

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

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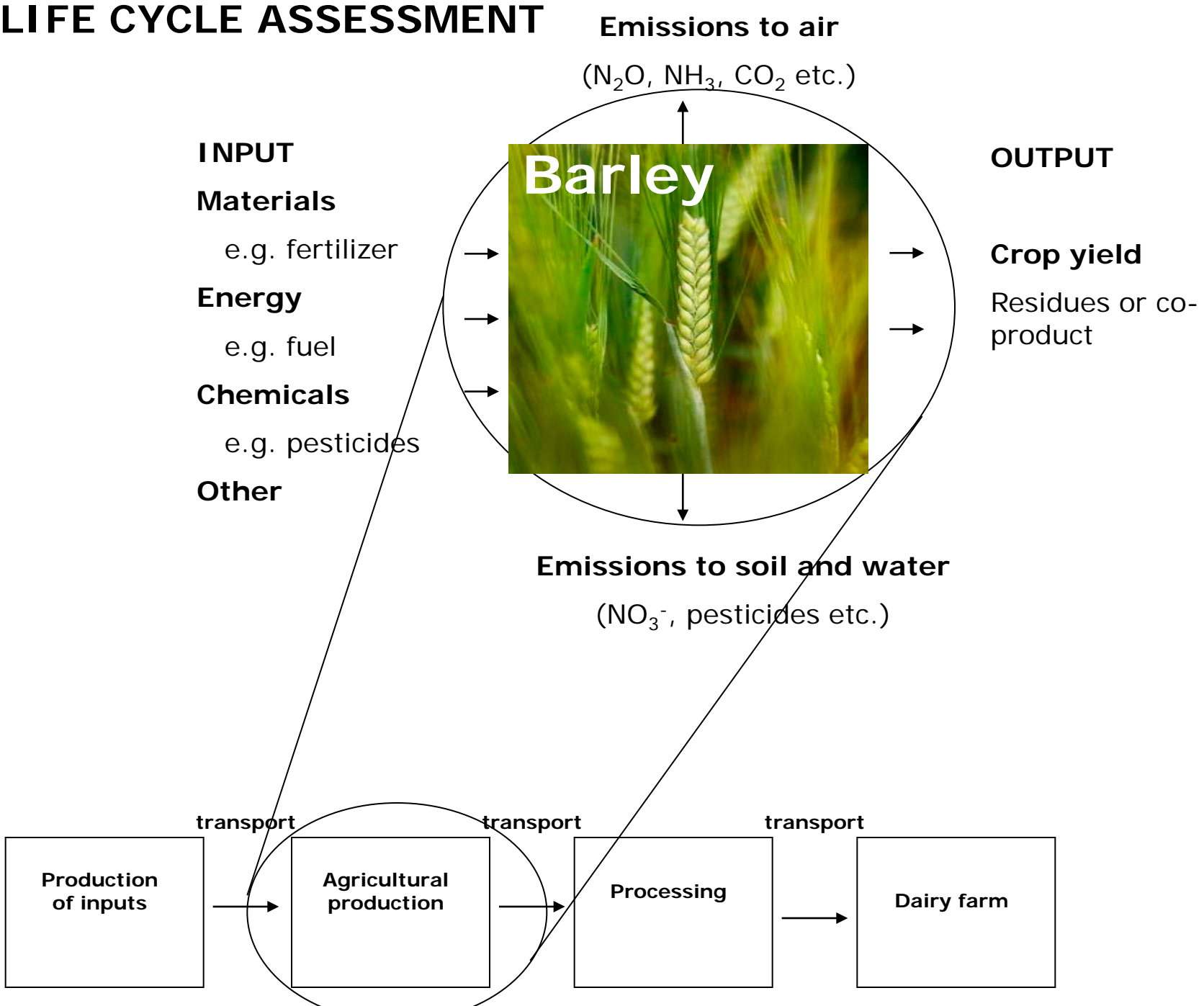
Maike Brask, Anne Louise F. Hellwing, Peter Lund, Martin R. Weisbjerg



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
 - CH₄ from enteric fermentation

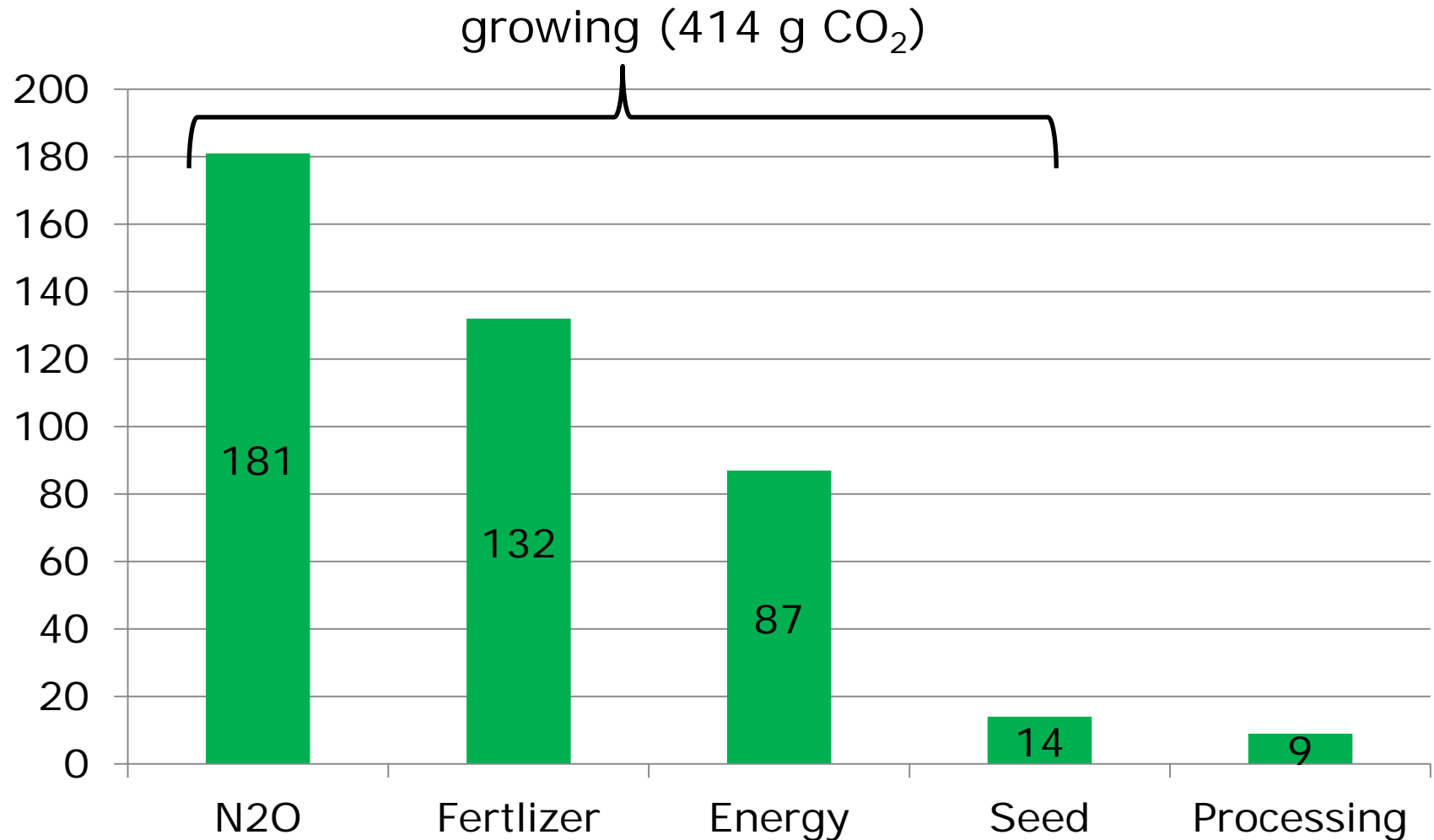
LIFE CYCLE ASSESSMENT



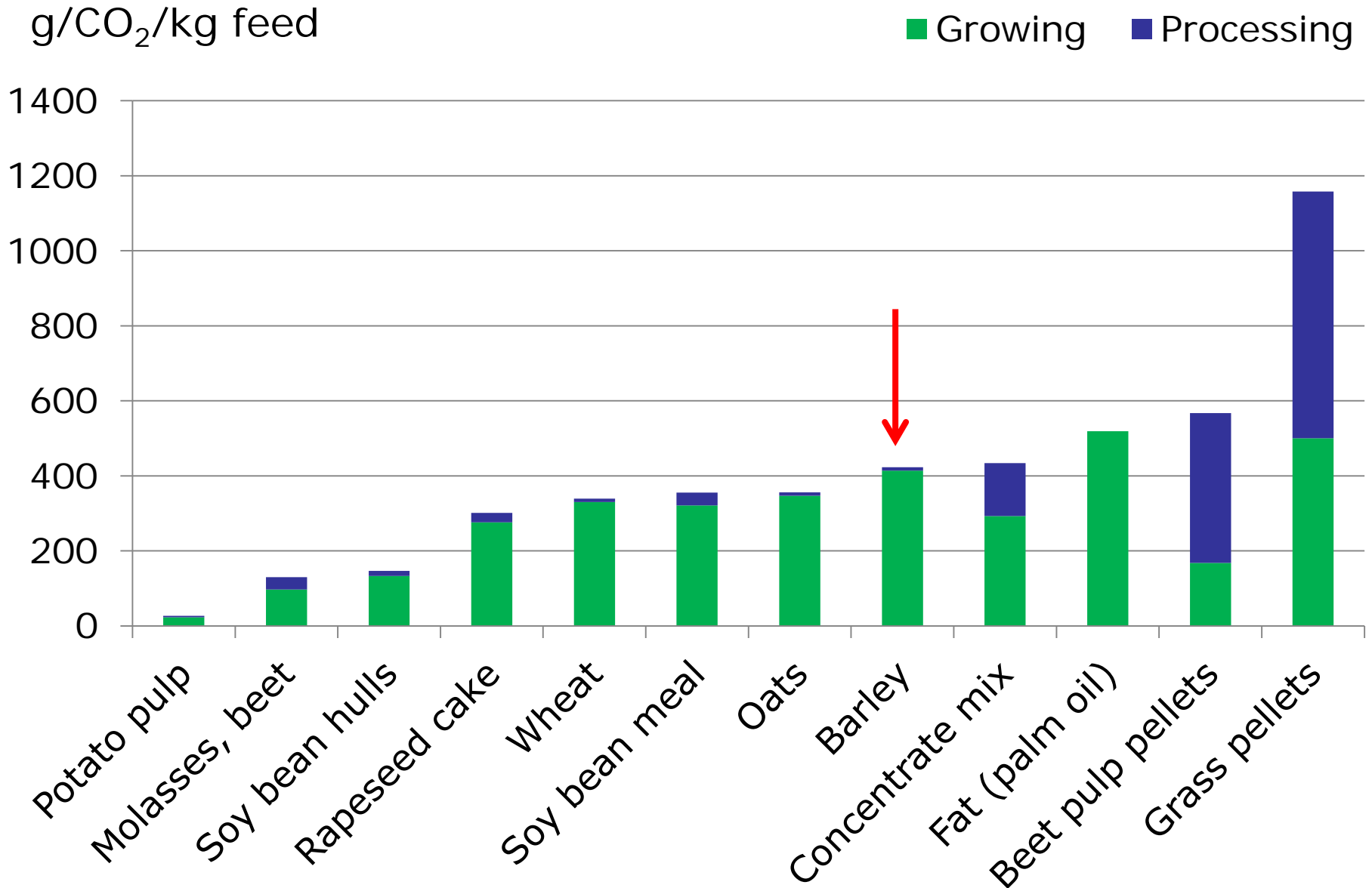
Carbon footprint of barley

- from growing and processing

g/CO₂/kg barley



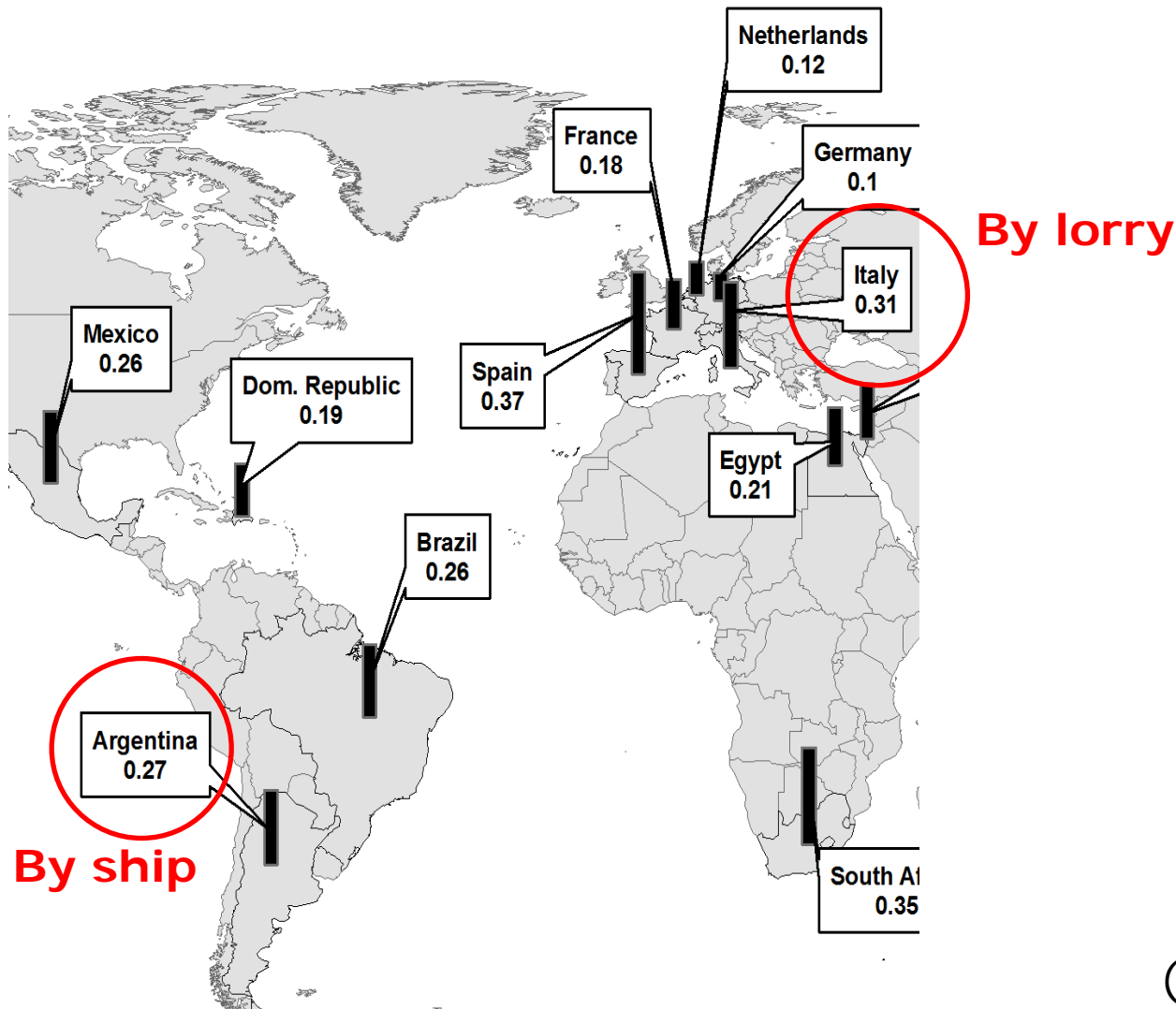
Carbon Footprint of feed



Emission of CO₂ from transport

	CO ₂ -eq, <i>g per tkm</i>
Ship	9
Lorry (40 t)	150
Lorry (28 t)	227
Lorry (16 t)	375
Train	40
Plane	1080

Transport of 1 kg product, kg CO₂ eq /kg product



(Knudsen, M.T. 2011)

Transport of feed

Feed	Land of origin	To DK	To factory	To farm	Total
		<i>CO₂/kg feed, g</i>			
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

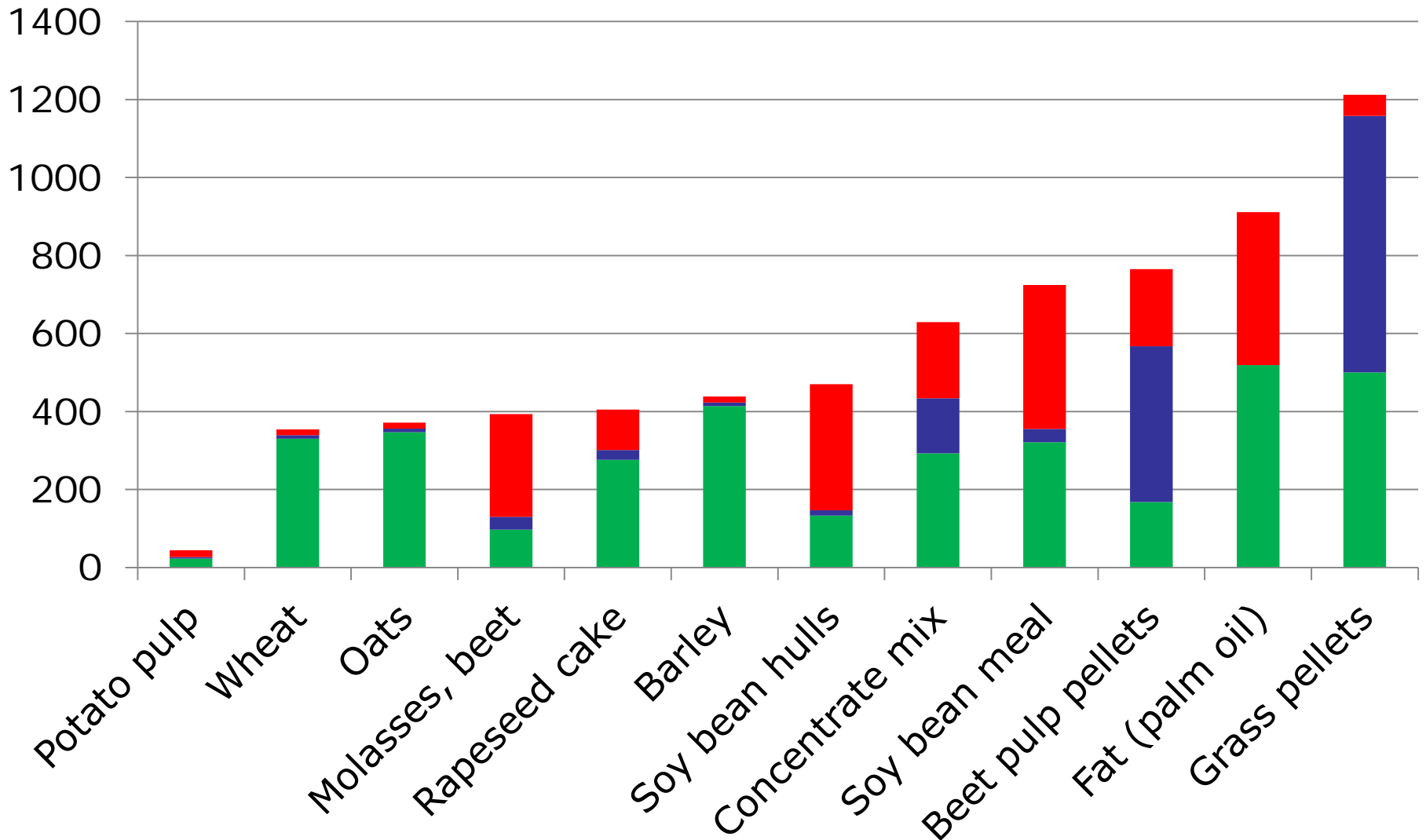
Carbon Footprint of feed

g/CO₂/kg feed

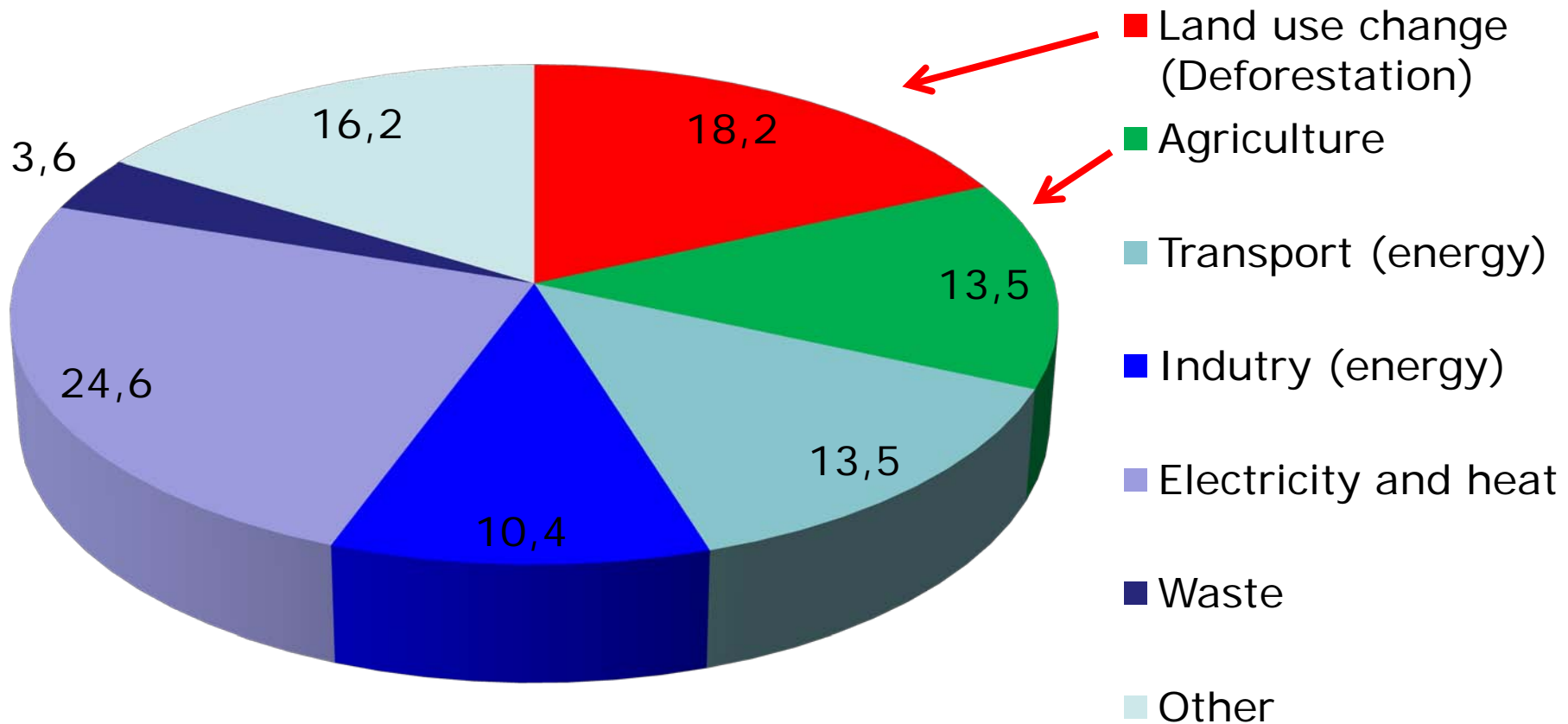
■ Growing

■ Processing

■ Transport



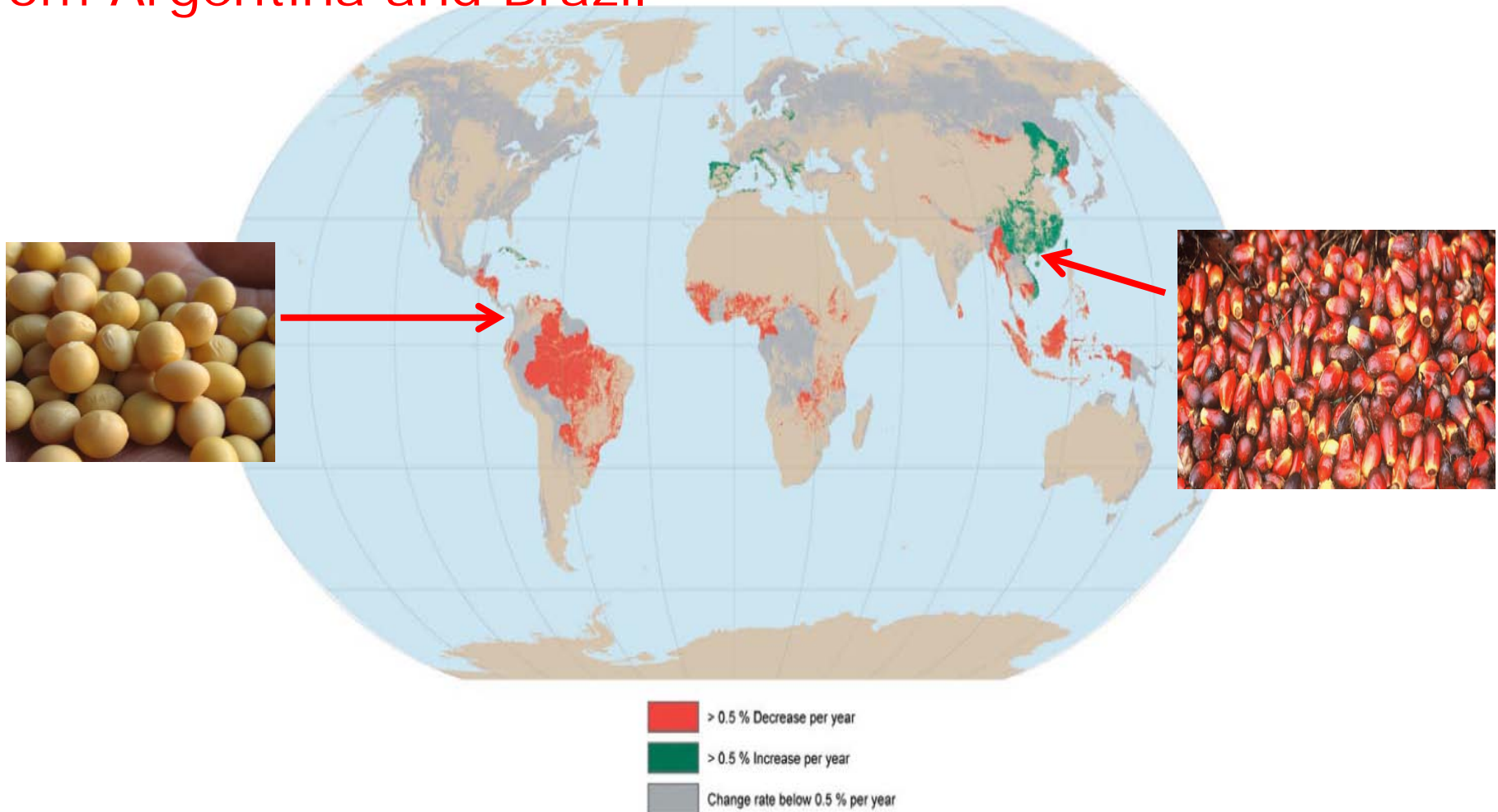
World GHG emissions



Direct LUC

Soy bean meal
from Argentina and Brazil

Palm oil from Malaysia



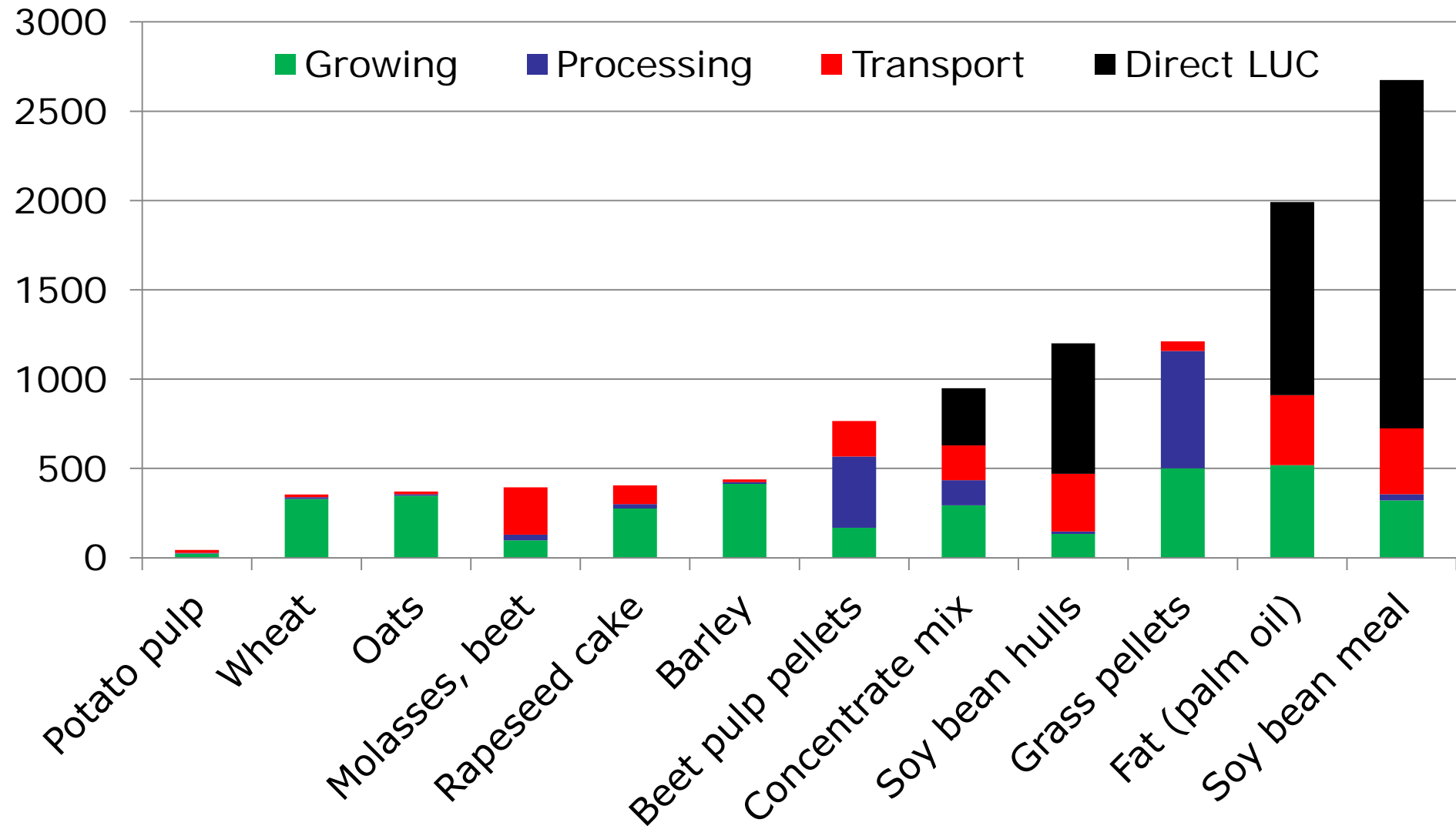
Direct LUC

Soy bean meal

Direct LUC	<i>g CO₂/kg</i>
Argentina	930
Brazil	7690

CF of feed – incl. direct LUC

g/CO₂/kg feed



Method II: Indirect LUC

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

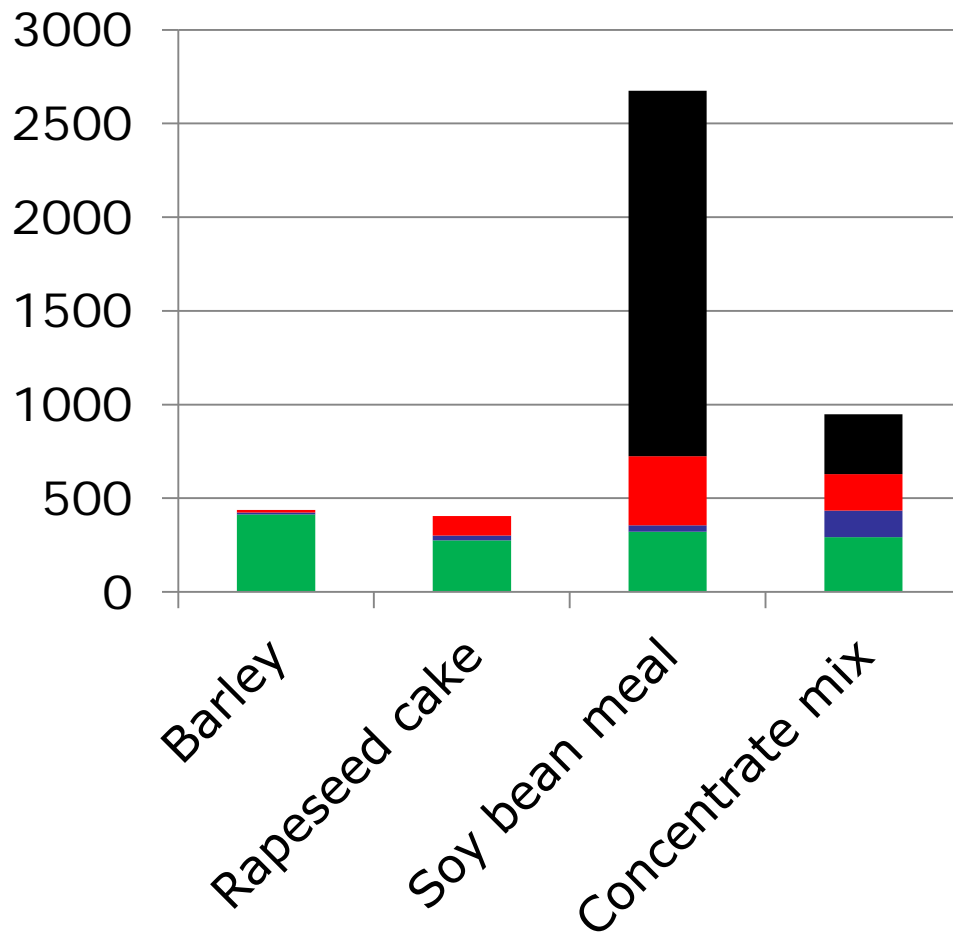
As the global demand for food increases, there will be increased pressure on land and thereby land use change somewhere in the world.

(Audsley et al., 2009)

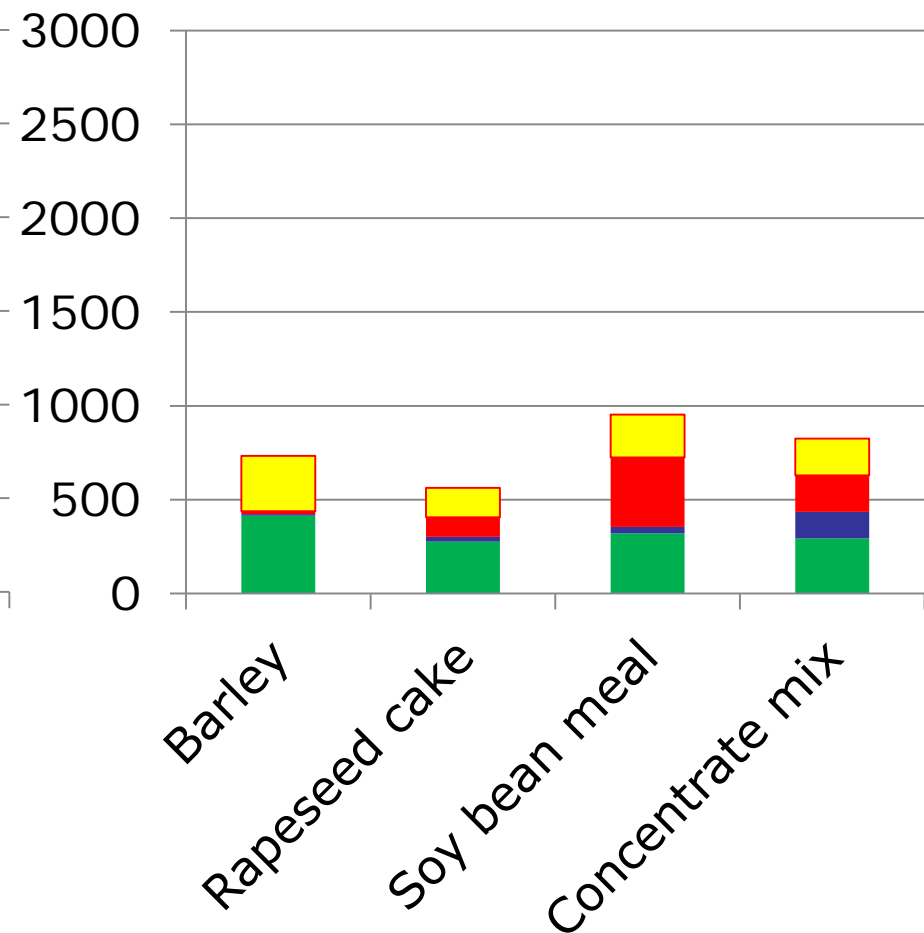


Including LUC – which method?

Direct LUC



Indirect LUC

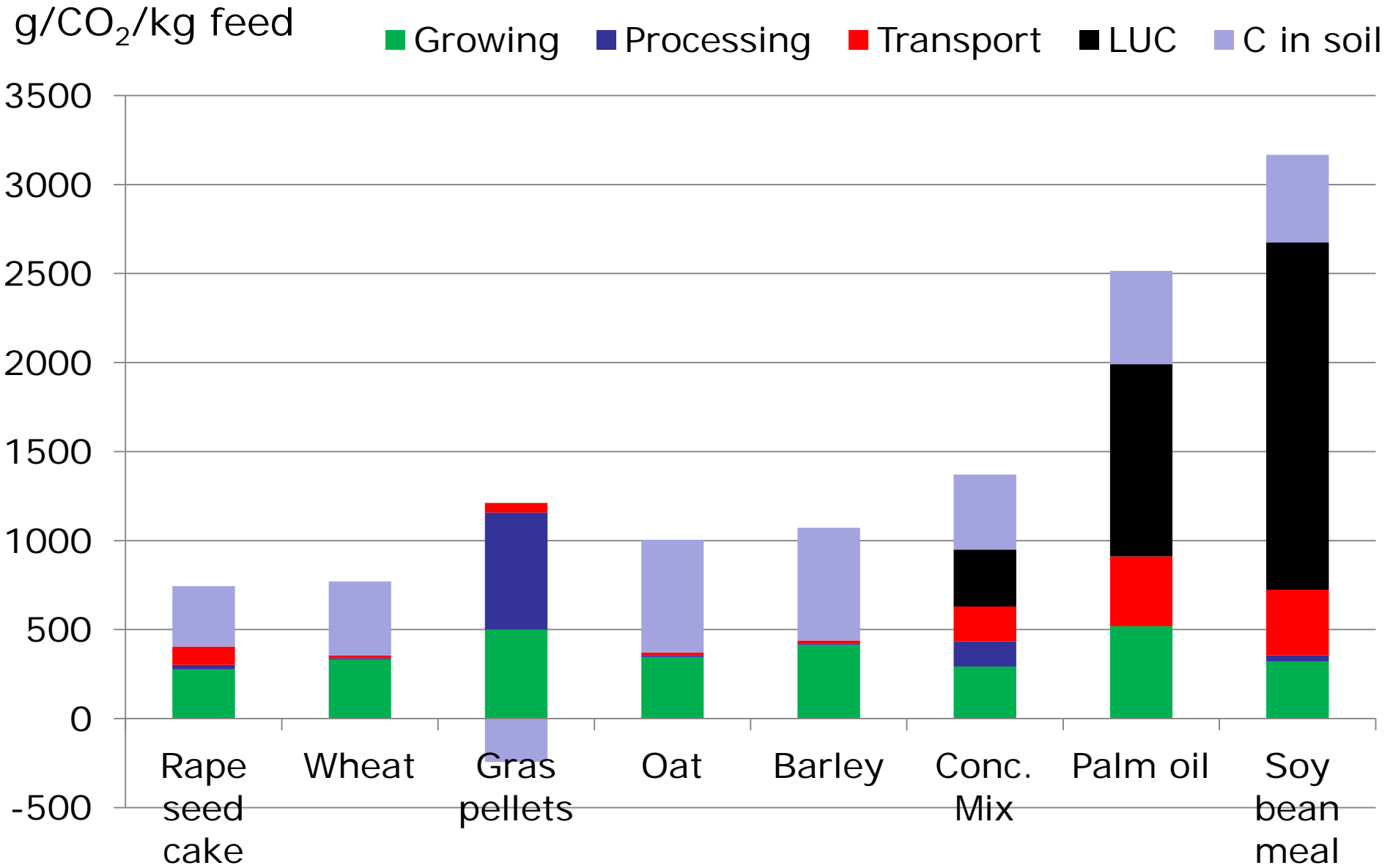


Impact of changes in soil carbon

	C in soil	kg CO ₂ eq/ha/year
Grass	sink	- 1910
Other crops	release	+ 3080

(Vleeshouwers & Verhagen, 2002)

CF of feed , g CO₂/kg



1. Feed rations based on silage:

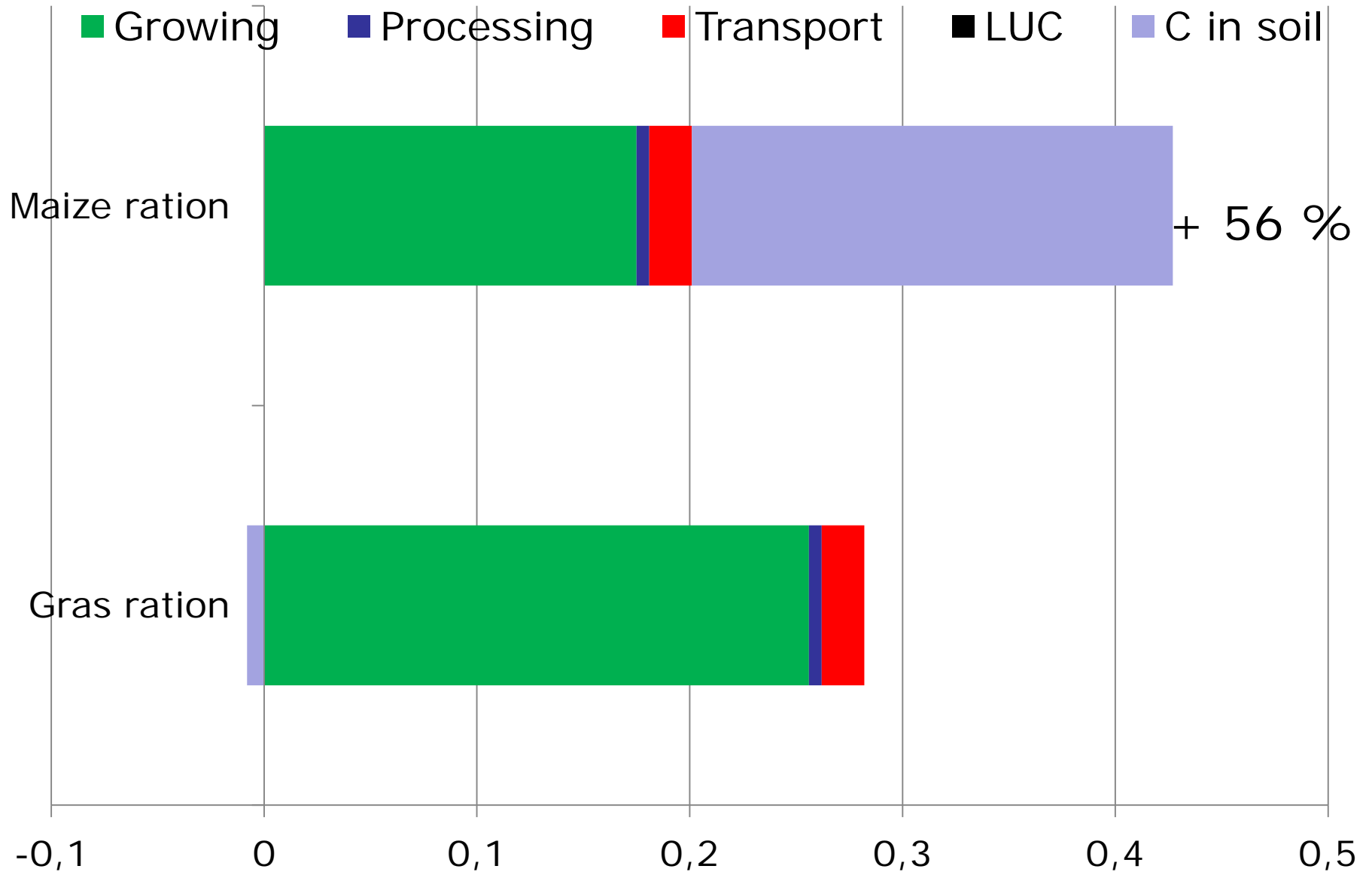
Grass silage vs. maize silage



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
CH₄:		
liter/day	516	474
CO ₂ -eq, g/kg ECM	385 (114)	337 (100)

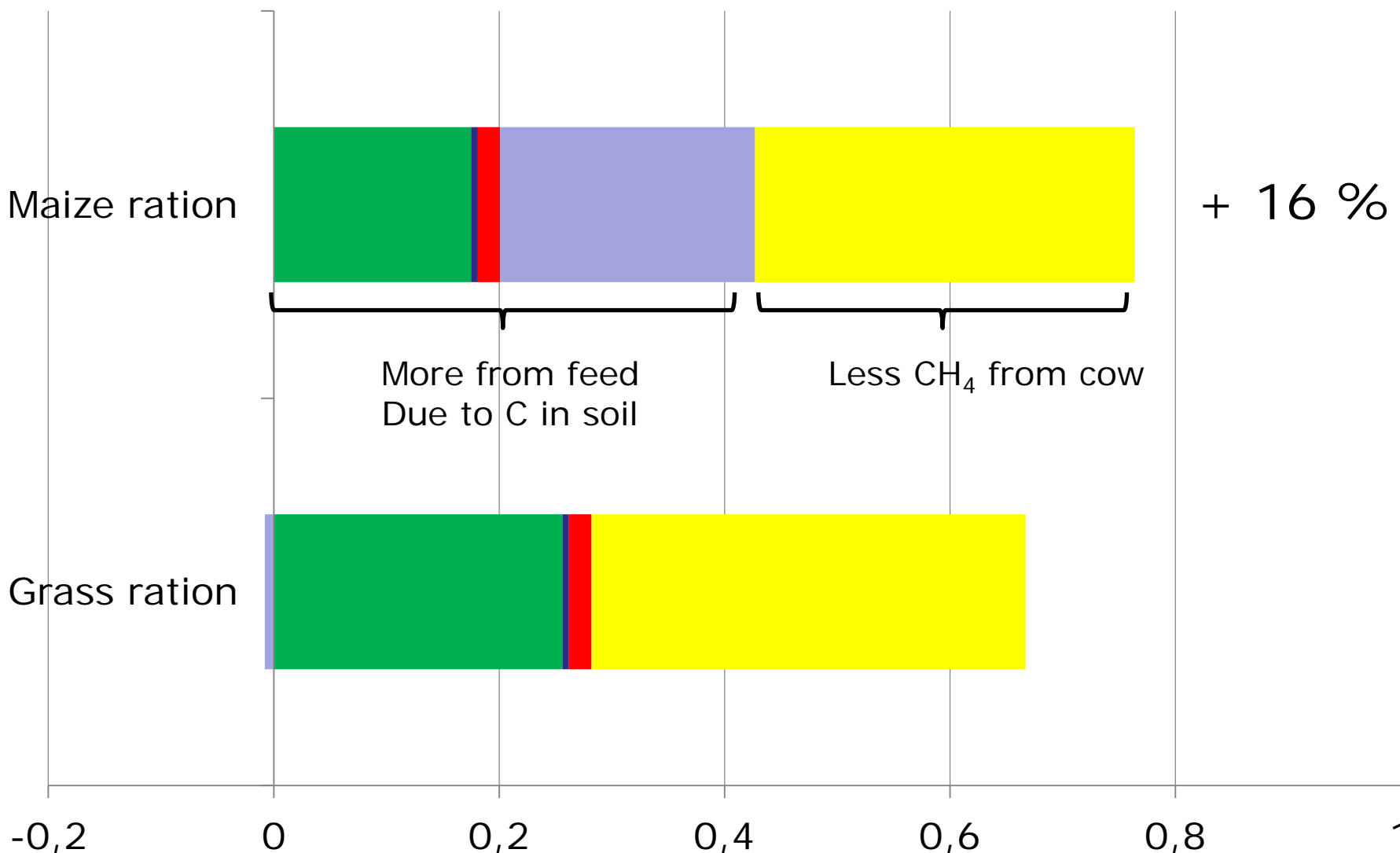


GHG from feed, kg CO₂/kg ECM



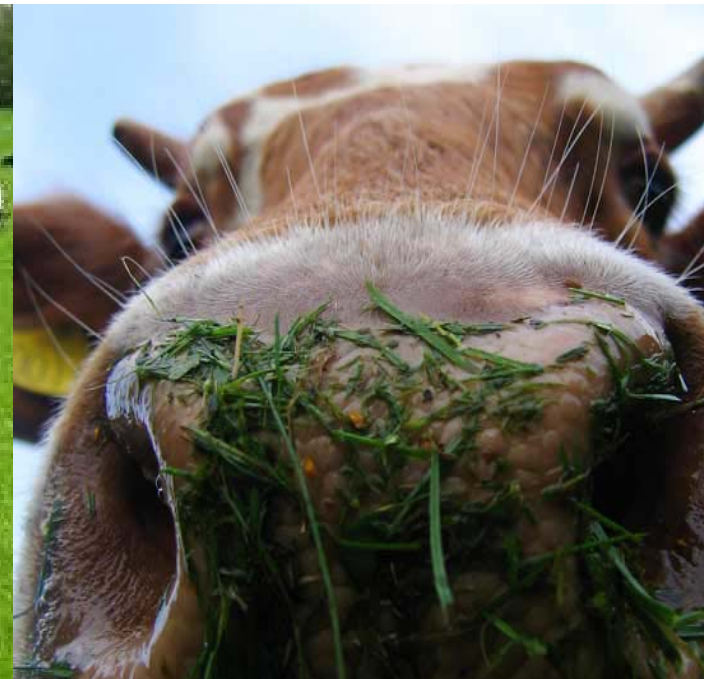
GHG from feed + CH₄ from cow, kg CO₂/kg ECM

■ Growing ■ Processing ■ Transport ■ LUC ■ C in soil ■ CH₄ cow



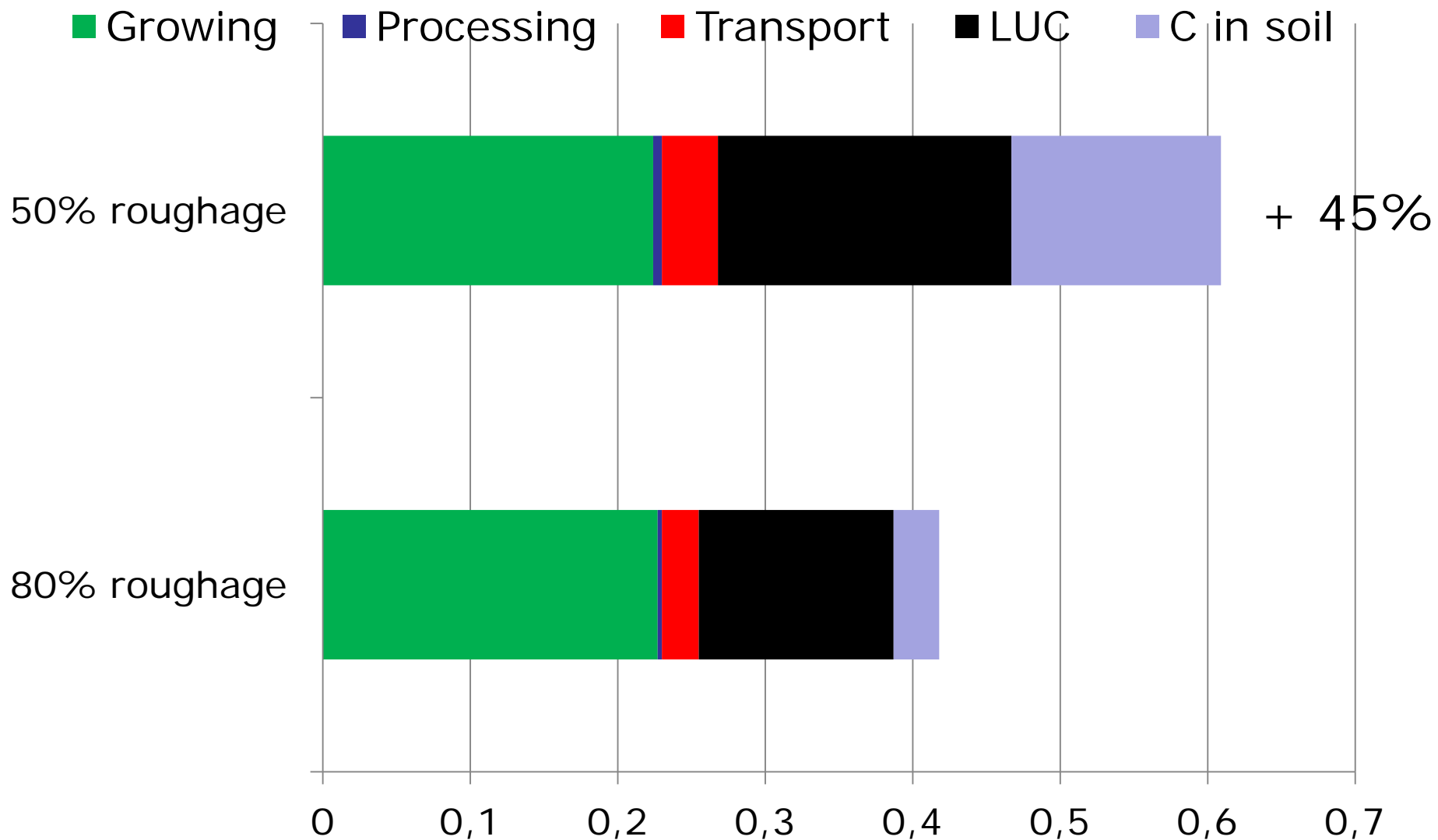
2. Roughage : Concentrate ratio

80 versus 50 % roughage



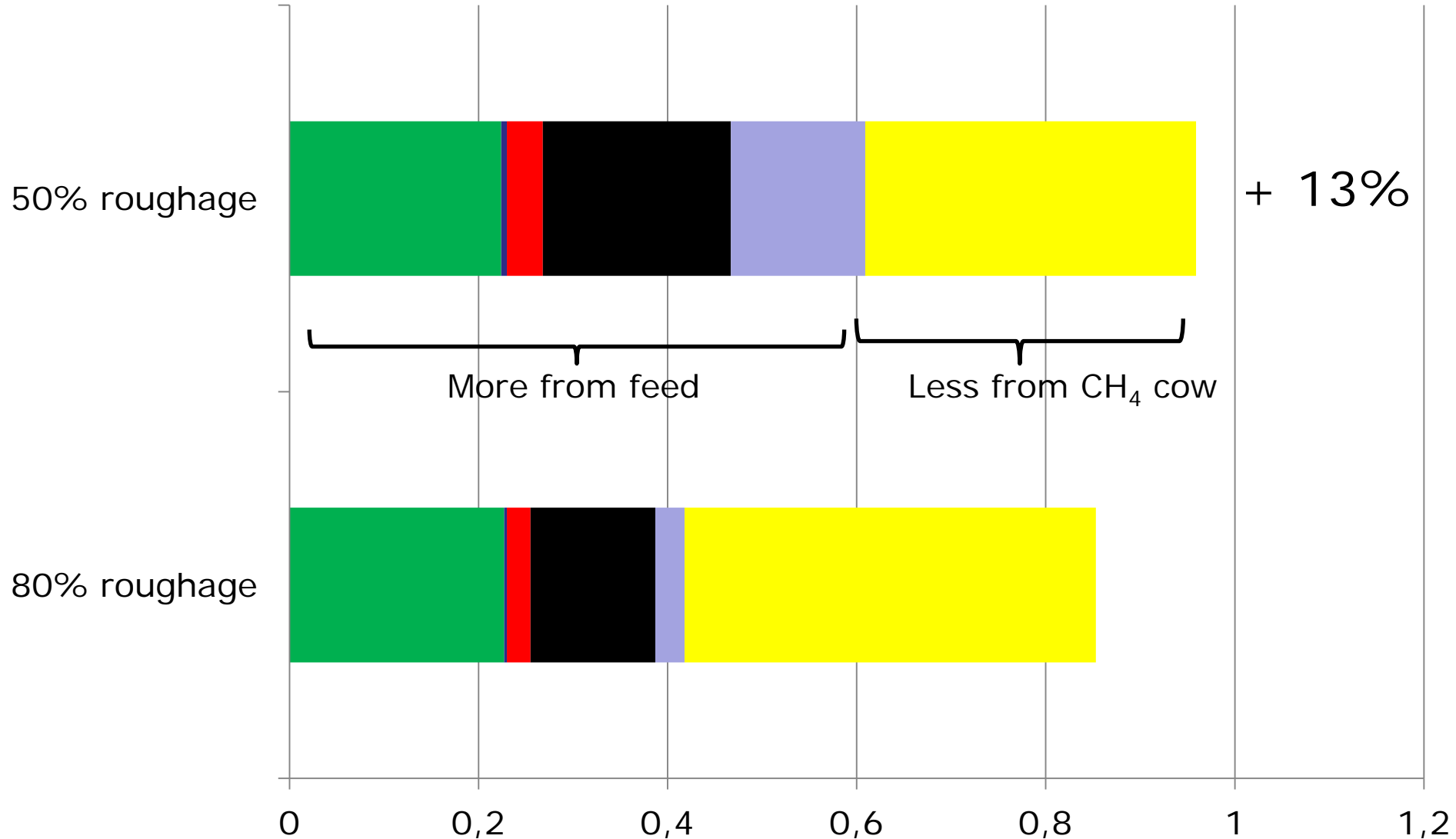
Ration	80% roughage	50% roughage
Feed intake, kg DM/d		
Wheat	2,0	6,9
Soybean meal	1,8	2,7
Maize silage	5,6	3,4
Grass silage	11,1	6,8
Total	20,4	19,8
Milk production:		
Kg ECM/d	30,2	30,1
CH₄:		
liter/dag	700	617
CO ₂ -eq, g/kg ECM	435 (124)	350 (100)

GHG from feed, kg CO₂/kg ECM



GHG from feed + CH₄ from cow, kg CO₂/kg ECM

■ Growing ■ Processing ■ Transport ■ LUC ■ C in soil ■ CH₄ cow



3. Type of protein feed

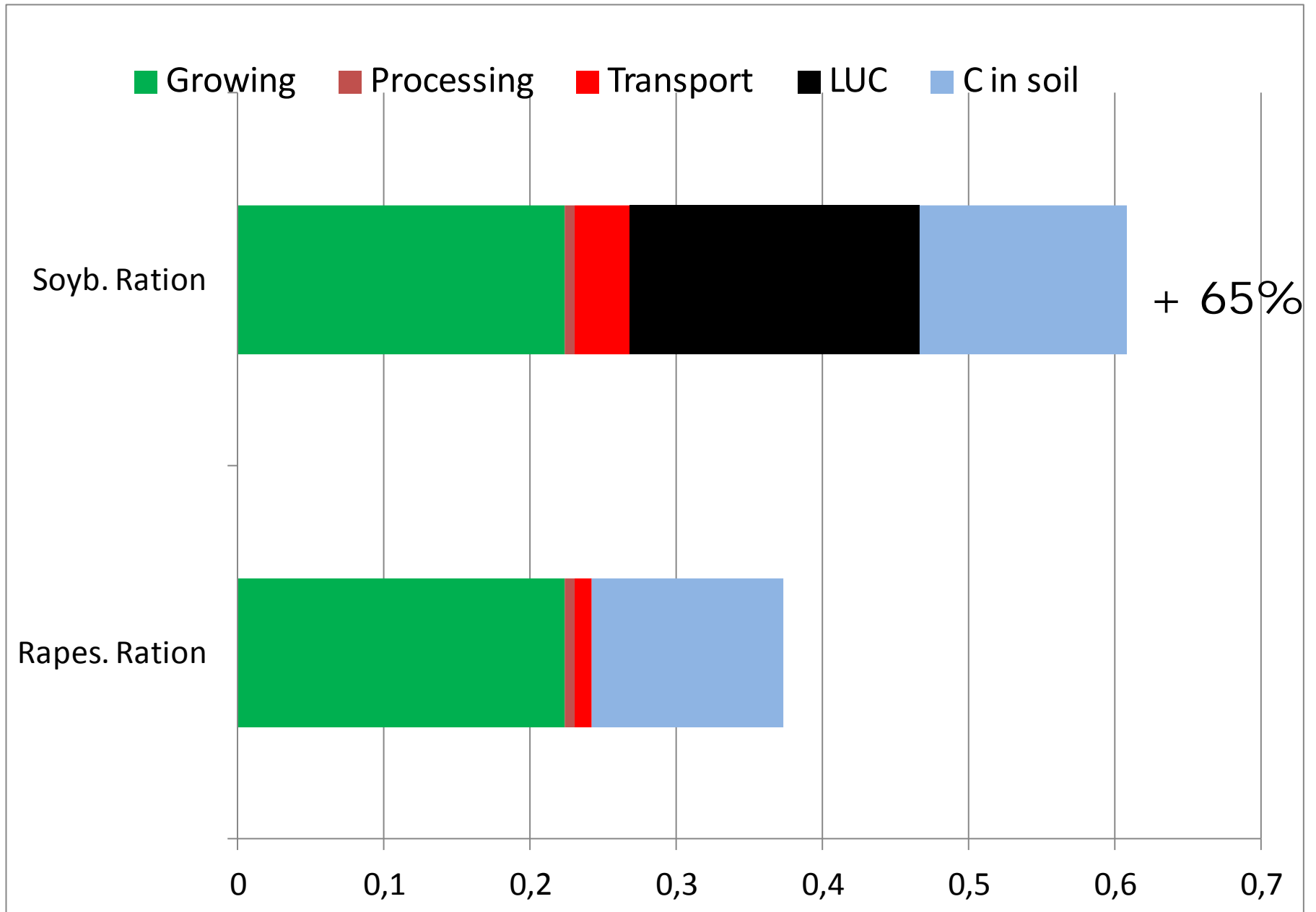
Rapeseed cake *versus* Soybean meal



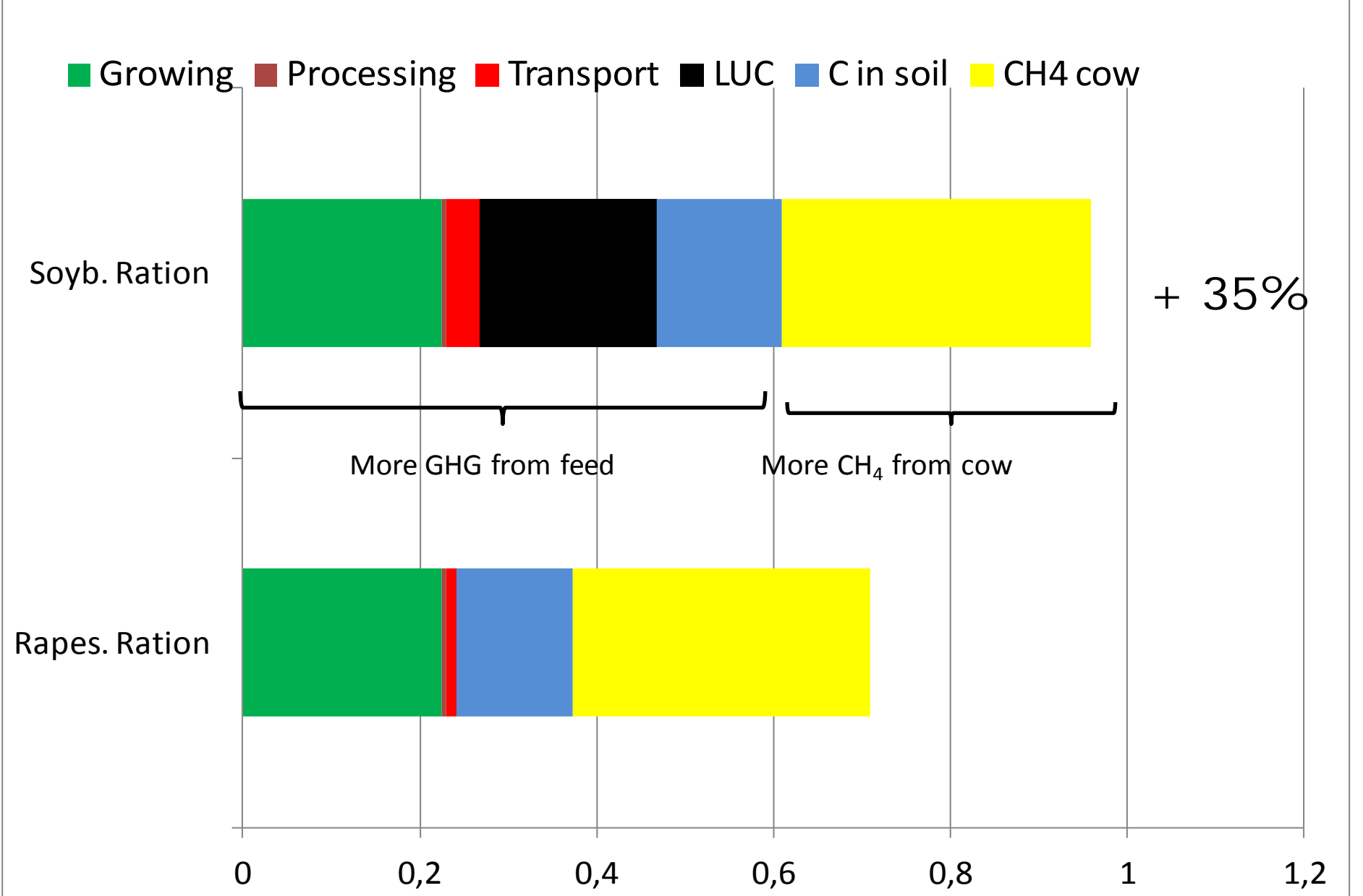
Ration- 50% roughage	Rapeseed cake	Soybean meal
Feed intake, kg DM/d		
Wheat	6.9	6.9
Soybean meal	0	2.7
Rapeseed cake	3.2	0
Maize silage	3.4	3.4
Grass silage	6.8	6.8
Total	19.8	19.8
Milk production:		
Kg ECM/d	30.1	30.1
CH₄		
liter/d	593	617
CO ₂ -eq, g/kg ECM	337 (96)	350 (100)



GHG from feed, kg CO₂/kg ECM



GHG from feed + CH₄ from cow, kg CO₂eq/kg ECM



Conclusion

- Carbon footprint per kg milk (from feed production and enteric CH₄) 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