

Greenhouse gas emissions from suckler cow production - the new whole farm-system model "HolosNorBeef"

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07.02.2017

Background

- The global population is expected to exceed 9 billion by 2050¹
- Global food production needs to increase by 70%¹
- Limited arable land reserves
- Natural resources available for food production vary considerably between countries



1) FAO (2009)

Background

- Norway: Increasing population → increasing food production
- Grass production accounts for 2/3 of cultivated area
- Milk/meat from ruminants account for 55% of food production on energy basis
- Increased utilization of domestic grassland and pastures
- Reduce greenhouse gas (GHG) emissions 40% by 2030



What are Greenhouse gas emissions?

- CO₂ – transport, electricity
- CH₄ – enteric fermentation, manure management
- N₂O – manure, soil management, fertilizer

- Global warming potential (GWP)²

–CO ₂	1
–CH ₄	25
–N ₂ O	298



2) IPCC 2007

GHG emissions from beef production

- Ruminants > monogastric
- Dairy beef < suckler beef
- Differences in GHG emissions between continents¹ and between farms within a country³
- Need for a flexible emission model adapted to production systems and national resources in Norway



- 1) FAO (2009)
- 3) Bonesmo et al.,(2013)

Background – Other studies

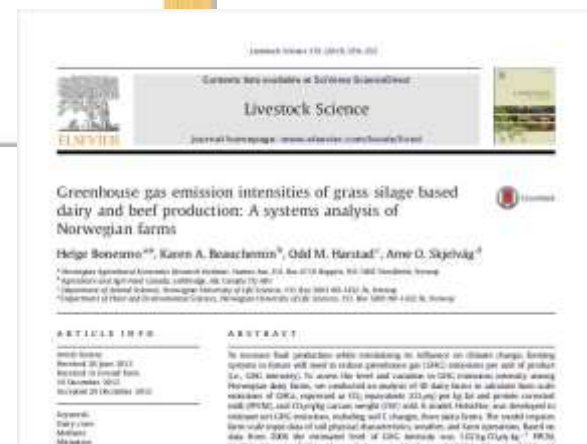
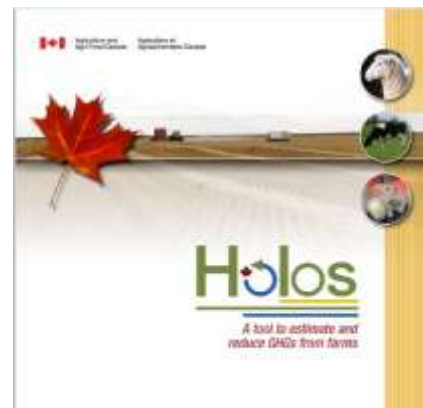
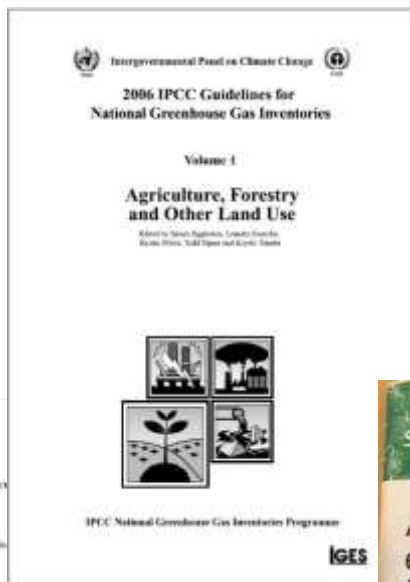
- **Holos**, Life cycle assessment from beef cattle in Canada⁴
 - 22 kg CO₂eq/kg carcass
- **HolosNor**, emissions from dairy cattle in Norway³
 - 17.3 kg CO₂eq/kg carcass young bulls
 - 1.02 kg CO₂eq/kg FPCM
- **BEEFGEM**, Irish farm model⁵
 - 18.9-23.1 kg CO₂eq/kg carcass

3) Bonesmo et al.,(2013)

4) Beauchemin et al., (2010)

5) Foley et al., (2011)

Developing HolosNorBeef

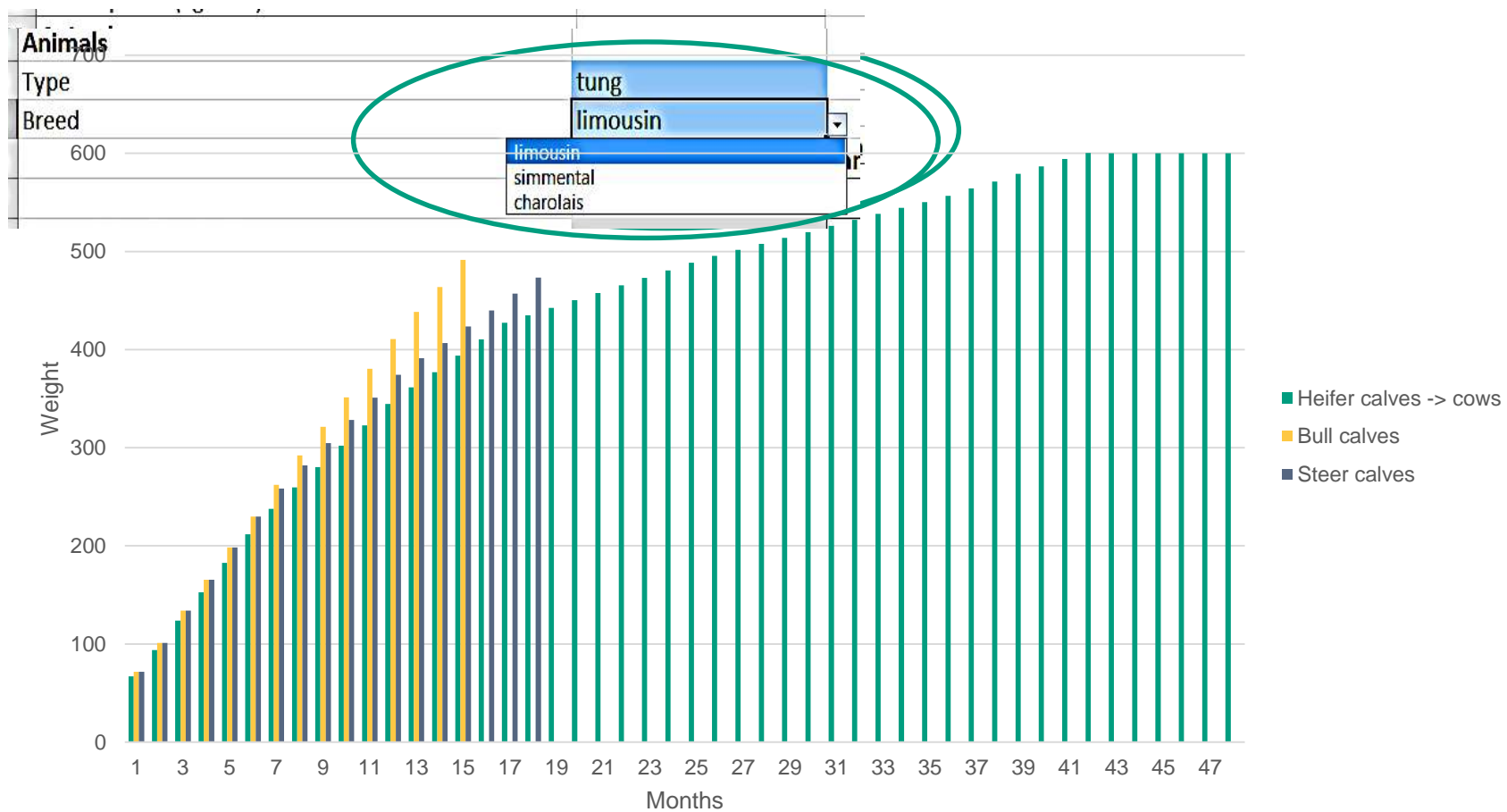


RCM regional model for estimation of dynamics of agricultural carbon pools
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 For words: Agriculture, Budget, Carbon, Modelling, Simulation, Soil
Abstract
 Swedish arable land covers 1.5 Mha and its organic carbon stores 540 Mha C. The climate will continue to be driven by anthropogenic CO₂ emissions, but the organic carbon stores (OCS) of arable land have been estimated to lose ca. 1 Mha C year⁻¹. We have developed a regional model (RCM) to estimate, using national agricultural crop production statistics and alternative functions to calculate annual C input to the soil together with a five-parameter soil carbon model (C5M), cultivated using long-term field data. In Sweden, annual yield statistics are reported for different crops. For each of eight agricultural regions, present regional carbon content and regional distribution of soil types have recently been reported. We use study, weather station data for each region together with crop type, field data from individual crop types and soil type to calculate an annual soil carbon parameter for each crop type parameter in each region. We use 14 soil types and 8 crop types, which gives 112 parameters for soil type and region, each representing a fraction of the region's area. For each year, region, crop and soil type, C2000 region calculates the change in young and old soil carbon per hectare, and sums up the changes to, e.g., national changes. With eight regions, we will have 808 parameters per year, which needs to be handled, and when it comes to soil in comparison between historically poor and wealthy lands. We will use the model to compare the soil C stocks between the IPCC baseline year 1960 and the present. In addition, we can assess the

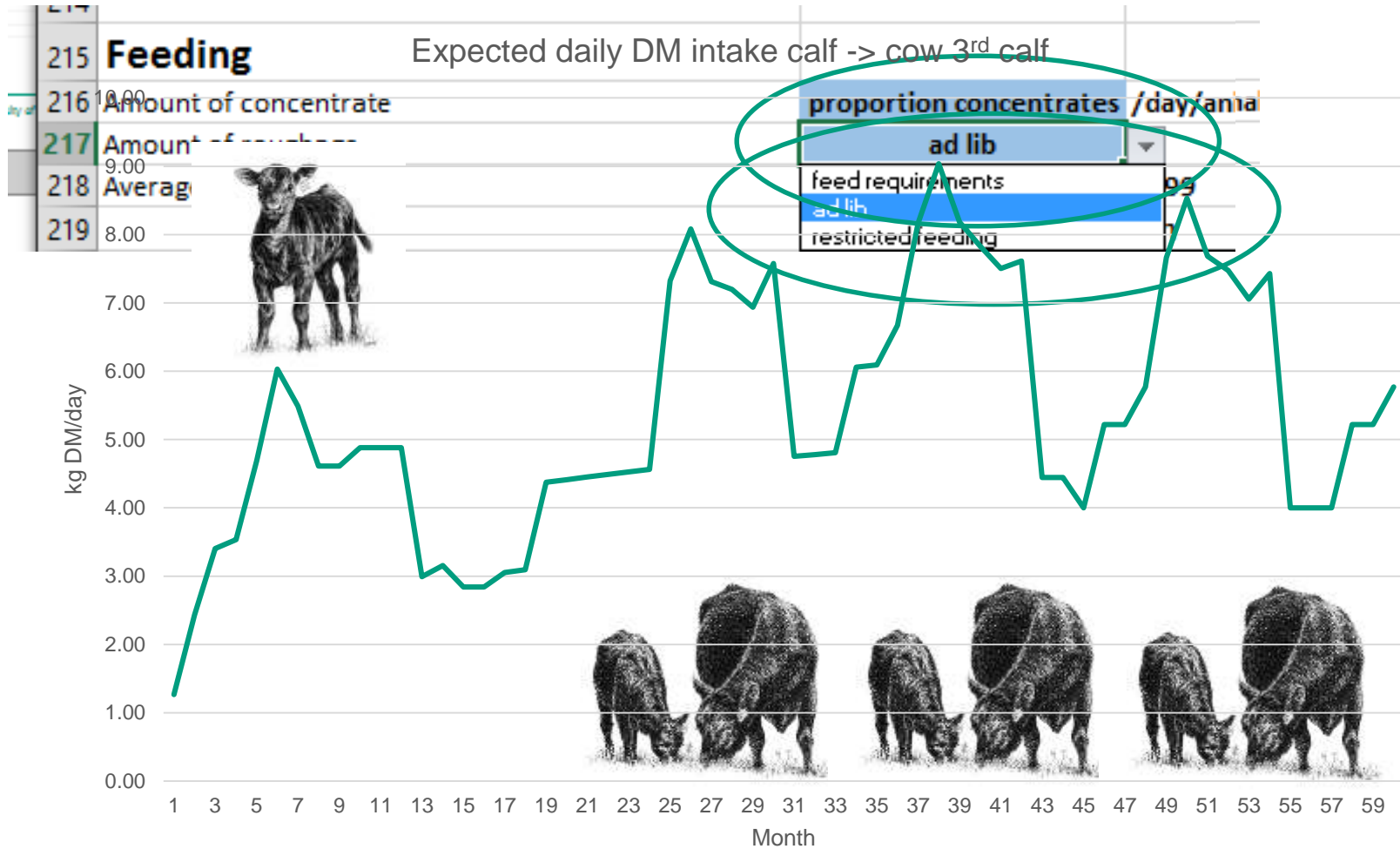
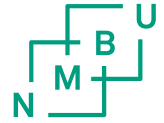
Input



Weights

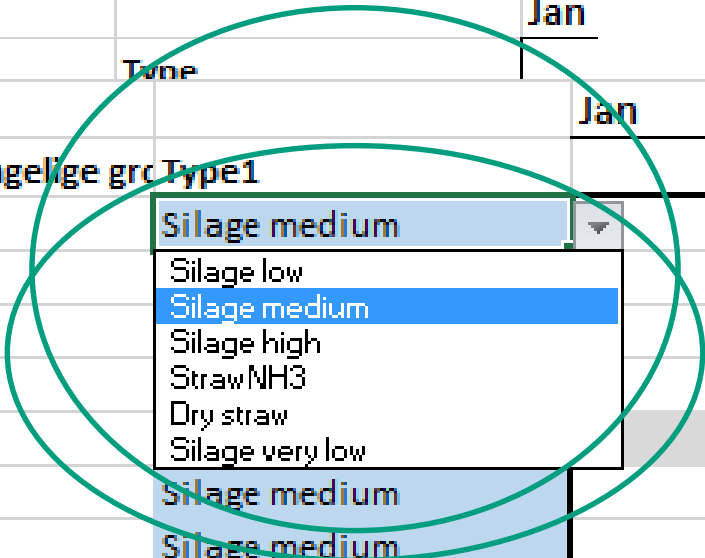


Feed requirement and feed intake

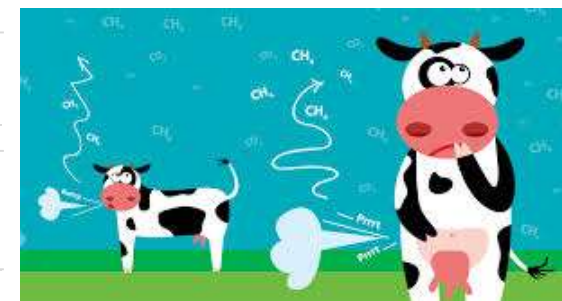
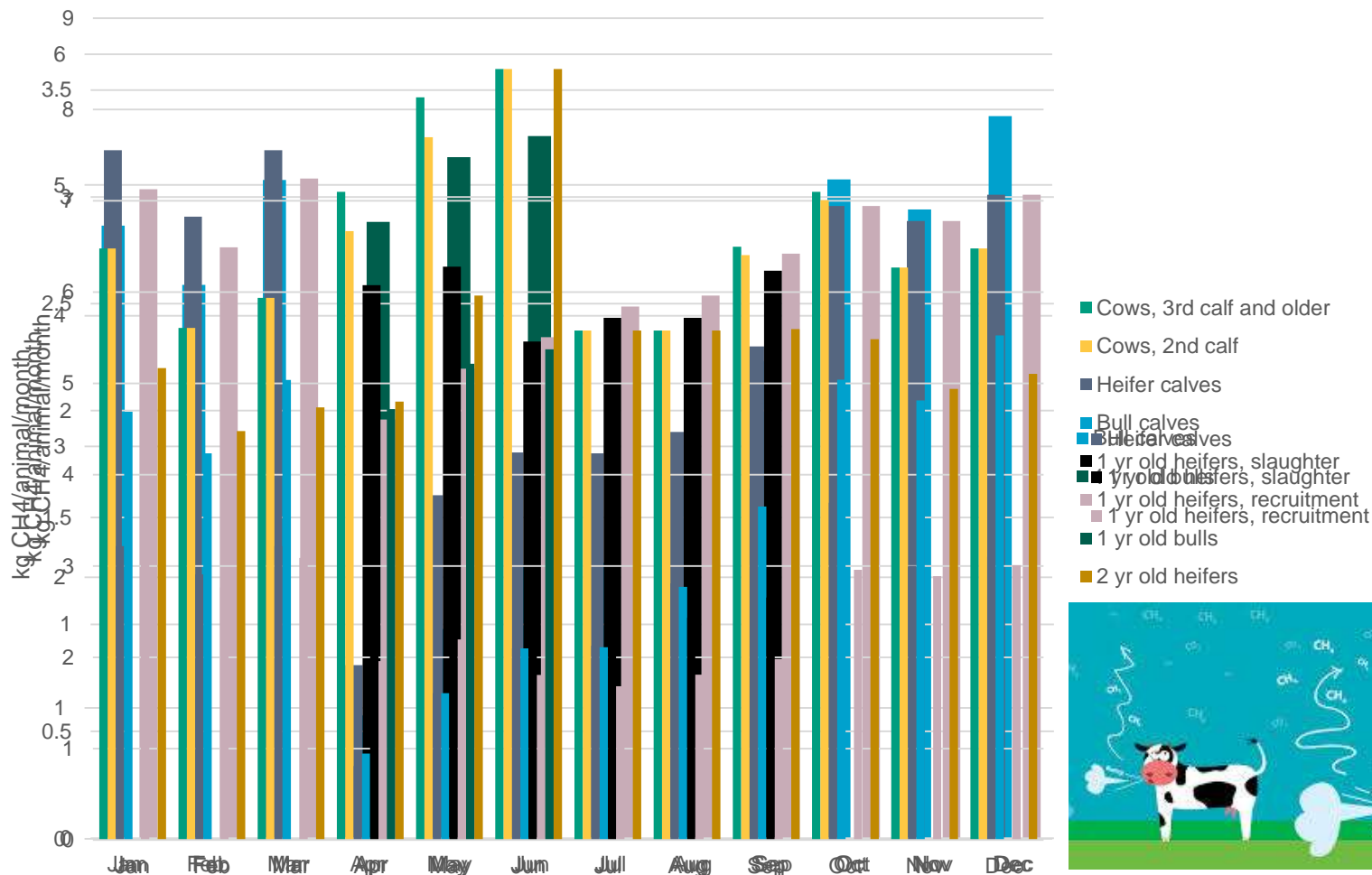


Feed

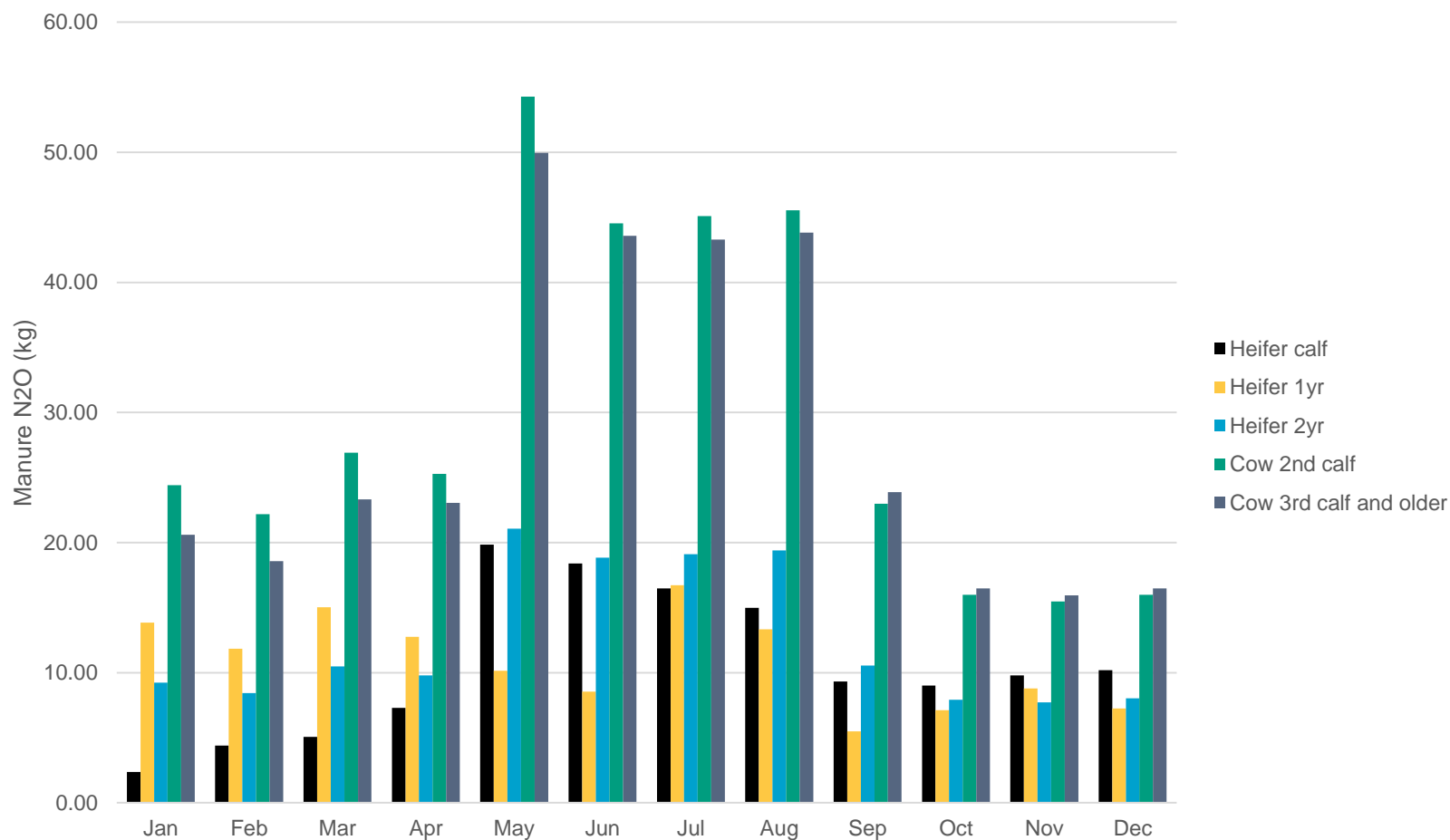
219			Jan
220	Concentrates	Time	
2234			Jan
2235	Grovfôr innefôring, andel (1 når eneste tilgjengelige gro Type1)		
2236	Cows	Silage medium	
2237	cows, 2nd calf	Silage low	
2238	Heifer calves	Silage medium	
2239	Bull calves	Silage high	
2240	Steer calves	StrawNH3	
2241	1 yr old heifers, slaughter	Dry straw	
2242	1yr old heifers, recruitment	Silage very low	
2243	1 yr old bulls	Silage medium	
2244	1 yr old steers	Silage medium	
2245	2 yr old heifers (first lact)	Silage medium	
2246	2 yr old bulls	Silage medium	
2247	2 yr old steers	Silage medium	
2248			



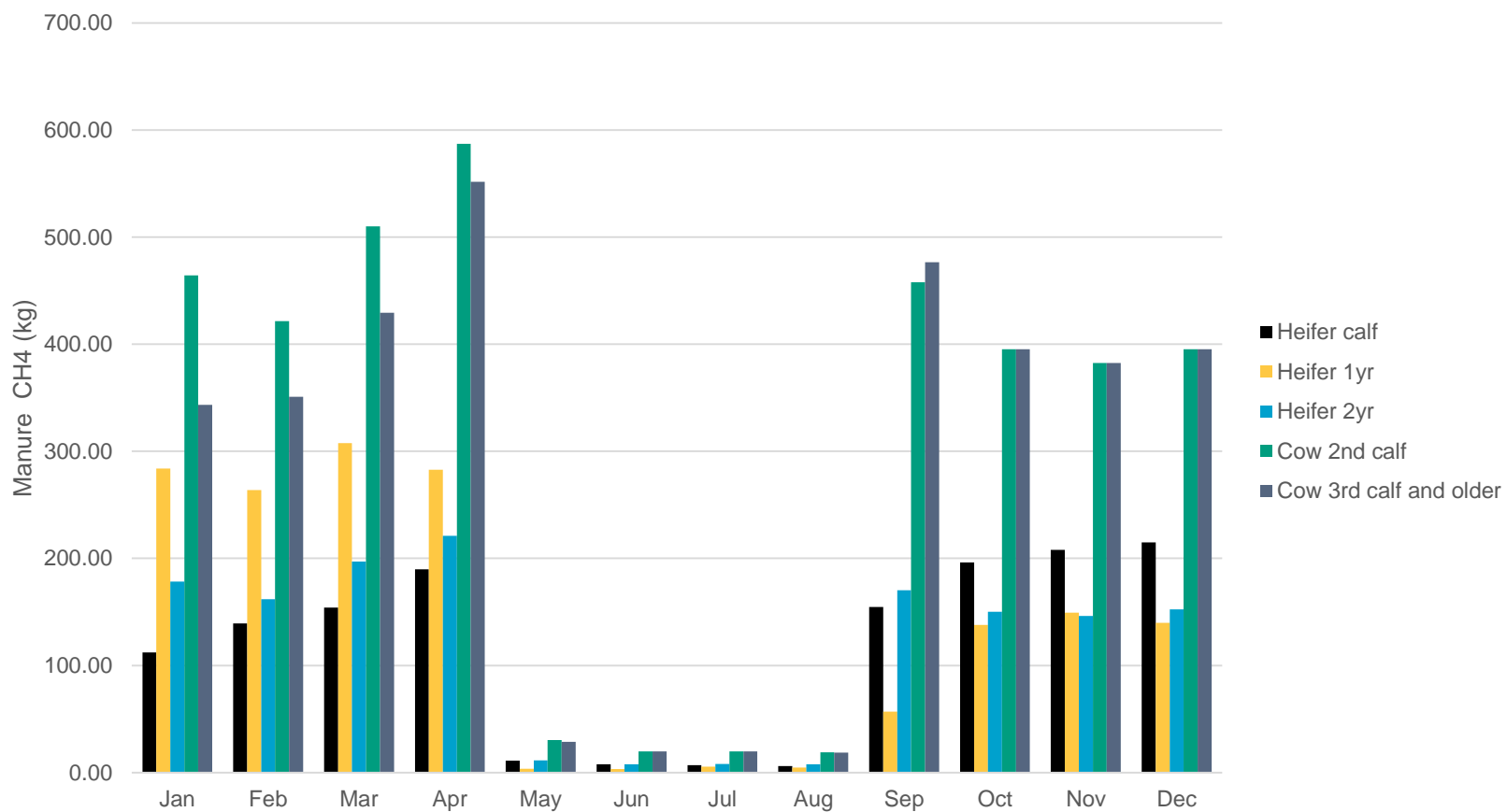
Enteric CH₄



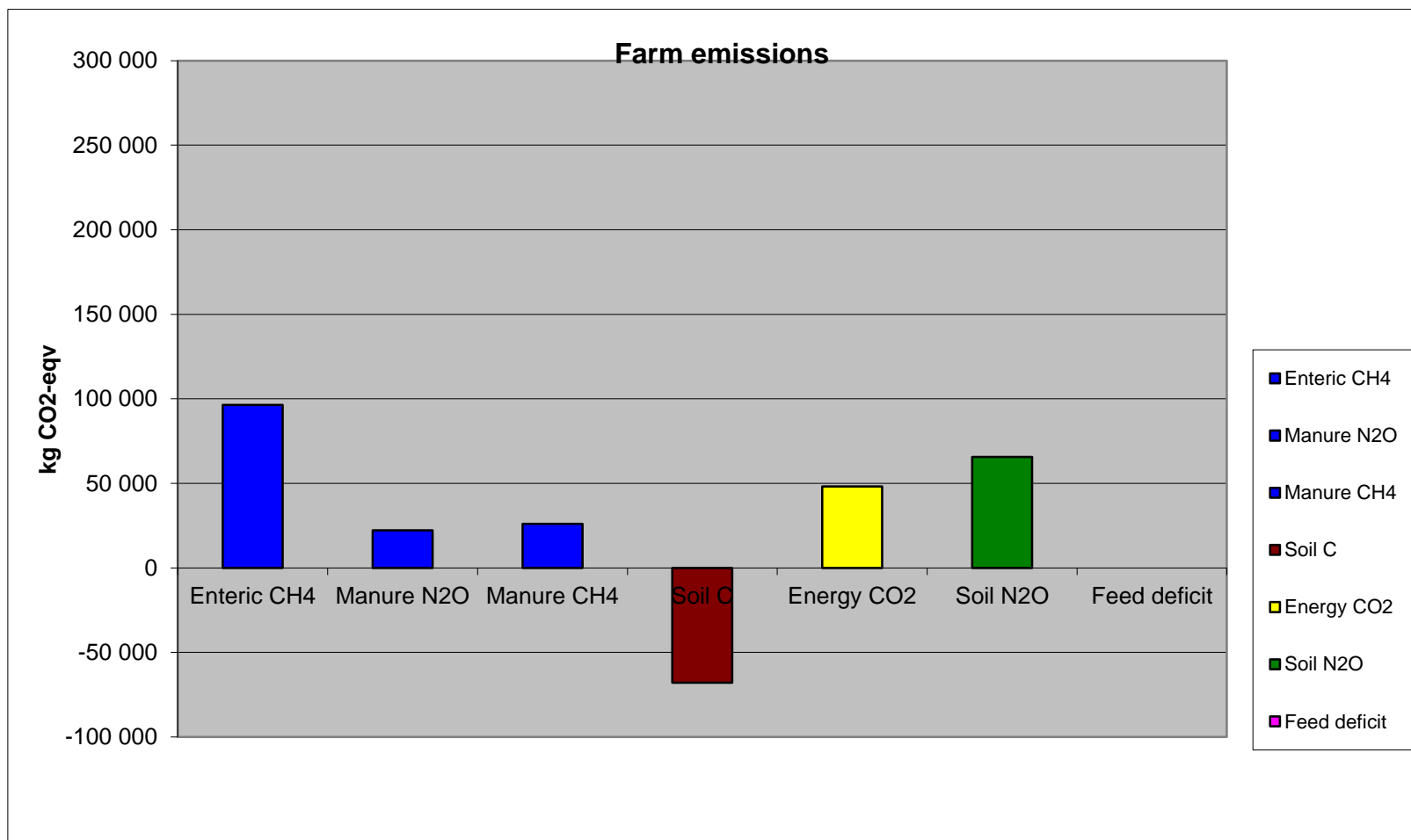
N₂O from manure



CH₄ from manure

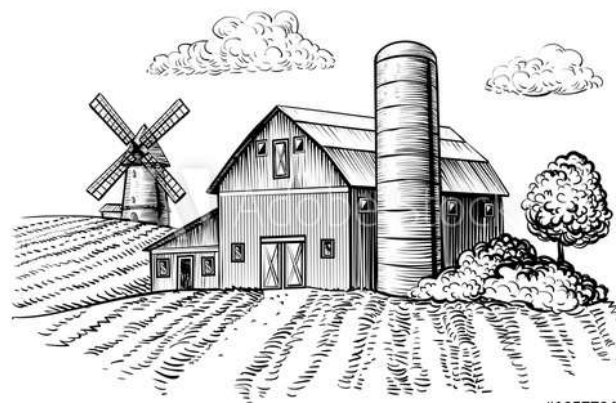
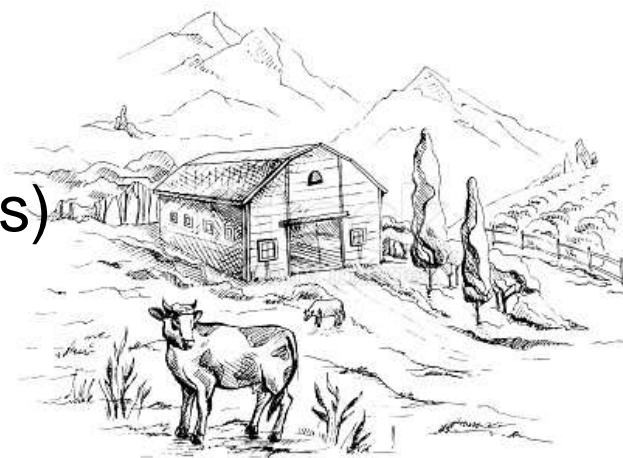


Total emissions



Data

- Farm data - 2 locations (A and B)
 - Areas and yield (silage and crops)
 - Silage quality
 - Soil and weather data
 - Fuel and electricity
 - Pesticides, fertilizer



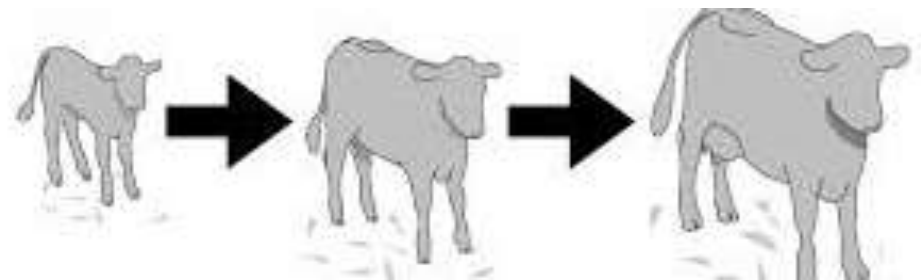
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Farm characteristics (unit)	A	B
Farm size (da) ⁶	446	415
Ley area (da) ⁶	389.1	401.2
Silage yield (kg) ⁶⁷	407564.6	475680.5
Silage moisture content (% DM) ⁶	33	32
Silage nutritive value (FUm) ⁶	0.87	0.84
Electricity (NOK) ⁶	26300	29100
Fuel (L) ⁶	3854.42	2947.36
Precervatives (NOK) ⁶	6293	440

6) NIBIO (2016)

7) Eurofins

- Animal data – average values
 - British (Angus/Hereford) and Continental (Charolais/Simmental/Limousin)
 - Stillbirth, proportion twins, death < 180 d
 - Replacement rate
 - Weights (birth, weaning, slaughter, adult)
 - Age (weaning, slaughter, first calf, ...)
 - Proportion concentrates
 - Proportion pasture

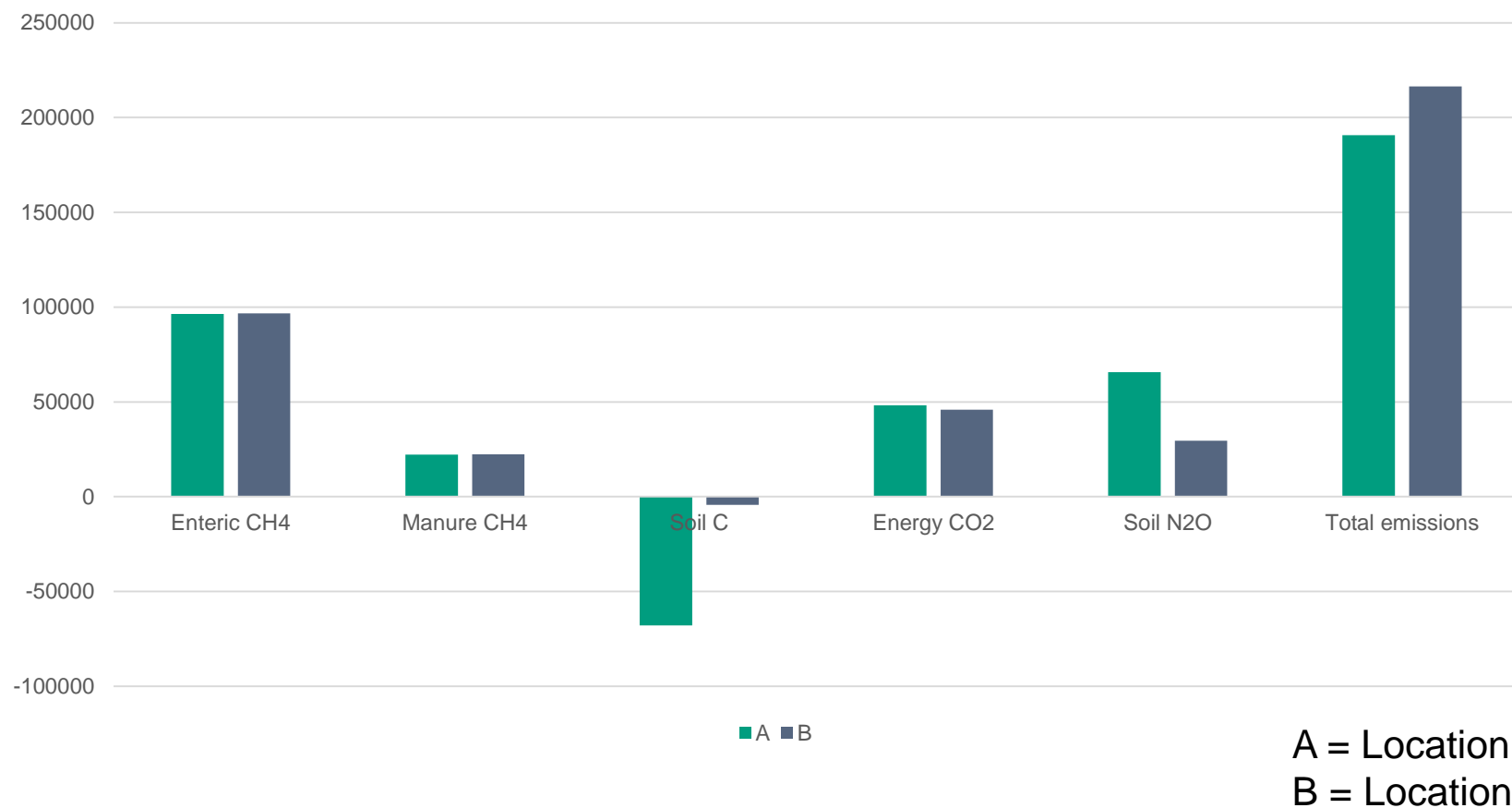


Animal characteristics (unit)	British	Continental
Cows, average final LW (kg) ⁸	600	800
Cows, slaughter weight (kg LW) ⁸	600	800
Heifers, birth weight (kg) ⁸	37.7	41.9
Heifers, weaning weight (kg) ⁸	250.5	295.3
Heifers, slaughter weight (kg LW) ⁸	456.5	518.9
Heifers, age at slaughter (months) ⁹	18.2	17.5
Heifers, age at first calving (months) ⁹	26.0	26.5
Young bulls, birth weight (kg) ⁸	39.6	44.8
Young bulls, weaning weight (kg) ⁸	268.5	322.3
Young bulls, slaughter weight (kg LW) ⁸	534.2	689.3
Young bulls, age at slaughter (months) ⁹	17.5	16.8
Beef produced (kg carcass) ⁹	7572.6	8914.7

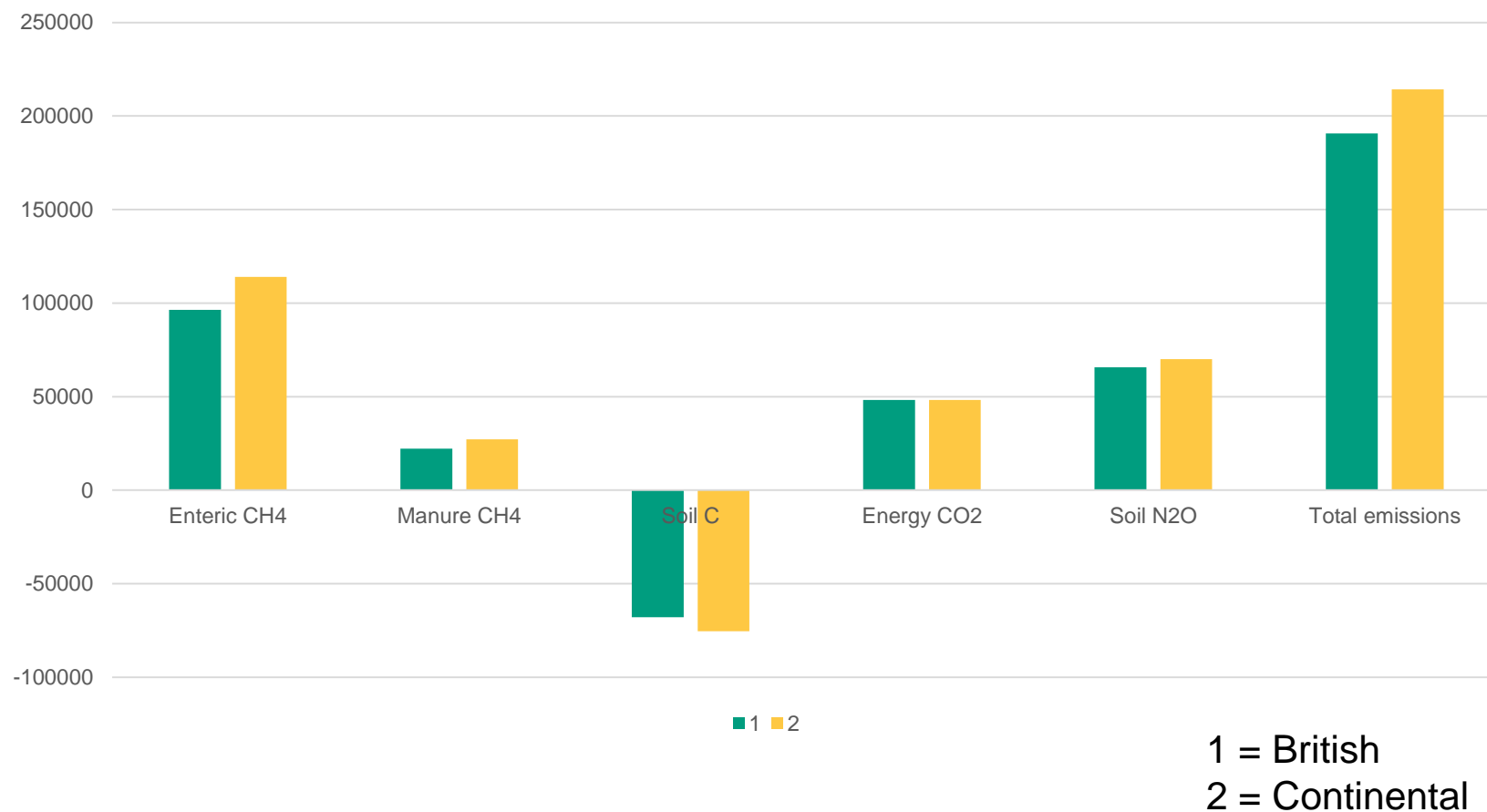
8) Aby et al 2012

9) Animalia 2016

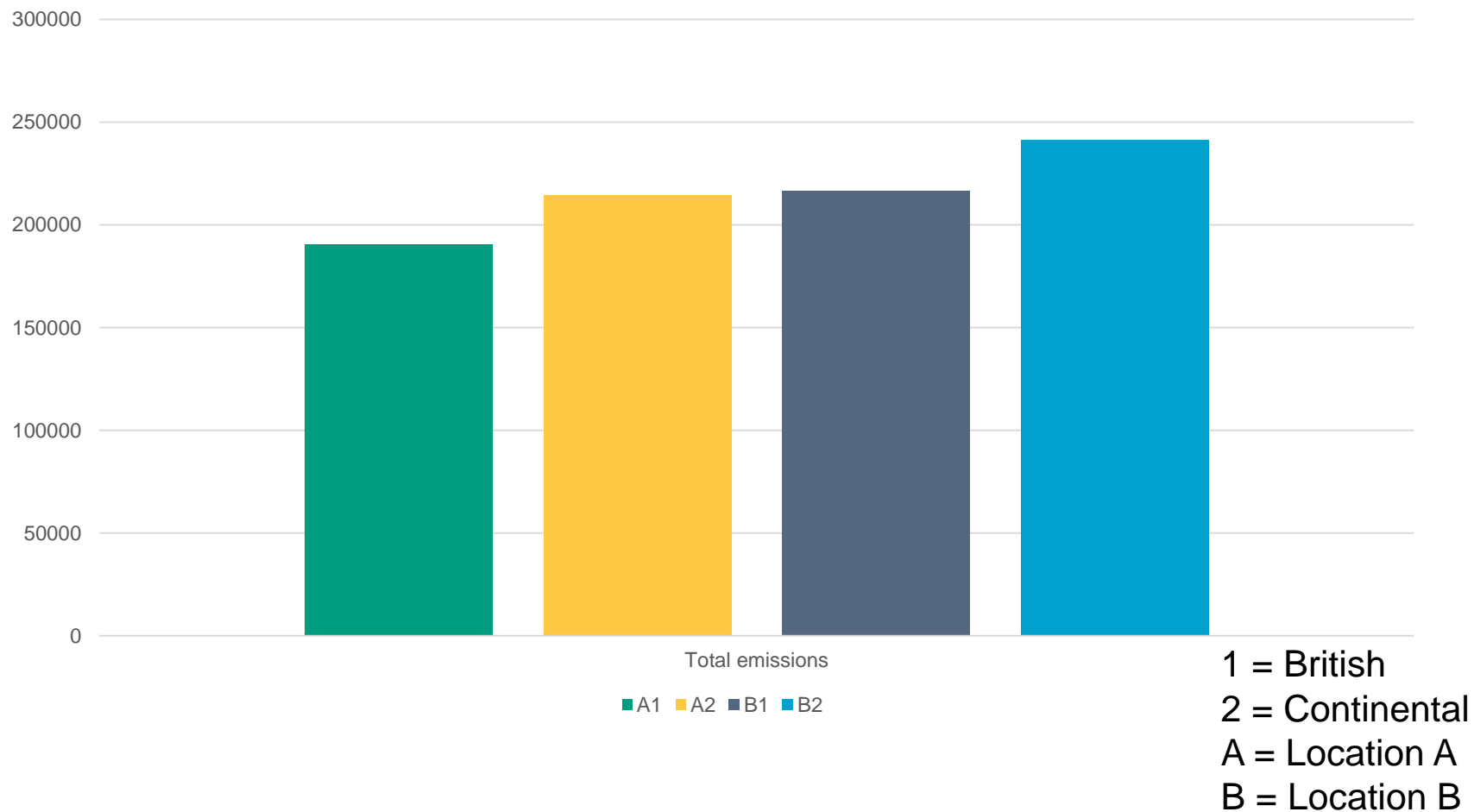
Emissions (CO₂ eq)



Emissions (CO₂ eq)



Emissions (CO₂ eq)



Emissions (kg CO₂ eq/kg beef)

	A		B	
	1	2	1	2
Direct kg CO ₂ per kg beef carcass	16.5	16.4	21.1	20.5
Total kg CO ₂ per kg beef carcass	25.2	24.0	28.6	27.1



Intensive system¹⁰: 25.4

1 British
2 Continental

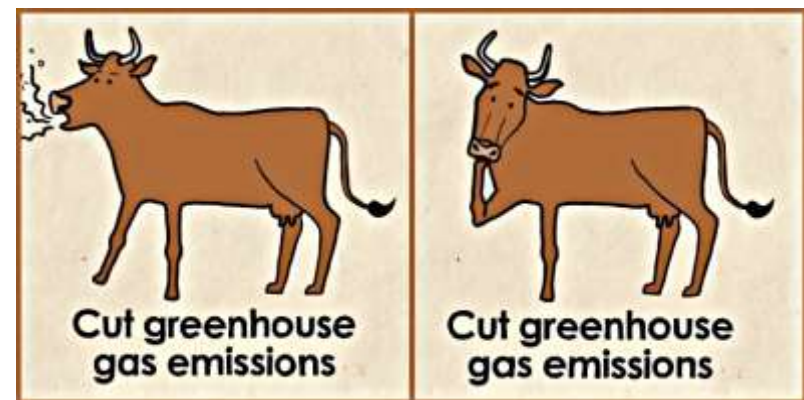


Intensive system¹⁰: 23.1
Extensive system¹⁰: 29.7

10) Mogensen et al 2015

Results and discussion

- The continental breeds have higher total emissions, but lower emissions/kg beef
- Emissions varies between regions and breeds
- GHG of average farms – variation!



Thanks for listening!

