



Dairy Life Cycle Assessment

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Presentation Outline

1. What is LCA?
2. Key performance indicators (footprints)
3. Dairy GHG emissions
4. CATIE Finca preliminary results
5. Intensification *transitions*



What is LCA?

**NH₃, NO_x,
N₂O, CO₂,**



**NH₃, N₂O,
CO₂,**



CH₄

**SO_x, NO_x,
CO₂,**



**NH₃, N₂O,
CO₂,**



**CH₄, NH₃,
N₂O**



Key performance indicators (agriculture)



Climate change

- Global warming potential (GWP)
- kg CO₂e
- CO₂, N₂O, CH₄



Acidification

- Acidification potential (AP)
- kg SO₂e
- NH₃, NO_x, SO₂



Eutrophication

- Eutrophication potential (EP)
- kg PO₄e
- P & N water, NH₃, NO_x

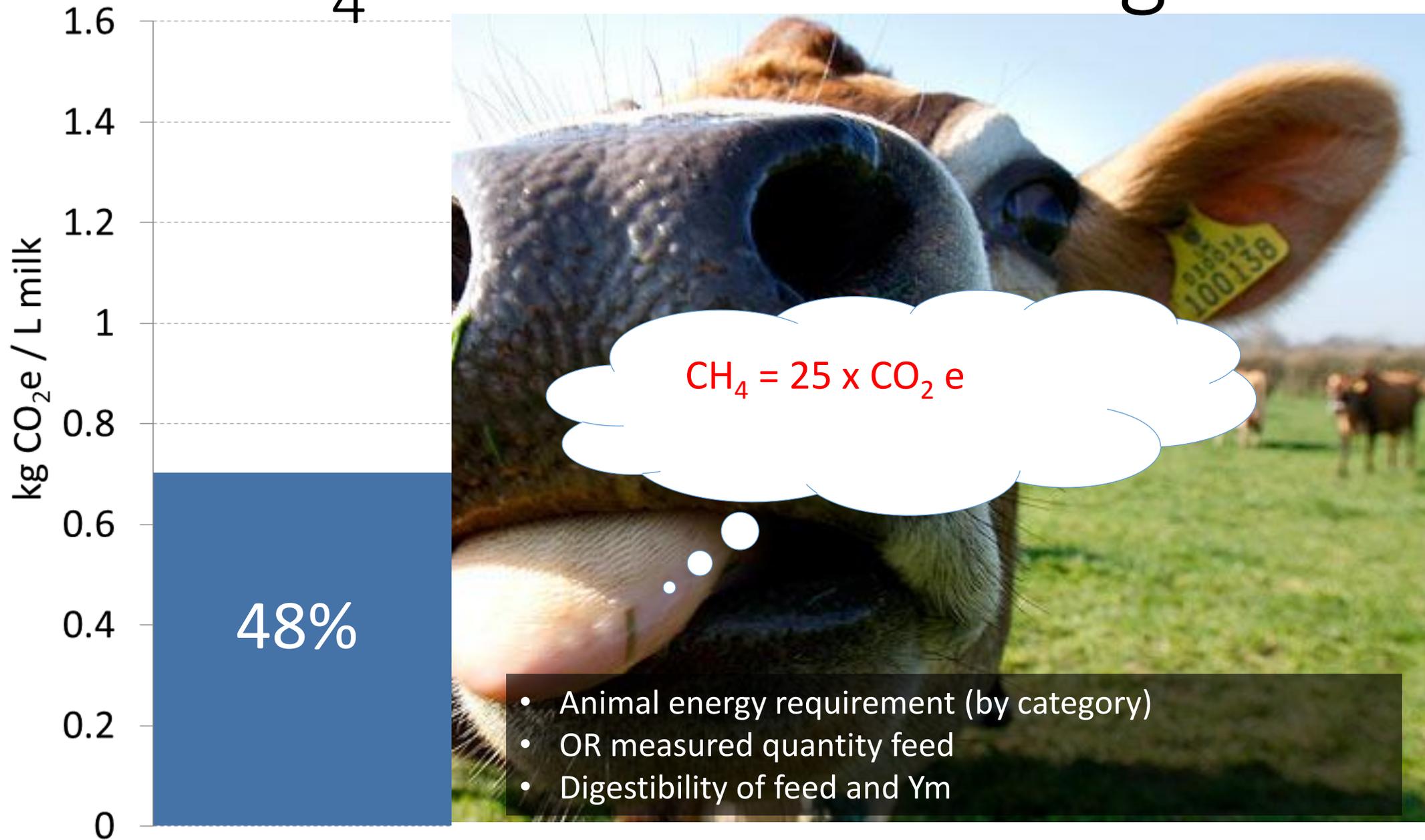


Finite resource use

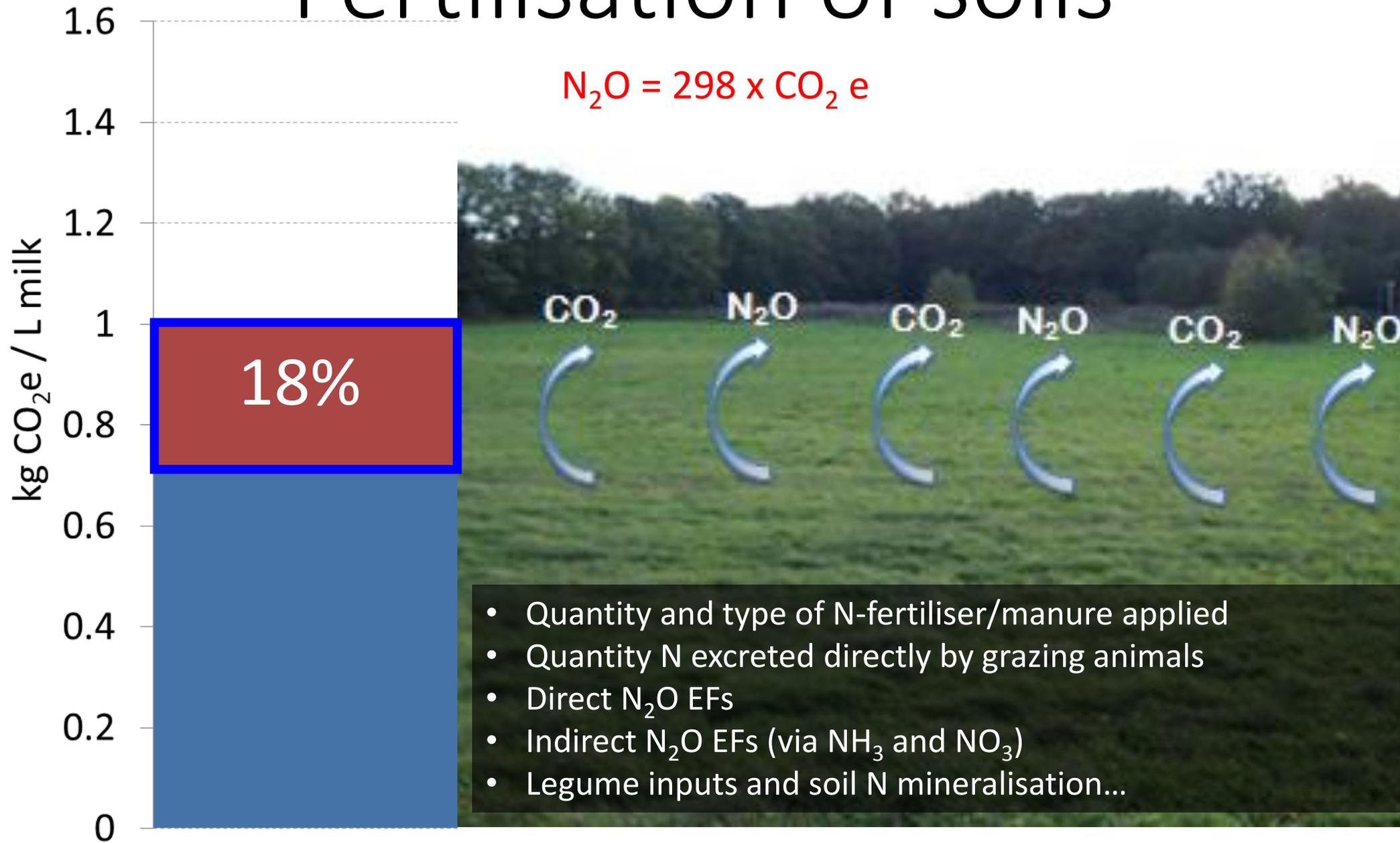
- Fossil resource depletion potential (FRDP)
- MJe
- Oil, gas, coal

Water use; Land area (biodiversity?), Soil quality (SOC and yield effects)

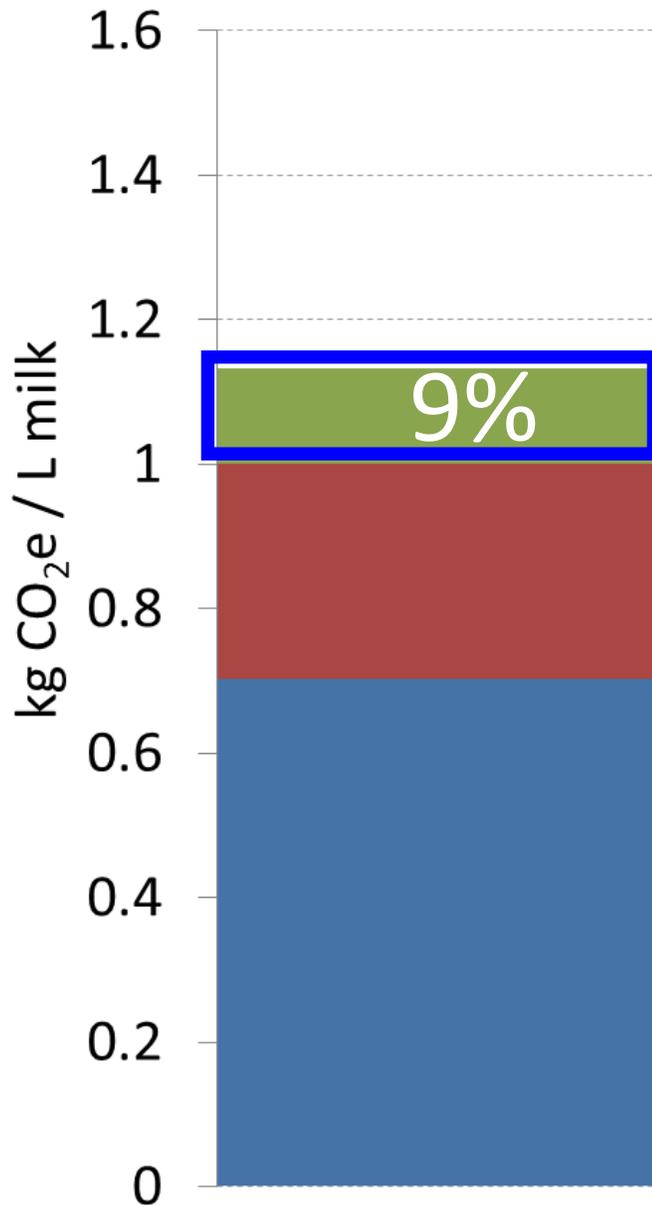
CH₄ from ruminant digestion



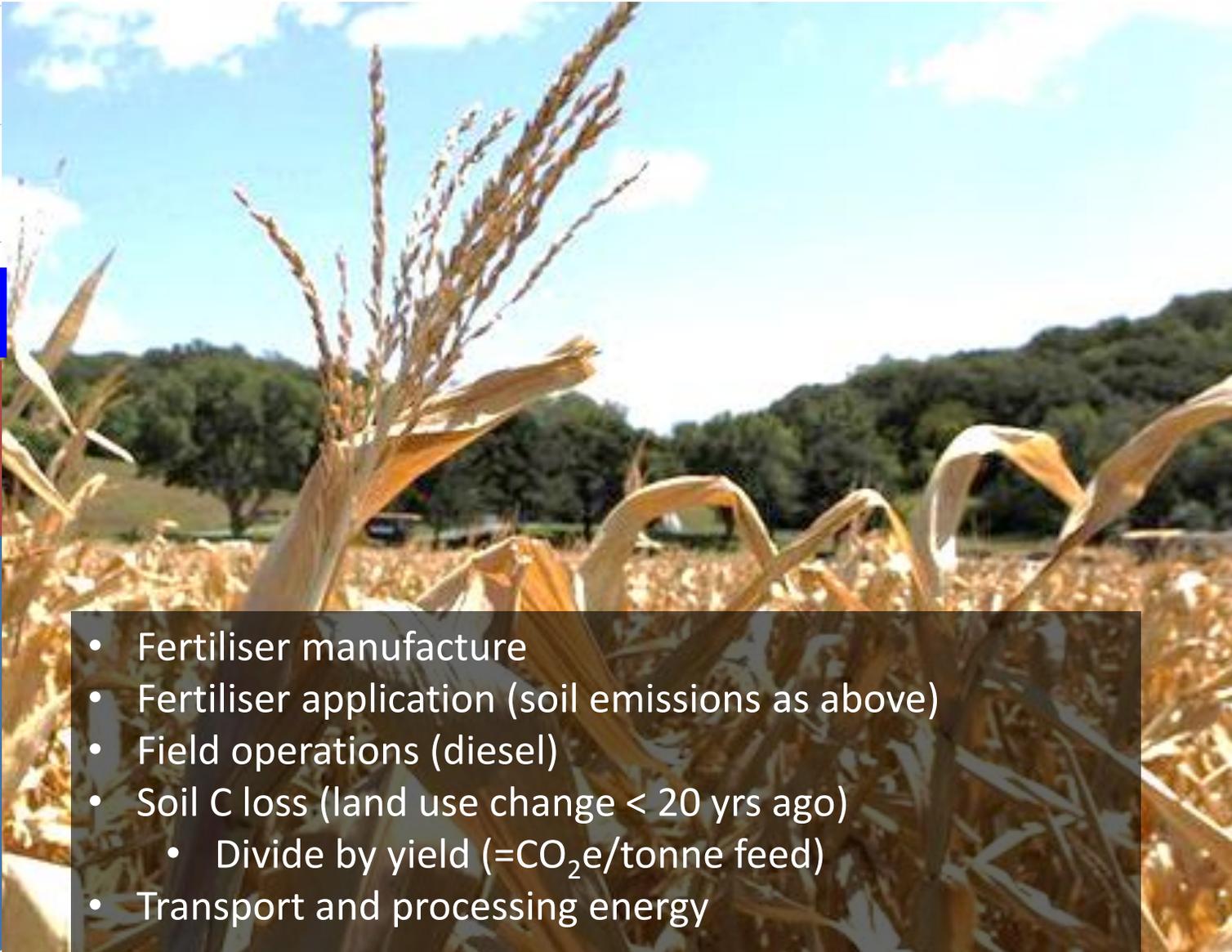
Fertilisation of soils



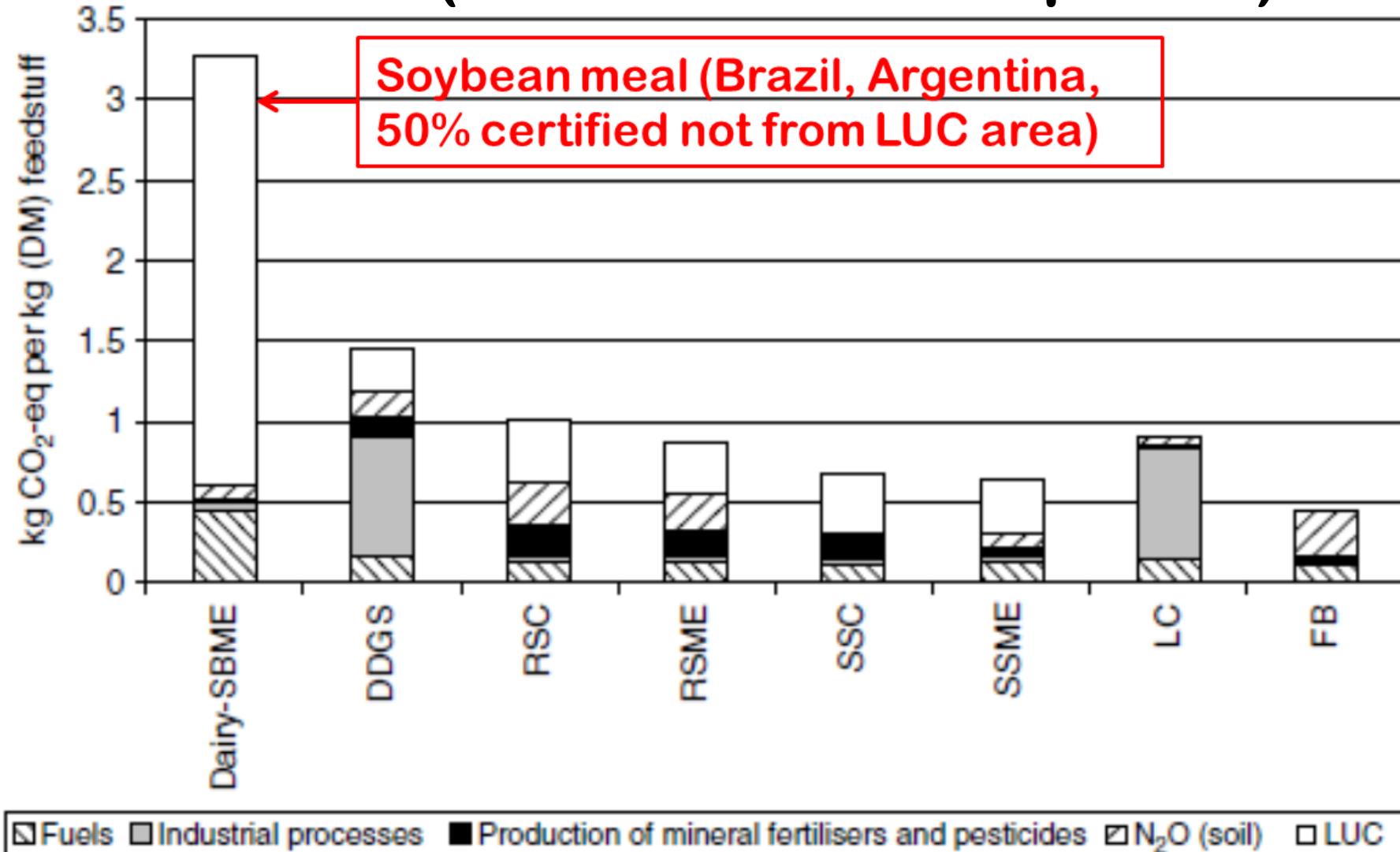
Concentrate feed production



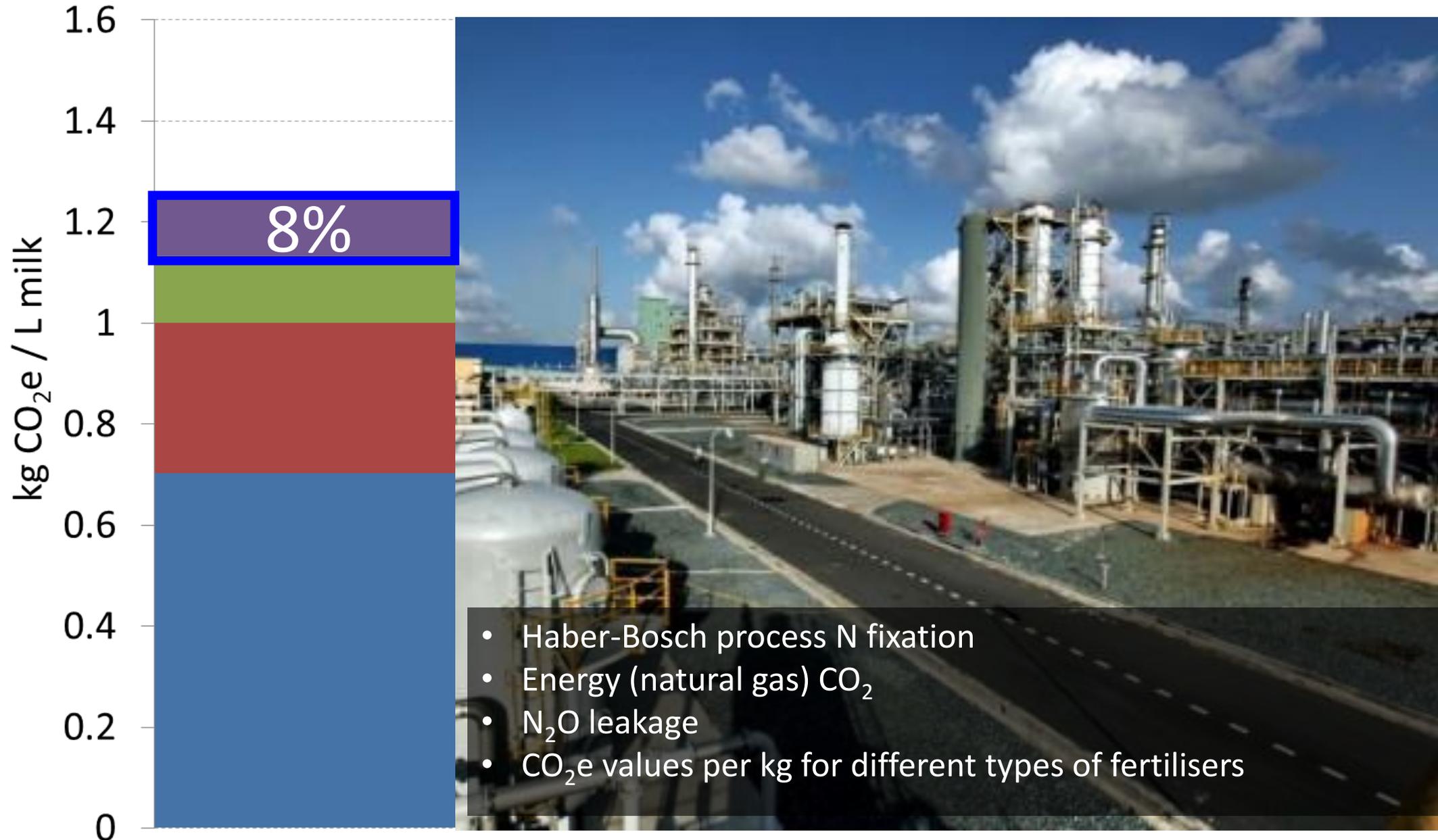
- Fertiliser manufacture
- Fertiliser application (soil emissions as above)
- Field operations (diesel)
- Soil C loss (land use change < 20 yrs ago)
 - Divide by yield (=CO₂e/tonne feed)
- Transport and processing energy



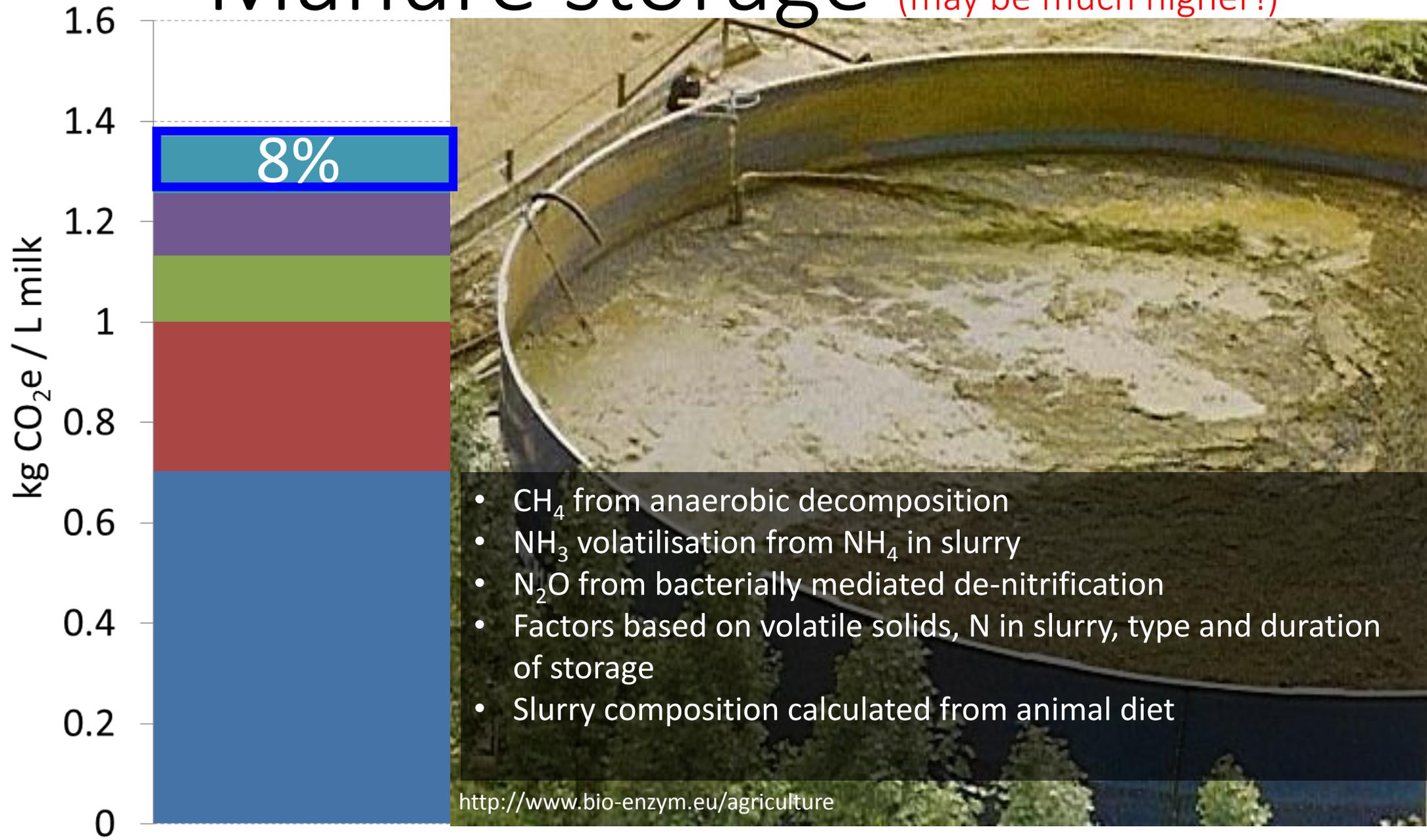
Concentrate feed production (animal feed footprints)



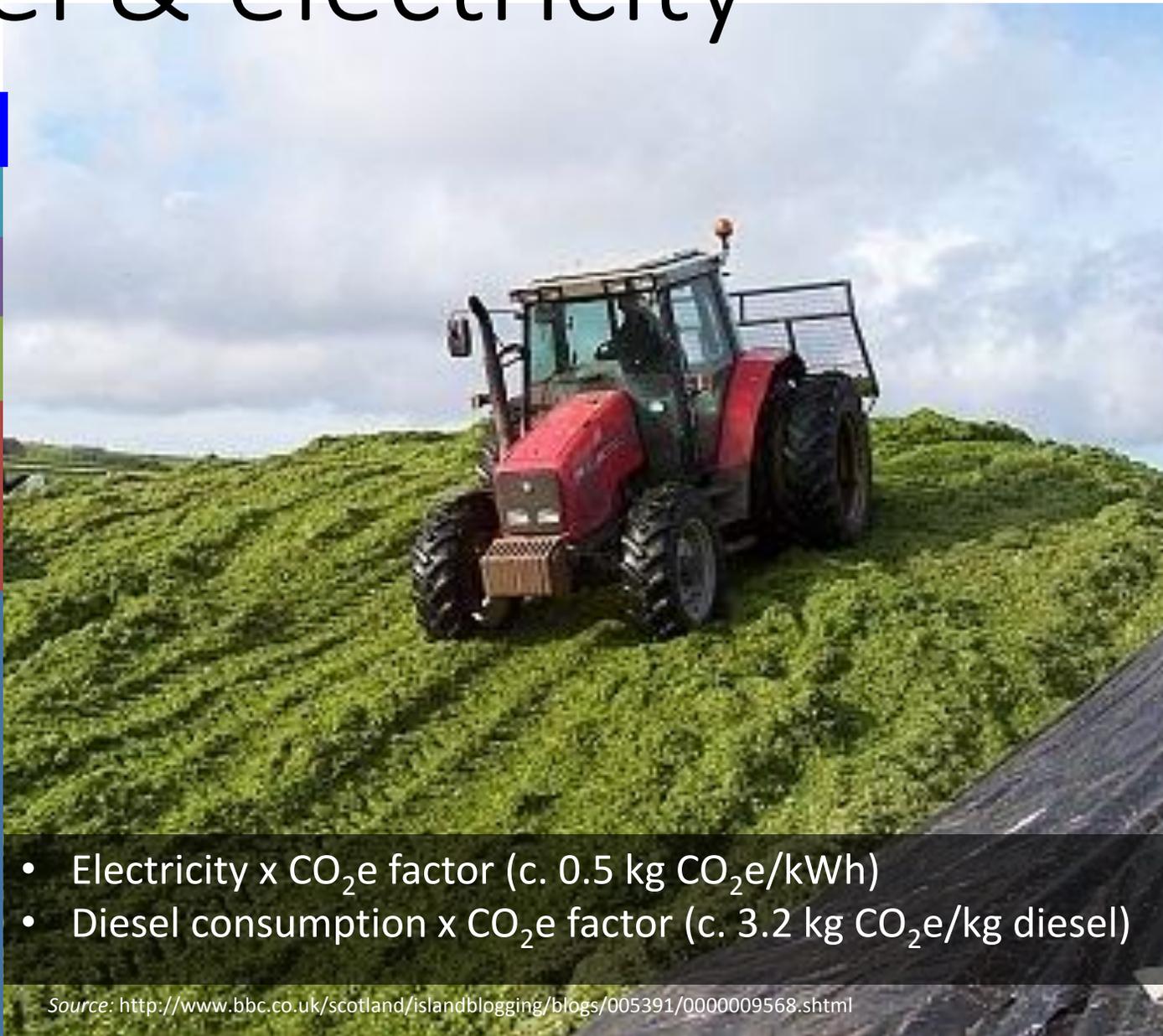
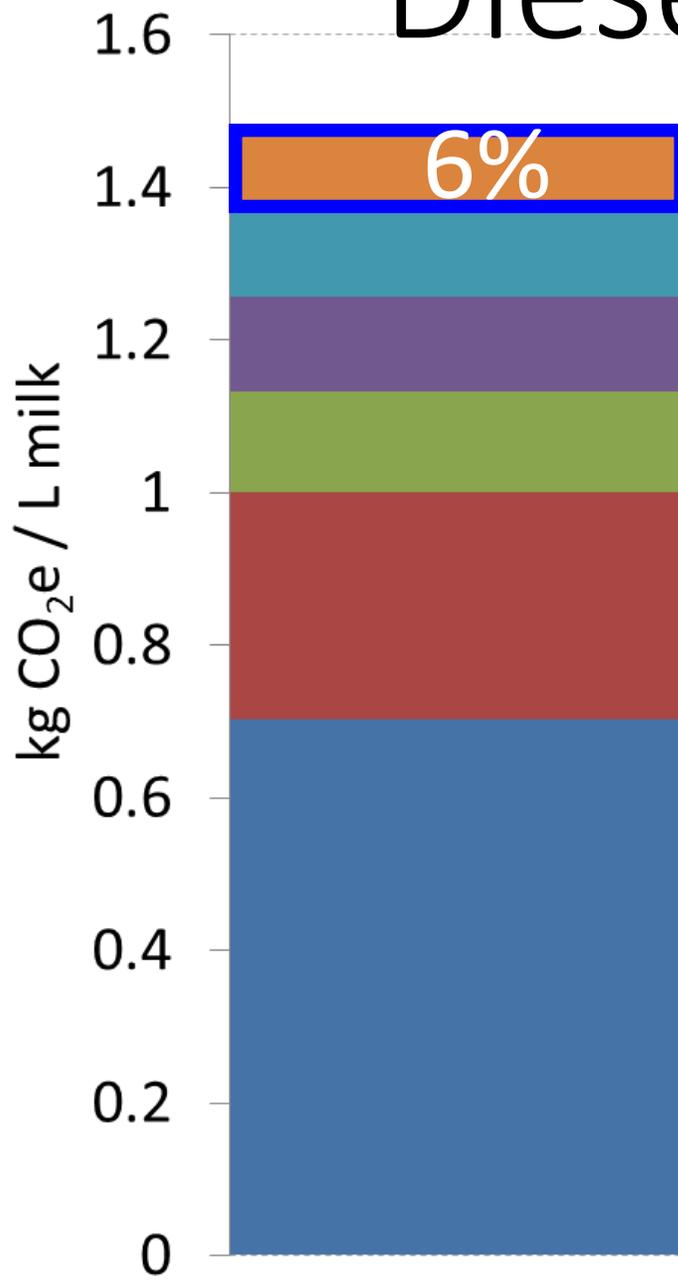
Fertiliser manufacture



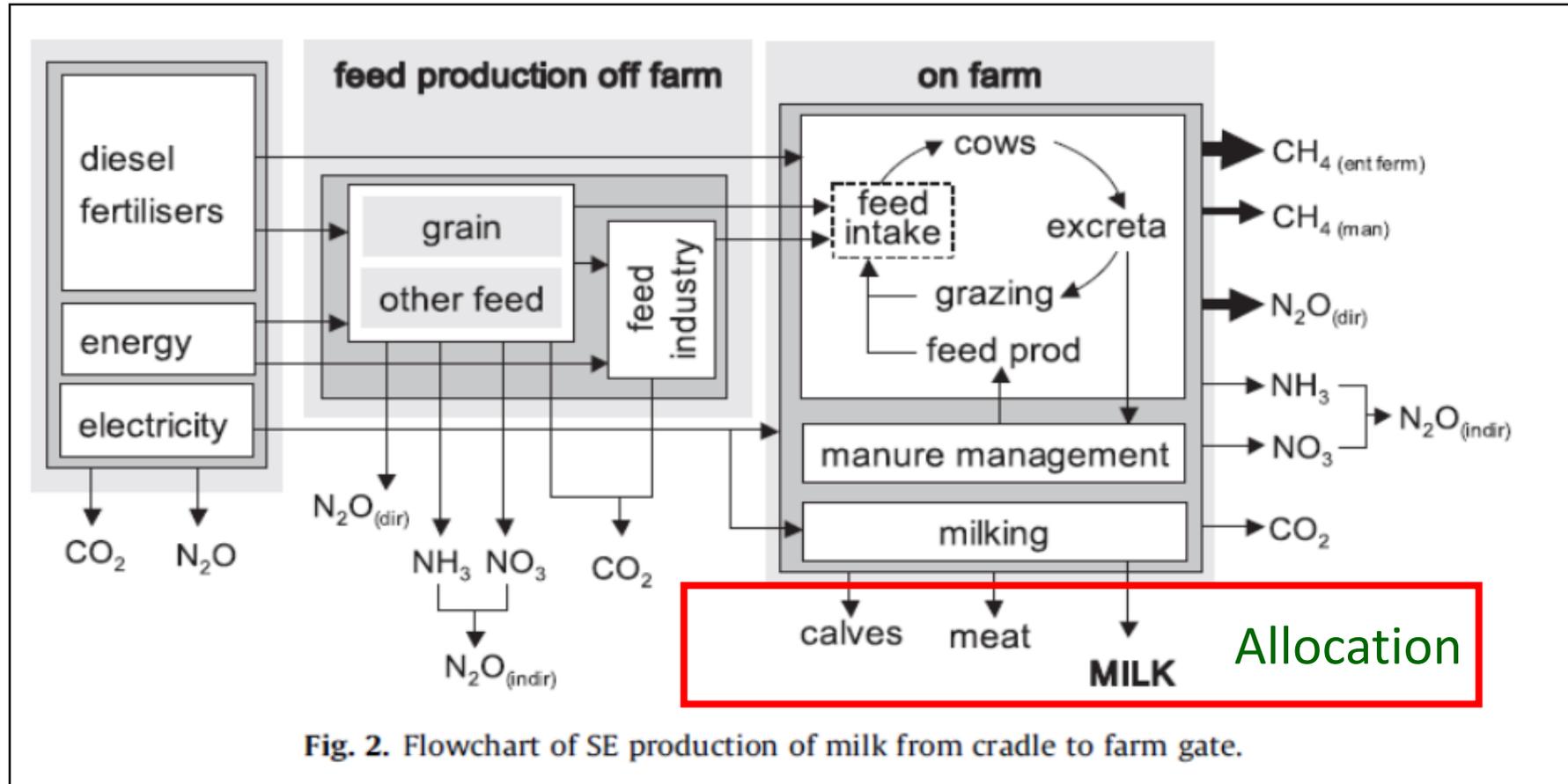
Manure storage (may be much higher!)



Diesel & electricity



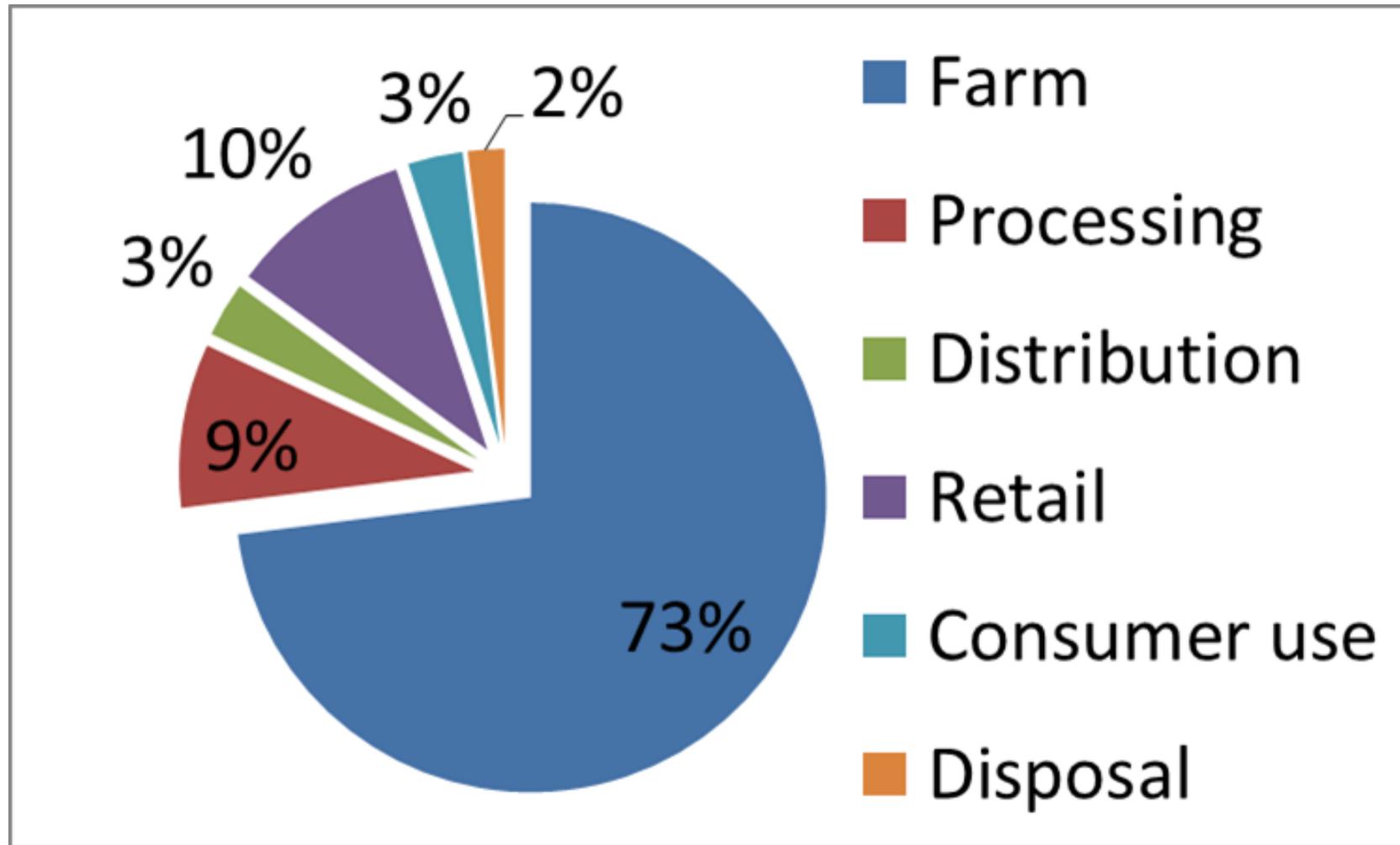
Allocating farm footprint to milk



Source: Kristensen et al. (2011). *Livestock Science*, 140: 136–148.

1. Sum farm emissions
2. Multiply by fraction attributable to milk production
3. Divide by milk volume (L), or kg FPCM

From farm to fridge to landfill...



Data source: Tesco (2012). Product carbon footprint summary.



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CATIE Finca Preliminary Results

(Eilidh Forster MSc dissertation, co-supervised by Jimena Esquivel)



CLEANER COWS

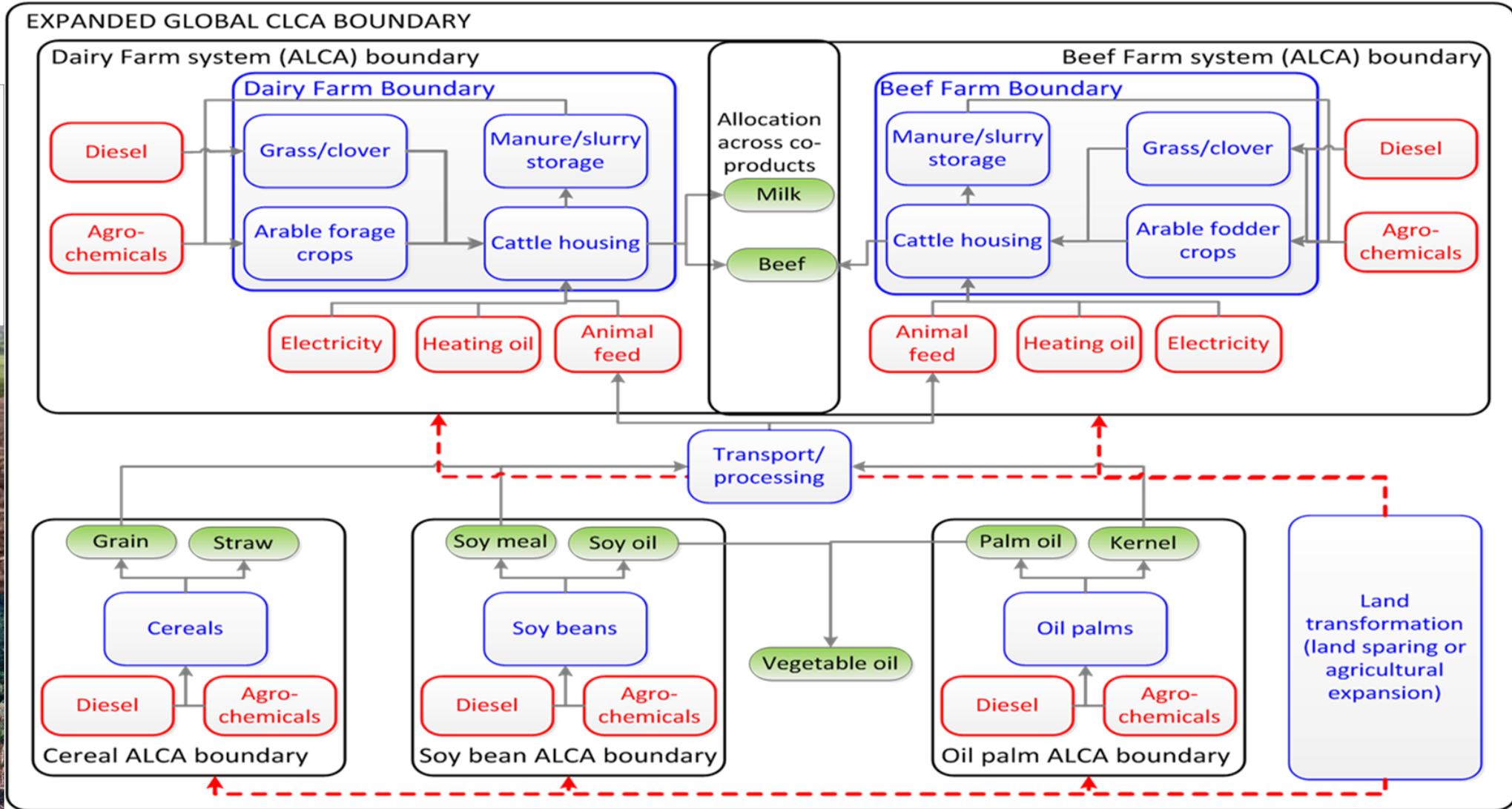
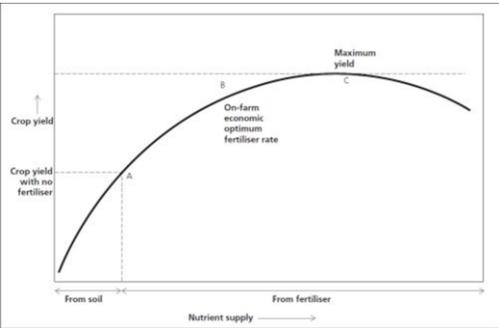
- Research cluster with Aberystwyth, Cardiff and Nottingham Universities
- Economic and consequential LCA modelling of dairy farm consolidation and intensification



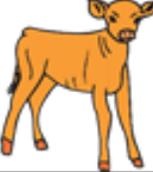
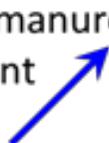
Pathways of consolidation



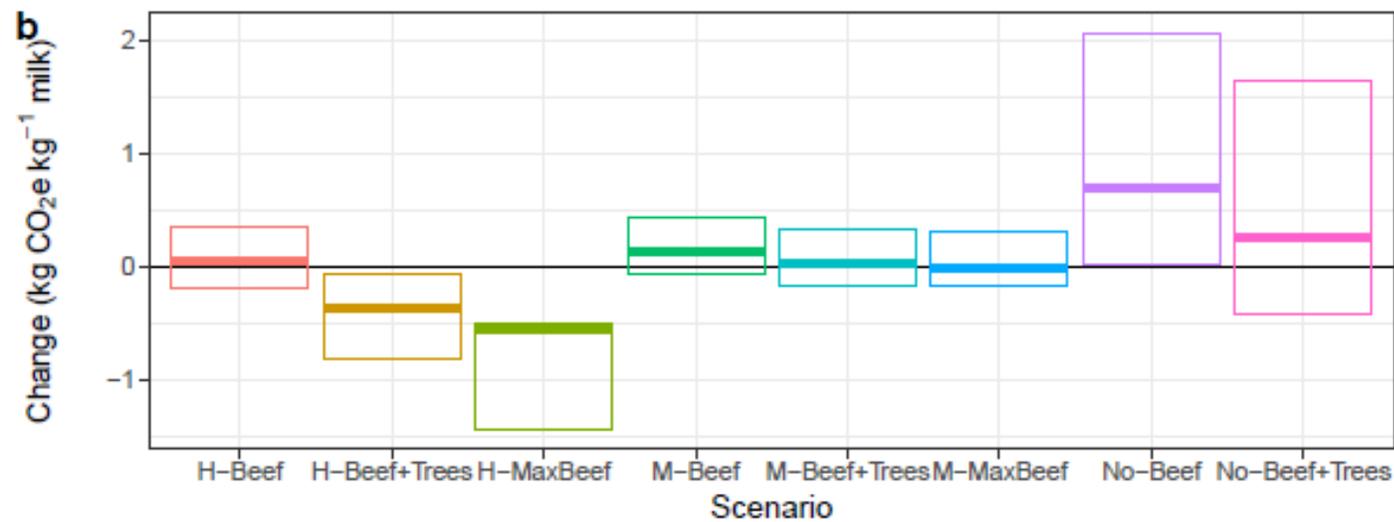
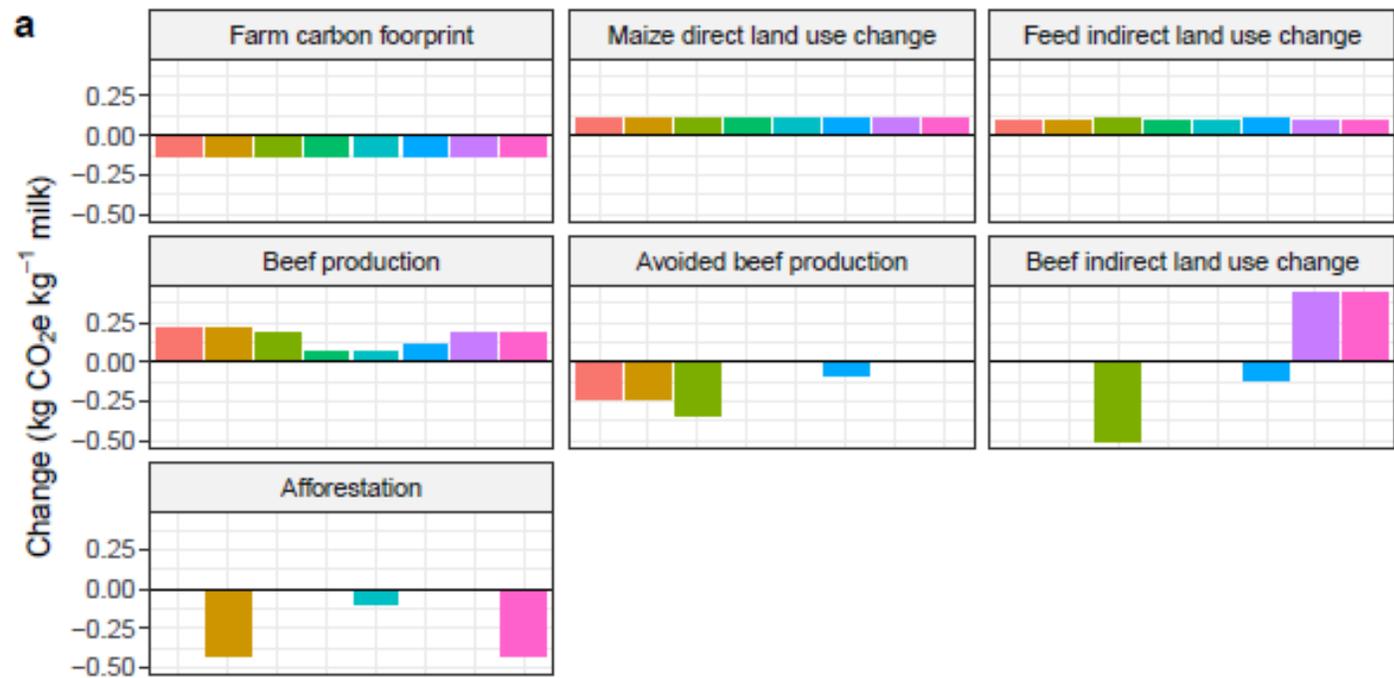
CLEANER COWS: Feed sources & beef co-production



GHG implications of dairy intensification

Factor trend	Milk footprint (per kg milk, life cycle basis)	National GHG Inventory (all sectors)	Rest-of-world GHG Inventory (all sectors)
Milk from maize increasing 	↓Reduced enteric CH ₄ ↓Higher yield per cow ↑Crop production (↑Cropland expansion) 	↓Reduced enteric CH ₄ ↑Crop production ↑Cropland expansion 	
Milk from concentrate increasing 	↓Reduced enteric CH ₄ ↓Higher yield per cow ↑Crop production 	↓Reduced enteric CH ₄ 	↑Crop production ↑Cropland expansion 
Milk from grass decreasing 	↓Reduced enteric CH ₄ ↓Reduced grass production 	Land sparing or extra production  ?  	Global land sparing?  
Dairy-beef production decreasing 	Neutral effect, depending on allocation method	↑Increased suckler-beef production?  	↑Increased suckler-beef production?  
Housing & manure management increasing 	↓Reduced grazing N _{ex} ↑Increased housing & storage emissions 	↓Reduced grazing N _{ex} ↑Increased housing & storage emissions 	

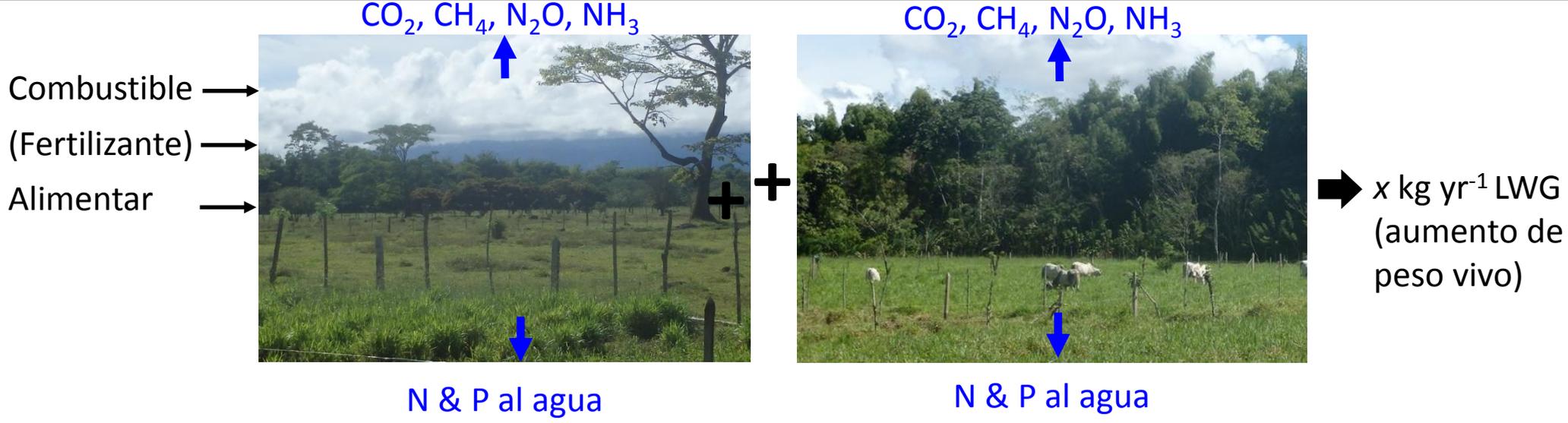
Green = positive effect (reduces footprint); red = negative effect (increases footprint); amber = uncertain overall effect.



▭ H-Beef ▭ H-Beef+Trees ▭ H-MaxBeef ▭ M-Beef
▭ M-Beef+Trees ▭ M-MaxBeef ▭ No-Beef ▭ No-Beef+Trees

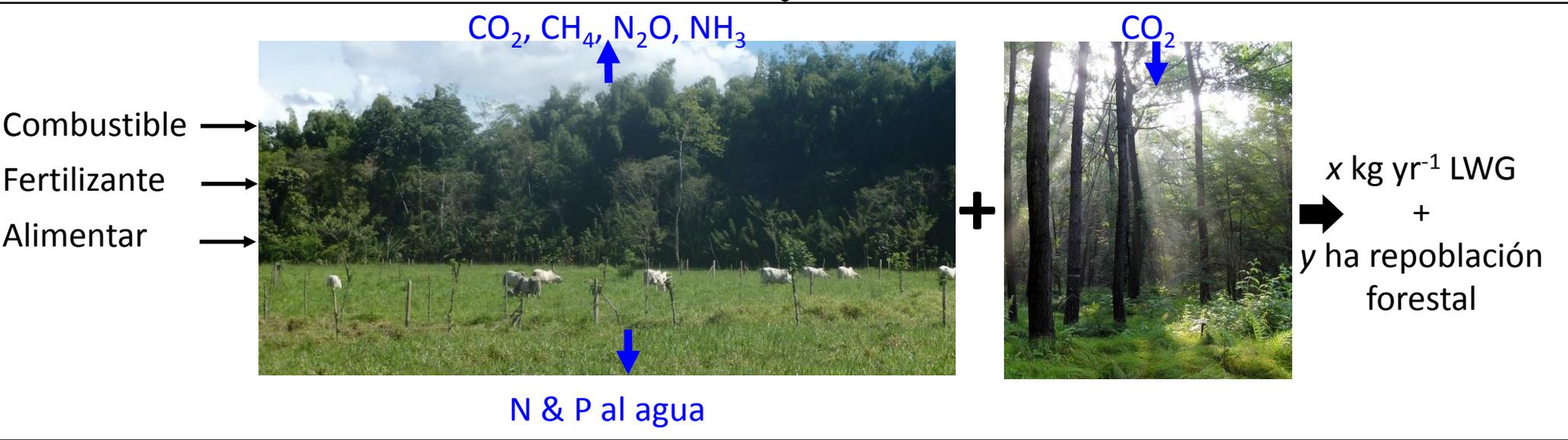


Beef land sparing in Costa Rica



Huella ambiental por kg de ganancia de peso vivo (pastos mixtos)

Una finca... o muchas fincas (escenario nacional)

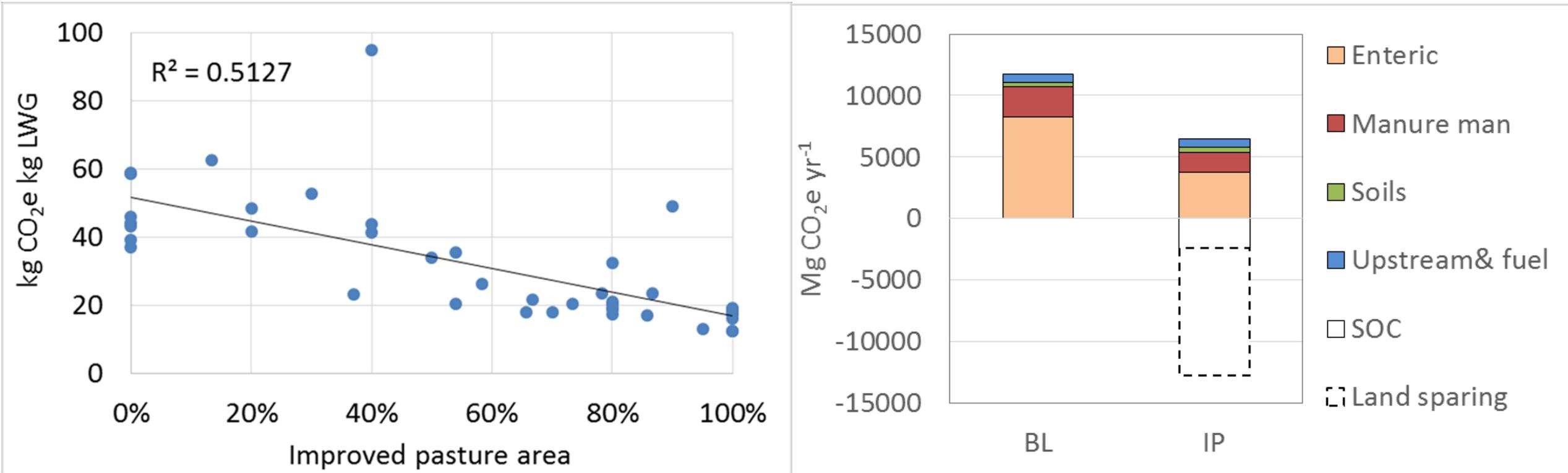


Variación neta de la carga de:

- kg CO₂e
- kg PO₄e
- kg SO₂e
- MJe

Huella ambiental por kg de ganancia de peso vivo (pastos mejorados)

Beef land sparing in Costa Rica



GHG benefits but acidification (NH₃) penalties
(fertiliser app & higher N content in improved grasses)



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Thanks for your attention

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