

Whole-farm systems modelling of greenhouse gas emissions from suckler cow beef production systems

S. Samsonstuen¹, B. A. Aaby¹, L. Aass¹

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¹ Norwegian University of Life Sciences, Faculty of Biosciences,
Aboretveien 6, 1432 Ås, Norway.

Background

- The global population is expected to exceed 9.7 billion by 2050¹
- Increase global food production by 50%¹
- Limited arable land reserves
- Natural resources available for food production vary considerably between countries



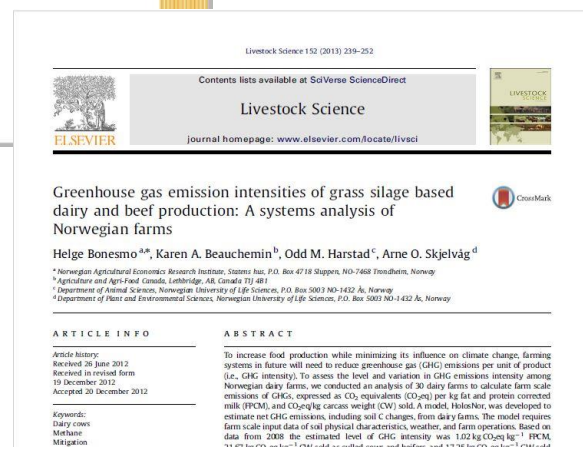
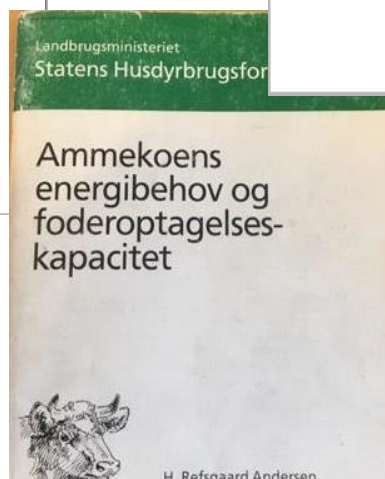
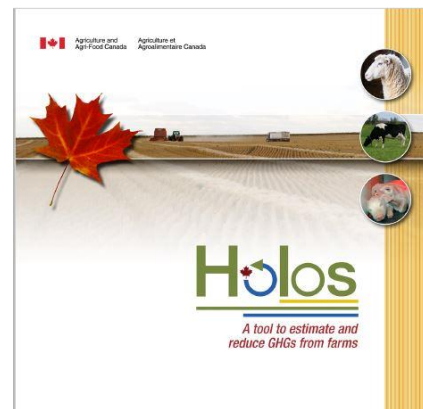
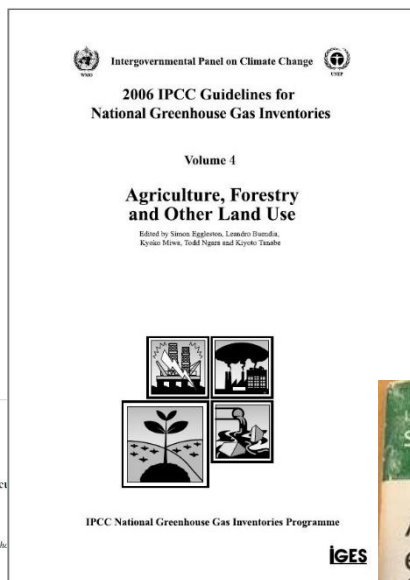
1) FAO 2017

Background

- Grass production accounts for 2/3 of cultivated area
- 55% of food production on energy basis
- Increased utilization of domestic grassland and pastures
- Reduce greenhouse gas (GHG) emissions 40% by 2030
- Need for a flexible emission farm scale model adapted to production systems and national resources in Norway



Developing HolosNorBeef



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ICBM regional model for estimations of dynamics of agricultural carbon pools

Olof Andrén^a, T. Kätterer and T. Karlsson
*Department of Soil Science, SLEI, P.O. Box 7014, SE-250 07 Uppsala, Sweden; *Author (fax: +46-18-672793; e-mail: olle.andren@mv.slu.se)*

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Abstract

Swedish arable land covers 3 Mha and its topsoil contains about 300 Mton C. The mineral soils seem to be close to steady-state, but the organic soils (about 10% of total arable land) have been estimated to lose ca. 1 Mton/year. We have devised a conceptual model (ICBMregion), using national agricultural crop yield/manuring statistics and allometric functions to calculate annual C input to the soil together with a five-parameter soil carbon model (ICBMr), calibrated using long-term field data. In Sweden, annual yield statistics are reported for different crops, for each of eight agricultural regions. Present topsoil carbon content and regional distribution of soil types have recently been measured. We use daily weather station data for each region together with crop type (derived from individual crop data) and soil type to calculate an annual soil climate parameter for each crop/soil type permutation in each region. We use 14 soil types and 9 crop types, which gives 126 parameter sets for each year and region, each representing a fraction of the region's area. For each year, region, crop and soil type, ICBMregion 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 1008 parameter sets per year, which easily can be handled, and what-if scenarios as well as comparisons between benchmark years are readily made. We will use the model to compare the soil C pools between the IPCC benchmark year 1990 and the present. In principle, we use inverse modelling

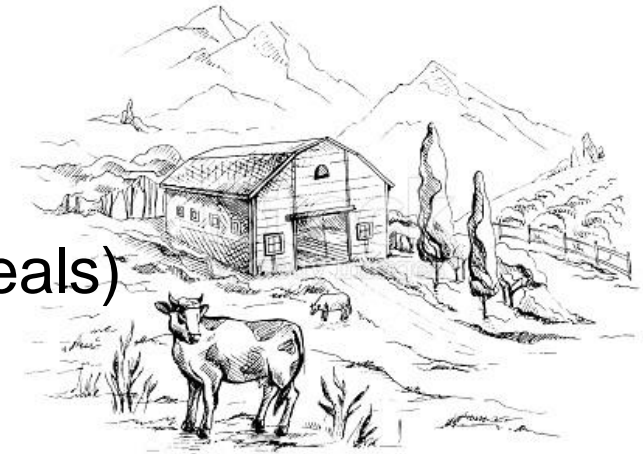
Input



Data material

Farm data - 2 locations (A and B)

- Areas and yield (silage and cereals)
- Silage quality
- Soil and weather data
- Fuel, electricity
- Pesticides, fertilizer



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| Farm characteristics (unit) | A | B |
|---|-------------|-------|
| Farm size ² (ha) | 44.6 | 41.5 |
| Pasture and ley area ² (ha) | 38.9 | 40.1 |
| Silage yield ²³ (FUm/ha) | 3020 | 3190 |
| Silage nutritive value ² (FUm) | 0.87 | 0.84 |
| Cereal area ² (ha) | 7.7 | 0.9 |
| Cereal yield ² (FUm/ha) | 5260 | 3600 |
| Electricity ² (kWh/year) | 26300 | 29100 |
| Fuel ² (L/year) | 3855 | 2947 |
| Preservatives ² (NOK) | 6293 | 440 |

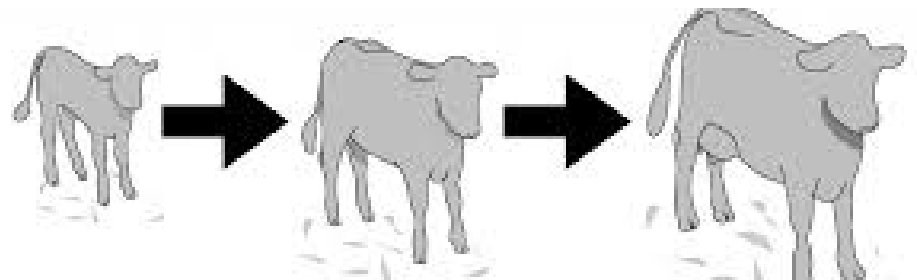
2) NIBIO 2016

3) Eurofins

British (Angus/Hereford)

Continental (Charolais/Limousin/Simmental)

- Stillbirth, proportion twins, death < 180 days
- Replacement rate
- Weights (birth, weaning, slaughter, adult)
- Age (weaning, slaughter, first calf, ...)
- Proportion concentrates
- Proportion pasture

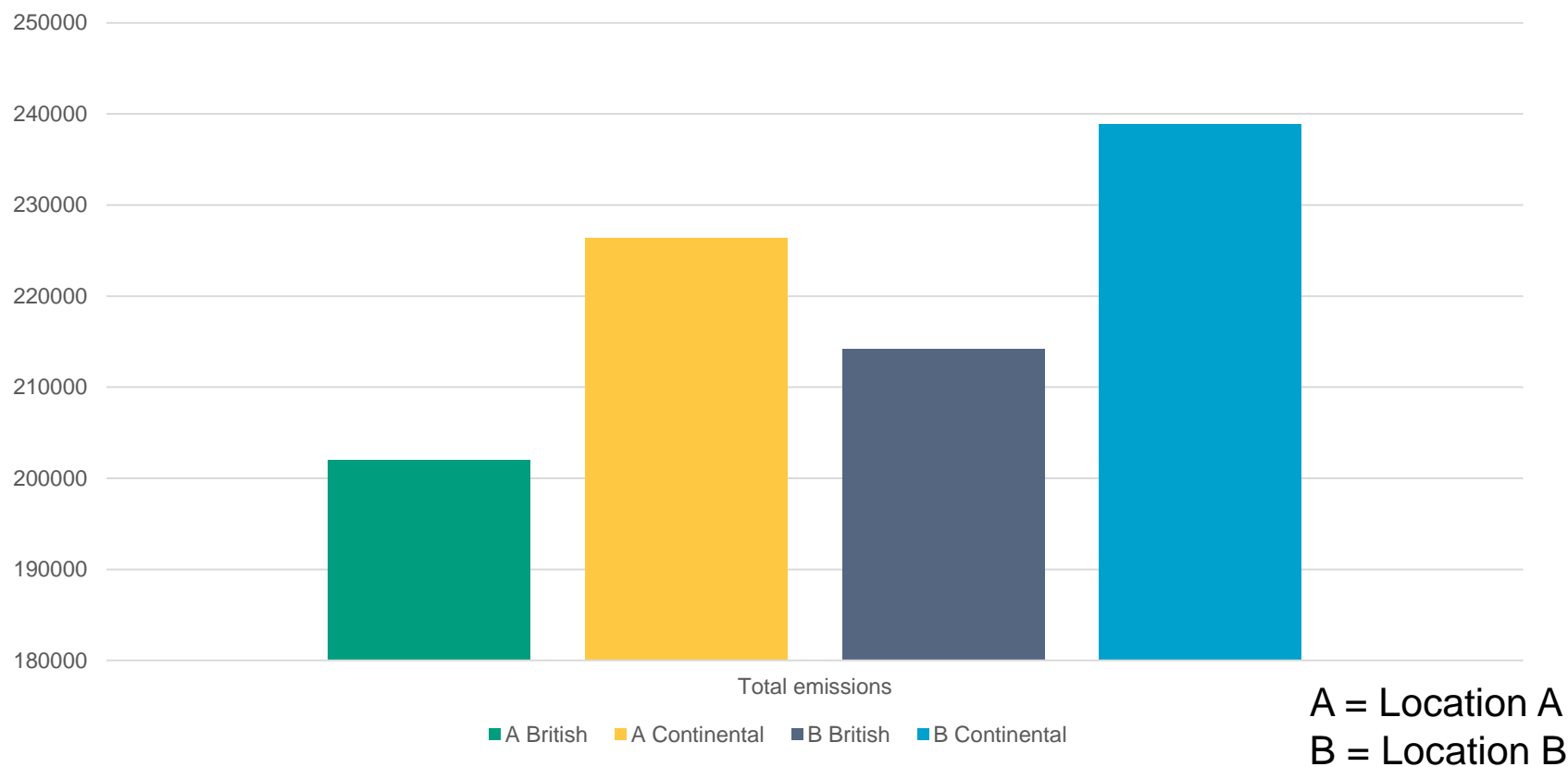


| Animal characteristics (unit) | British | Continental |
|---|---------|-------------|
| Cows, average final LW ⁴ (kg) | 600 | 800 |
| Heifers, birth weight ⁴ (kg) | 38 | 42 |
| Heifers, weaning weight ⁴ (kg) | 251 | 295 |
| Heifers, age at slaughter ⁵ (months) | 18.2 | 17.5 |
| Heifers, age at first calving ⁵ (months) | 26.0 | 28.9 |
| Young bulls, birth weight ⁴ (kg) | 40 | 45 |
| Young bulls, weaning weight ⁴ (kg) | 269 | 322 |
| Young bulls, age at slaughter ⁵ (months) | 17.5 | 16.8 |
| Heifers carcass weight ⁴ (kg) | 206 | 244 |
| Young bulls, carcass weight ⁴ (kg) | 291 | 353 |
| Beef produced ⁵ (kg carcass) | 7699 | 9635 |

4) Aby et al 2012

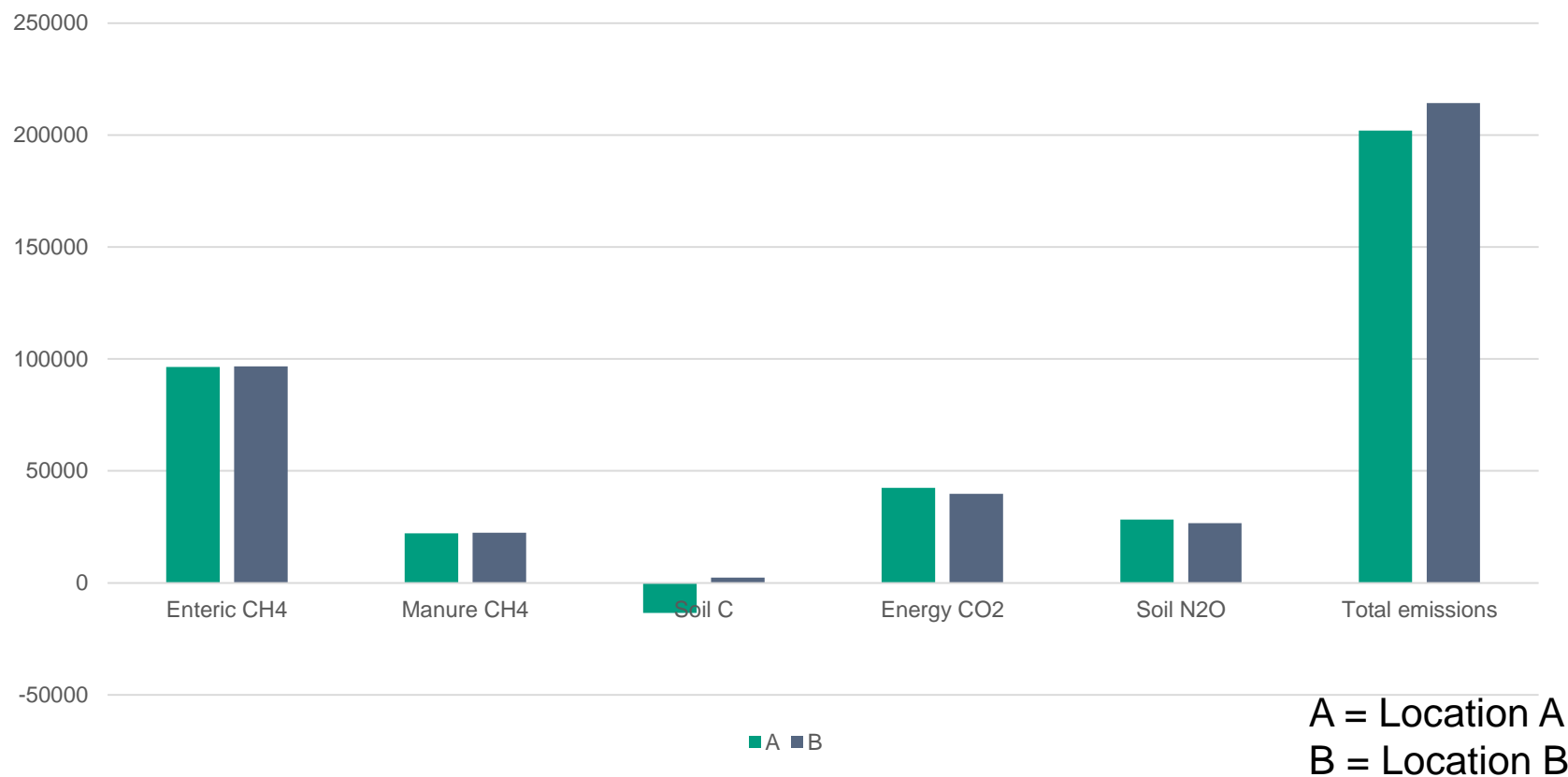
5) Animalia 2016

Total emissions (CO₂ eq)



Samsonstuen et al, in prep

Emissions (CO₂ eq) - location

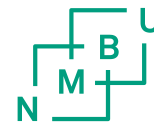


Samsonstuen et al, in prep

Emissions (CO₂ eq) – breed



Samsonstuen et al, in prep



Emission intensities (kg CO₂ eq/kg beef)

| | A | | B | |
|---|---------|-------------|---------|-------------|
| | British | Continental | British | Continental |
| Direct kg CO ₂ per kg beef carcass | 21.4 | 19.4 | 22.9 | 20.7 |
| Total kg CO ₂ per kg beef carcass | 26.2 | 23.5 | 27.8 | 24.8 |

Samsonstuen et al, in prep

Emission intensities (kg CO₂ eq/kg beef)

| | A | | B | |
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Intensive system⁶: **25.4**



Average farm⁷ : **22**



Intensive system⁶: **23.1**
Extensive system⁶: **29.7**



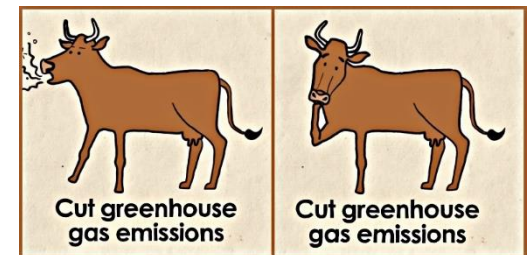
Average farm⁸ : **23.1**

- 6) Mogensen et al 2015
- 7) Beauchemin et al 2010
- 8) Foley et al 2011

Conclusions

- Emission intensities of the same magnitude as the other Nordic countries
- The Continental breeds have higher total emissions, but lower emission intensities
- Location important to consider
- Emissions varies between location and breed
- Average inputs
- Expect large variation between individual farms

Next step: 30 commercial suckler cow farms



Thank you for your attention!

