Climate smart cattle farming – management and systems aspects

Troels Kristensen, Lisbeth Mogensen & John Hermansen
Department of Agroecology
Aarhus University
Denmark

AARHUS
UNIVERSITY
DEPARTMENT OF AGROECOLOGY

LIFE DAIRYCLIM

Invited speak: Methagene Cost – Padova October 2016

Content

Introduction
- What is the problem?
- Climate smart – how to measure?

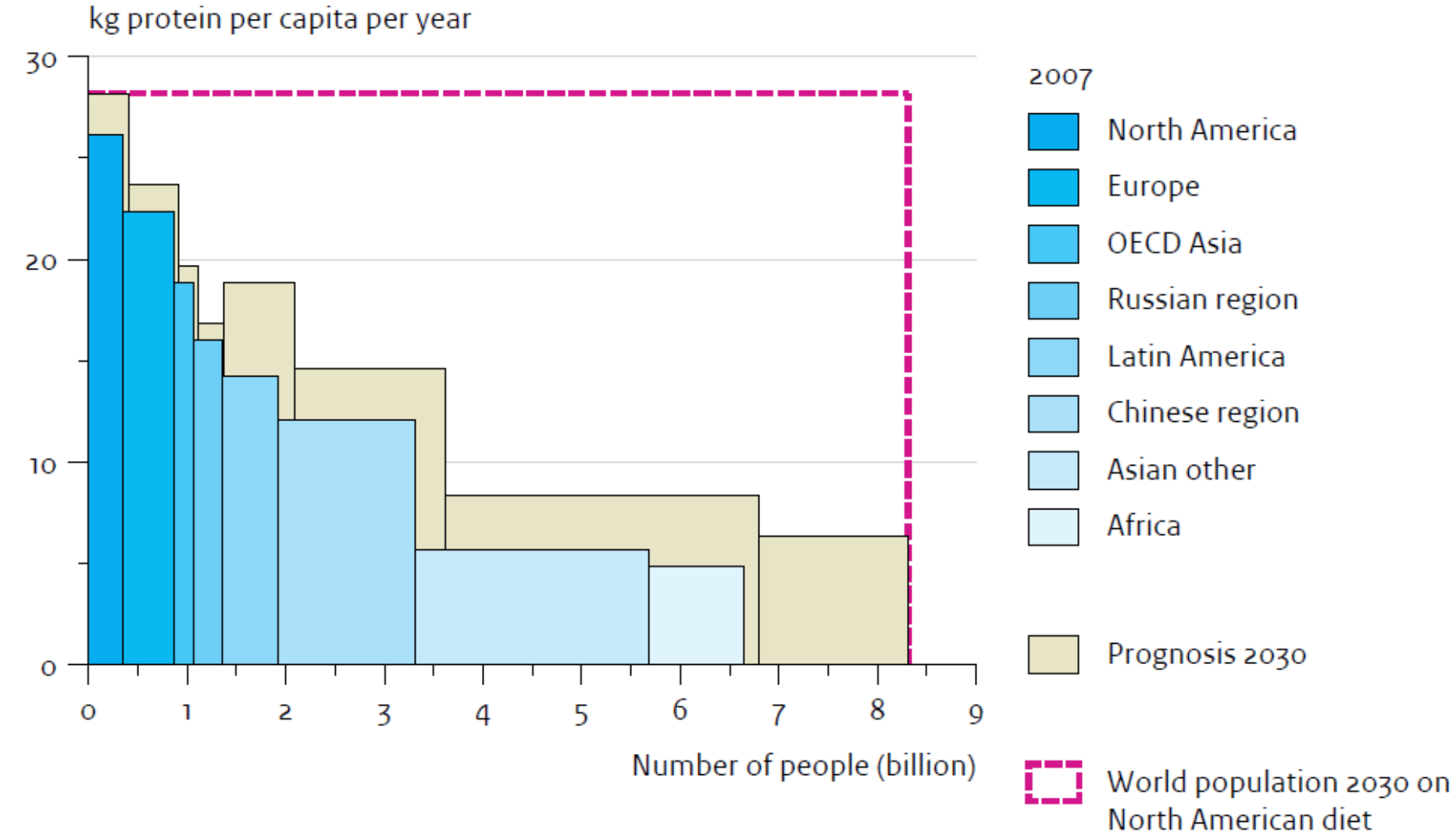
Emission from livestock

Dairy cattle
- Historic development
- Mitigation through productivity and technologies

Beef cattle
- Different systems

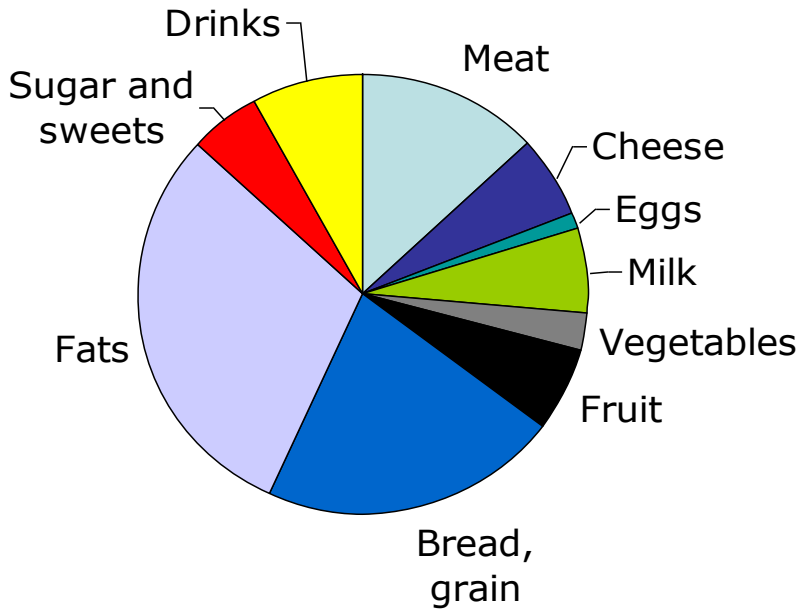
Conclusions

Actual and forecasted intake of animal protein per region

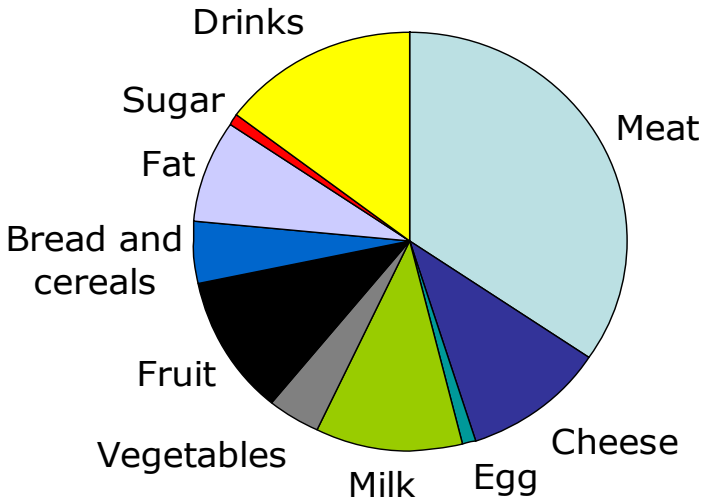


Animal products in the diet contributes more to global warming than to calories

Sources of energy in a Danish person's food (% of total MJ)



Carbon footprint of a Danish person's food (% of CO_2 eq)



Hermansen & Olesen, 2009

Climate smart – how to measure?

Method

LCA
National

System definition

Animal level
Farm level
Consumer level

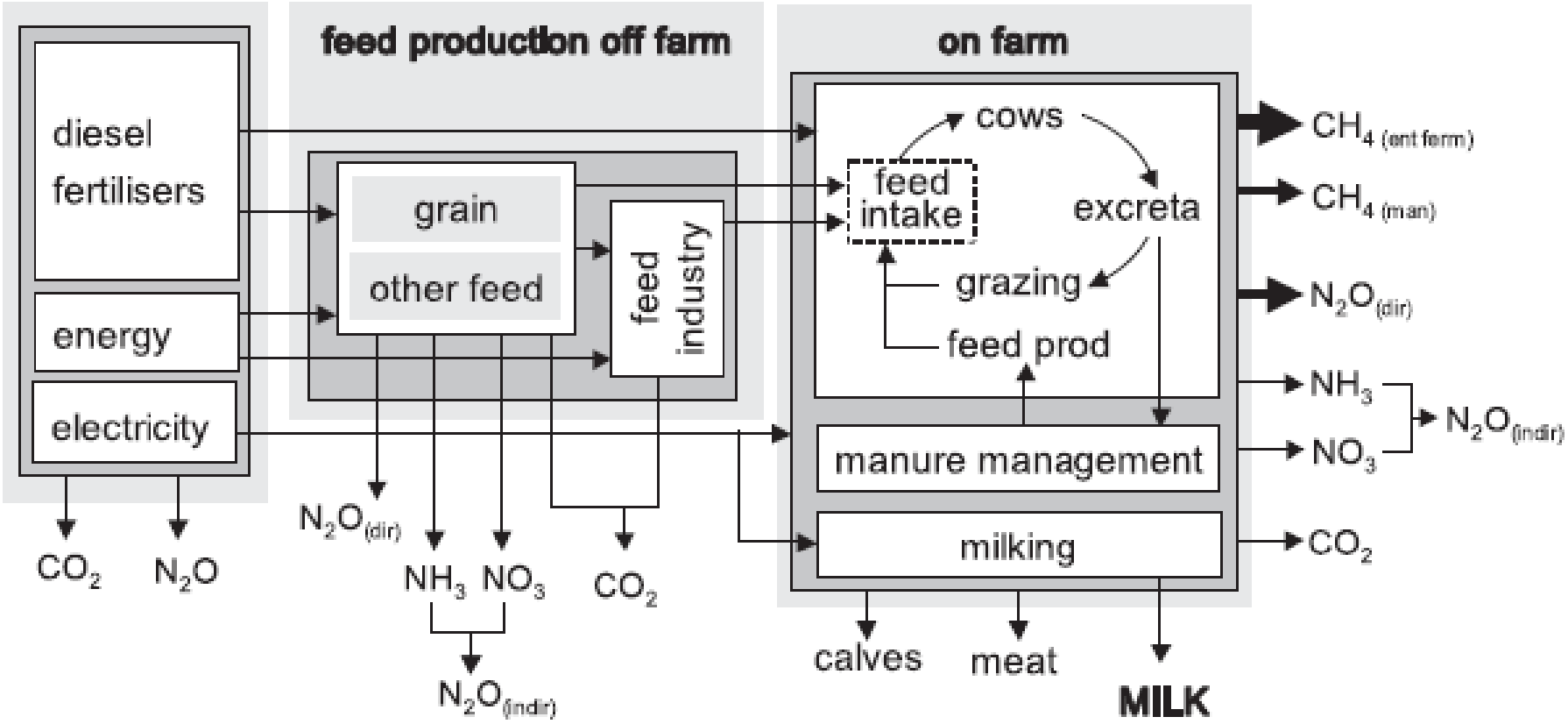
Allocation

Economic
Mass
Biological

Unit

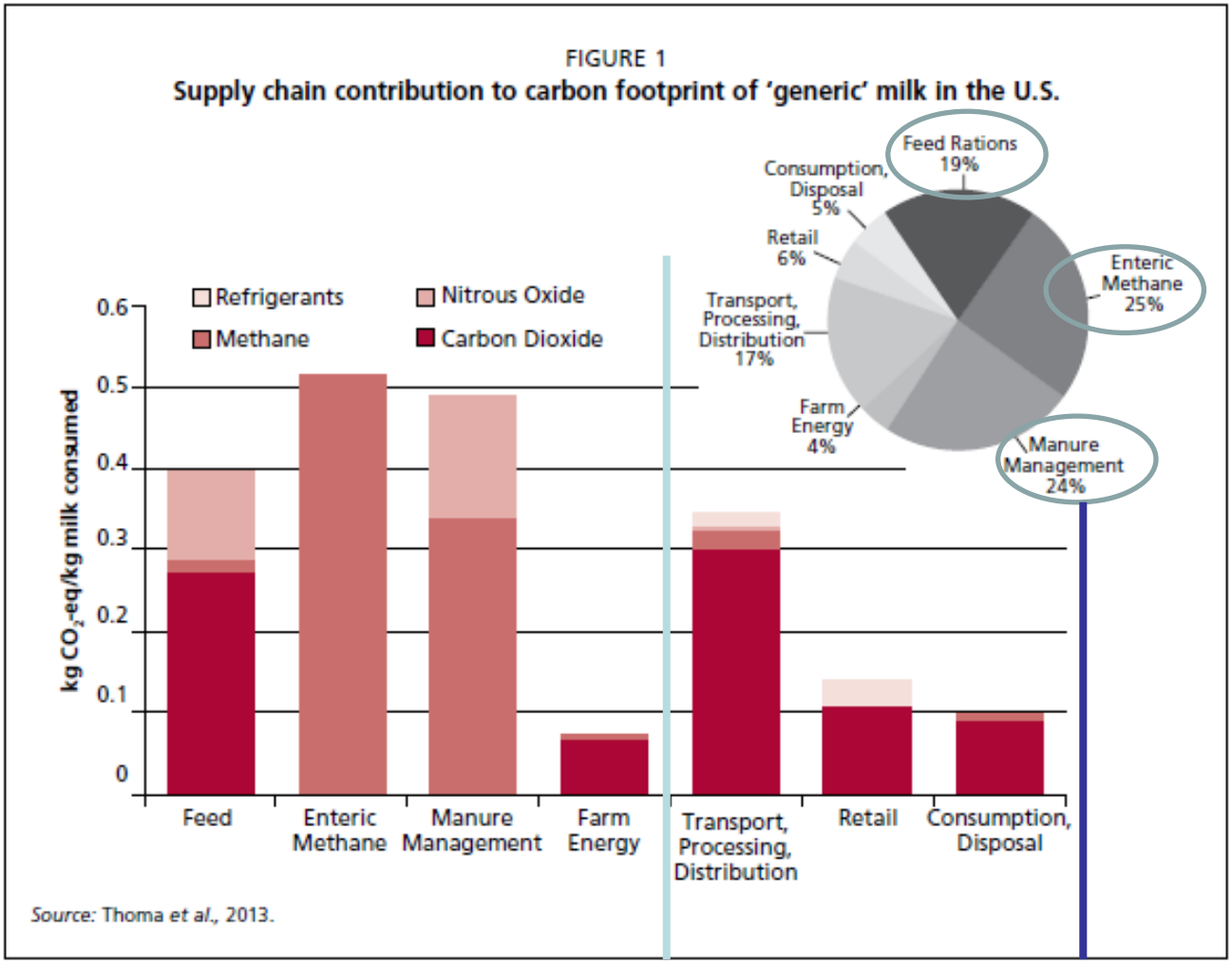
Per livestock unit
Per kg product
Per MJ energy
Per kg protein
Per area used

Illustration of a dairy system – input and output and important internal flows used in a LCA approach



A. Flysjö et al. / Agricultural Systems 104 (2011) 459–469

Dairy production – emissions in the supply chain



The 3 big ones

Farm level

Consumer level

Dairy production

GHG from cow, heifer and bulls

Historic perspective

Effect of productivity

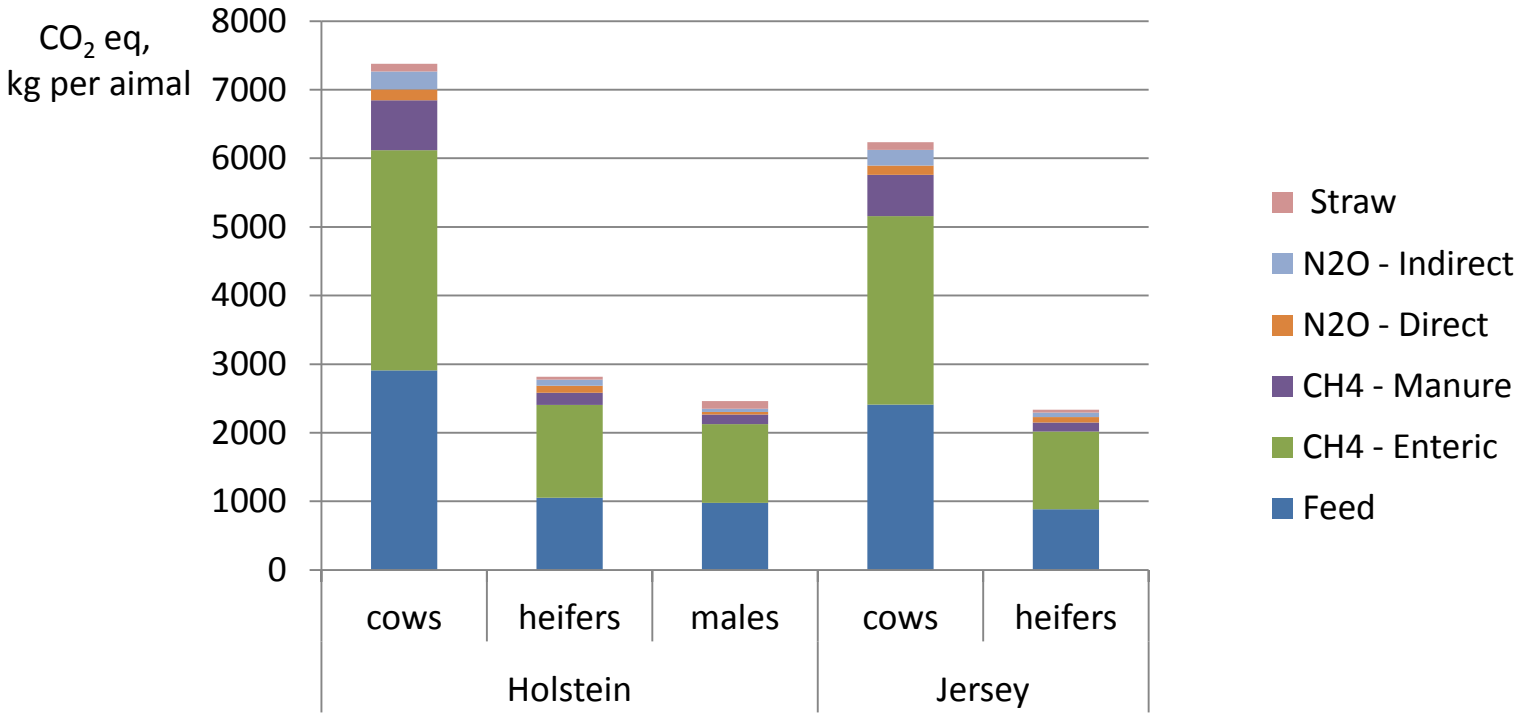
Effect of technology

Effect of system

Effect of management

GHG Emissions from each group of animals and breed

DK standard herd annual data

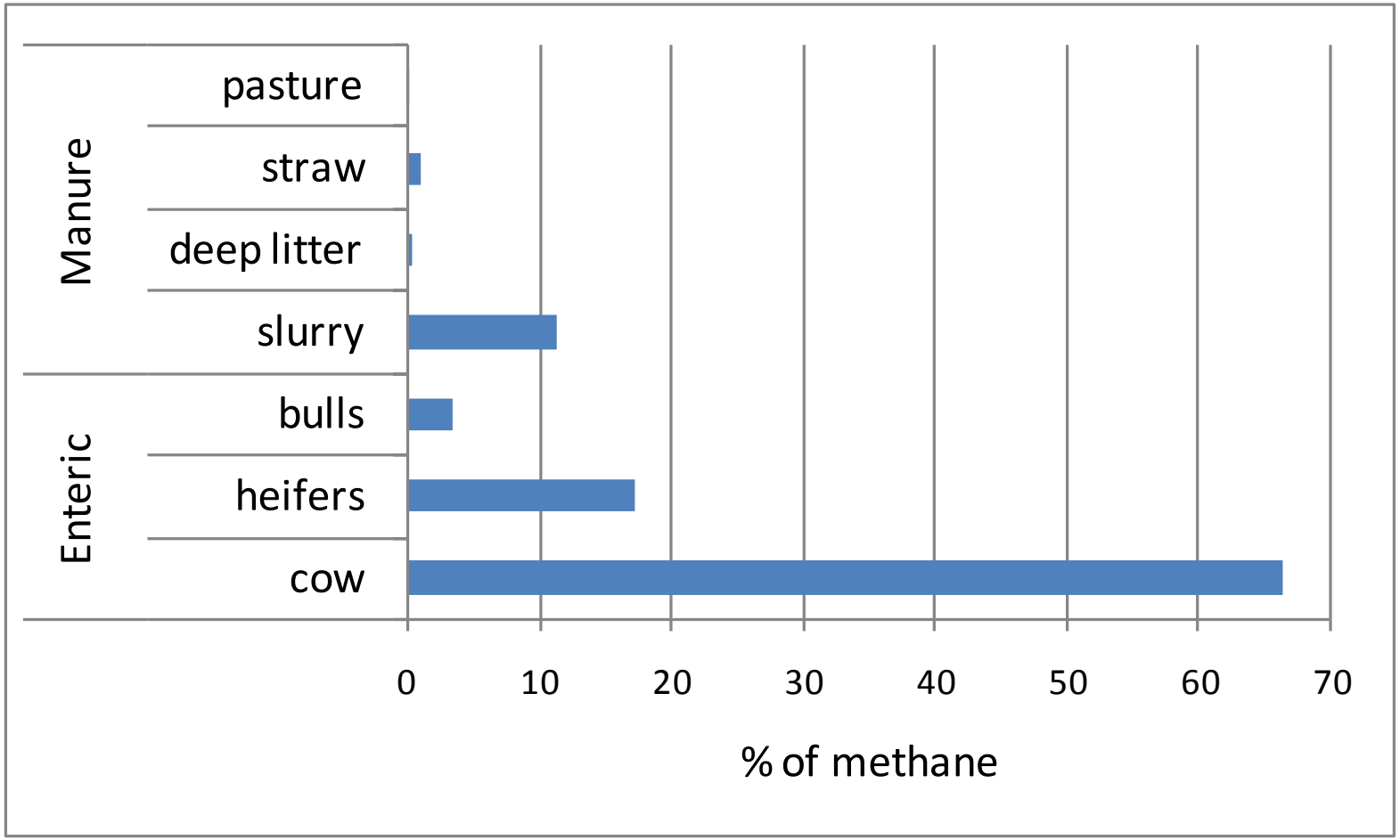


CO_2 eq. % of herd	67	24	9	75	25
CO_2 eq. per kg ECM	0.82			0.86	
CO_2 eq. per kg LWG		6.83			5.08

Riva et al. 2013

LCA of Danish milk production

Methane – where does the emission occurs ?



Kristensen et al, 2011 / Livest. Sci., 140, 136-148

Historic perspective
Typical danish dairy farms

1920 – representing local production and marketing

1950 – representing the period with emerging mechanization and introduction of new technologies and a more global marked

1980 – representing a period with heavily use of external resources like fertilizer and protein

2010 – today with focus on balancing production and risk of environmental damage.

Kristensen et al. 2015 / Livest. Sci. (178) 306-312

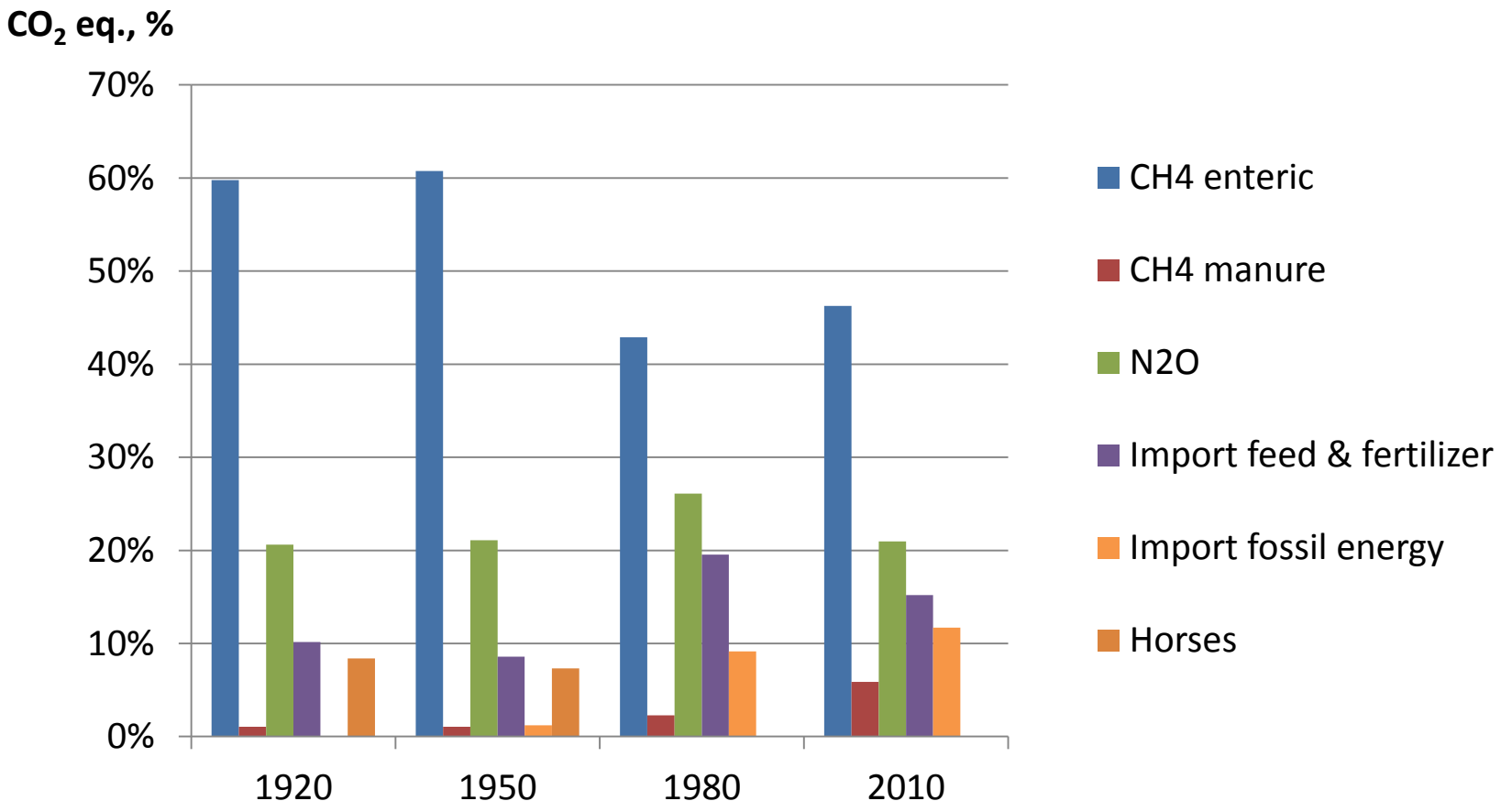
Dairy - historical development

Key figures typical dairy farms 1920 – 2010 in Denmark

Year	1920	1950	1980	2010
Yield, kg ECM / cow / year	1804	3435	5058	8994
Meat, kg / 1000 kg ECM	42	29	46	23
Fertilizer, kg N / ha	5	22	129	74
Protein, g crude protein / kg DMI	142	137	180	157
Feed efficiency, kg ECM / kg DMI (herd level)	0.39	0.62	0.62	0.90
Total emission, kg CO_2 eq.	4392	5088	9830	10761
Per kg ECM	2.43	1.48	1.94	1.20
Allocation				
Per kg ECM	1.27	0.92	1.02	0.81
Per kg meat	25	18	20	16

Kristensen et al., 2015

Sources to emission in the dairy system ab farm



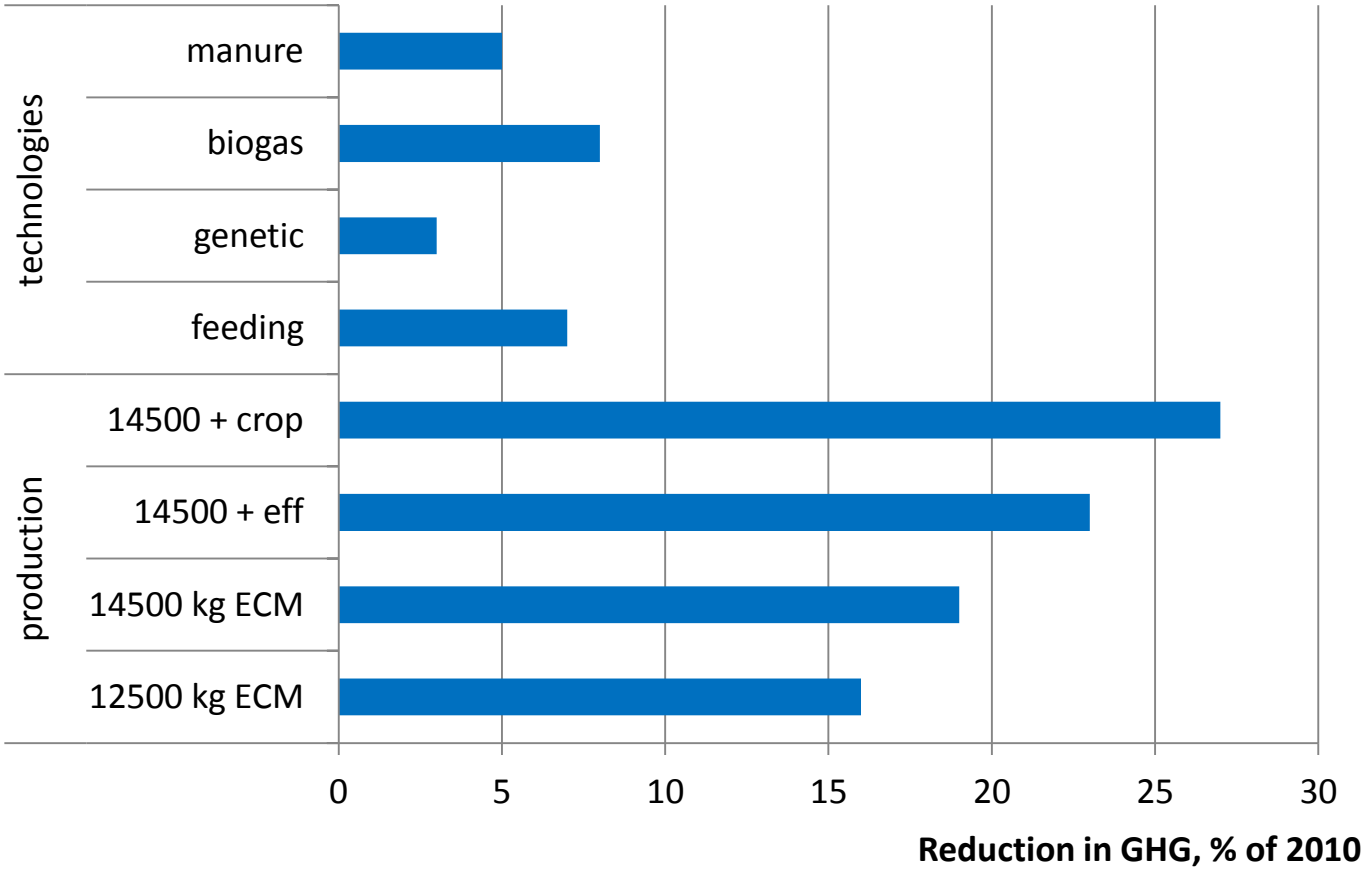
Emission in 2040 – different scenarios

	O: Present (2010)	I: Conser-vative	II: Optimist	III: Optimist + High herd efficiency 1)	IV: III + Increased crop production (20%)
Year	2010	2040			
Yield per cow	9000	12500	14500	14500	14500
Efficiency - ECM / DMI (herd)	0.89	1.09	1.18	1.21	1.21
Stocking rate - ECM / ha (farm)	7372	8781	9494	9705	11630
CO_2 eq. per kg ECM (no allocation)	1.20	1.01	0.94	0.92	0.87

1) 3 %-units

Potential reduction in emission per kg milk in 2040 compared to 2010

Dairy productivity and different technologies

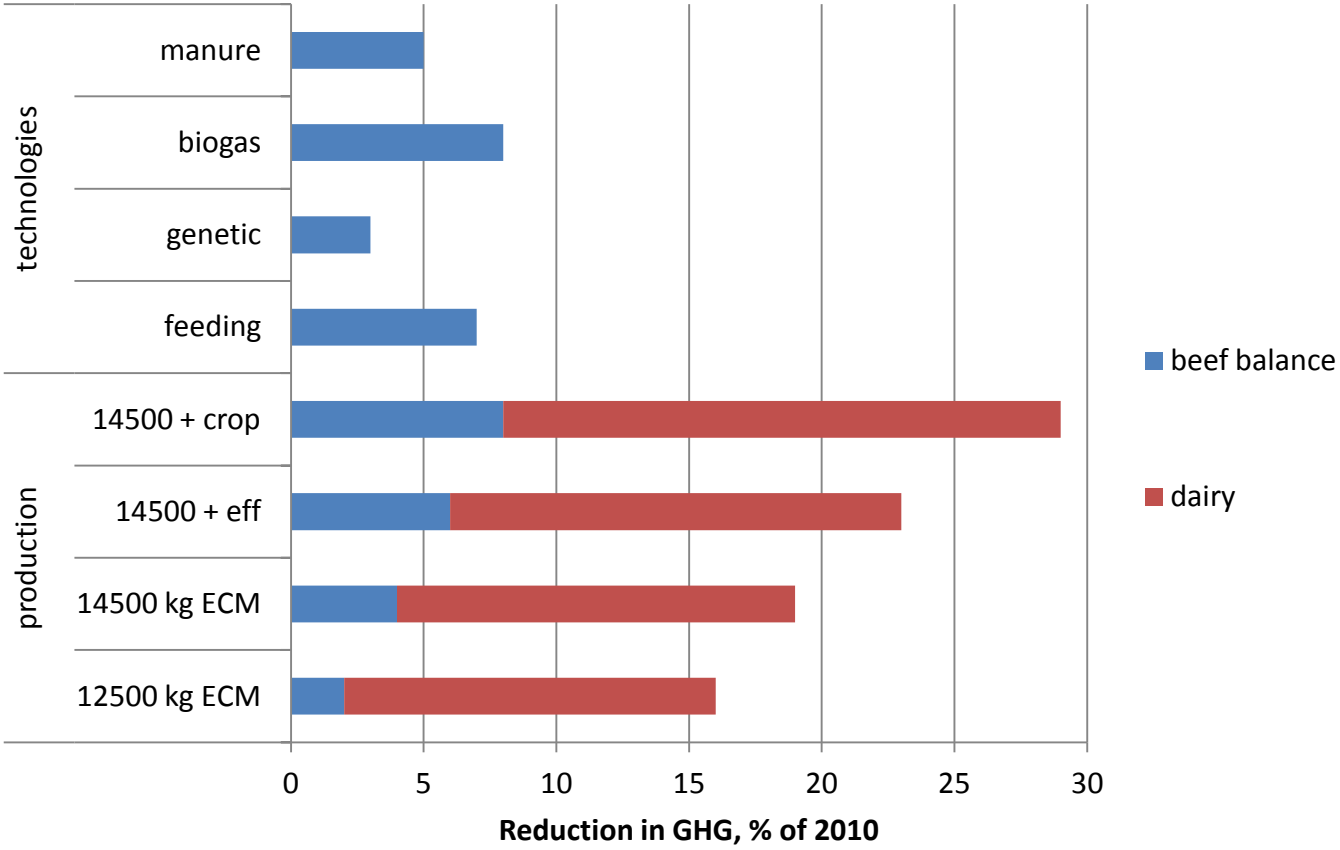


More milk – less meat - effect on GHG

	O: Present (2010)	I: Conservative	II: Optimist
Year	2010	2040	
Yield per cow	9000	12500	14500
Meat per 1000 kg ECM	23.4	16.4	14.1
Beef from suckler cows, kg	0	7.0	9.3
CO_2 from suckler cows (22 kg CO_2 / kg meat)	0	160	213
CO_2 eq. per kg 1000 kg ECM and 23.4 kg beef	1200	1170	1153

Potential reduction in GHG per kg milk in 2040 compared to 2010

Dairy productivity, beef balance and different technologies



Prolonged lactation – a management strategy to reduce emission? *(preliminary results)*

	Standard	All 17	First 17	Older 17
Yield, kg ECM per cow	10474	10032	10461	9988
Kg meat per cow (herd level)	155	117	139	129
Young stock no per cow	1.0	0.76	0.89	0.84
ECM / kg DMI (cow)	1.35	1.32	1.35	1.31
ECM / kg DMI (herd)	1.06	1.09	1.09	1.07
CO_2 eq kg annually				
- per AU	11095	10271	10807	10456
- per ECM	1.06	1.02	1.03	1.05
- per ECM – beef ajusted *(11.3 kg CO_2 eq. per kg meat)*	0.89	0.89	0.88	0.90
- per ECM – beef and area ajusted *(net 10.000 kg CO_2 eq. per ha bioenergy)*	0.89	0.78	0.86	0.82

Based on Lehmann et al. 2016

Organic vs. conventional dairy production

(data from 67 farms, Denmark, year 2001-2003)

	Production system	
	Conventional	Organic
Emission, kg CO_2 eq. / kg ECM	1.20	1.27
- farm level, %	88	98
Milk, kg ECM per cow	8201	7175
Feed efficiency (herd), ECM / DMI	0.95	0.82
Fertilizer, kg N per ha	68	0
Manure, kg N per ha	168	130
Landuse, m^2 per kg ECM	1.78	2.37

Kristensen et al, 2011 / Livest. Sci., 140, 136-148

Mitigations options – Dairy

Herd level

A: Increased feed efficiency
More milk per DMI (herd)

B: Herd structure
- Lower replacement
- Sexed semen
- Extended lactation

C: Higher milk yield

Farm level

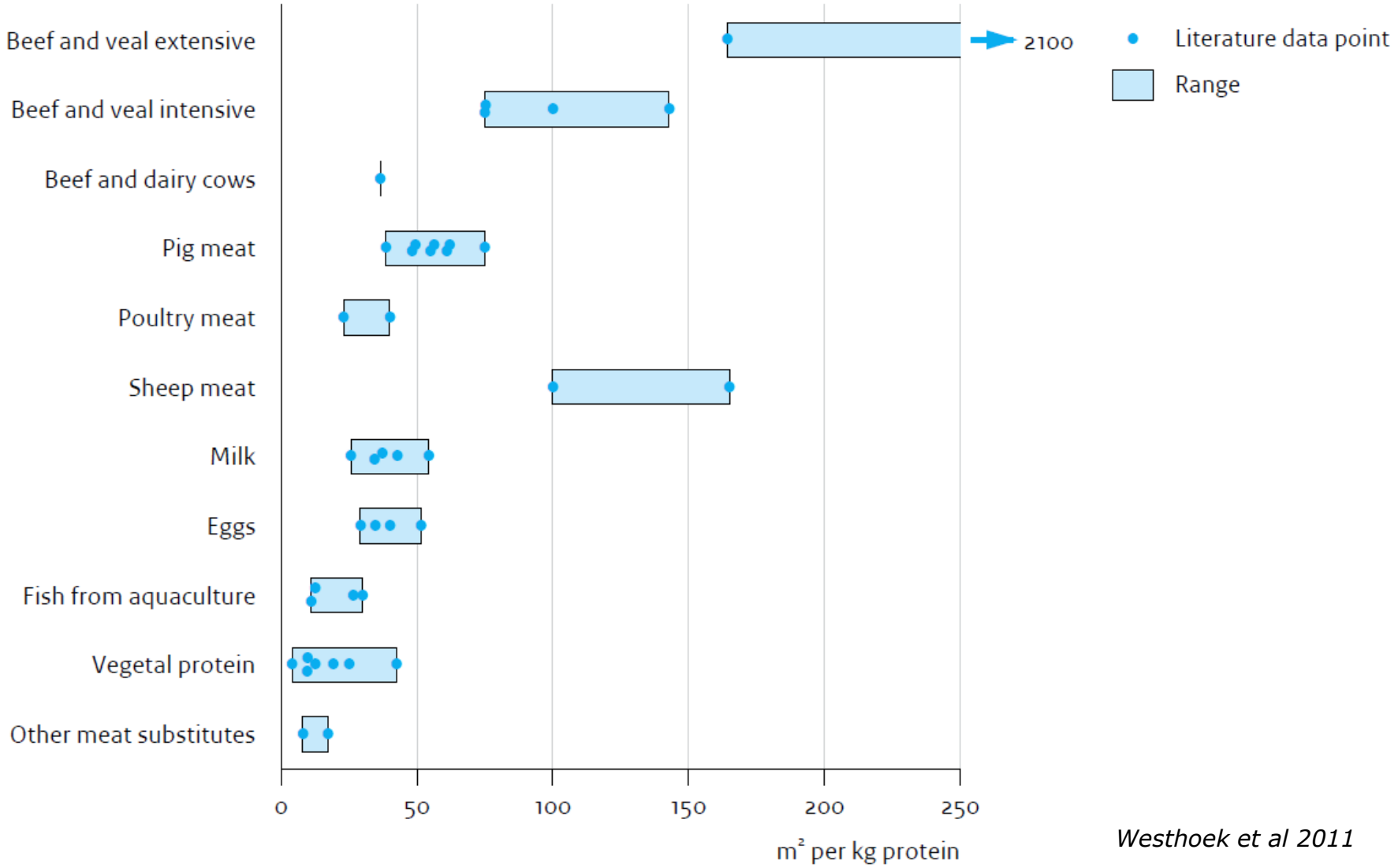
D: High proportion of home grown feed

E: Higher proportion of grassland

F: Increased manure utilization

Beef: Land use & emission

Land use per kg protein, m²



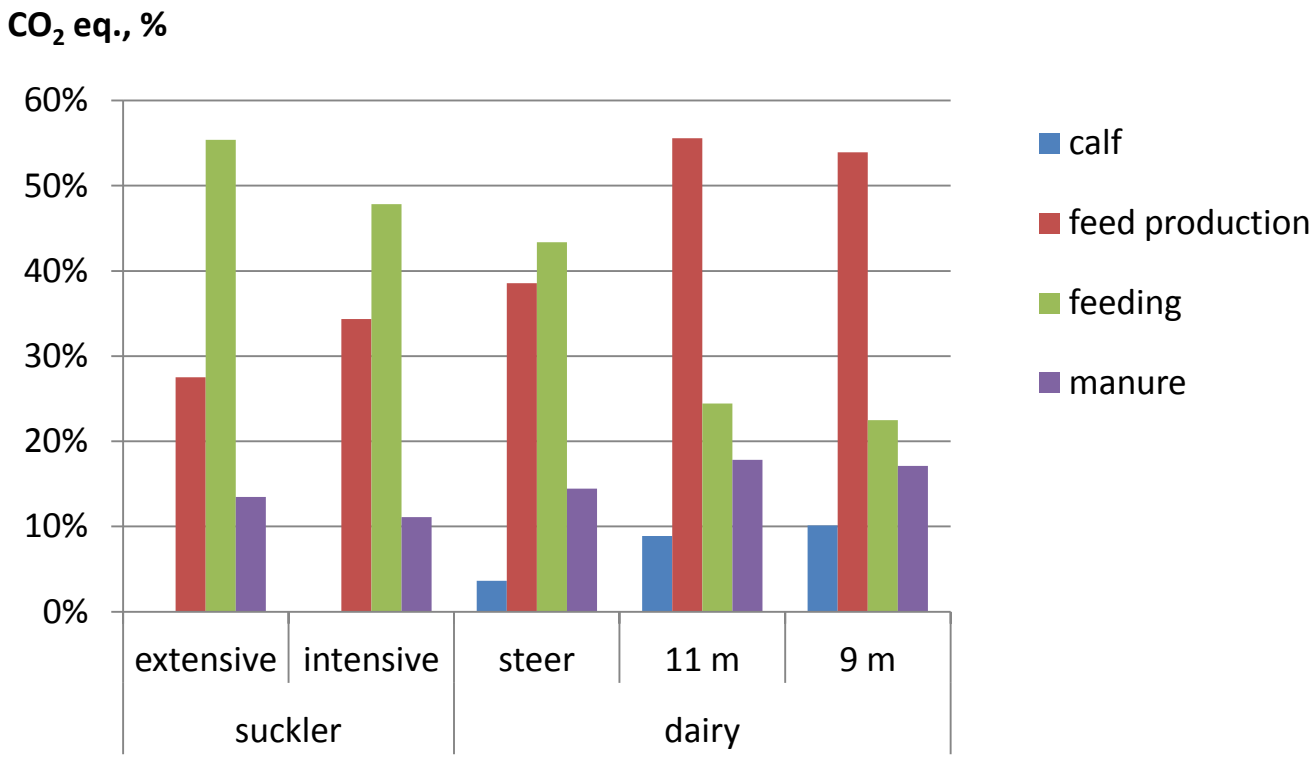
Westhoek et al 2011

Danish beef production – effect of system

	Suckler system		Dairy system		
Type Age at slaughter	Extensive	Intensive	Steer 25 m	Bull 11 m	Bull 9 m
Daily LW gain (male) g/day	600	1300	750	1280	1320
Feed use (herd) Kg DM/kg LW gain	15.8	11.5	7.3	4.7	4.3
Roughage, % of DMI	97	85	88	9	10
Carbon footprint Kg CO_2 eq. / kg carcass	30.7	22.9	16.8	9.0	8.9
Landuse, m^2 / kg - Rotation	14.2	19.7	17.3	11.5	10.3
- Permanent	141	26.4	0	0	0

Mogensen et al., 2015

Danish beef production – effect of system



Conclusions

A: No production system or type of management is superior

B: Climate smart production has to look for

- High feed efficiency (herd and chain level)
- Reduced manure N output
- Increased use of low emission feed (grass, byproducts)
- A system approach to include all inputs and outputs and internal relations at farm level

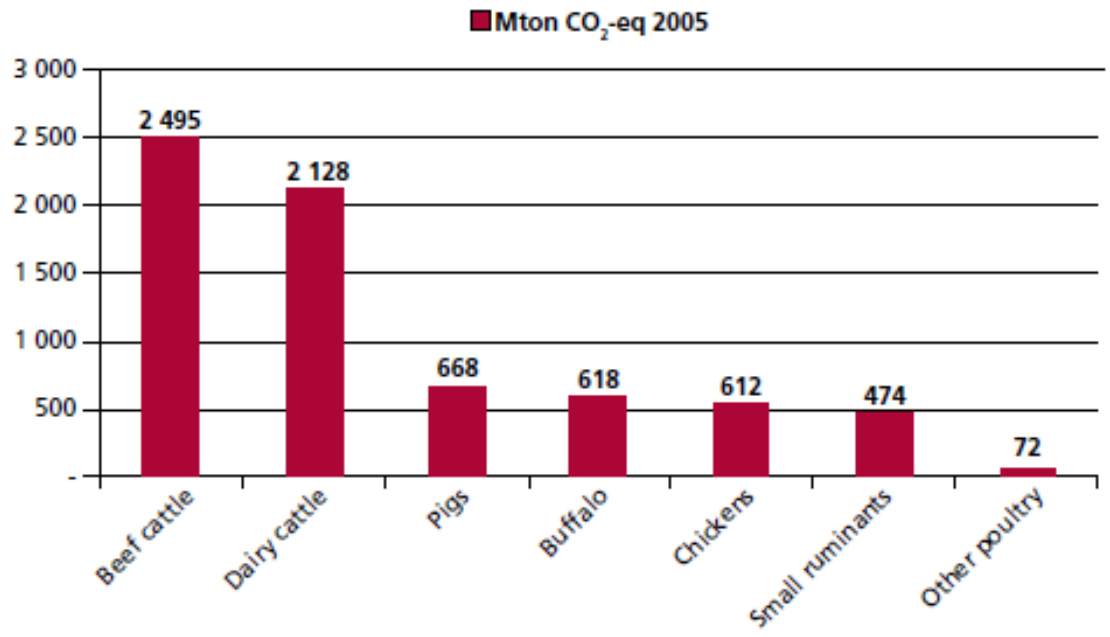
Thank you for your attention

When assessing the mitigation potential of various practices, users must consider the combined effects of interactions among animal-manure-soil-crop processes related to whole-farm profitability, effectiveness in the field (vs experimental results) and the likely adoption rate.

Hristov et al. 2013

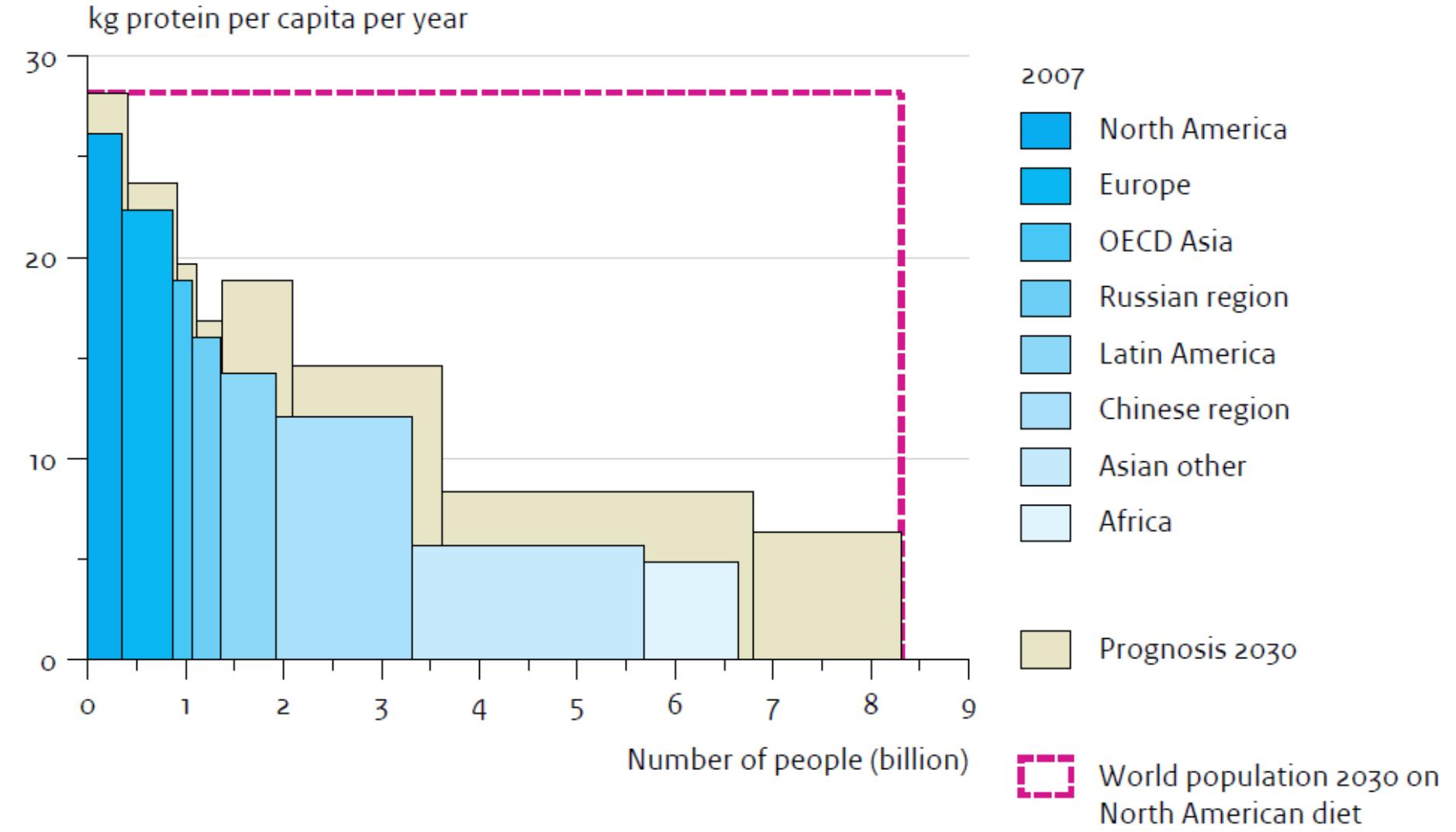
FIGURE 2

Total emissions from the global livestock sector, by main animal species and commodities



Source: Gerber *et al.*, 2012.

Actual and forecasted intake of animal protein per region



Westhoek et al. 2011