

# Including soil carbon and land use changes to comparison of carbon footprints of beef production systems

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## Objective & Methods

The aim of this study was to compare dairy beef production of major Finnish importer countries, Denmark and Germany, to Finnish production (Pulkkinen et al., 2016; Mogensen et al., 2015; Zehetmeier et al., 2012).

In addition, the effect of emissions due to carbon stock changes and from land use changes in soya cultivation in comparison to different production systems were estimated. An estimate of the most common feed crop rotations of feeds grown on farm and their effects on soil carbon stock change was done on only mineral soils, as the used Yasso07 and ICBM models are limited on mineral soils. Land use change emission were estimated based on available literature for soy production in South America.

Also, uncertainties of the comparison were estimated.

## Results

The carbon footprints of beef from Danish and German dairy bulls are significantly lower than Finnish, when compared without including emissions from carbon stock and land use changes (see Figure 1). This is due to:

- the average efficiency of feed production, i.e. the harvest yield in proportion to the used nitrogen fertilizer levels,
- the structure of production, as in Denmark part of the dairy bulls are grown only to 9.4 months of age, because of the national milk production supplies male calves for rearing in abundance, and
- the lower slaughter age leads to lower enteric fermentation emissions.

## Conclusions

This study shows challenges in comparison of different LCA studies with evolving methodologies, but can still indicatively shed light on the differences of greenhouse gas emissions of the studied beef production systems and the causes for differences between them including the effect on emissions of changes in carbon stocks and land use. The lack of models to estimate carbon stocks on organic soils is a major limitation affecting the comparison. There are also various methods and data available for the assessment of emissions of land use changes, which also alters the comparisons between countries.

### References:

- Mogensen, L., Hermansen, J. E., Nguyen, L., and Preda, T. 2015. Environmental impact of beef by life cycle assessment (LCA) – 13 Danish beef production systems. DCA Report no. 061, Aarhus University.
- Pulkkinen, H., et al. 2016. Naudanlihanuotannon ympäristövaikutukset ja niiden vähennyskeinojen mahdollisuudet (in Finnish). Presentation of FootprintBeef-project 21.4.2016.
- Zehetmeier, M., Baudraco, J., Hoffmann, H. and Heißenhuber, A. 2012 Does increasing milk yield per cow reduce greenhouse gas emissions? A system approach. *Animal* (2012), 6:1, pp 154–166

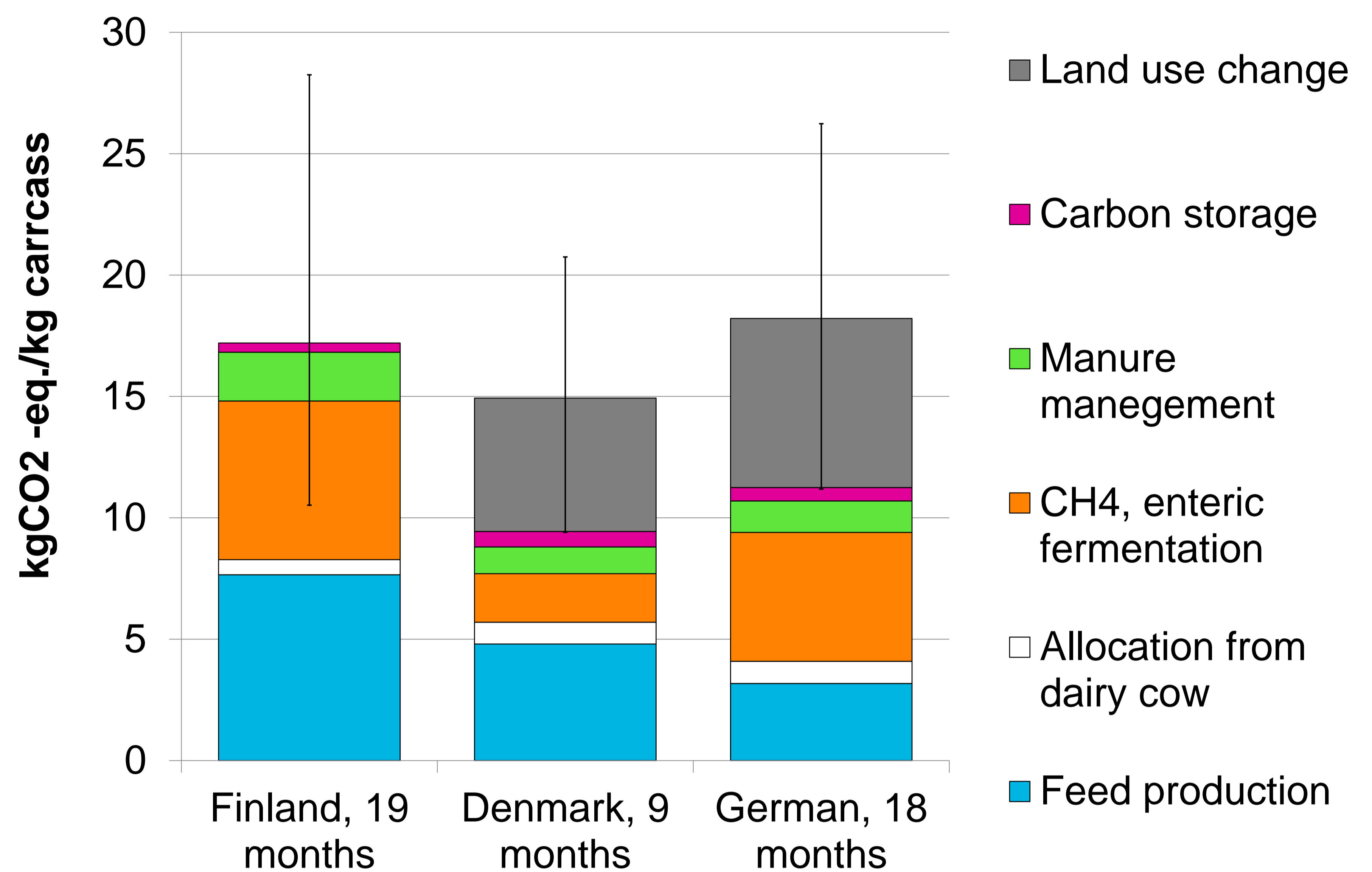


Figure 1. Greenhouse gas emissions of dairy bulls by different sources with the emissions from changes in carbon stocks and land use, and without carbon temporarily sequestered in feeds. Emission caused by the change in carbon stocks is the average of the results of Yasso and ICBM models, and for Finland, the average of Northern and Southern Finland. Emission caused by land use change are average of the minimum and maximum estimates. Error bars represent most important sources of uncertainties in the comparison.

On mineral soils, there does not seem to be significant differences in carbon sequestration of the home-grown feeds. In all countries, feed production seems to release carbon from the soil instead of sequestering. In the Finnish crop rotation maybe the release is somewhat less on mineral soils than in the Danish or German rotations, but in fact, carbon release from organic soils is excluded here, and if included, it would increase Finnish emissions most likely significantly.

In contrast, the inclusion of emissions caused by changes in land use of soybean meal to alters the comparison between countries, and in particular, the emissions from Danish and German bull. In Finland no soy is used for cattle.