



Carbon footprint of organic dairying in six European countries

Life cycle assessment of 34 farms

Project SOLID EU-FP7

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Life Cycle Assessment and carbon footprint

Environmental life cycle assessment is focused on measurable emissions produced during products life cycle

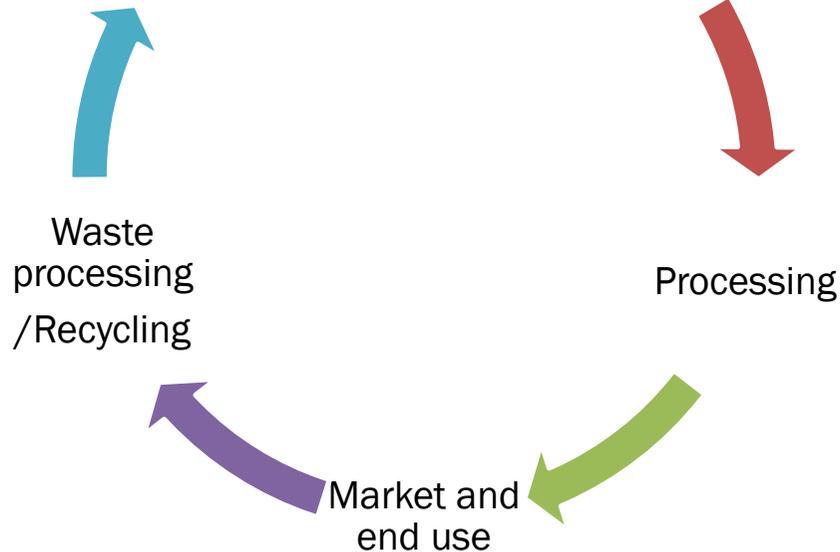
Greenhouse gases:

Methane
Nitrous oxides
Carbon dioxide

are presented as CO₂ equivalents



Boundaries in this study, From cradle-to-farm gate



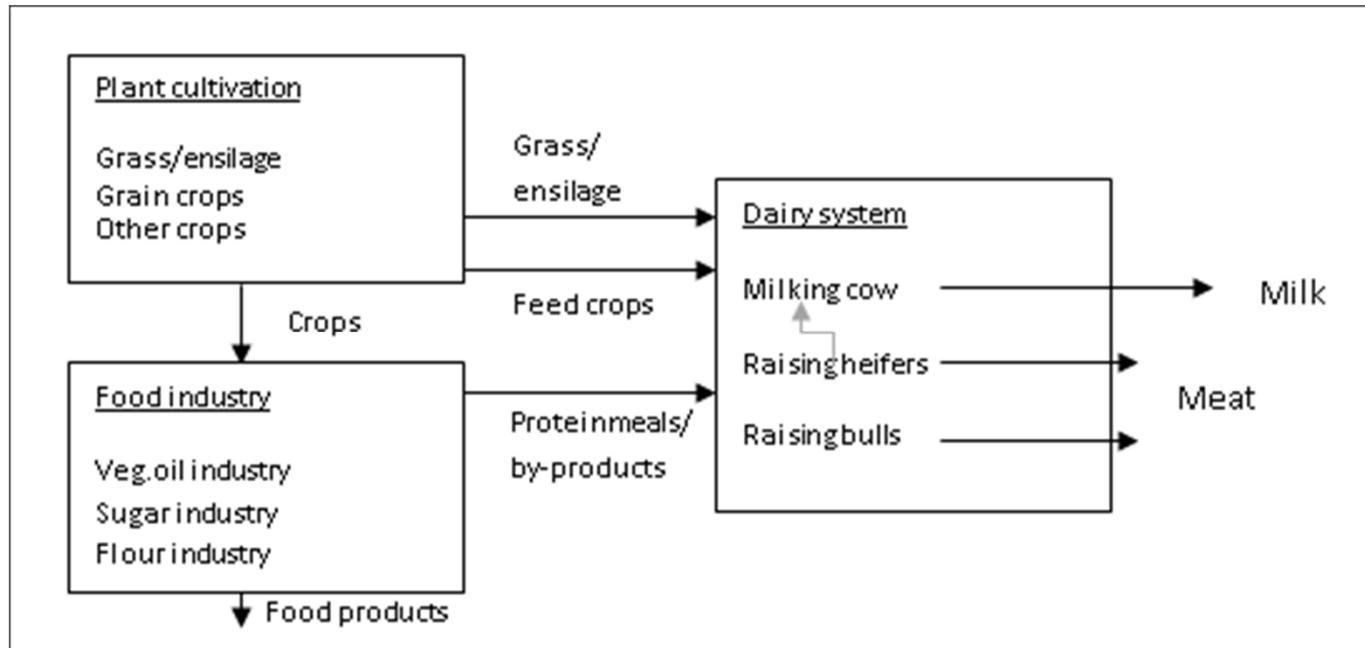
Material and methods:

Carbon footprint calculation method

- described in Schmidt & Dalgaard (2012) and in Dalgaard et al. (2014)
 - Following ISO-standardized methodology and IPCC (2007) guidelines
- Result is given as kg CO₂ equivalents per functional unit, which here is 1kg Energy Corrected Milk (ECM).
 - ECM is defined as raw milk with 4.10 % fat and 3.30 % protein (Sjaunja 1990)



Milk production system boundaries



In the attributional approach emissions are allocated to co-products. Here economic allocation is used for meat and milk.



Farm data from six countries, 34 organic farms



Austria
Belgium
Denmark
Finland
Italy
United Kingdom



Farm data used for calculations

- Fertilisers: Imported and exported organic fertilizers (manure and straw)
- Energy use: traction diesel, grain drying, electricity
- Crops produced on farm (ha, yield, fertilizer use)
- Milk yield
- Herd details (dairy cows, heifers, calves, bulls)

Number of fallen, slaughtered, exported and imported animals + weights

- Housing system and time indoor
- Imported feeds
- Feeds cultivated and used on farm



General farm characteristics - range

Attribute [unit]	<u>Austria</u>		<u>Belgium</u>		<u>Denmark</u>		<u>Finland</u>		<u>Italy</u>		<u>United Kingdom</u>	
	min	max	min	max	min	max	min	max	min	max	min	max
			<u>Total range</u>									
Dairy cows [Number]	10	17	Dairy cows [heads] 9 to 480									
Milk yield per dairy cow [kg ECM]	4187	5000	Milk yield [kg ECM] 4187 to 10233									
Time on pasture [%]	55	65	Time on pasture [%] 25 to 75									
Imported manure and straw [kg N]	4	30	Imported Org.fertil [kg N] 0 to 7570									
Rotational grassland [ha]	0	0	Rotational grassland [ha] 0 to 249									
Permanent grassland [ha]	13	24	Permanent grassland [ha] 0 to 122									



Results: Carbon footprint, average of 34 farms

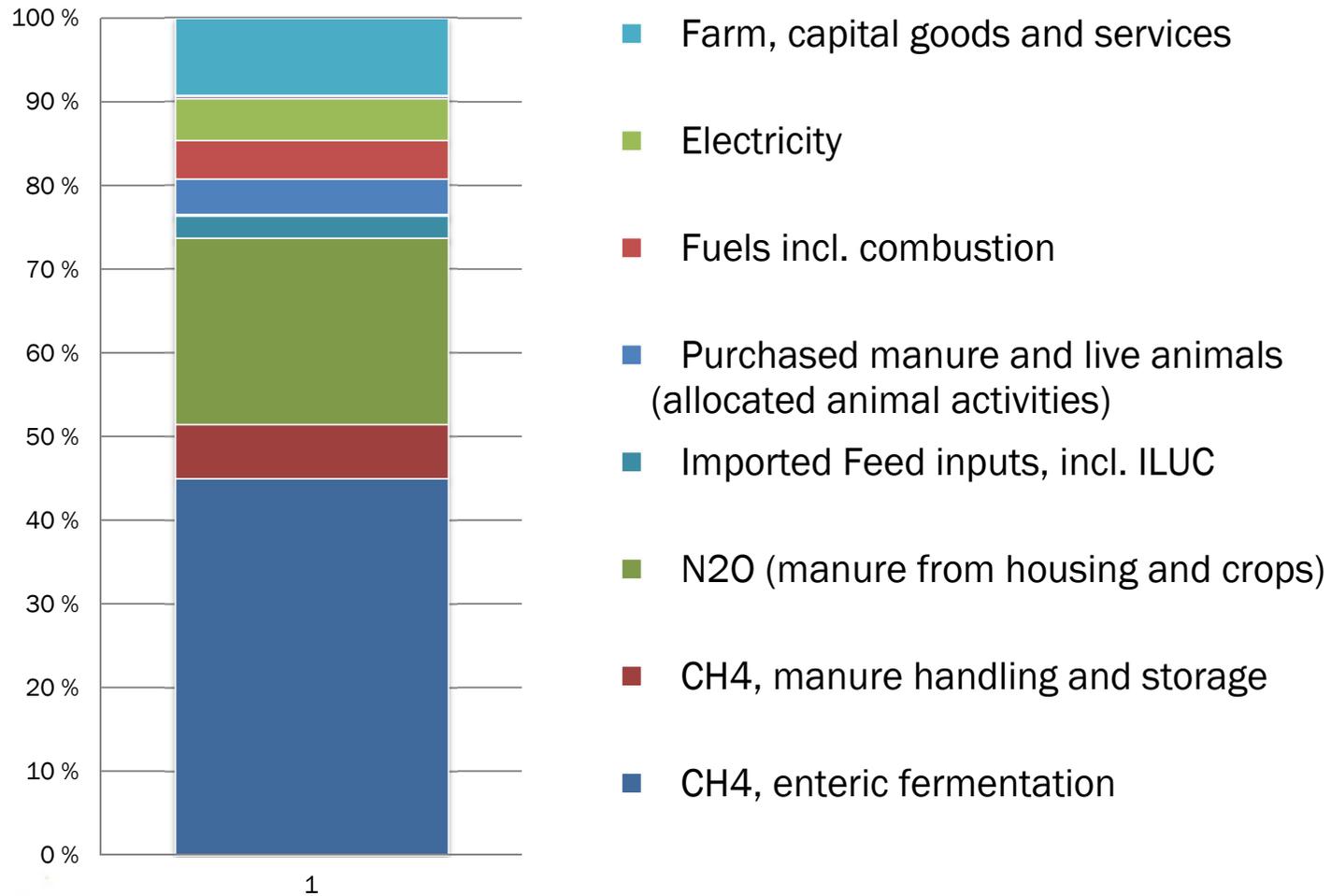
Table 3. Average carbon footprint of organic dairying in six European countries ^{a)} per 1 kg ECM, allocated between the processes ..., n_{farms} = 34.

European average	Dairy cows	Raising heifers and bulls	Crop cultivation	Total
Direct emissions	[kg CO ₂ -eq]	[kg CO ₂ -eq]	[kg CO ₂ -eq]	[kg CO ₂ -eq]
CH ₄ enteric fermentation	0.43	0.16		
CH ₄ manure handling and storage	0.07	0.02		
N ₂ O	0.03	0.01	0.25	
Sum of Direct emissions	0.53	0.19	0.25	0.97
Emissions outside animal activities				
Feed inputs		0.0003		
Imported feed inputs		0.035		
Manure land application		0.002		
Purchased manure and live animals		0.056		
Fuels		0.061		
Electricity		0.066		
Transport		0.005		
Destruction of fallen cattle		0.0000		
Farm, capital goods and services		0.123		
Sum of Emissions outside animal activities		0.35		
Total				1.32 (SD 0.22)

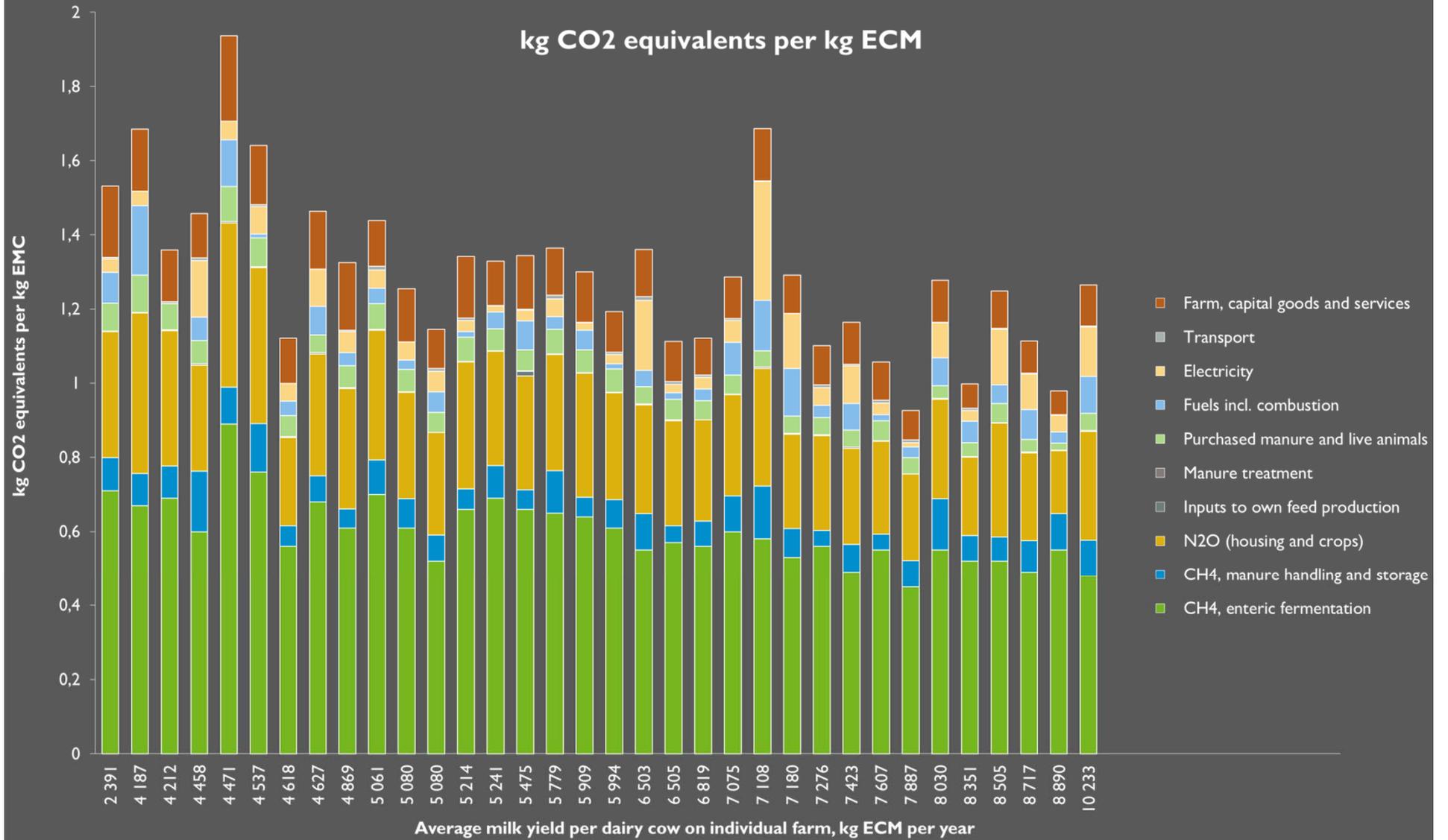
a) Austria, Belgium, Denmark, Finland, Italy and United Kingdom



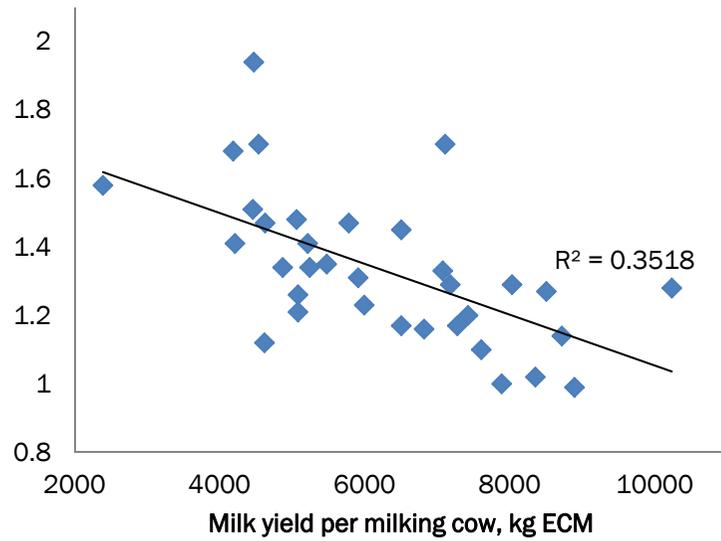
Contributions to total GHG emissions, %



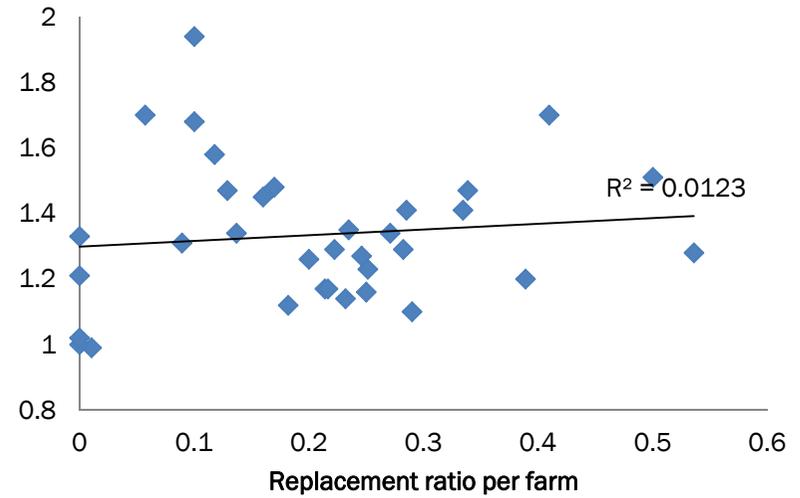
kg CO2 equivalents per kg ECM



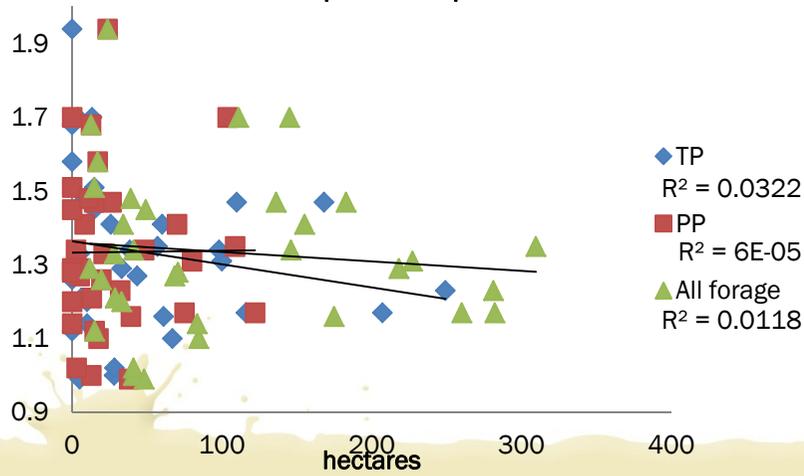
Carbon footprint and milk yield



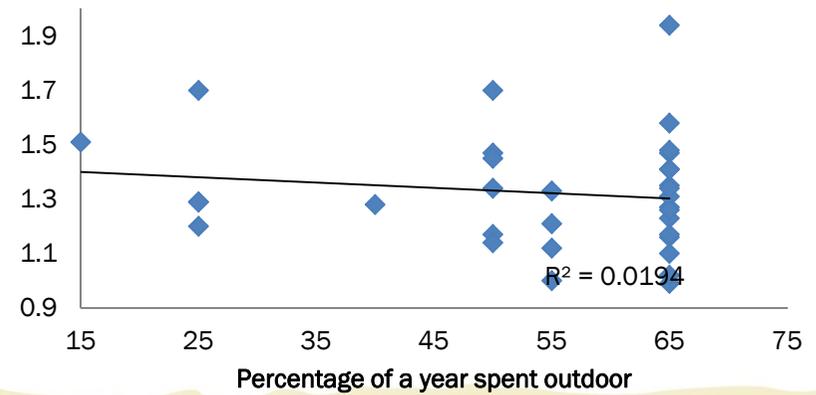
Carbon footprint and replacement ratio of dairy COWS



Carbon footprint and pasture area



Carbon footprint and time outdoor, % of year



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Carbon footprints of organic dairying in six European countries—real farm data analysis

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Abstract Dairy farming is the largest agricultural contributor to greenhouse gas emissions in Europe. In this study, the carbon footprint of organic dairying was

in 45 % of total GHG emissions, which is also consistent with previous studies.

Conclusions

- Mean carbon footprint of 34 European organic dairy farms was 1.32 kg CO₂ eq per kg ECM with SD 0.22.
- Largest contributor to GHG is CH₄ from enteric fermentation which accounts for nearly half of all GHG emissions in total, second largest is N₂O from crop cultivation

Mitigation:

- Variation can be seen between farms in milk yields and CF: by raising milk yields CF per kg ECM lowers
- In countries where milk yield is already high, mitigation options must be considered individually
- Nutritional and genetic attributes should be studied further to gain knowledge of mitigation potentials of lower yielding farms.
- Feed design can aid in reducing methane emissions

Method development:

- Current method doesn't take into account carbon sequestration. Adding this would benefit farms using more grassbased permanent pastures

In mitigation design other impact categories should be taken into account to avoid unwanted tradeoffs and to obtain a better understanding of total environmental impacts of organic dairy farming



Thank you!

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and Low Input Dairying

