Climate smart cattle farming – management and systems aspects

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

Emission from dairy and beef cattle

Dairy cattle
- Historic development
- Mitigation through productivity and technologies

Beef cattle
- Different systems

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Climate smart cattle farming – why it is an issue

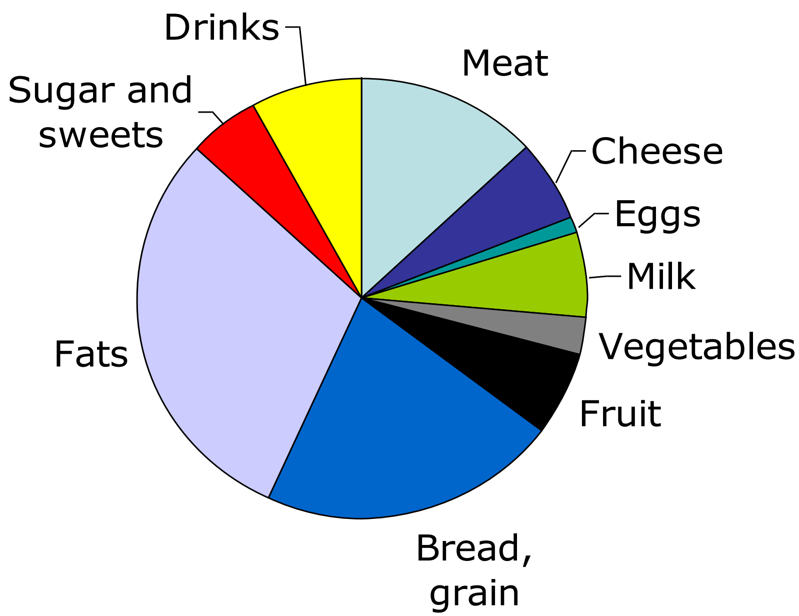
1: Livestock responsible for about 18 % of total global emission

2: Cattle responsible for 65 % of total emission from livestock

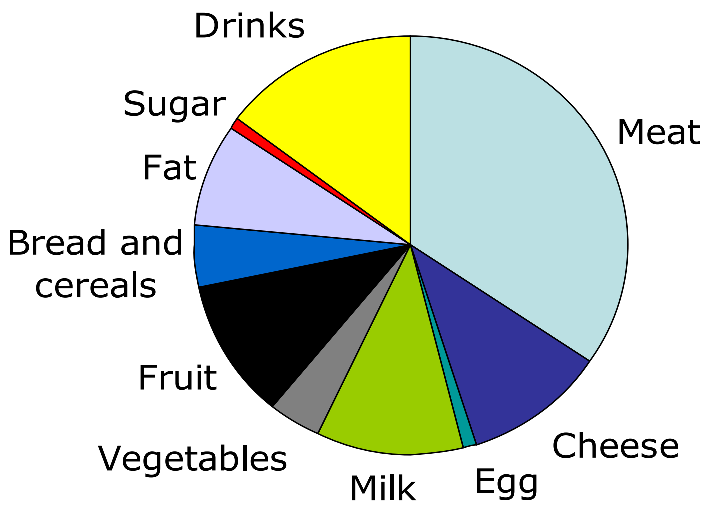
3: Global demand for livestock based food will increase by up to 50%

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

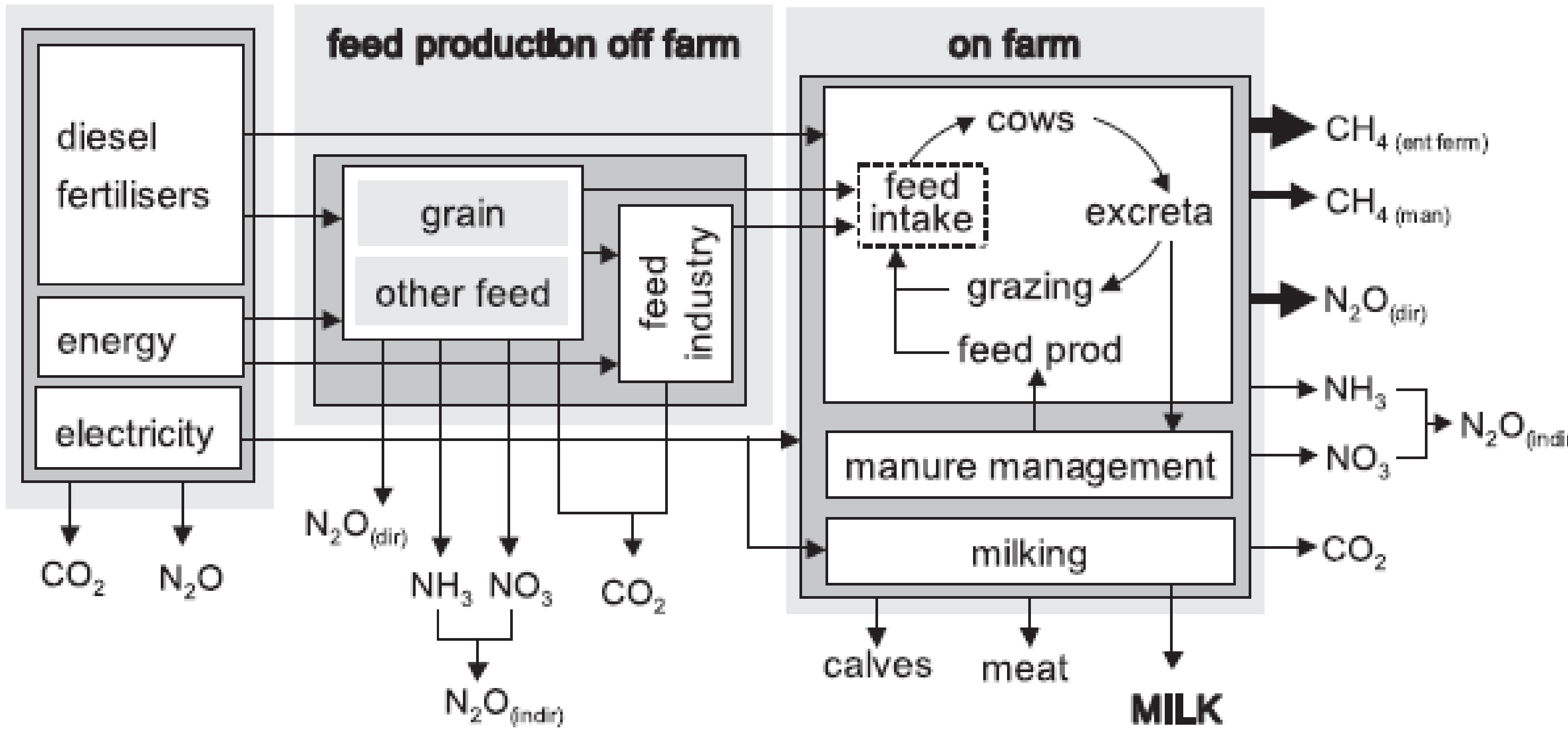
Allocation

Economic
Mass
Biological

Unit

Per livestock unit
Per kg product
Per MJ energi
Per kg protein
Per intake
Per area used

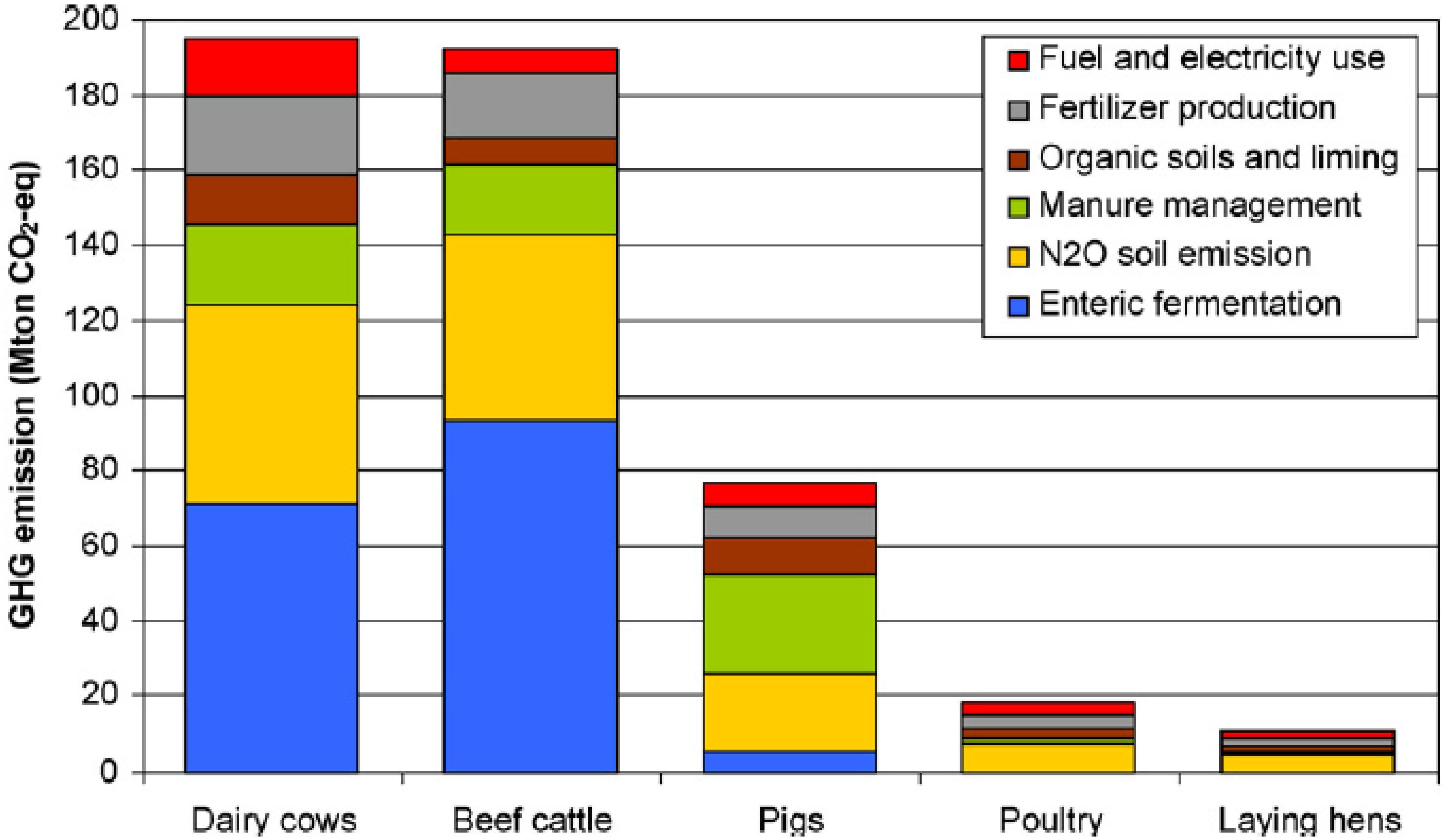
Illustration of a dairy system –
input and output and important internal flows used in a LCA approach



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

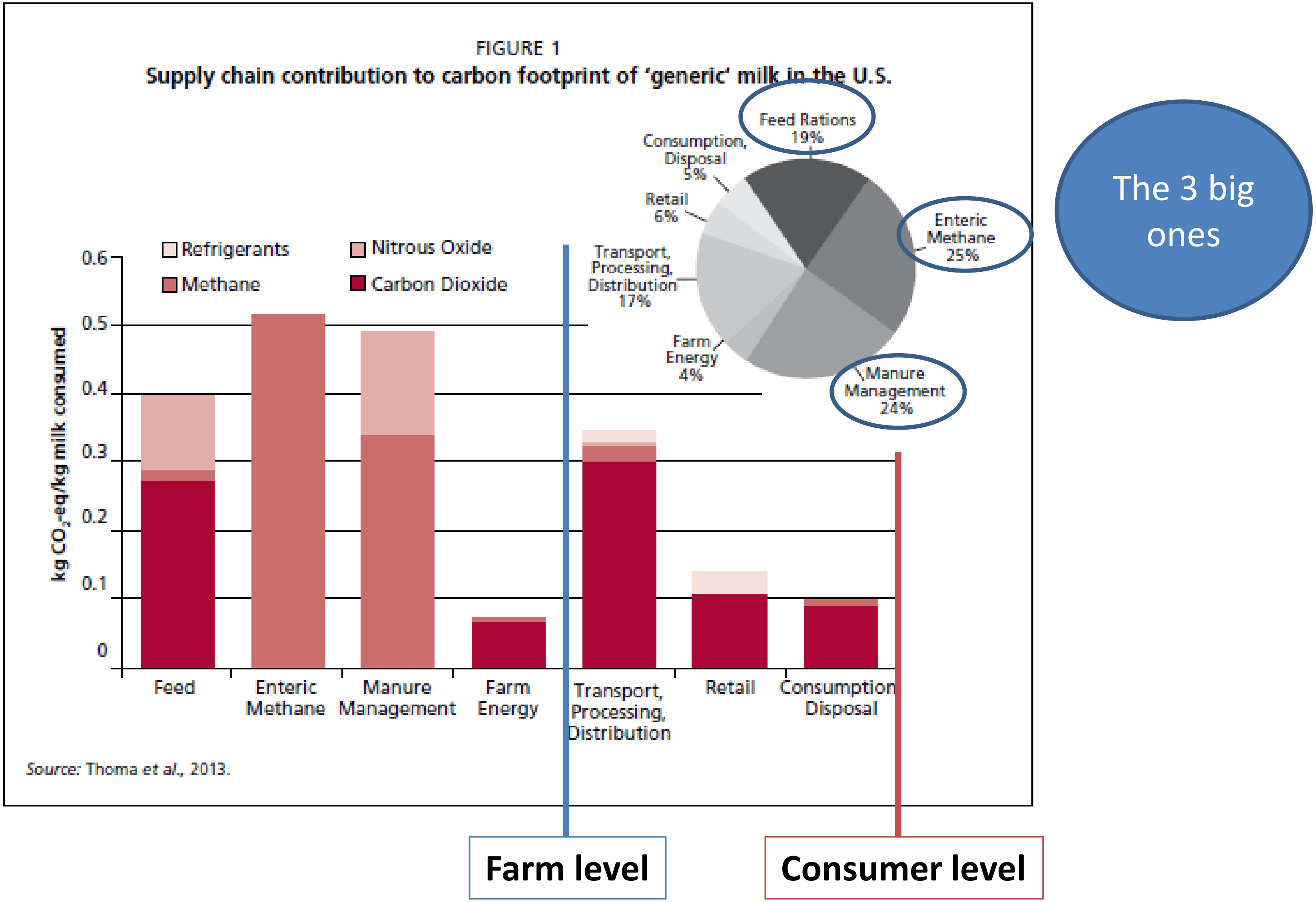
Emission from livestock (EU 27) – which sources are important

J.P. Lesschen et al. / Animal Feed Science and Technology 166–167 (2011) 16–28



CO_2 e. per kg 1.3 22.6 3.5 1.6 1.7

Dairy production – emissions in the supply chain



Three big ones – combined effect on GHG, two examples

A: Increased feed efficiency

- Less emission crop production
- Less emission enteric
- Less emission from manure

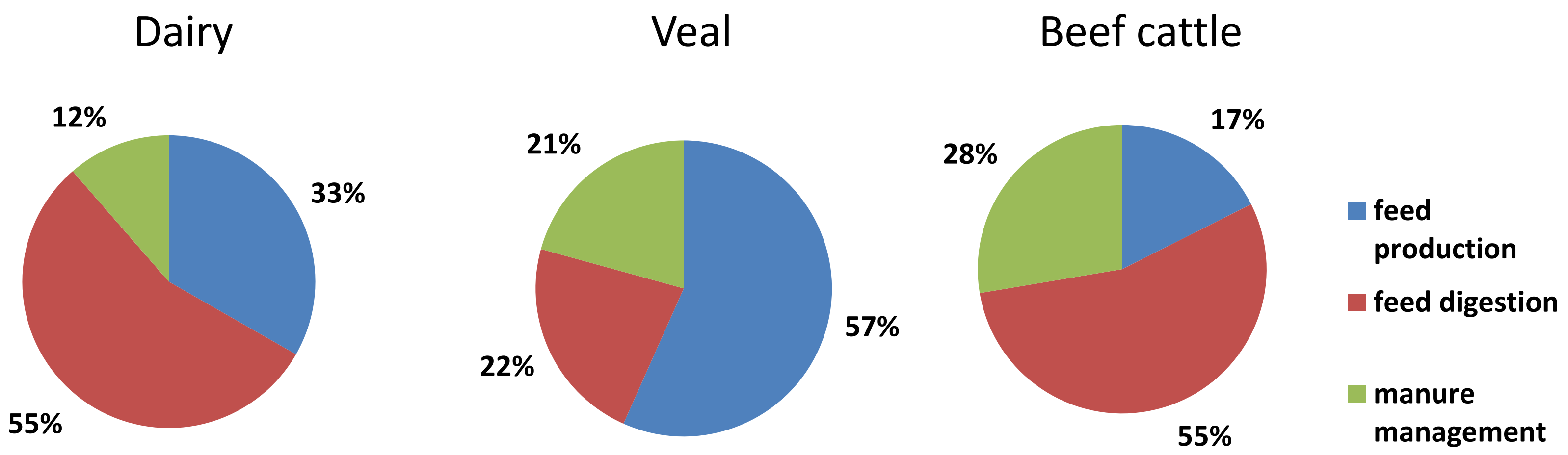
Large effect on emission

B: Increased concentrate

- More emission from crop production
- Less emission from enteric
- More emission from manure

Low or even negative effect on emission

The three big ones – relative emissions dairy, veal and beef cattle production



Mogensen et al., 2015

Dairy production

GHG from cow, heifer and bulls

Historic perspective

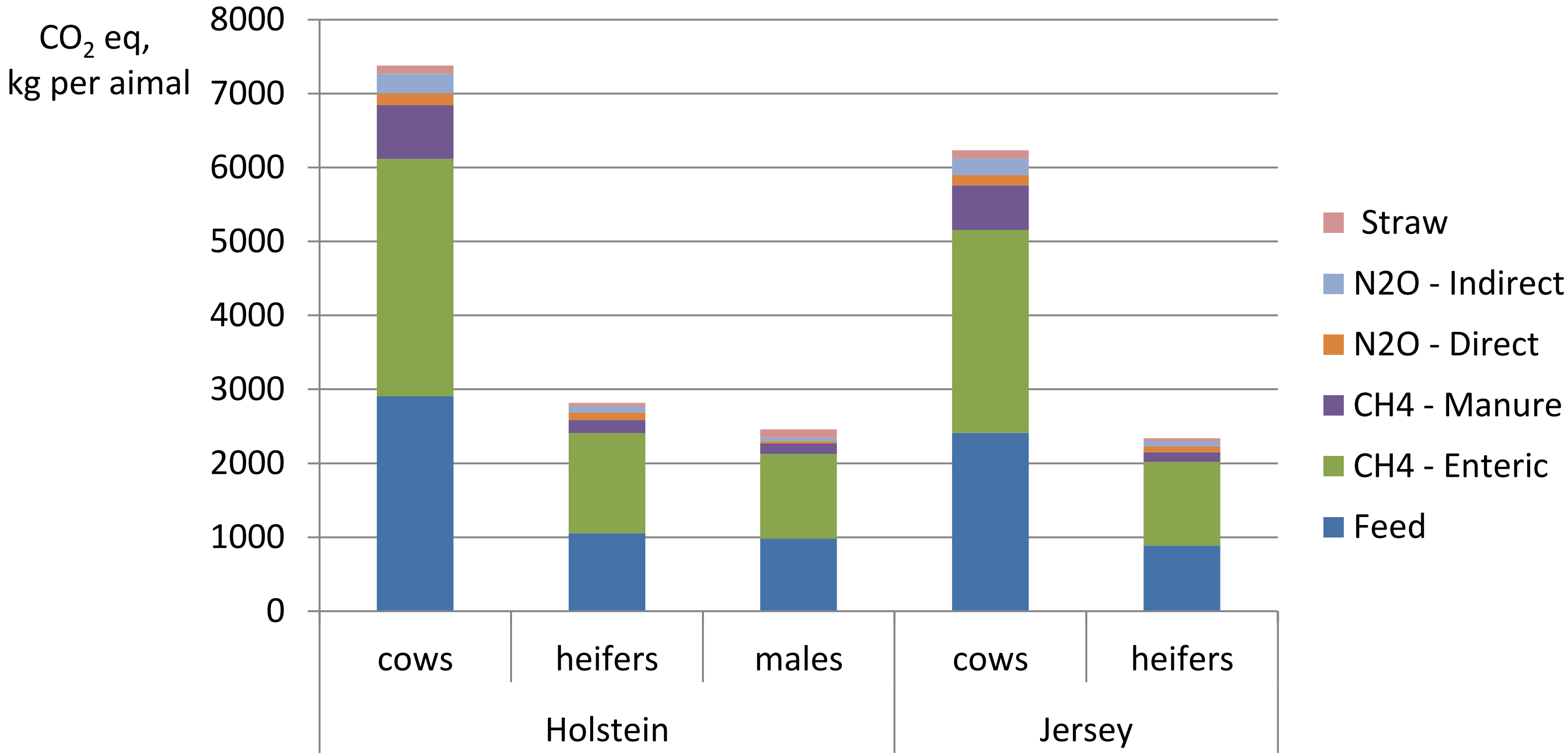
Effect of productivity

Effect of technology

Effect of system

Effect of management

Emissions from each group of animals and breed
DK standard herd 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

Typical 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.

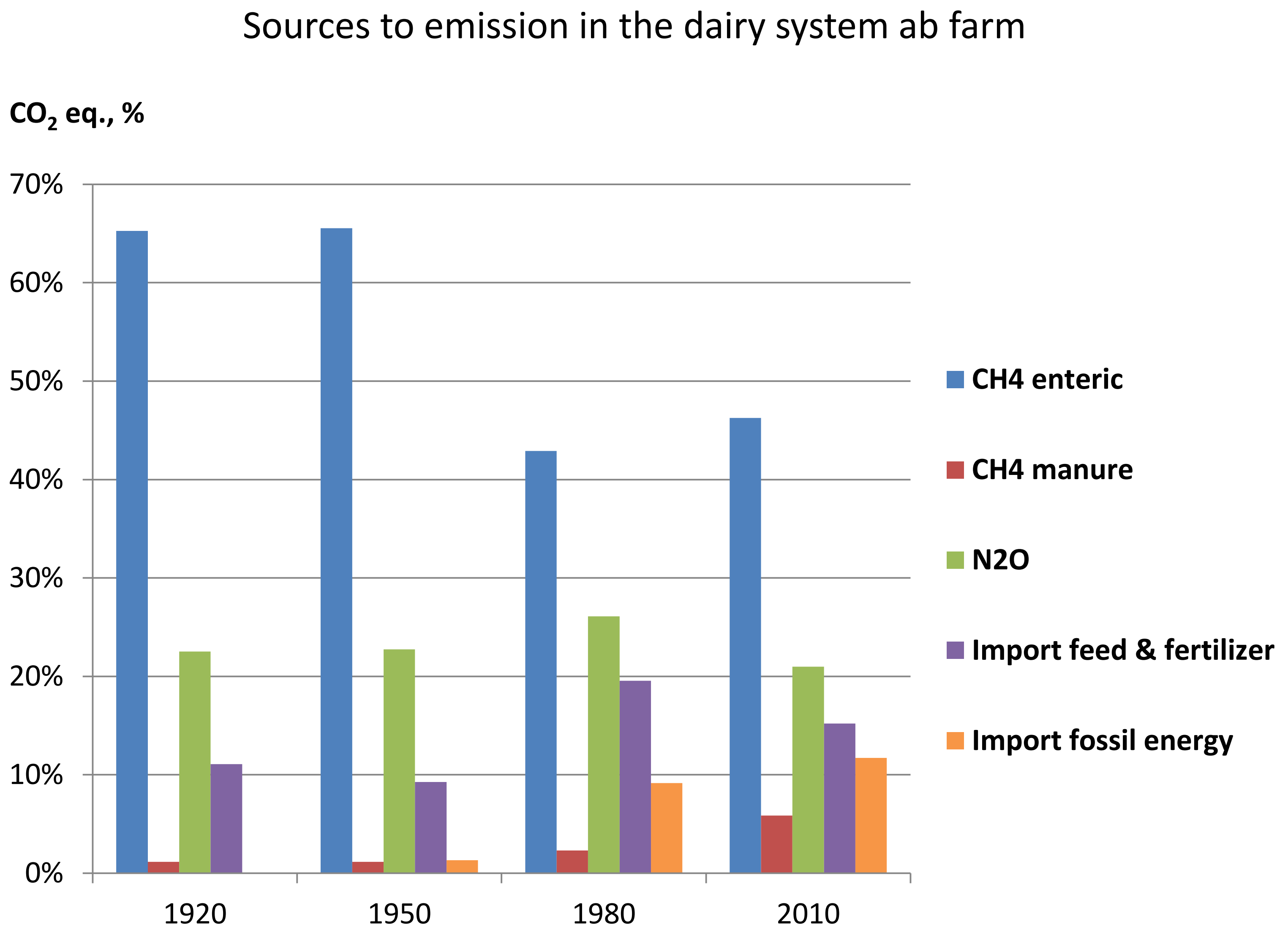
Kristensen et al. 2015

Dairy - historical development

Key figures typical dairy farms 1920 – 2010 in Denmark.

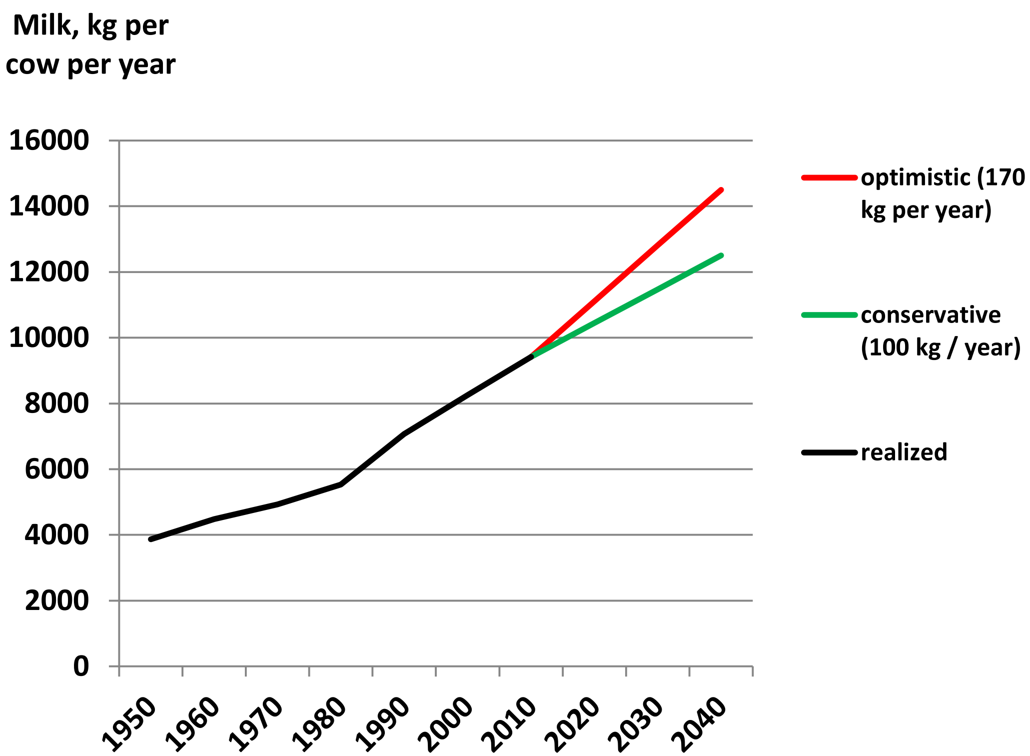
Year	1920	1950	1980	2010
Yield, kg ECM / cow / year	1804	3435	5058	8994
Meat, kg / 1000 kg ECM	42	29	46	23
Fertilizer, kg N / ha	5	22	129	74
Protein, g crude protein / kg DM	142	137	180	157
Feed efficiency, kg ECM / kg DMI	0.39	0.62	0.62	0.90
Total emission, kg CO_2 eq.	4392	5088	9830	10761
Per kg ECM	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
CO2 eq., %
70%
60%
50%
40%
30%
20%
10%
0%
1920
1950
1980
2010
CH4 enteric
CH4 manure
N2O
Import feed & fertilizer
Import fossil energy

Herd production in 2040 ????

Milk recording Holstein in Denmark 1950-2010



Optimistic = reality??

- Genomic selection
- Feed ration evaluation
- Cow specific information
- Housing facilities
- Health management

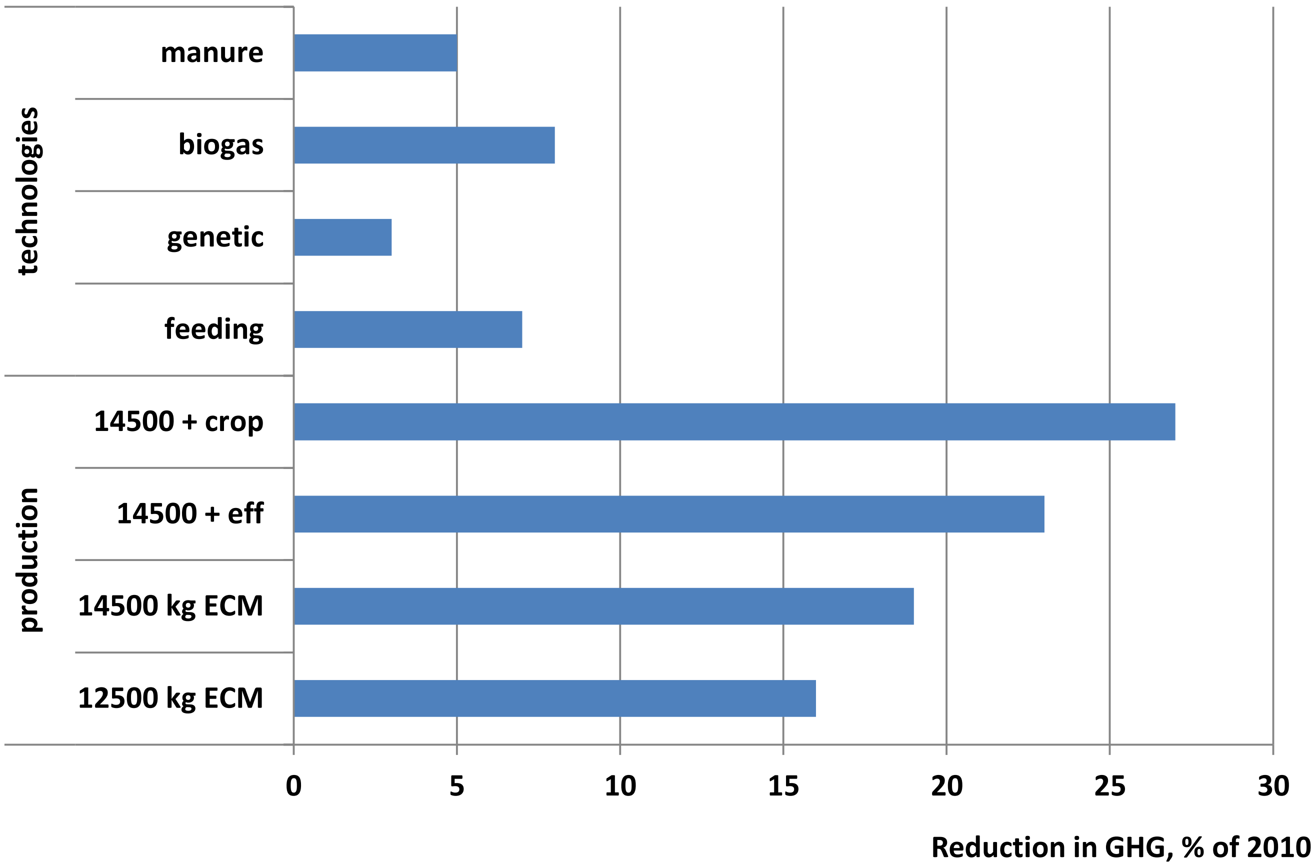
Kristensen & Weisbjerg, 2015

Emission in 2040 – different scenarios

	Present (2010)	I: Conservative	II: Optimist	III: II + 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, kg 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

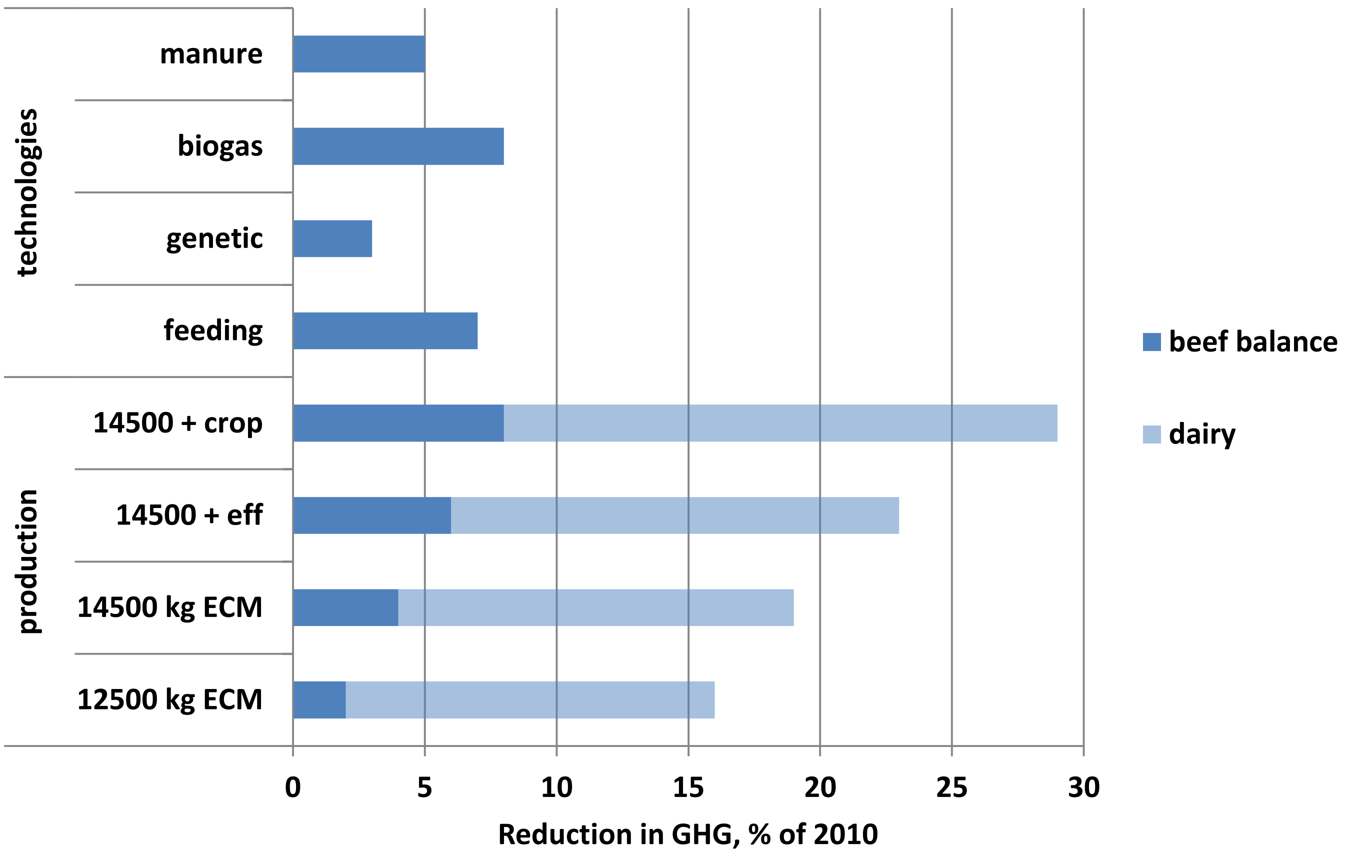
Potential reduction in GHG per kg milk in 2040 compared to 2010
Dairy productivity and different technologies



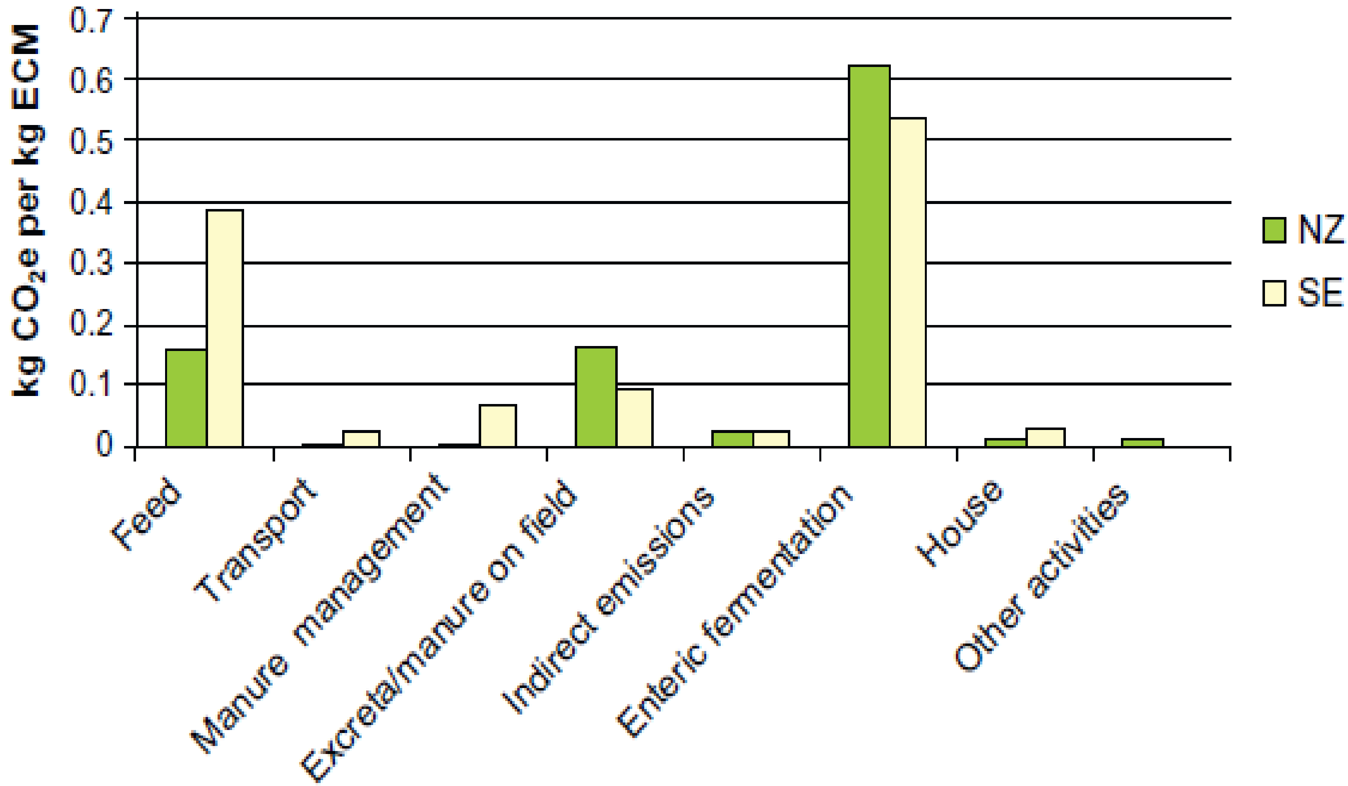
More milk – less meat effect on GHG

	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



Pasture (New Zealand – 4100 kg ECM) vs confinement (Sweden – 8800 kg ECM)



Total CO_2 eq

NZ 1.00

S 1.16

ECM / DMI
NZ: 0.87
S: 1.01

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

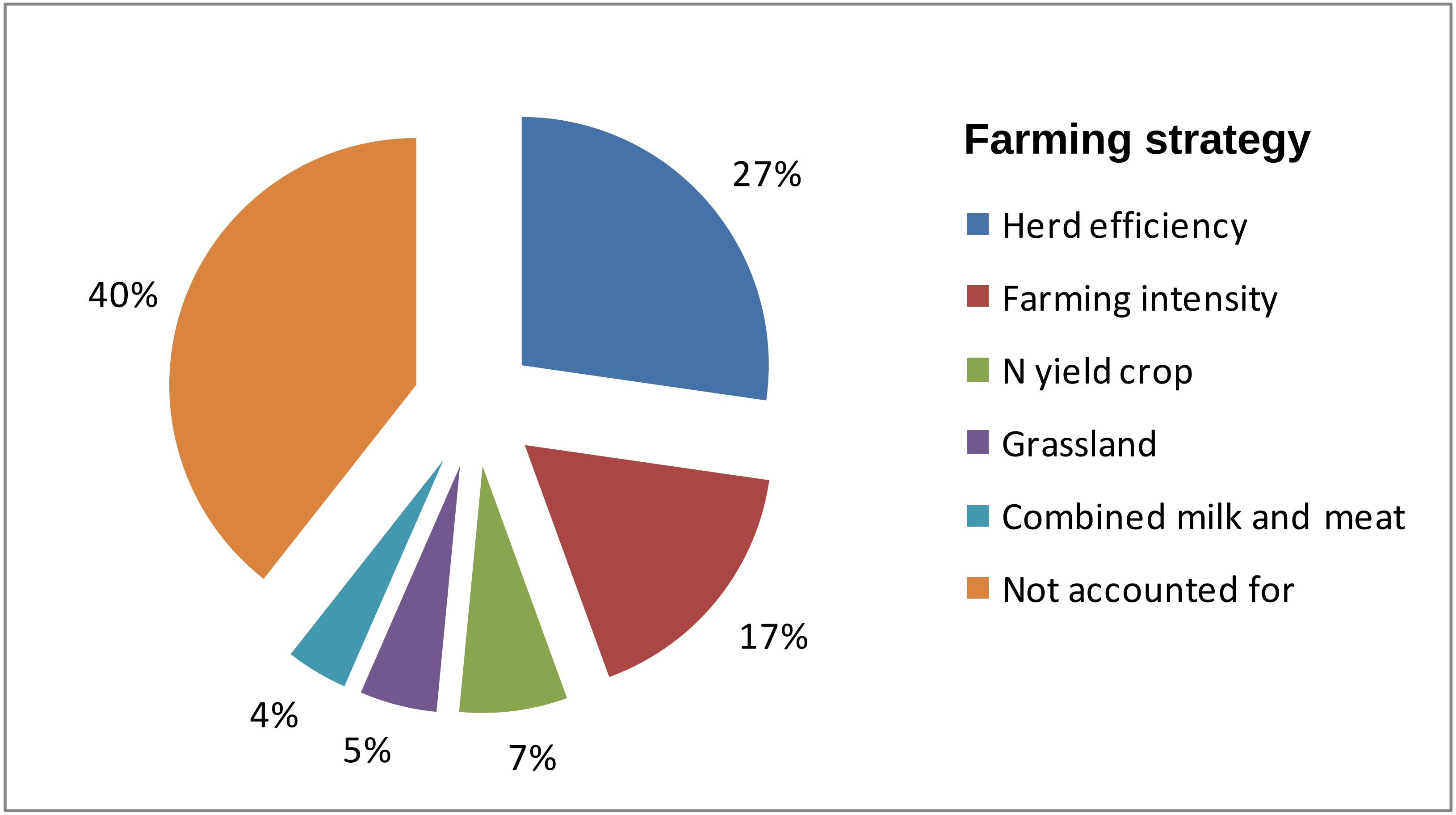
Organic vs. conventional dairy production

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

	Production system	
	Conventional	Organic
Emission, kg CO2 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)

Variation in CF of milk explained by different farming strategies



Kristensen et al, 2011

Mitigations options

Herd level

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

B: Longevity – lower replacement

+ Sexed semen

+ Extended lactation

C: Higher milk yield

Farm level

D: High proportion of home grown feed

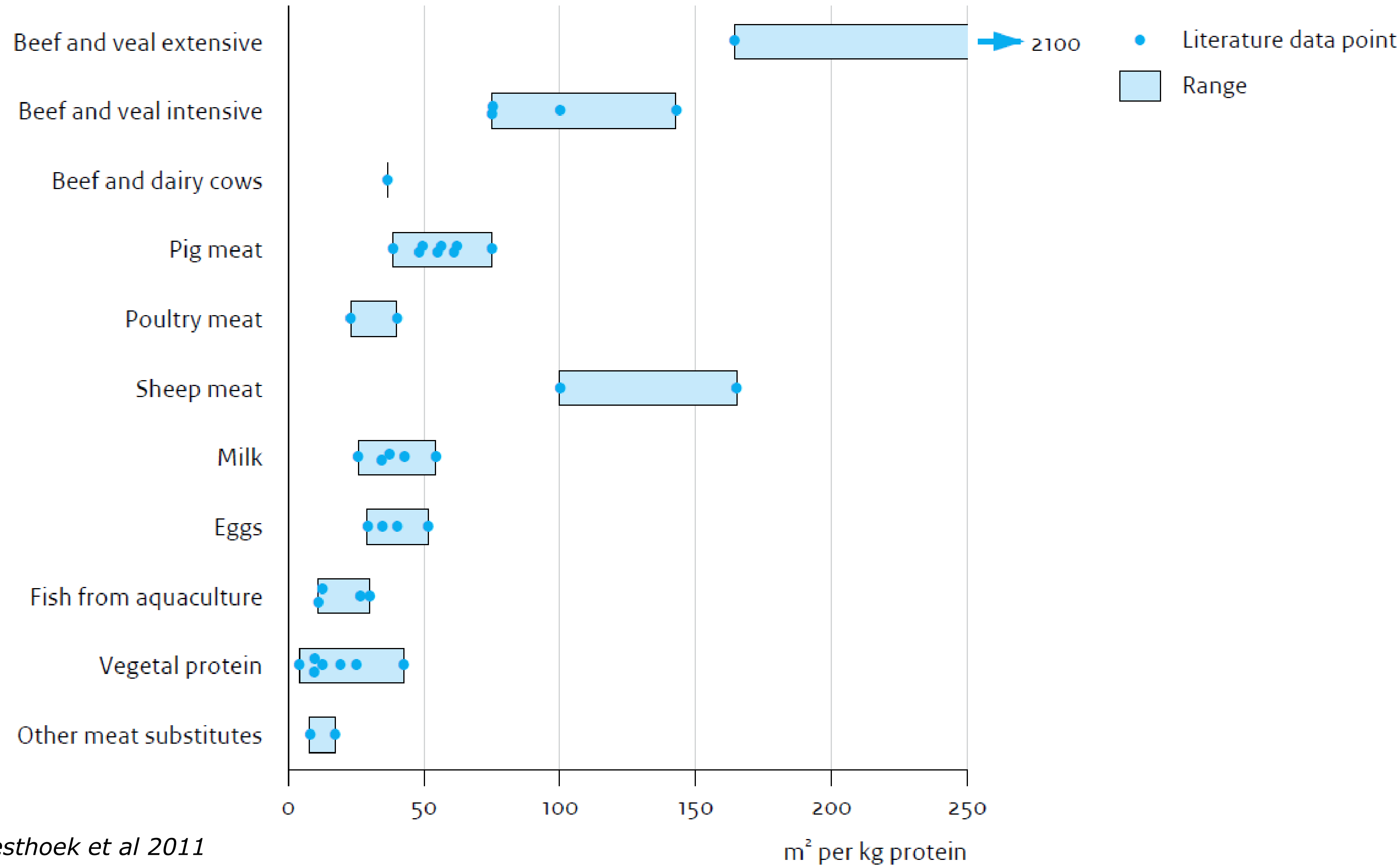
E: Higher proportion of grassland

F: Increased manure utilization

Will we be able to move dairy production in these direction???

Beef and landuse

Land use per kg protein, m²



Westhoek et al 2011

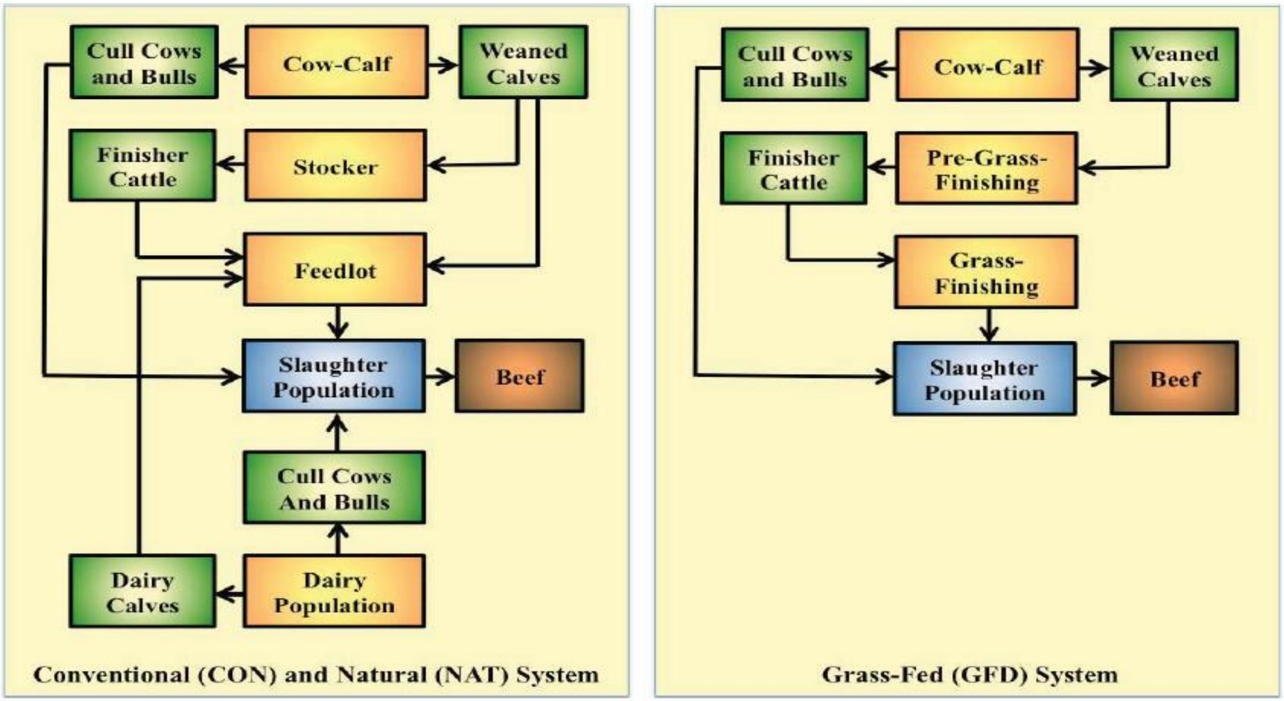
Danish beef production

	Suckler system		Dairy system		
Type Age at slaughter	Extensive	Intensive	Steer 25 m	Bull 11 m	Bull 9 m
Daily gain (male) g/day	600	1300	750	1280	1320
Feed use (herd) Kg DM/kg 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 per kg - Rotation	14.2	19.7	17.3	11.5	10.3
- Permanent	141	26.4	0	0	0

Mogensen et al., 2015

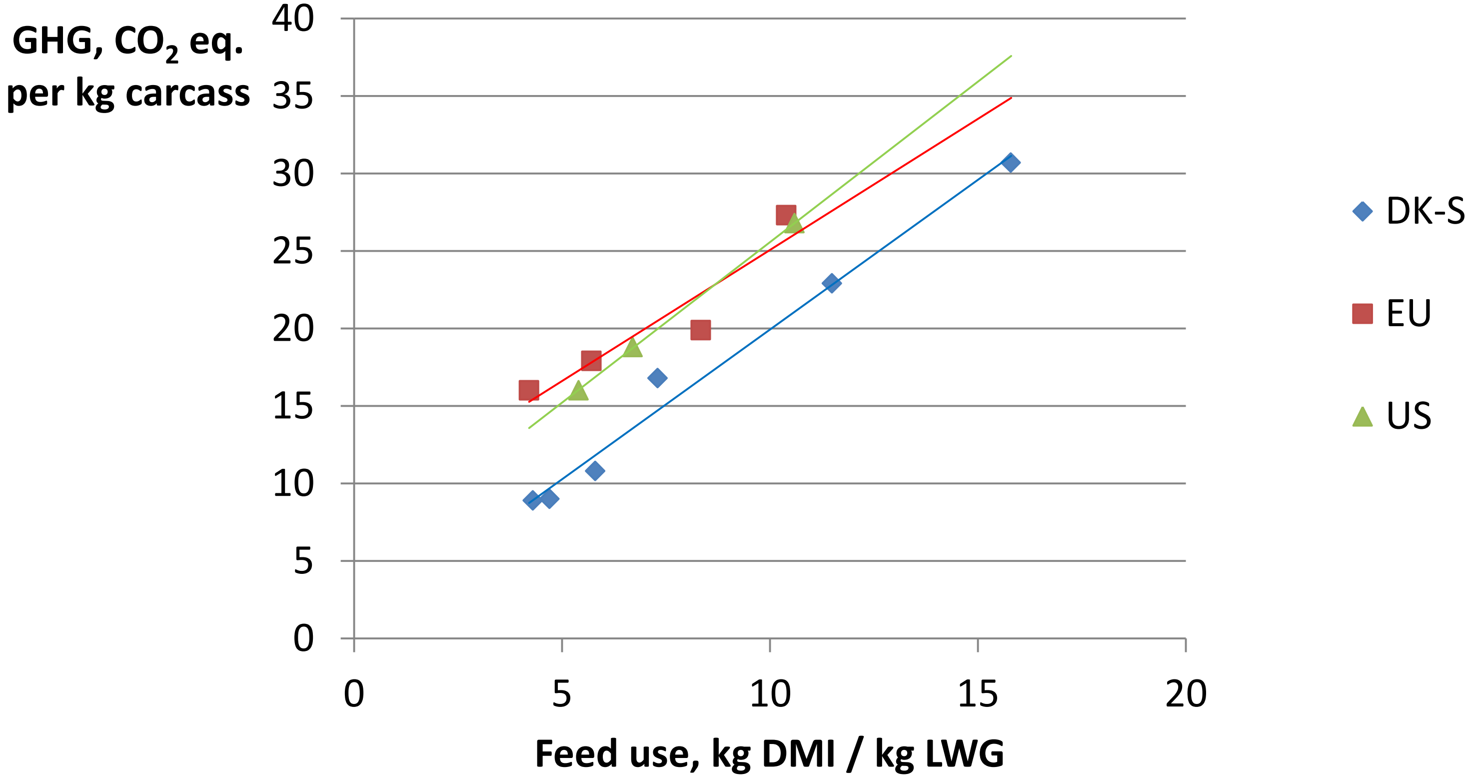
Feedlot – with or without growth enhancing technology and grassland based beef production in US – *Capper, 2012. Animals*

Figure 2. Schematic representation of the animal systems modeled within the study.



growth-enhancing technology	yes	no	no
Feed intake	5.4	6.7	10.6 kg DM / kg gain
Emission, GHG	16.0	18.8	26.8 kg CO_2 eq. / kg carcass

Effect of feed efficiency on GHG per kg product (beef) – three studies



Conclusions

A: No production system or type of management is superior

B: Climate smart production has to look for

- High feed efficiency (herd or 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

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

Thank you for your attention

Hristov, A.N., Oh, J., Lee, C., Meinen, R., Montes, F., Ott, T., Firkins, J., Rotz, A., Dell, C., Adesogan, A., Yang, W., Tricarico, J., Kebreab, E., Waghorn, G., Dijkstra, J. & Oosting, S. 2013. *Mitigation of greenhouse gas emissions in livestock production – A review of technical options for non-CO2 emissions.* Edited by Pierre J. Gerber, Benjamin Henderson and Harinder P.S. Makkar. FAO Animal Production and Health Paper No. 177. FAO, Rome, Italy.