Life cycle assessment of milk at farm gate

- focus on green house gas emission

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Session 7

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Structure of the presentation

1) Introduction – focus on GHG – Carbon foot print

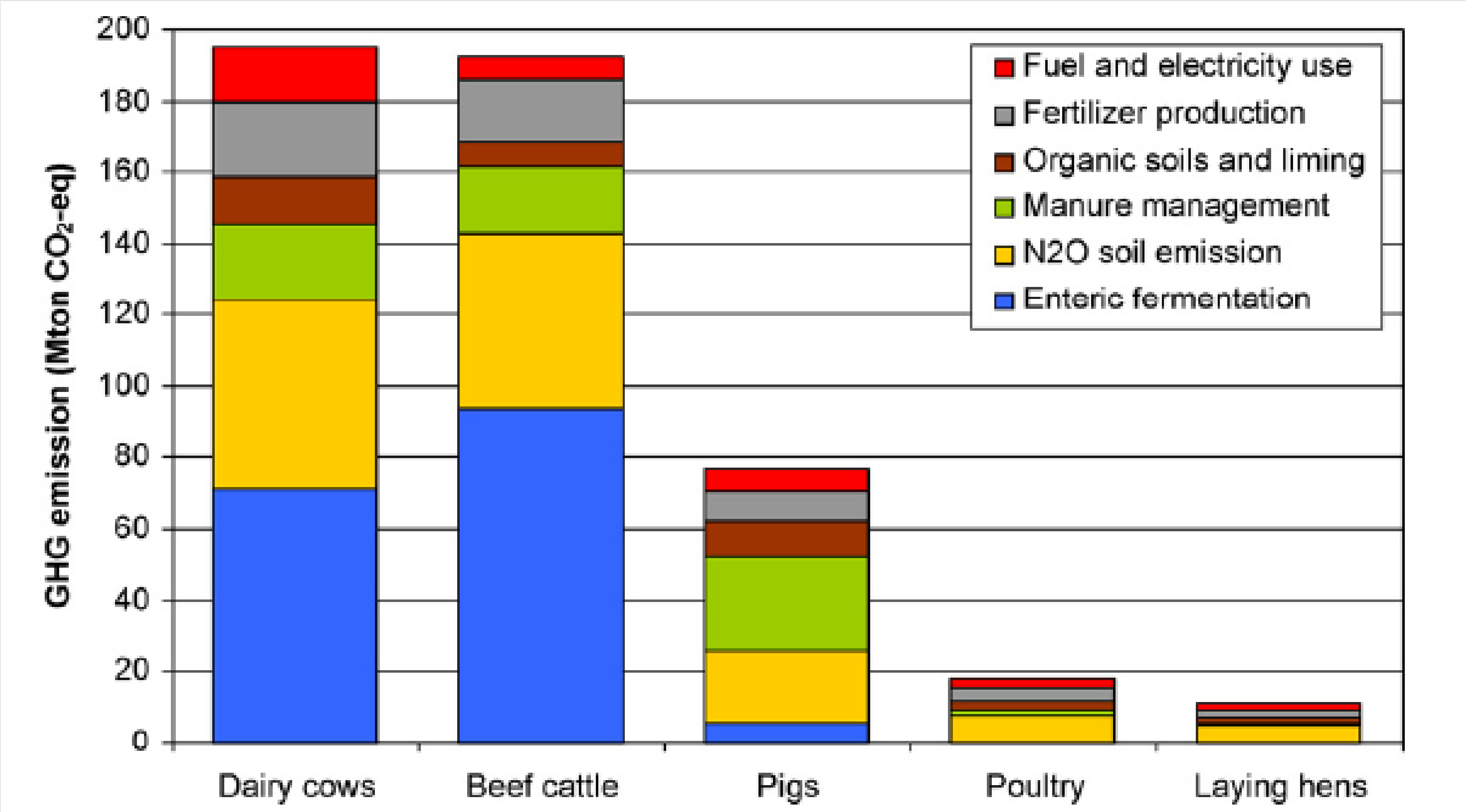
2) The Life Cycle Assessment - method

3) Farm as part of the total chain

4) Farm emission – how to calculate, results, reduction potential

5) Conclusion and perspectives

Carbon footprint (CF) from livestock in EU 27



Lesschen et al. 2011

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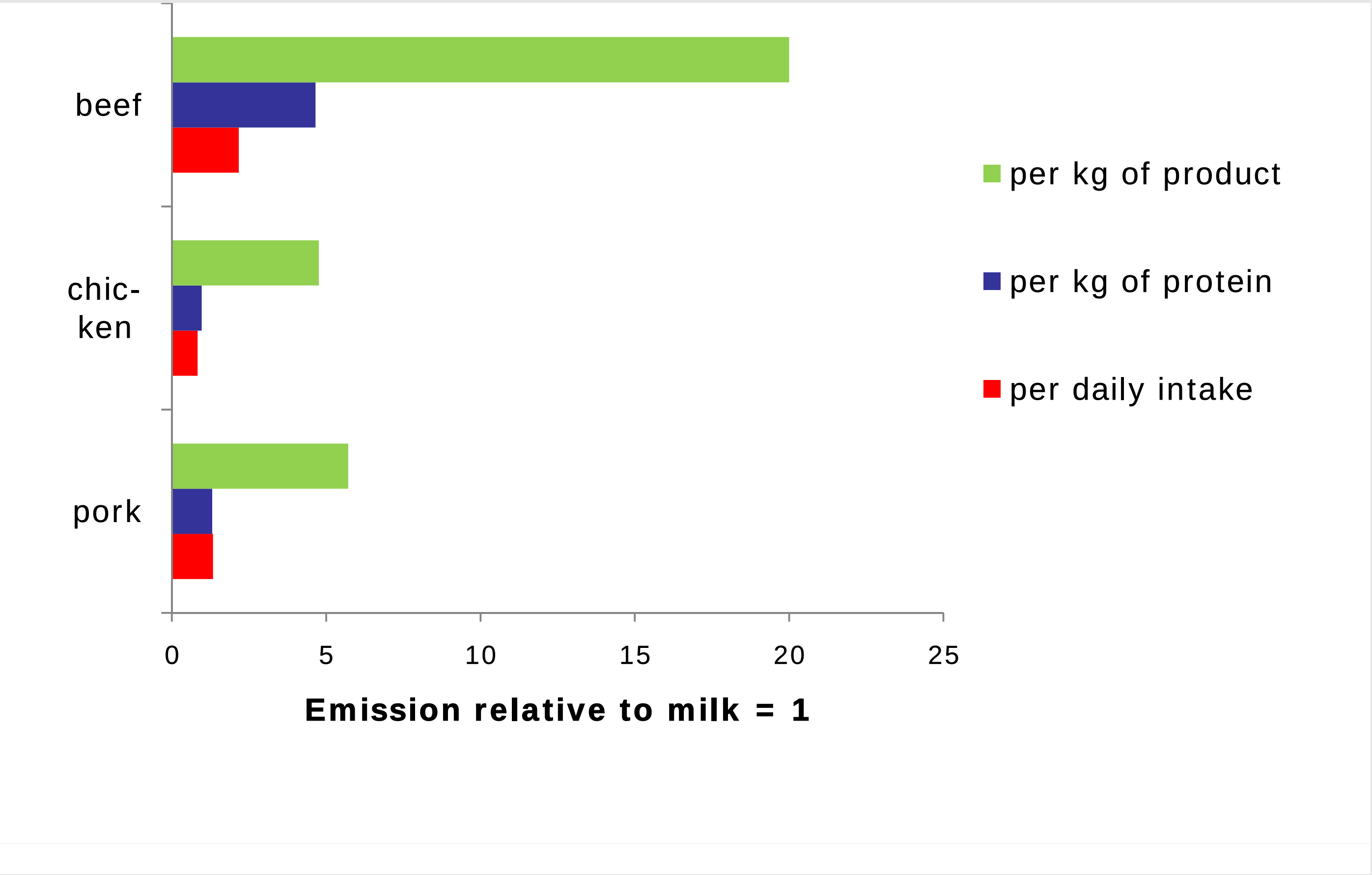
Emission from different livestock product shown for three different functional units



de Vries & de boer, 2011

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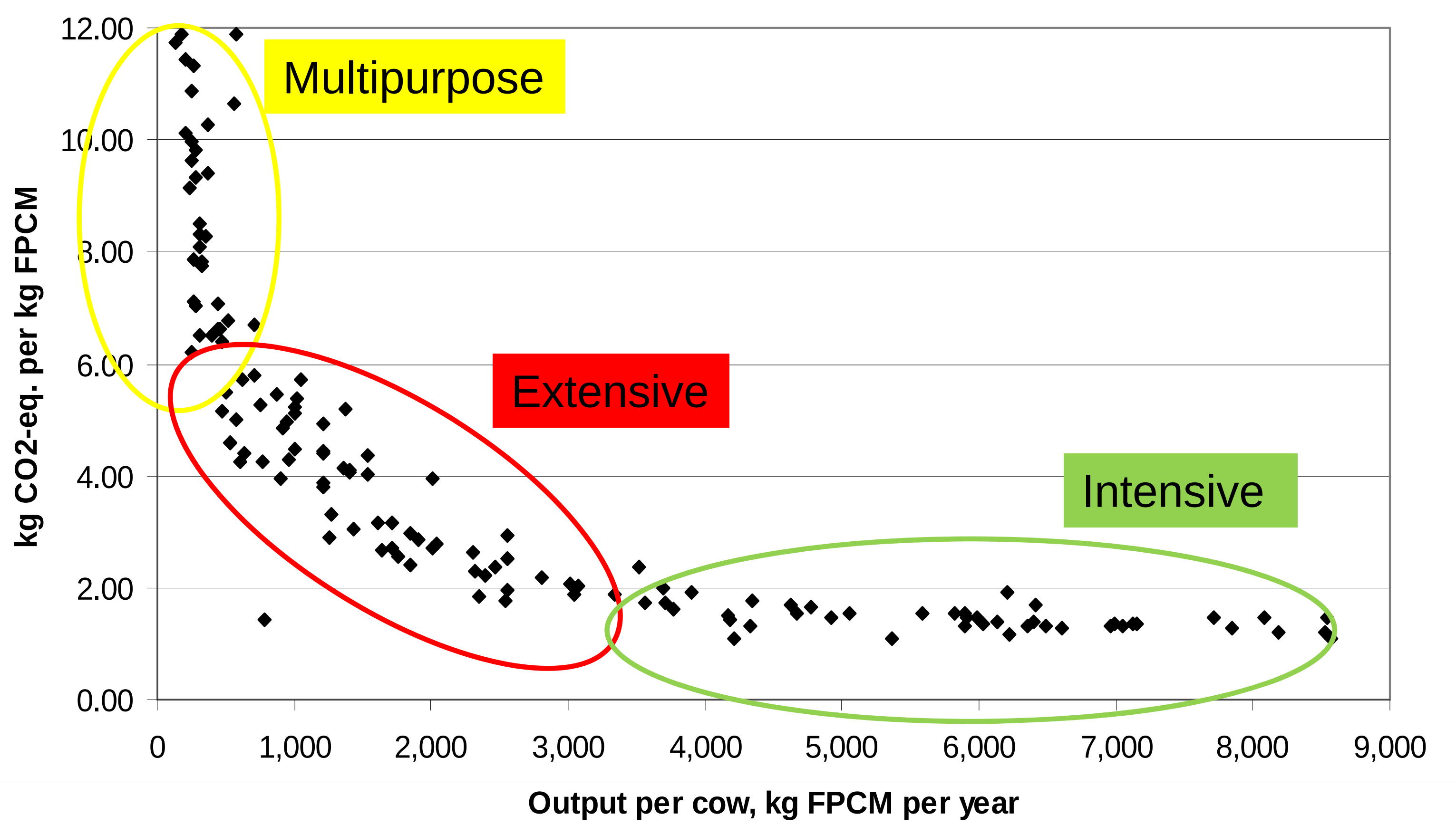
Carbon footprint through the chain in relation to milk output per cow, national data



Gerber et al. 2011

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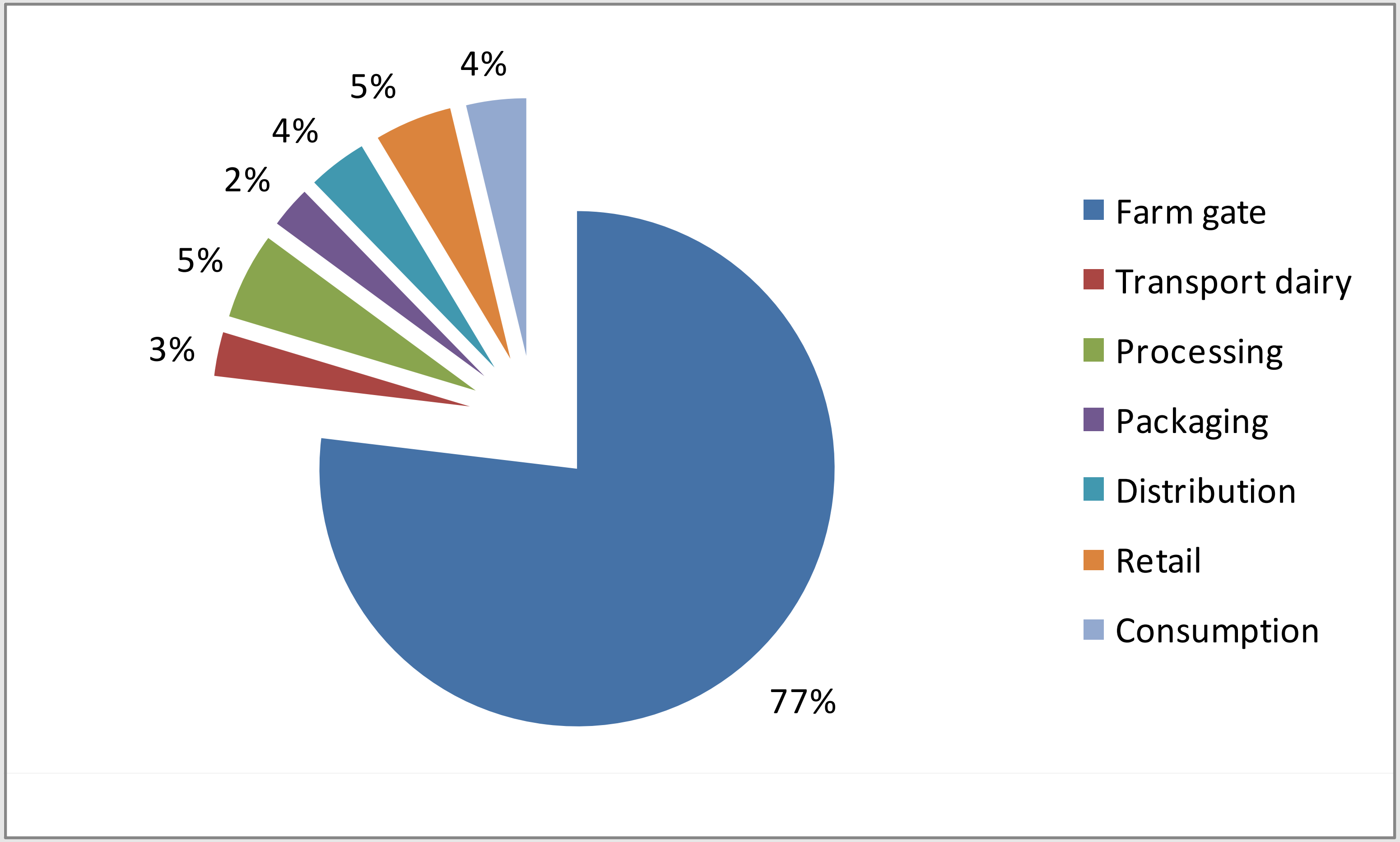
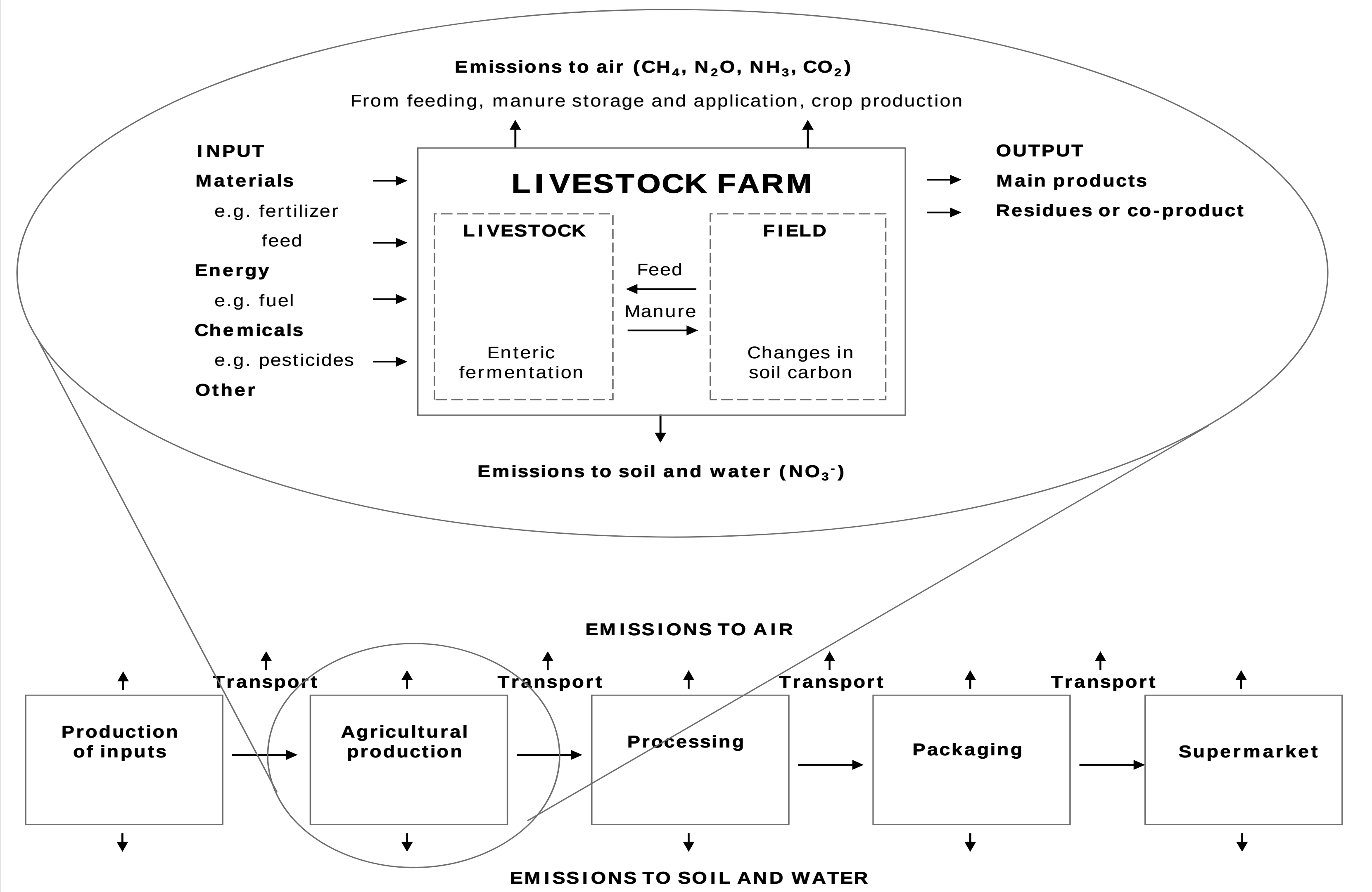
Life cycle of milk – CF from different stages through the chain



www.usdairy.com/sustainability

LCA whole farm approach



Hermansen & Kristensen, 2011

LCA of Danish milk production

Production, annual data

	Production system	
	Conventional	Organic
No of farms	35	32
Herd size, no of cows	122	115
Milk, kg ECM per cow	8201	7175
Live weight gain, kg per cow 1)	179	174
Feed intake, kg DM per cow	6593	6618
- roughage, % of DMI	55	69
- pasture, % of DMI	8	19
1) Herd live weight gain		

(Kristensen et al, 2011)

LCA of Danish milk production

Production, annual data

	Production system	
	Conventional	Organic
Stocking rate, LSU per ha	1.80	1.12
Maize, % of area	17	3
Grassland in rotation, % of area	24	45
Grassland permanent, % of area	6	10
Fertilizer, kg N per ha	68	0
Manure, kg N per ha	168	130
Production, NE (1000 MJ)per ha	50	37

(Kristensen et al, 2011)

LCA of Danish milk production

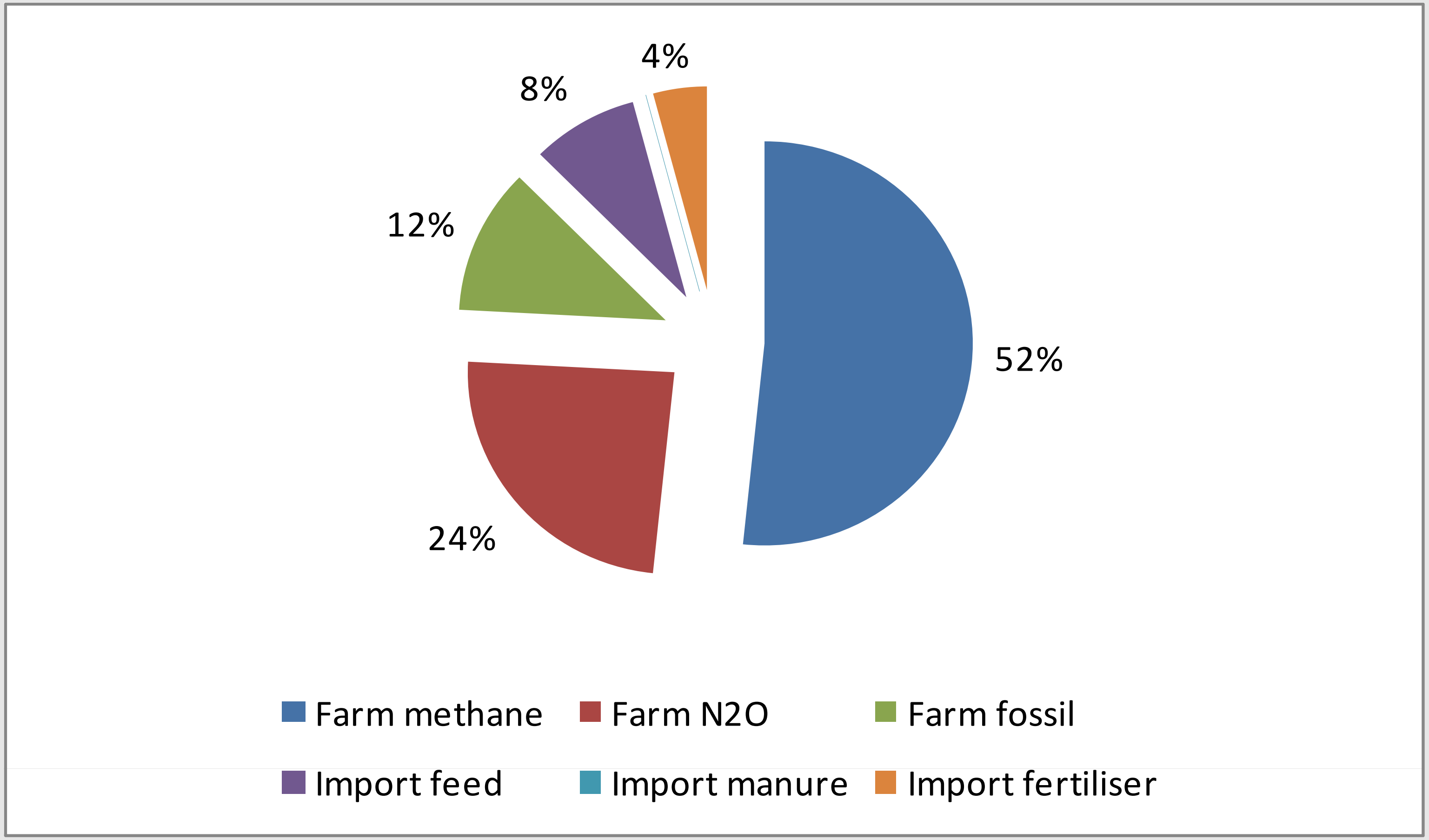
GHG emission from different pollutants, kg CO_2 eq. per kg of ECM

	Production system	
	Conventional	Organic
Total	1.20	1.27
Internal (farm level)	1.05	1.24
-Methane	0.62	0.69
-Nitrous oxide	0.29	0.35
-Fossil energy	0.14	0.20
External (import)	0.15	0.03
-Feed	0.10	0.01
-Manure	0	0.02
-Fertilizer	0.05	0

(Kristensen et al, 2011)

LCA of Danish milk production

Emission in CO_2 eq. from various sources



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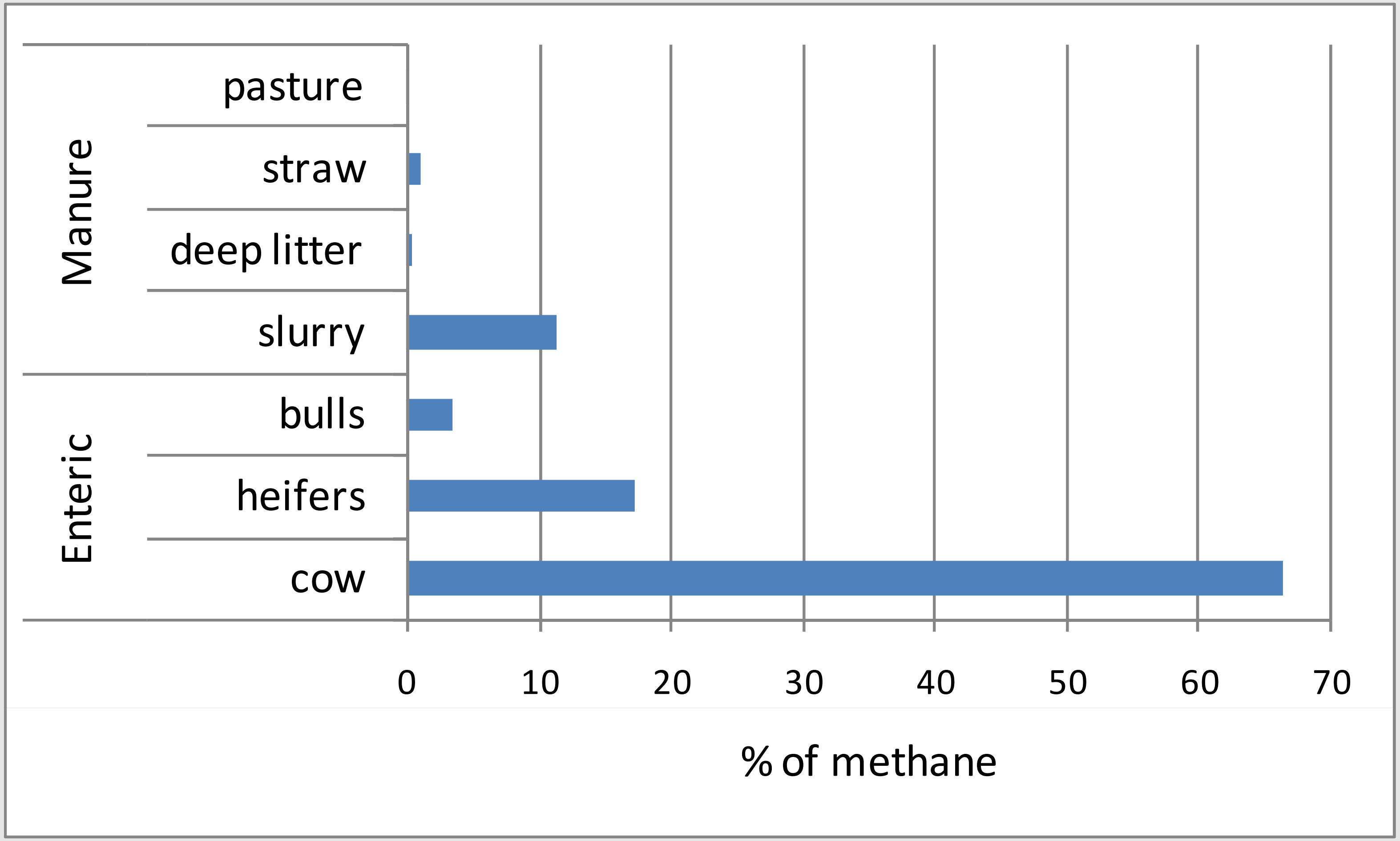
LCA of Danish milk production

Methane – where do the emission occurs ?



Estimated enteric methane by **different models**. *Production data from 218 herds*

Model no.	Source	Type	Kg per cow		Kg per 1000 kg ECM	
			Mean	SD	Mean	SD
0	IPCC, 2006	1	117	0	15,0	1,4
1	IPCC, 2006	2	130	14	16,6	1,6
2	Kirchgessner et al., 1991	3	106	7	13,6	1,0
3	Mills et al., 2003	3	145	11	18,6	1,6
4	Ellis et al., 2007	3	115	10	14,7	1,3
5	Giger-Reverdin et al., 2003	3	163	11	20,9	1,8
6	Mills et al., 2003	4	147	14	18,8	2,2
7	Yan et al., 2000	4	138	19	17,6	2,3
8	Giger-Reverdin et al., 2003	4	164	23	21,0	1,9
9	Kirchgessner et al., 1995	4	120	12	15,4	3,2
			137	12	17,5	1,7

1) TIER 1 IPCC, 2006
2) TIER 2 IPCC, 2006
3) Production models
4) Feed ration models

Reduction of methane emission per kg of milk in intensive systems

Mitigations options

Feeding

Herd structure

Breeding

Farm management

Trade offs

Effect on emission of other GHG

Pollution swapping

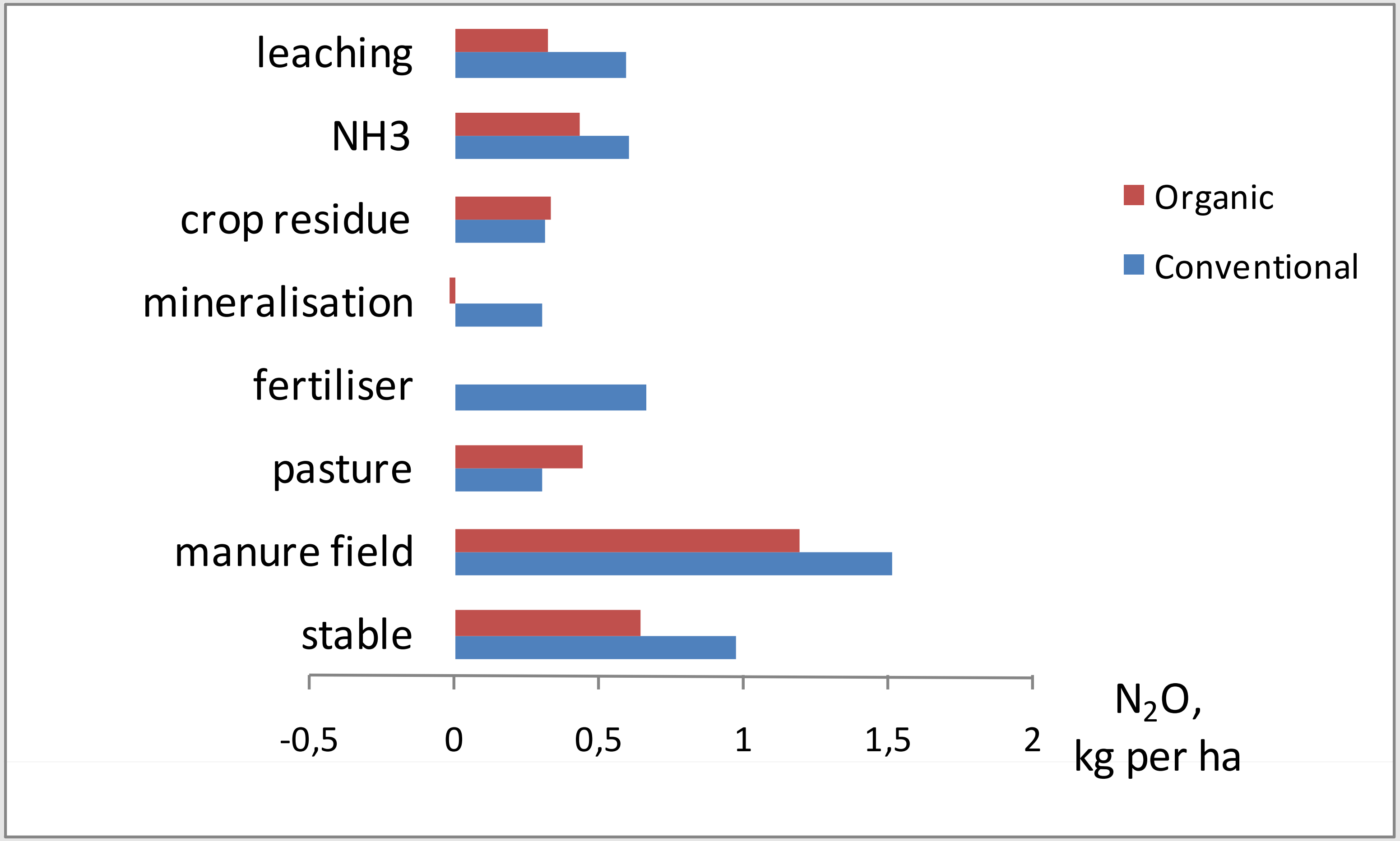
Product quality and food security

Animal health

Social acceptable

LCA of Danish milk production

Nitrous oxide – where do the emission occurs ?



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Reduction of N_2O emission per kg of milk in intensive systems

Mitigations options in relation to livestock

Reduced N intake

Manure management

Utilization of legumes

Allocation of emission between multiple products

Allocation methods

1) Attributional *(average)*

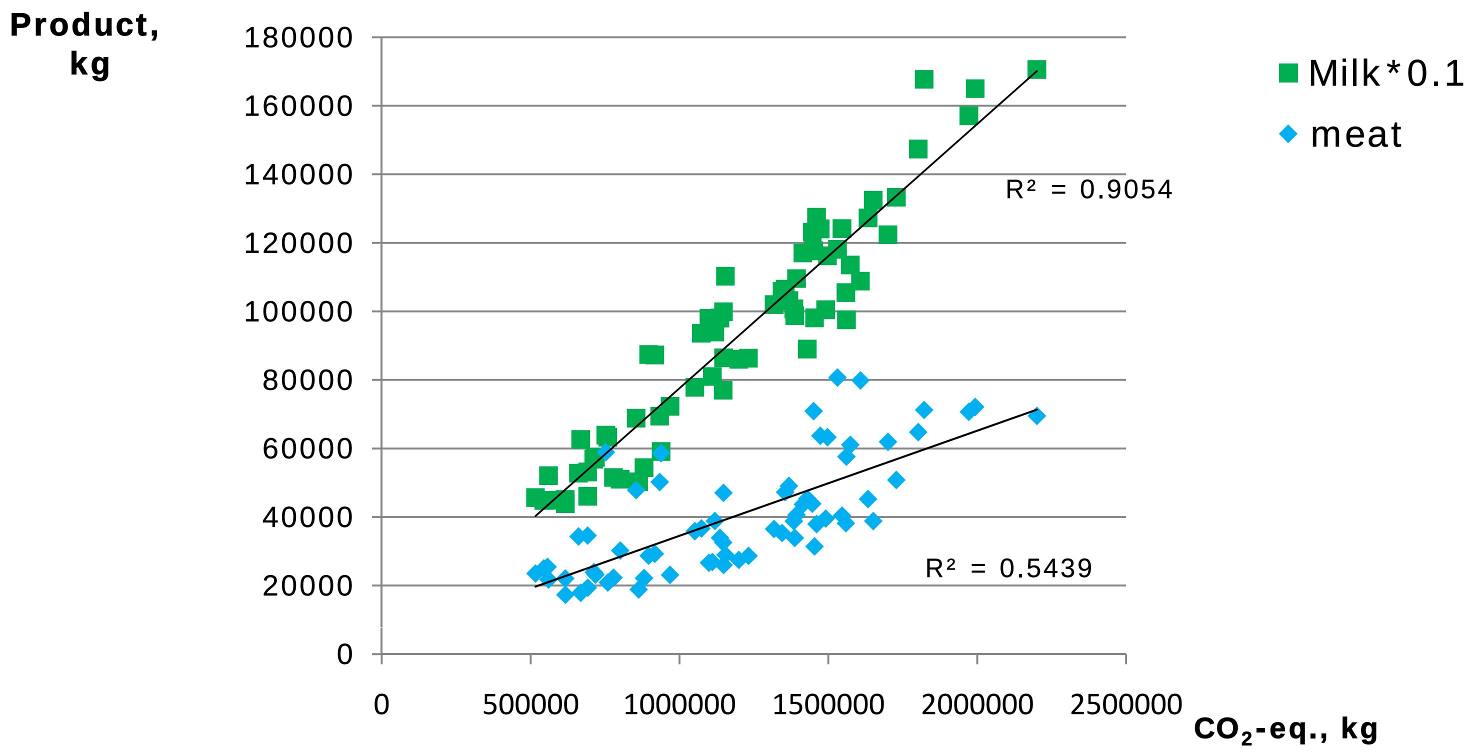
- -mass, kg
- -protein, kg
- -biological (NE)
- -economic value

2) Consequential *(marginal)*

- -CO_2 other meat products

LCA of Danish milk production

Allocation between milk and meat



Total CO_2 eq. = 1.03 * kg milk + 4.17 * kg meat ($r^2 = 0.92$)

Kristensen et al, 2011

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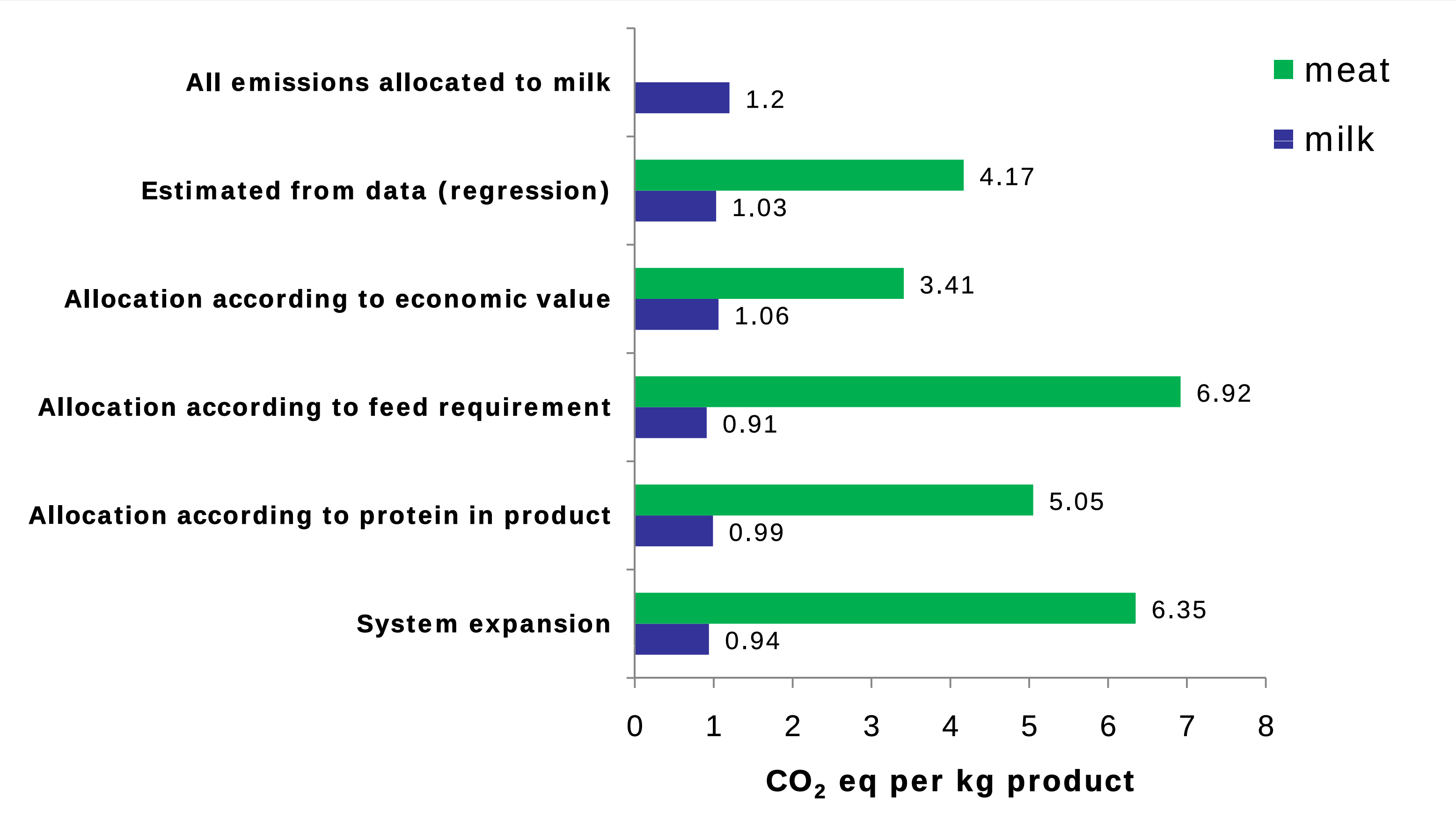
CF of milk and meat

Effect of different methods for allocation of total emission



Kristensen et al, 2011

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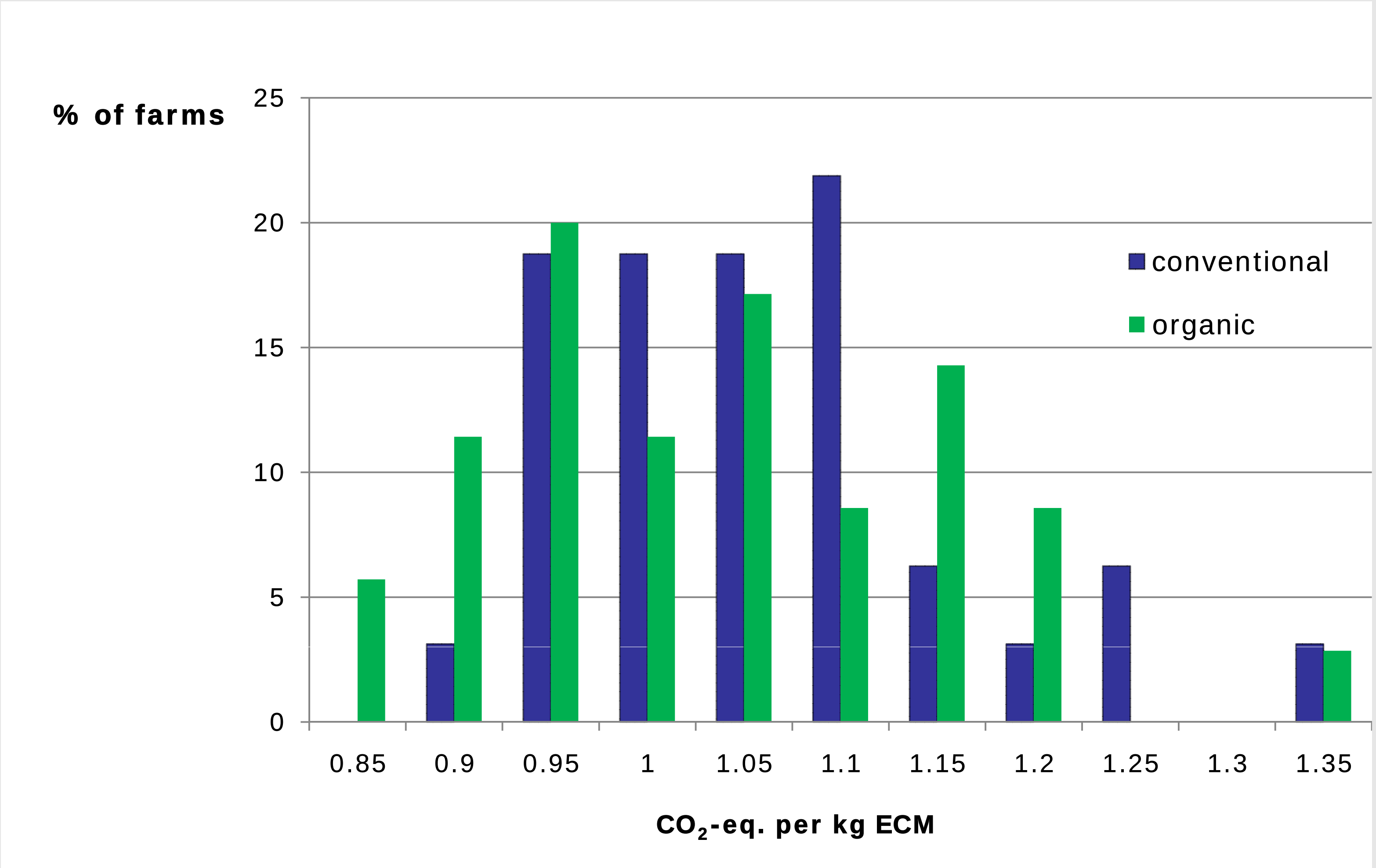
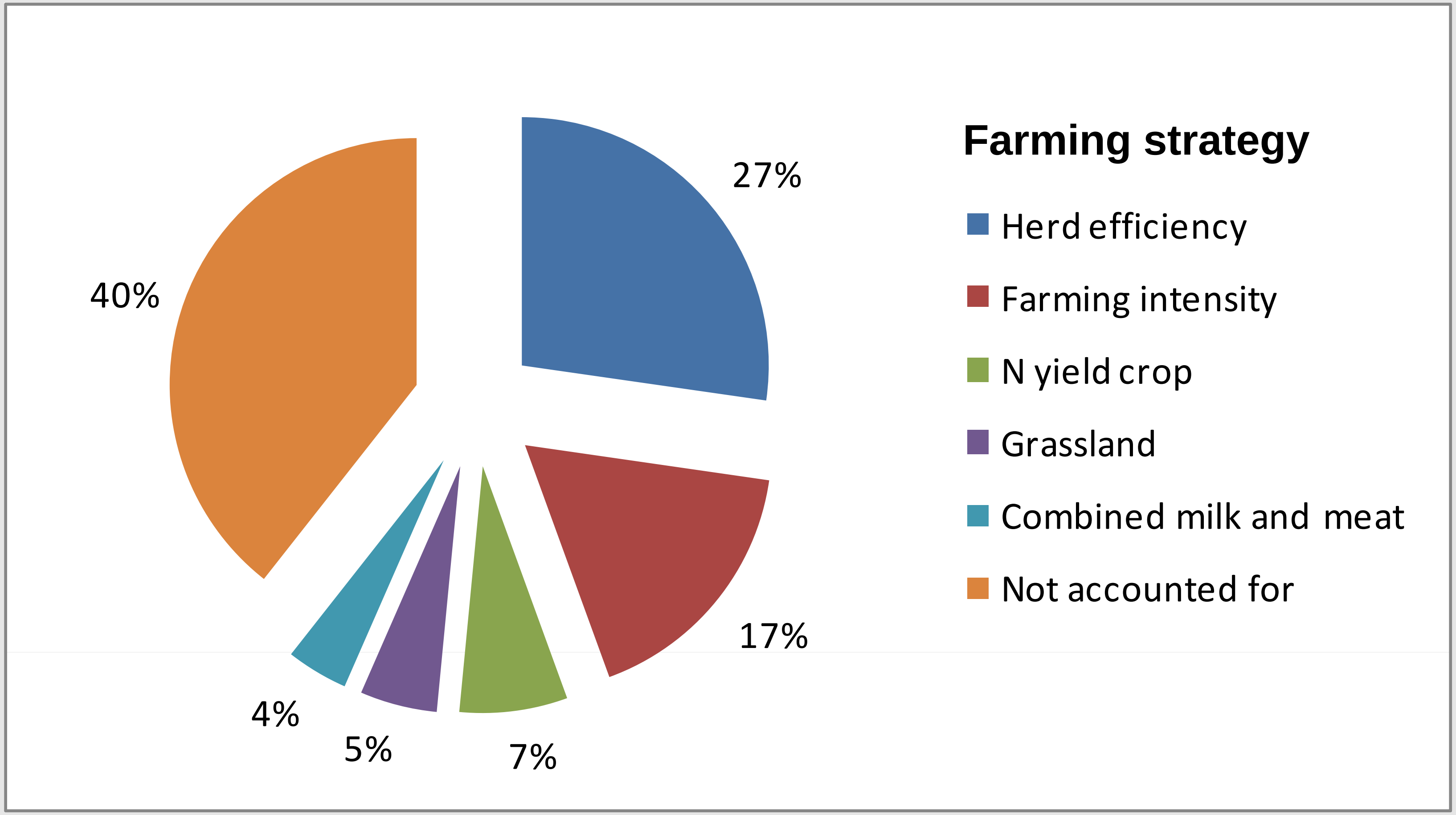
Variation in CF of milk between farms



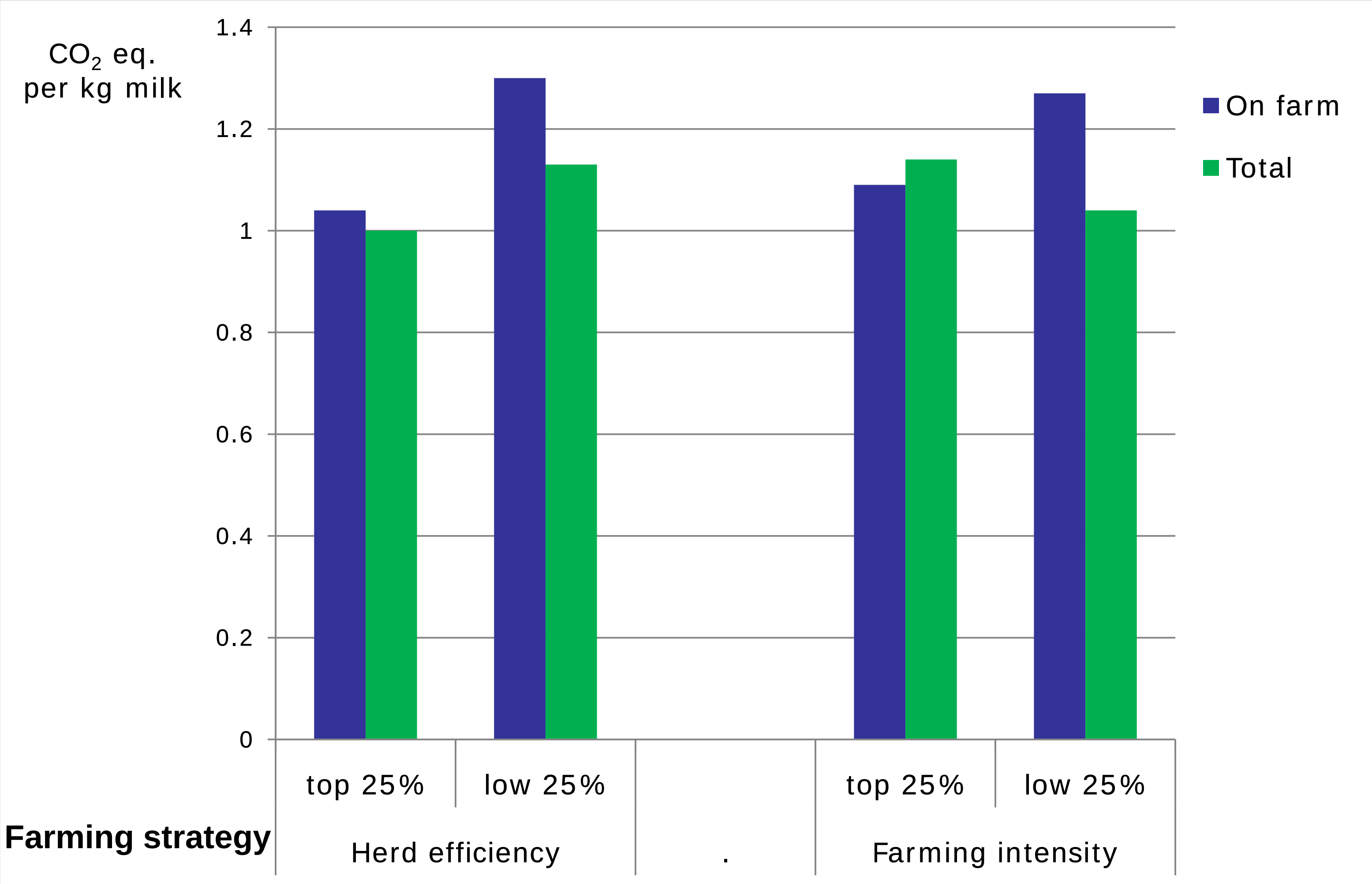
Kristensen et al, 2011

Variation in CF of milk explained by different farming strategies



Kristensen et al, 2011

CF of milk related to farming strategy



Kristensen et al, 2011

Uncertainty

1) Production data and emission factors

CF = amount x EF

2) Models

3) Allocation method

4) Other methodological choices

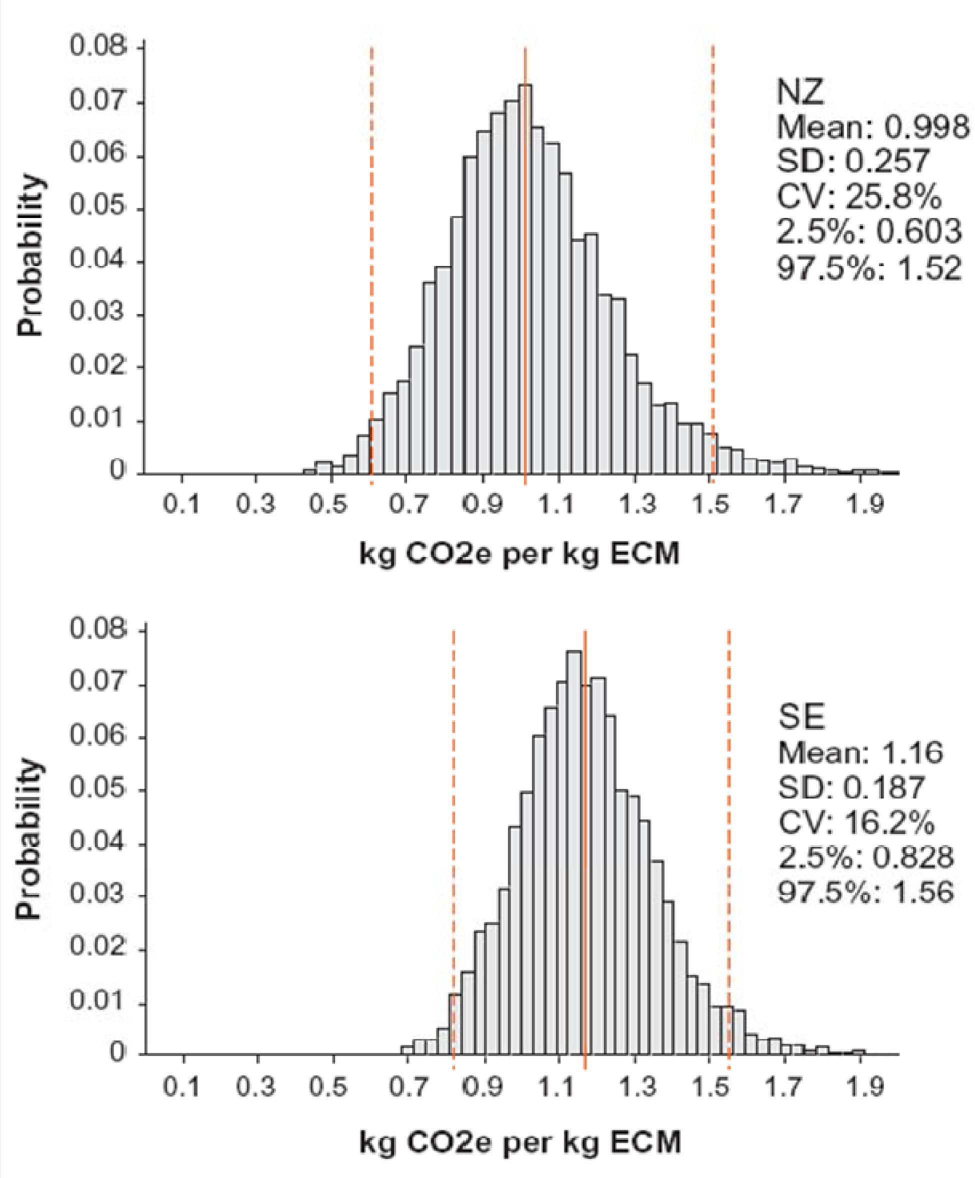
Uncertainty – production data

Type of production	CV, %
Concentrate	4
Roughage	19
Fertilizer	5
Manure	16
Milk	3

Effect of uncertainty on EF

- Methane 20%
- Nitrous oxide
  - N applied 100%
  - N pasture 100%
- NH_3 emission 20%
- Fossil energy 20%

Analysed by Monte Carlo simulation



Flysjo et al, 2011

Conclusions – CF of intensive milk production

Uncertainty relative large compared to reported differences between systems

Large variation between studies due to methodological choices

CF of Danish milk

- Farm emission 80-90 % of total emission through the chain

- Enteric methane largest source

-Fossil energy only 10-20 % of total CF

-Variation in herd efficiency the most important factor for CF

-Low stocking rate reduces CF from import

Thank you for your attention