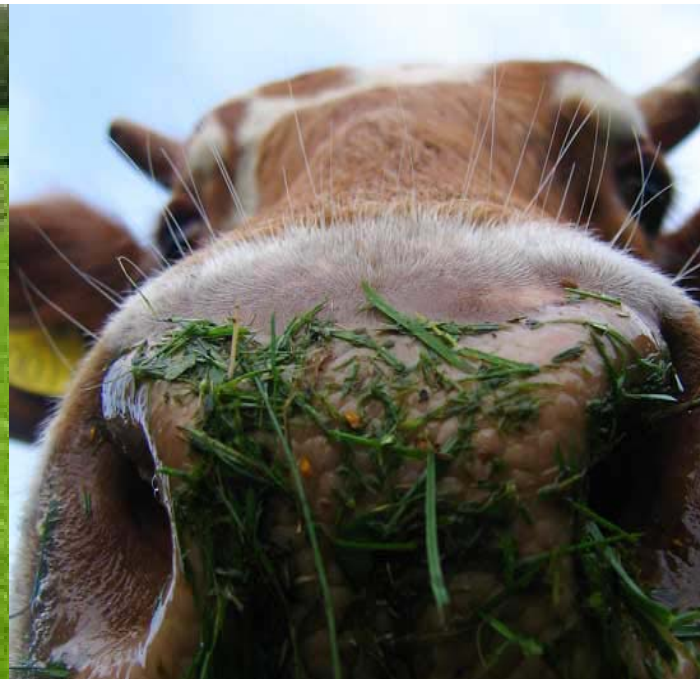
(Vleeshouwers & Verhagen, 2002)

CF of feed , g CO_2/kg



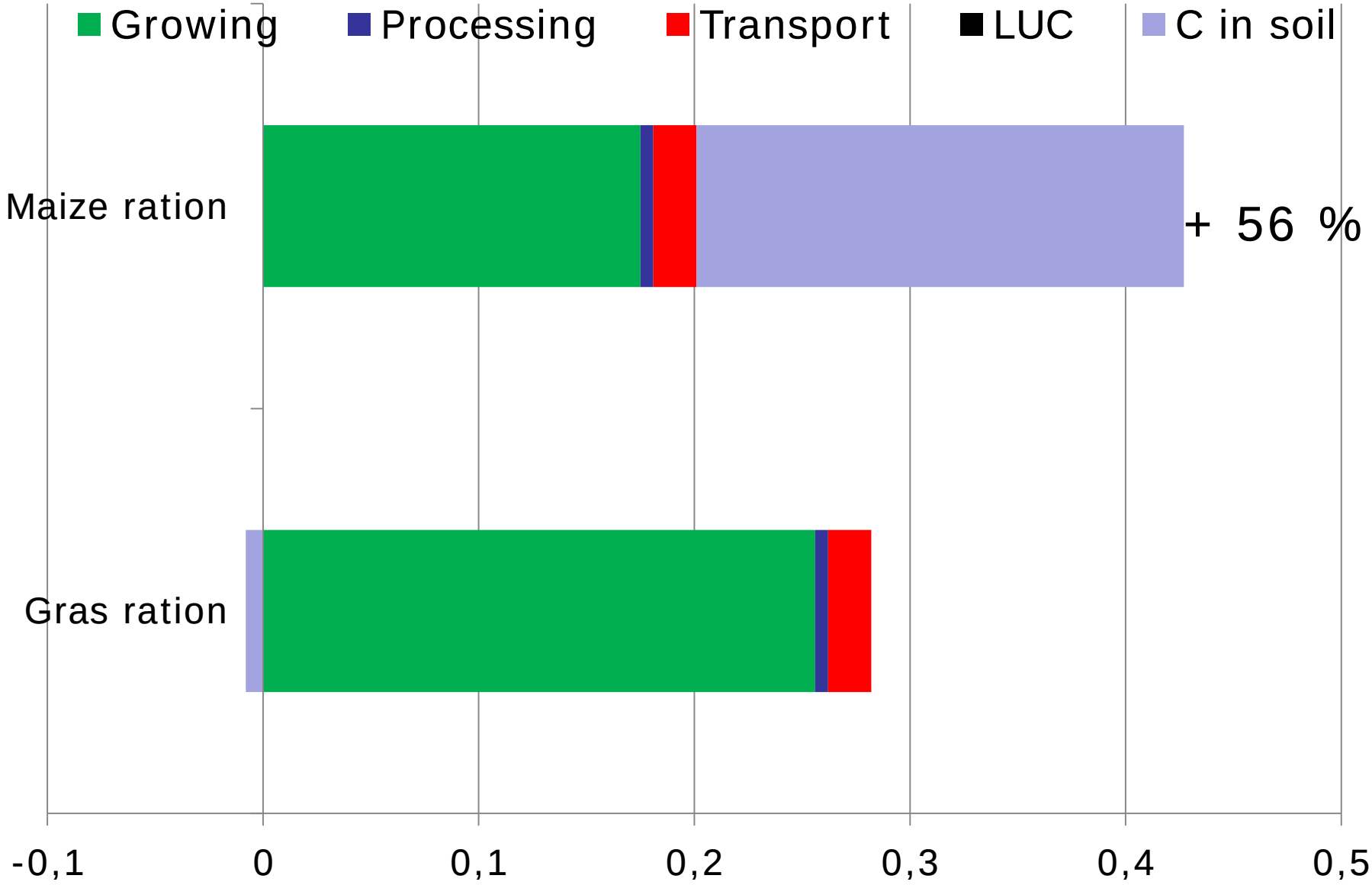
1. Feed rations based on silage:

Grass silage vs. maize silage

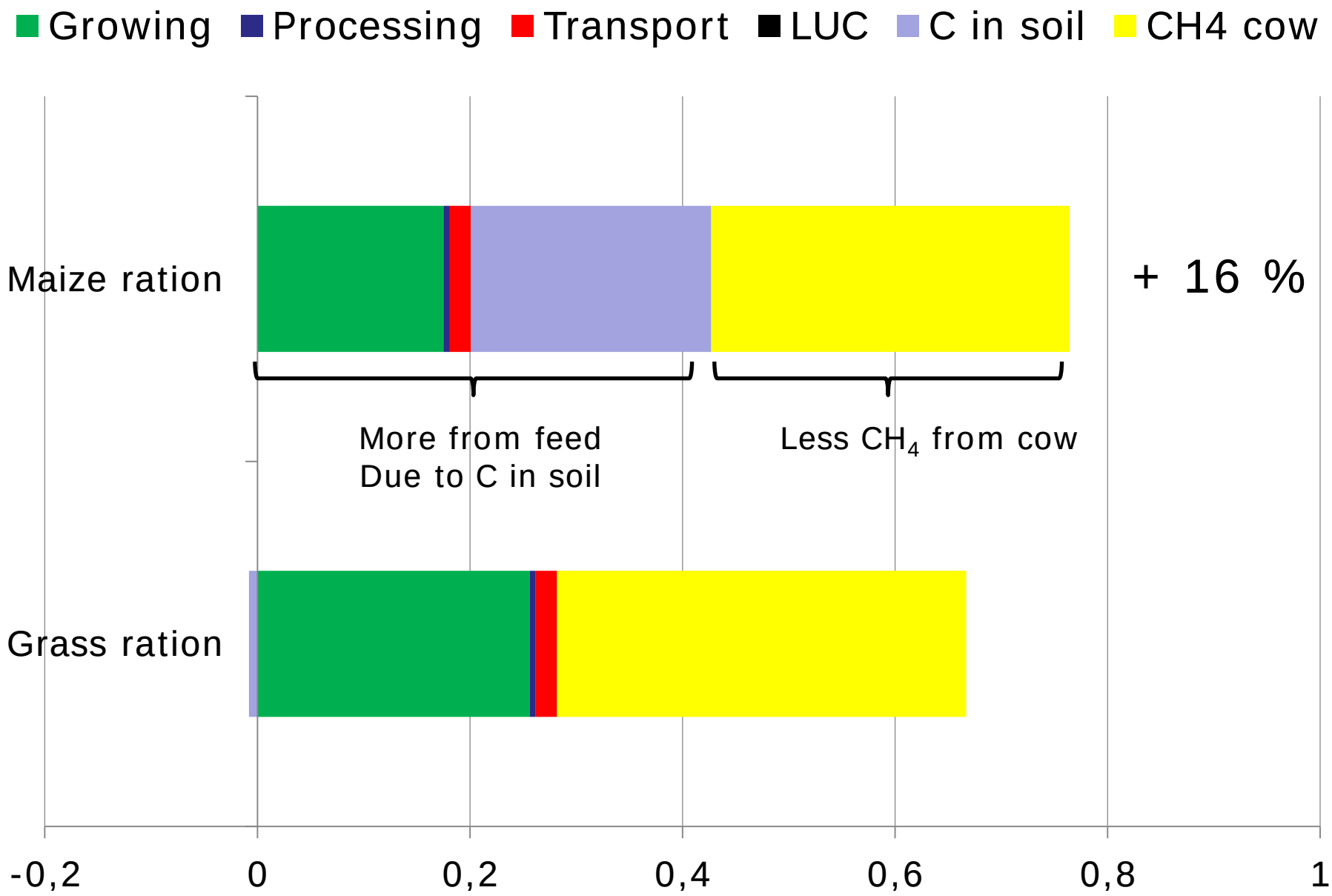


Ration	Grass silage	Maize silage
Feed intake, kg DM / d:		
Wheat	1.6	1.7
Rape seed cake	4.1	4.2
Grass silage	11.0	0
Maize silage	0	11.2
Total	16.6	17.1
Milk production:		
Kg ECM/day	23.9	24.3
CH_4:		
liter/day	516	474
CO_2-eq, g/kg ECM	385 **(114)**	337 **(100)**

GHG from feed, kg CO_2/kg ECM

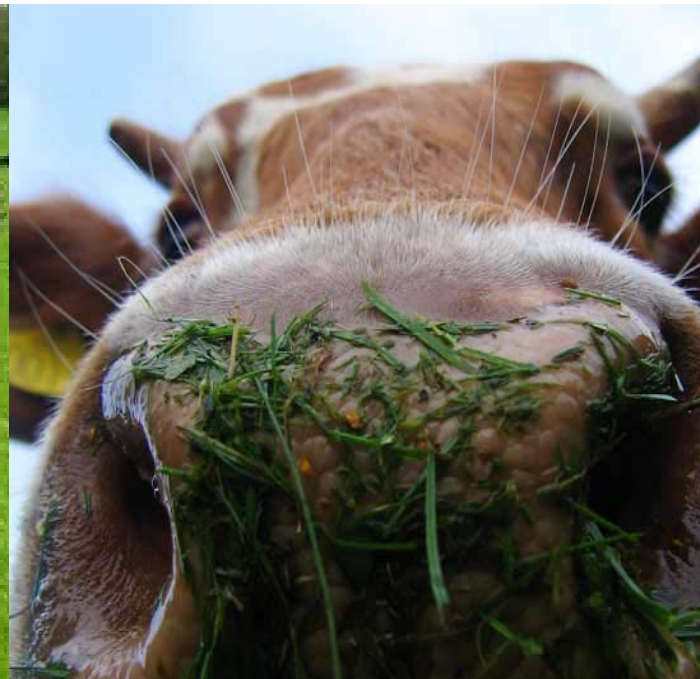


GHG from feed + CH_4 from cow, kg CO_2/kg ECM



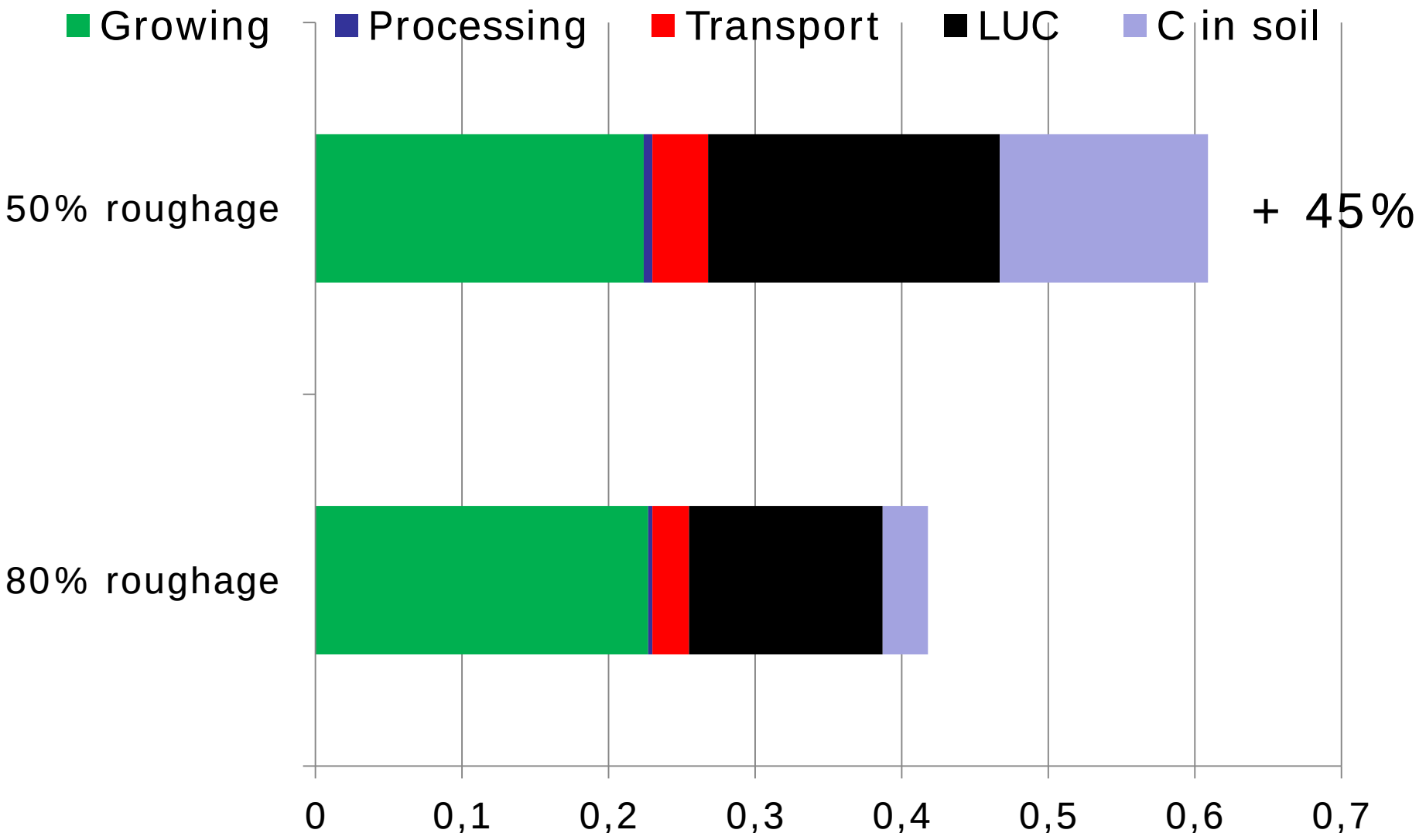
2. Roughage : Concentrate ratio

80 versus 50 % roughage

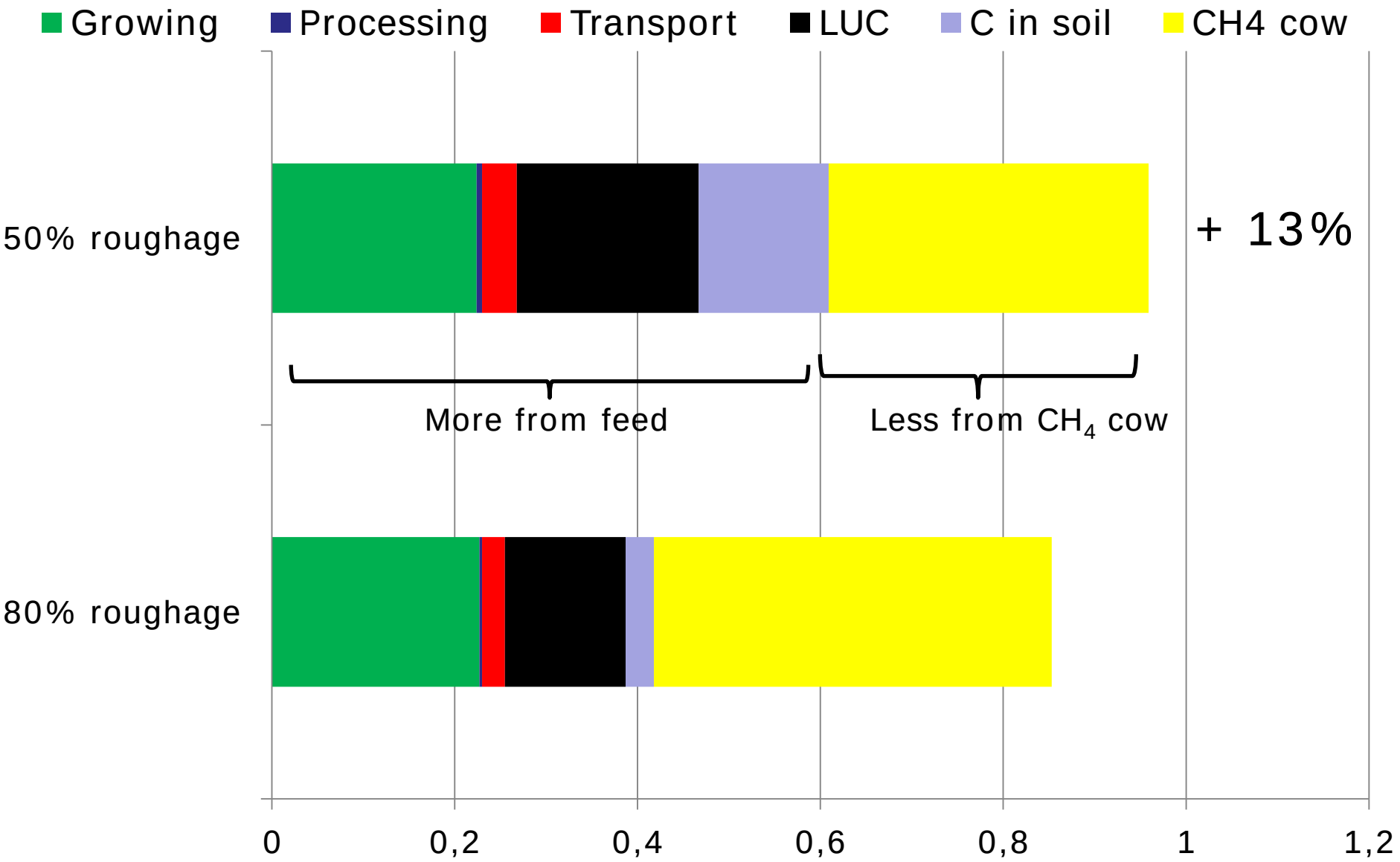


Ration	80% roughage	50% roughage
Feed intake, kg DM/d		
Wheat	2,0	6,9
Soybean meal	1,8	2,7
Maize silage	5,6	3,4
Grass silage	11,1	6,8
Total	20,4	19,8
Milk production:		
Kg ECM/d	30,2	30,1
CH_4:		
liter/dag	700	617
CO_2-eq, g/kg ECM	435 **(124)**	350 **(100)**

GHG from feed, kg CO_2/kg ECM

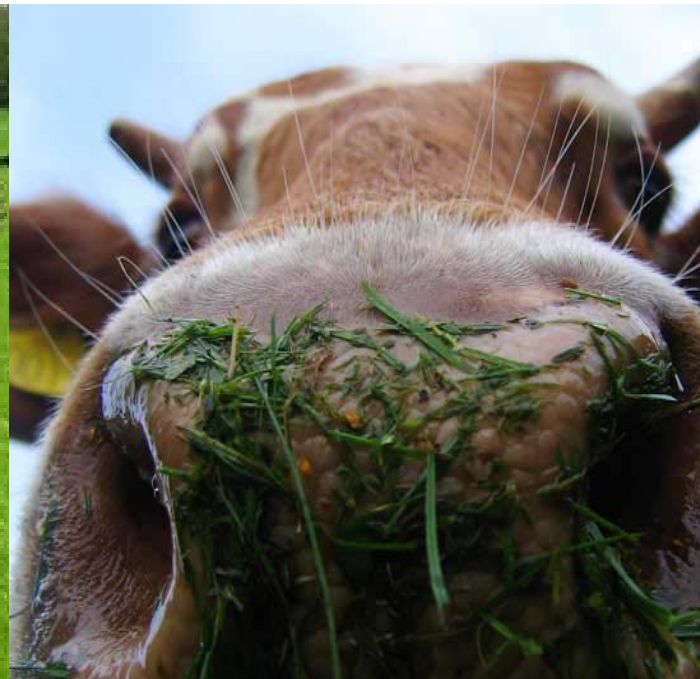


GHG from feed + CH_4 from cow, kg CO_2/kg ECM



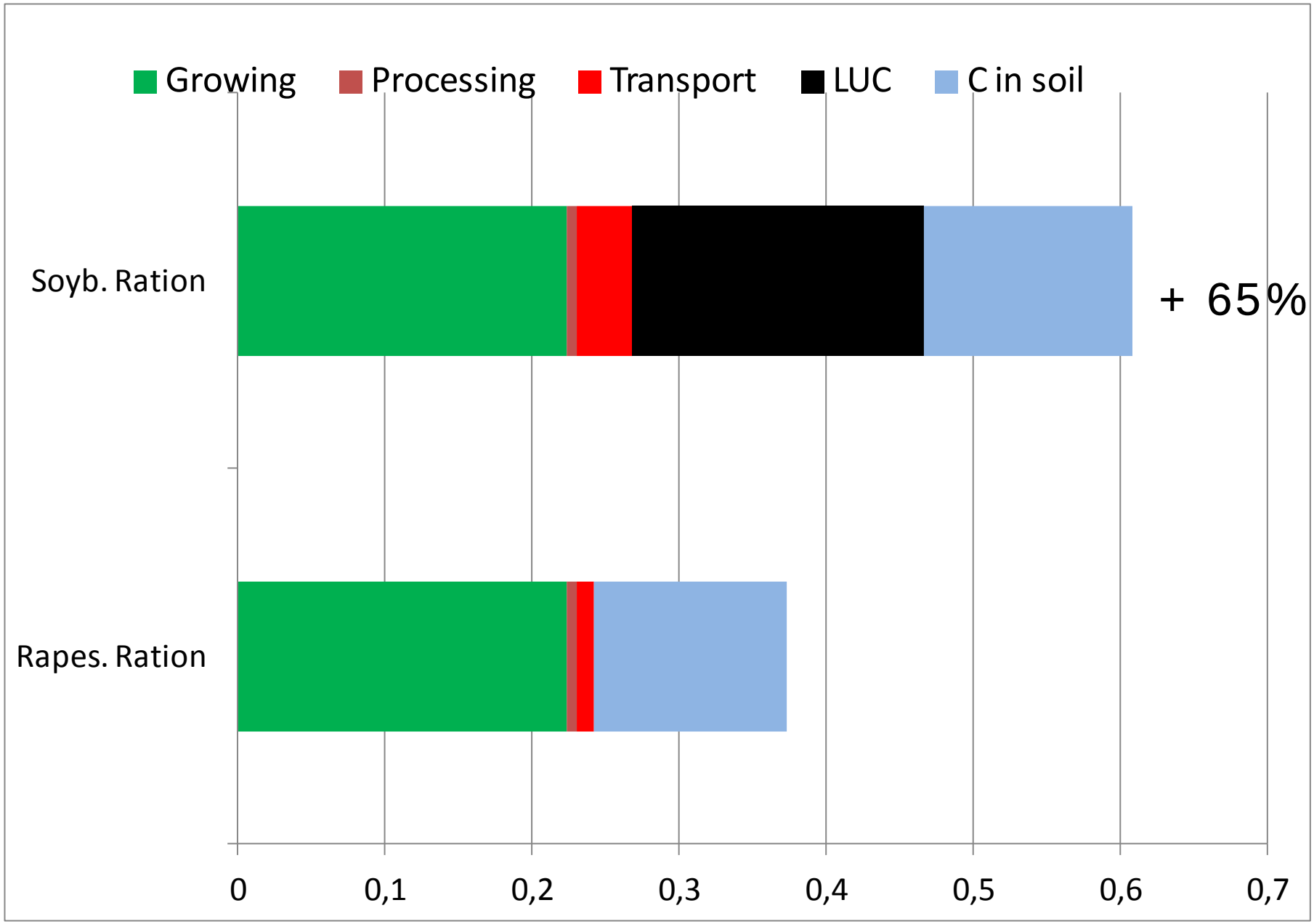
3. Type of protein feed

Rapeseed cake *versus* Soybean meal

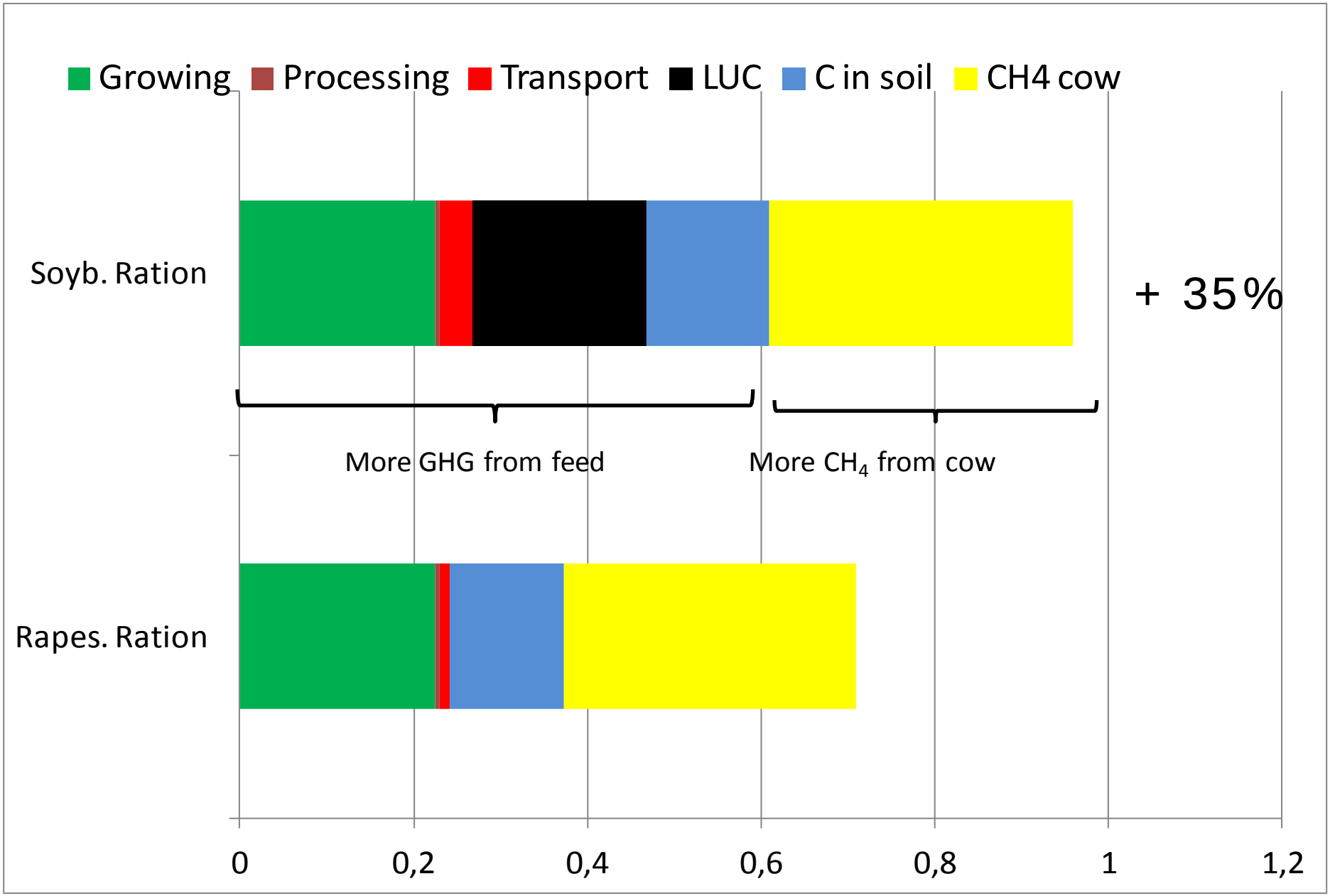


Ration- 50% roughage	Rapeseed cake	Soybean meal
Feed intake, kg DM/d		
Wheat	6.9	6.9
Soybean meal	0	2.7
Rapeseed cake	3.2	0
Maize silage	3.4	3.4
Grass silage	6.8	6.8
Total	19.8	19.8
Milk production:		
Kg ECM/d	30.1	30.1
CH_4		
liter/d	593	617
CO_2-eq, g/kg ECM	337 **(96)**	350 **(100)**

GHG from feed, kg CO_2/kg ECM



GHG from feed + CH_4 from cow, kg CO_2eq/kg ECM



Conclusion

- Carbon footprint per kg milk (from feed production and enteric CH_4) can be reduced by choice of feed:
  - Rapeseed cake in stead of soybean meal

    (though mainly caused by LUC)
  - Increased Roughage : concentrate ratio?

    (depend also on type of concentrated feed)
  - Grass-clover silage >< maize silage ?

    (depend on how contribution from C sequestration in soil is included)

Conclusion II

- Carbon footprint from feed production:
  - Contribution from ‘Land Use Change (LUC) - deforestation’ and ‘changes in soil C’ are often hotspots in the calculation
  - Methods needs to be further developed

- Emissions from produced manure will also be affected by feeding strategy – not included
  - Methods and further development needed