SOLID | Sustainable Organic and Low Input Dairying

Environmental impact of organic milk production: New evidence from the SOLID project

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Future Sustainability of organic and low-input milk production: Challenges and Solutions
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SEVENTH FRAMEWORK PROGRAMME

Overview

- GHG emissions from the dairy sector
- SOLID WP4: Environmental assessment
- Results from LCA of organic milk
- GHG hotspots and mitigation options
- Conclusions

Background

Agriculture differs from other sectors in that the primary contribution towards global warming is from non-CO_2 greenhouse gases.

Over half of all agricultural emissions are from N_2O; 35% are due to methane and only about 8% are due to CO_2.

World dairy sector contributes around 4% of anthropogenic GHG emissions

Source	CO_2 (e) per kg of milk
Europe and N. America	1 to 1.5
Sub-saharan Africa	7.5

In addition farming systems have considerable potential to absorb CO_2 from the atmosphere through soil carbon sequestration

Source: Gerber et al. 2010. Greenhouse Gas Emissions from the Dairy Sector

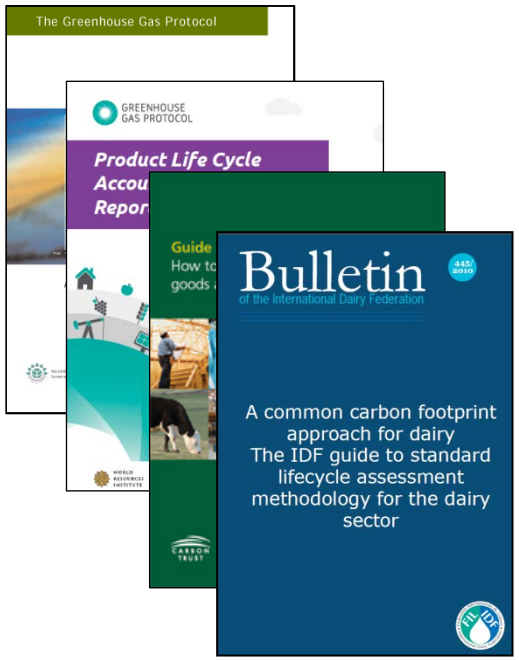
SOLID Workpackage 4: Environmental assessment

- Task 4.1: Environmental sustainability assessment tool box assessing dairy chains
- Task 4.2: Decision support for improvement options in dairy production systems
- Task 4.3: Assessment of multifunctional dairy systems

Two approaches to assessing a farm's greenhouse gas emissions:

1. Whole-farm approach - GHG Protocol Product Standard (2011), PAS 2060 (2010);
2. Product Life Cycle Assessment (LCA) PAS 2050 (2008, 2010), IDF (2010)

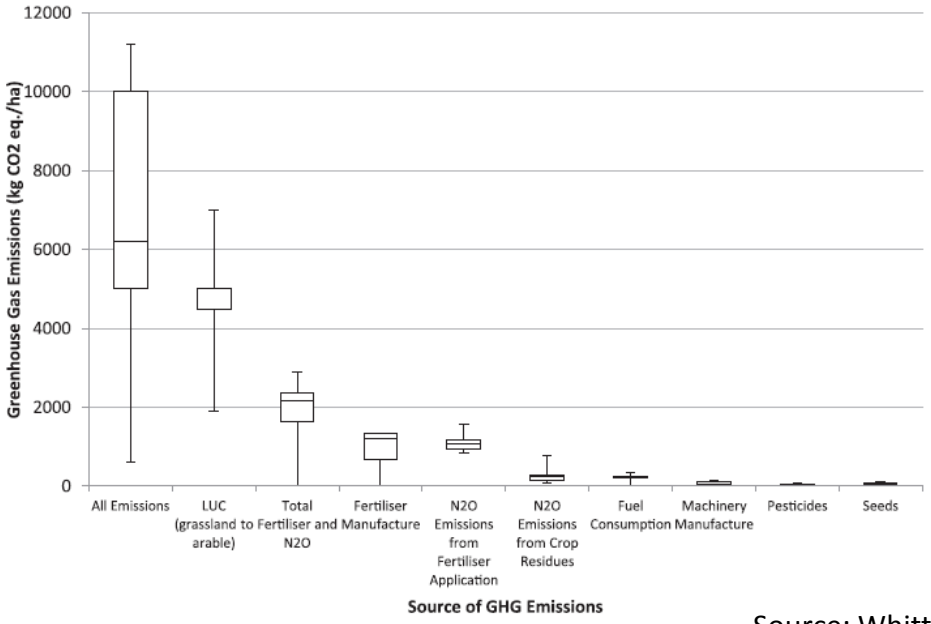
	CALM	CPLAN	Man. Energy & Carbon	Farm Carbon Calculator
Developed by	CLA	D & J Coulter	CALU	CFF
Format	Web	Web & Spreadsheet	Paper	Web
Availability	Free	1) Free (simple) 2) Pay-click-calculate (more complex) 3) Consultancy (spreadsheet not publicly available)	Free	Free
Purpose	Farm management	Farm management; policy development	Farm management	Farm management; certification; marketing
Ease of use	High	High	Medium	High
Methodology		IPCC plus UK		Climate Friendly



http://tinyurl.com/CO2tools

Comparisons between tools and approaches:

Farm number	Milk yield category	CALM - kg CO_2e for whole farm	Cool Farm Tool Kg CO_2e per litre of milk
Dairy Farm 1	**HIGH**	**1499**	**1.2**
Dairy Farm 2	HIGH	727	1.3
Dairy Farm 3	MEDIUM	740	1.2
Dairy Farm 4	**LOW**	**-407**	**1.5**

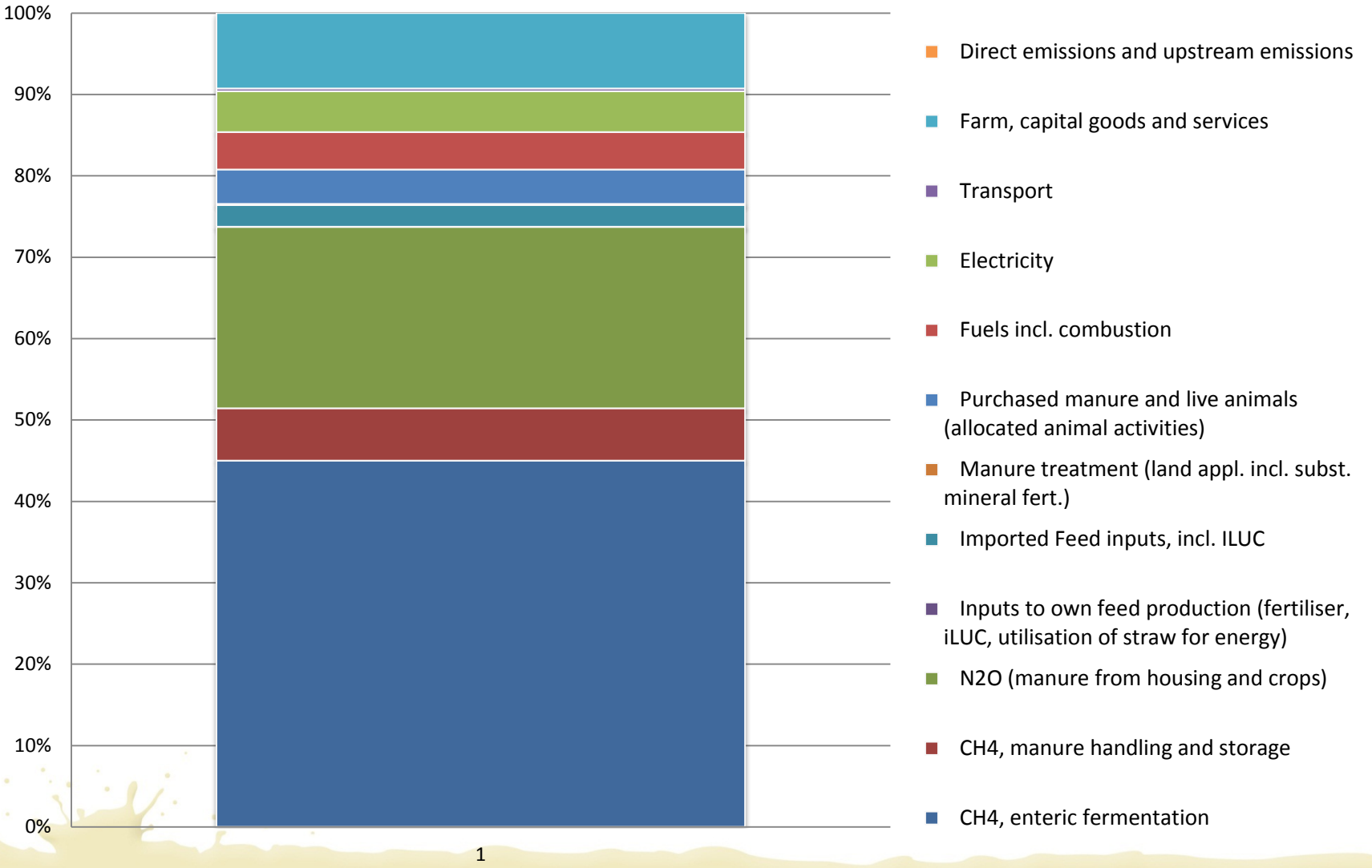


Source: Whittaker et al. 2013.

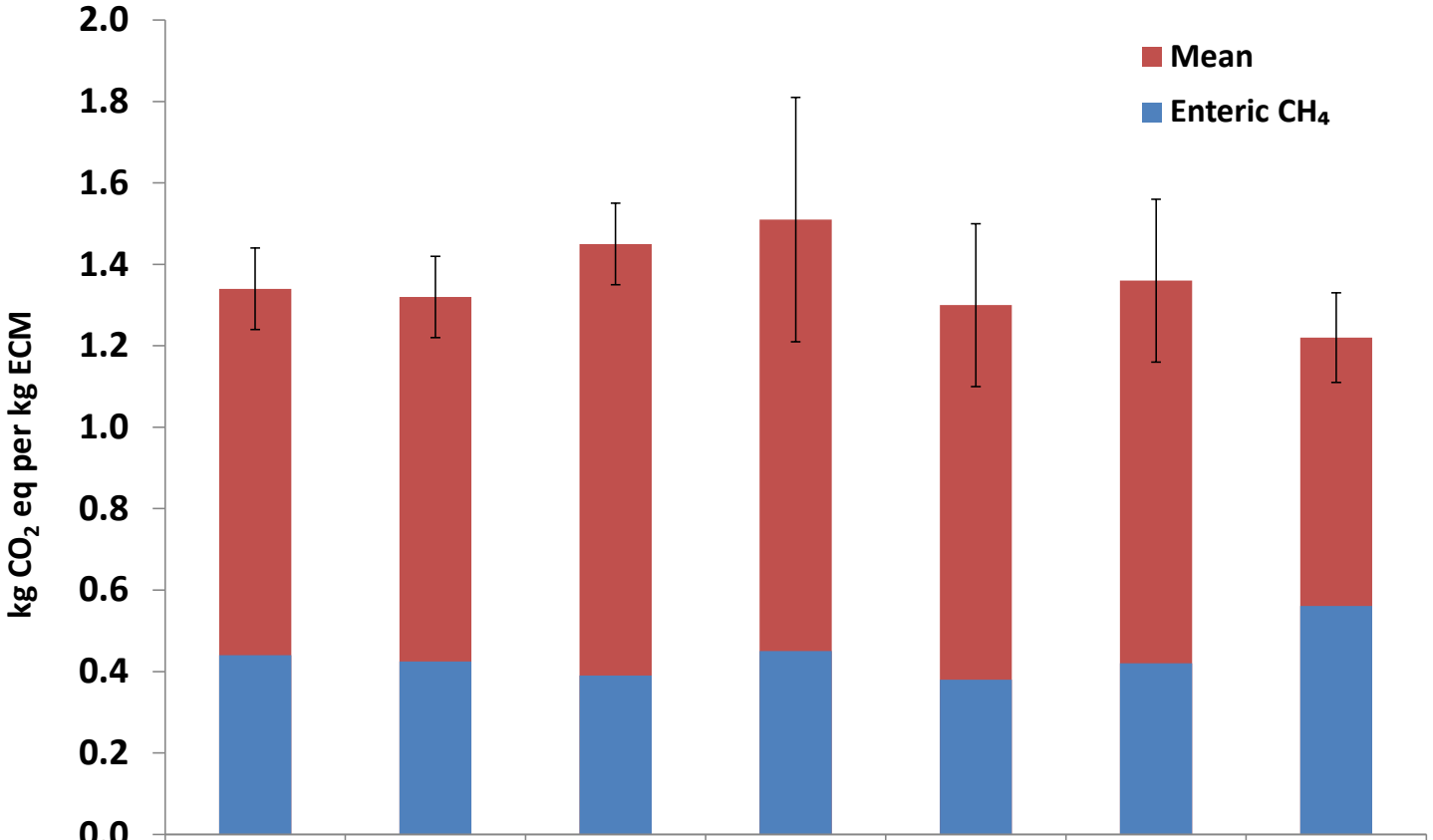
LCA and Arla carbon footprint model

- Arla carbon footprint model; global warming potential assessment tool
- System boundaries are set from cradle to farm gate
- Emissions from agriculture include CO_2, No_x and CH_4 (carbon dioxide, nitrous oxides and methane)
- Conversion of emissions to CO_2 equivalents by multiplying with characterisation factors (N_2O by 25 and CH_4 by 298)
- Result is given as kg of CO_2 equivalents per kg of Energy and protein Corrected Milk (ECM)

Contribution to GHG emissions, %



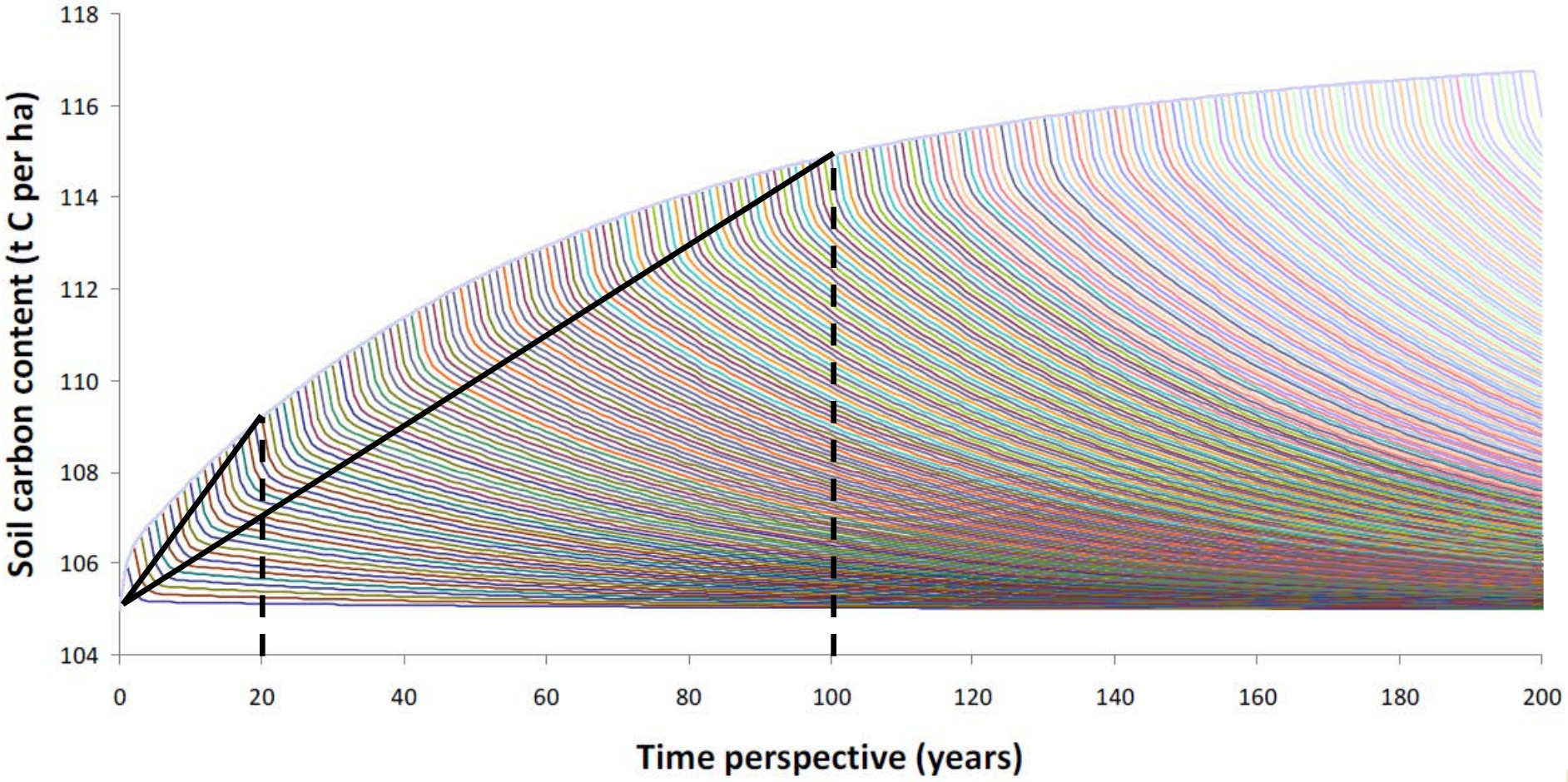
Carbon footprint, average by country



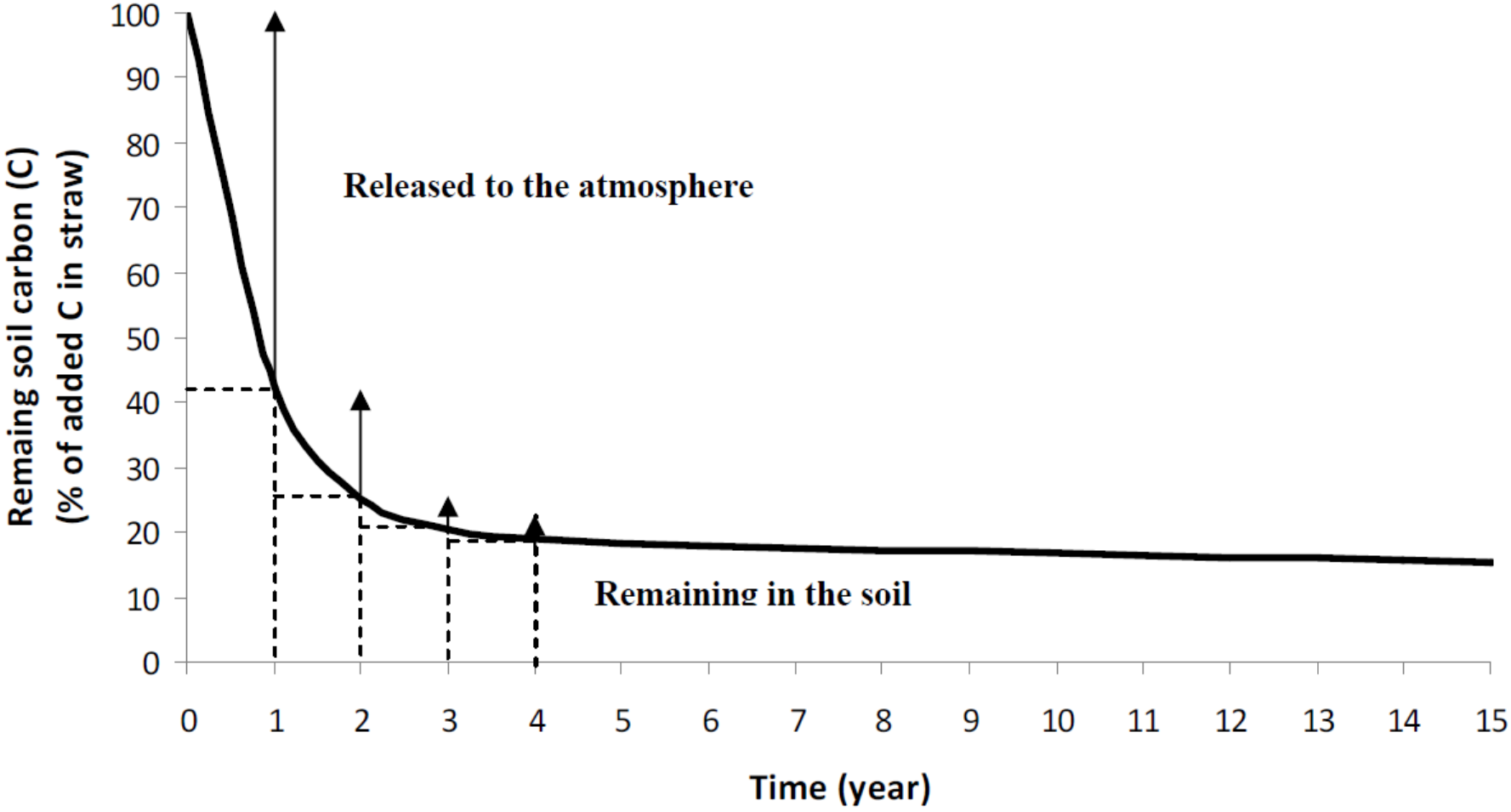
	UK	DK	FI	AT	BE	IT	AHDB (non-organic)
Mean	1.3	1.3	1.5	1.5	1.3	1.4	1.2
Enteric CH_4	0.4	0.4	0.4	0.5	0.4	0.4	0.6

Build up of soil carbon towards a new steady state

– based on decay curves of single C additions



Decay of biomass carbon added to the soil



Organic farming practices and carbon sequestration:

Lower reliance on imported feed within organic systems can help to avoid deforestation/land clearance for growing crops such as soya and maize

Use of legumes and livestock manures in agroecological systems can also lead to greater amounts of soil carbon

Whilst these practices are not limited to the organic sector, the mixed nature of organic farms more readily allows for their application

Recent meta-analysis by Gattinger *et al.* (2012)* confirms higher soil organic carbon concentrations (0.18 ± 0.06%) and stocks (3.50 ± 1.08 t C ha^{-1}) in top soils under organic management.

*Gattinger et al. 2012. Enhanced top soil carbon stocks under organic farming

Image: Defra & Wiki Commons

The approach is published in J of Clean Prod (2013):

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An approach to include soil carbon changes in life cycle assessments

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ABSTRACT

Globally, soil carbon sequestration is expected to hold a major potential to mitigate agricultural greenhouse gas emissions. However, the majority of life cycle assessments (LCA) of agricultural products have not included possible changes in soil carbon sequestration. In the present study, a method to estimate carbon sequestration to be included in LCA is suggested and applied to two examples where the inclusion of carbon sequestration is especially relevant: 1) Bioenergy: removal of straw from a Danish soil for energy purposes and 2) Organic versus conventional farming: comparative study of soybean production in China. The suggested approach considers the time of the soil CO_2 emissions for the LCA by including the Bern Carbon Cycle Model. Time perspectives of 20, 100 and 200 years are used and a soil depth of 0–100 cm is considered. The application of the suggested method showed that the results were comparable to the IPCC 2006 tier 1 approach in a time perspective of 20 year, where after the suggested methodology showed a continued soil carbon change toward a new steady state. The suggested method estimated a carbon sequestration for the first example when storing straw in the soil instead of using it for bioenergy of 54, 97 and 213 kg C t^{-1} straw C in a 200, 100 and 20 years perspective, respectively. For the conversion from conventional to organic soybean production, a difference of 32, 60 or 143 kg soil C ha^{-1} yr^{-1} in a 200, 100 or 20 years perspective, respectively was found. The study indicated that soil carbon changes included in an LCA can constitute a major contribution to the total greenhouse gas emissions per crop unit for plant products. The suggested approach takes into account the temporal aspects of soil carbon changes by combining the degradation and emissions of CO_2 from the soil and the following decline in the atmosphere. Furthermore, the results from the present study highlights that the choice of the time perspective has a huge impact on the results used for the LCA. For comparability with the calculation of the global warming potential in LCA, it is suggested to use a time perspective of 100 years when using the suggested approach for soil carbon changes in LCA.

1. Introduction

Climate change is increasingly regarded as a major problem and mitigation options are discussed (e.g. IPCC, 2007). Carbon sequestration, which is removal or temporary storage of carbon from the atmosphere for example in vegetation or soil, is seen as a way of mitigating climate change by temporarily avoiding some radiative forcing (Brandão et al., 2013). Soil carbon sequestration is the temporary storage (or release) of carbon in the soil and is in agricultural soils expected to hold a major potential for agriculture's global warming mitigation potential to reduce agricultural emissions and increase C sequestration. Thus, Smith et al. (2007) estimated soil C sequestration to contribute about 89% to the global mitigation potential from agriculture. However, the importance of soil C sequestration is poorly reflected in current LCA's (Koerber et al., 2009), since the majority of studies have not included soil C sequestration in the overall greenhouse gas estimations, mainly due to methodological limitations (Brandão et al., 2011). Though, recently a few LCA studies have attempted to include soil C changes – using mainly modeling and using time horizons of a few to 30 years (Hörtenhuber et al., 2010; Röös et al., 2010; Halberg et al., 2010; Hillier et al., 2009; Mila i Canals et al., 2008; Gabrielle and Gagnaire, 2008), although the time horizon used is not explicitly stated in all of the studies. Soil carbon changes are normally estimated by modeling since the full extent of the soil carbon changes caused by changes in agricultural practices will

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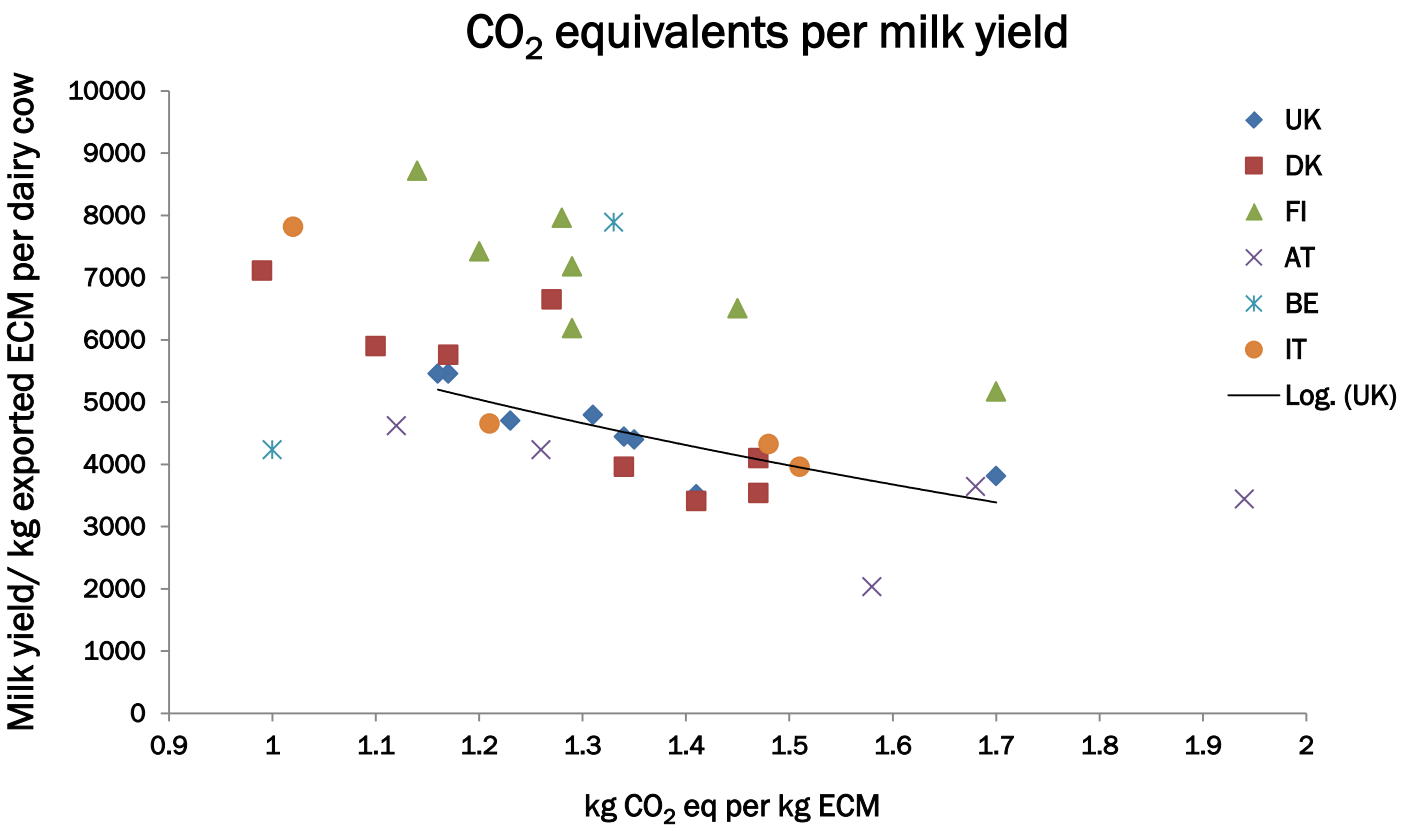
Lower carbon footprints with higher milk yields



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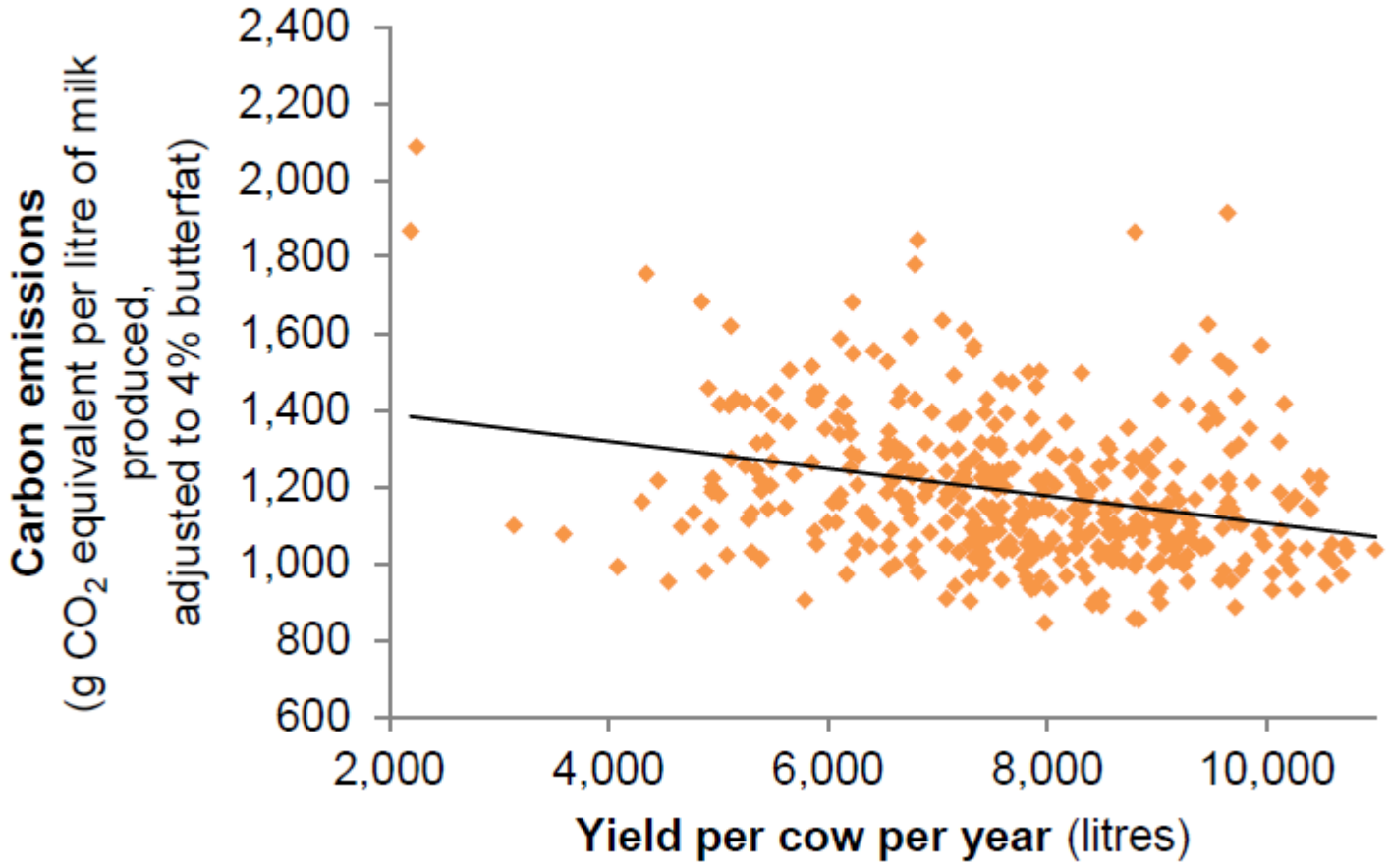
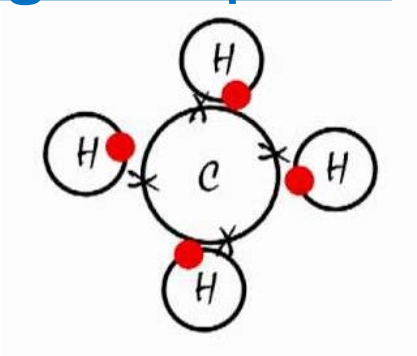


AHDB DAIRY

Mitigation options

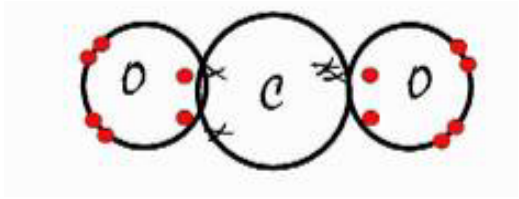


Precision feeding and feed management

High sugar grasses and tannins

Concentrate feeds

Dietary lipids, saponins and essential oils



Direct expansion (DX) cooling system; can be up to 60% more efficient

Variable speed drive on vacuum pump

Insulate pipes and water heater tanks

Pre-cooling system in the parlour

Conclusions

- Choice of tool depends on what you want to achieve: if trying to assess whole farm performance and get a quick overview, a CALM or C-Plan approach is more appropriate
- A more detailed, LCA assessment requires more time (and money) but can identify savings throughout the supply chain in GHG and financial terms
- Largest contributors to Dairy GHG is CH_4 from enteric fermentation and N_2O from crop cultivation and fertiliser use
- Variation can be seen between farms in milk yields and GHGs: by raising milk yields, GHG per kg ECM lowers, especially when focusing on enteric fermentation.
- Adding carbon sequestration to these CF calculations would provide a more complete picture of GHG emissions from organic dairy farms.

Thank you!