Life cycle assessment
- the role of dairy cattle breeding and the effect on future breeding goal

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Outline

- Life cycle assessment (LCA)
- The present situation
- LCA - dairy for the future
- Breeding goal considerations
- A few Breeding scheme simulations
- Possible solutions

The system – national or global and LCA - agriculture

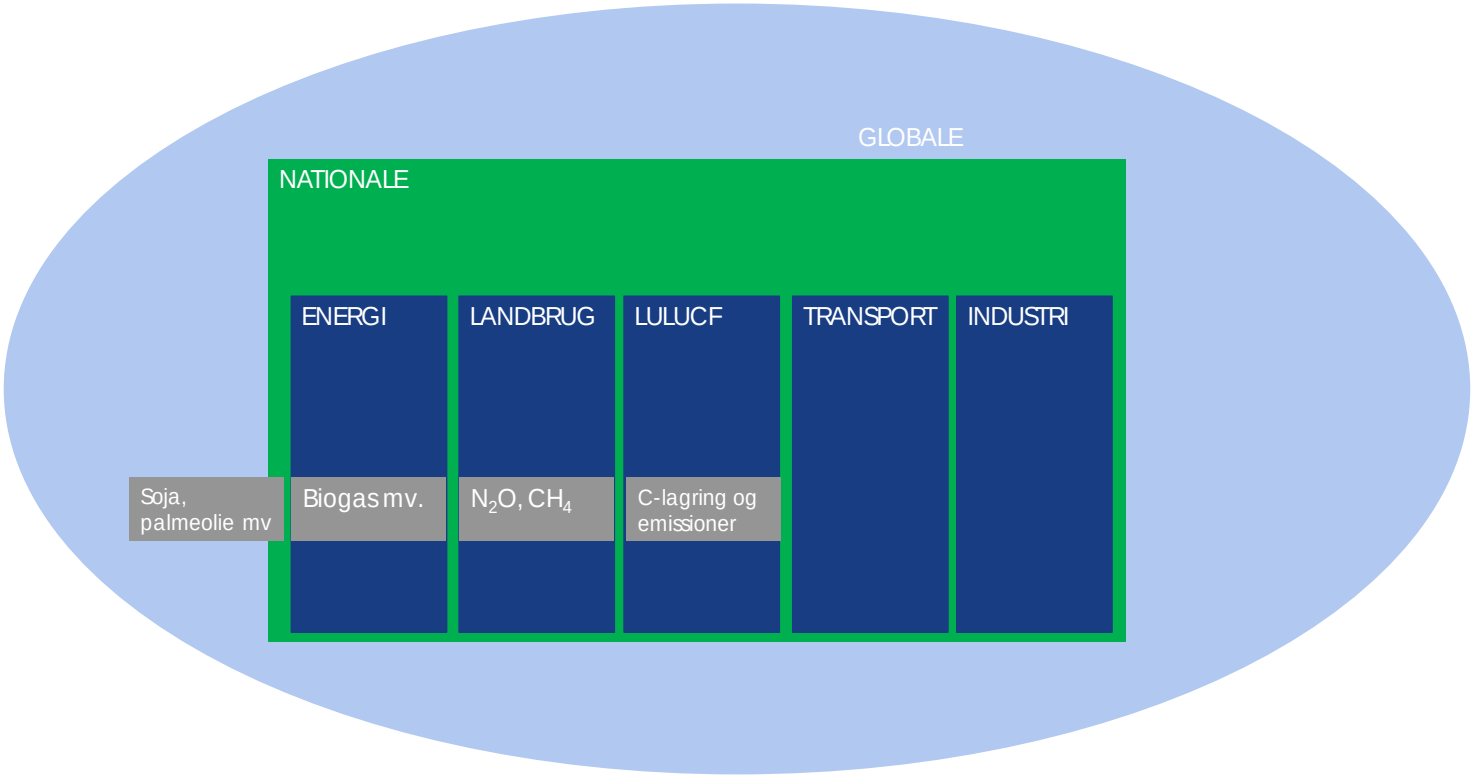
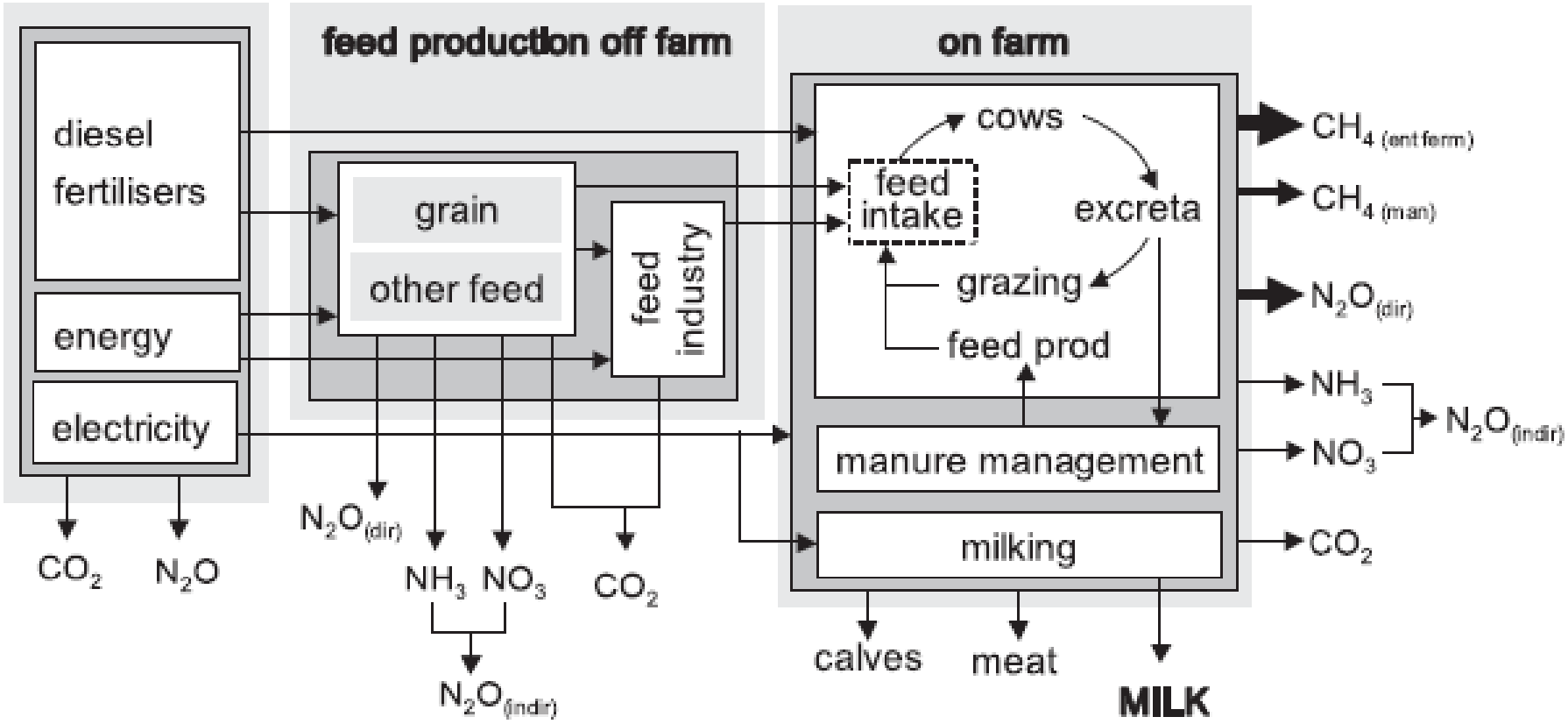


Illustration of a dairy system – input and output and important internal flows used in a LCA approach



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

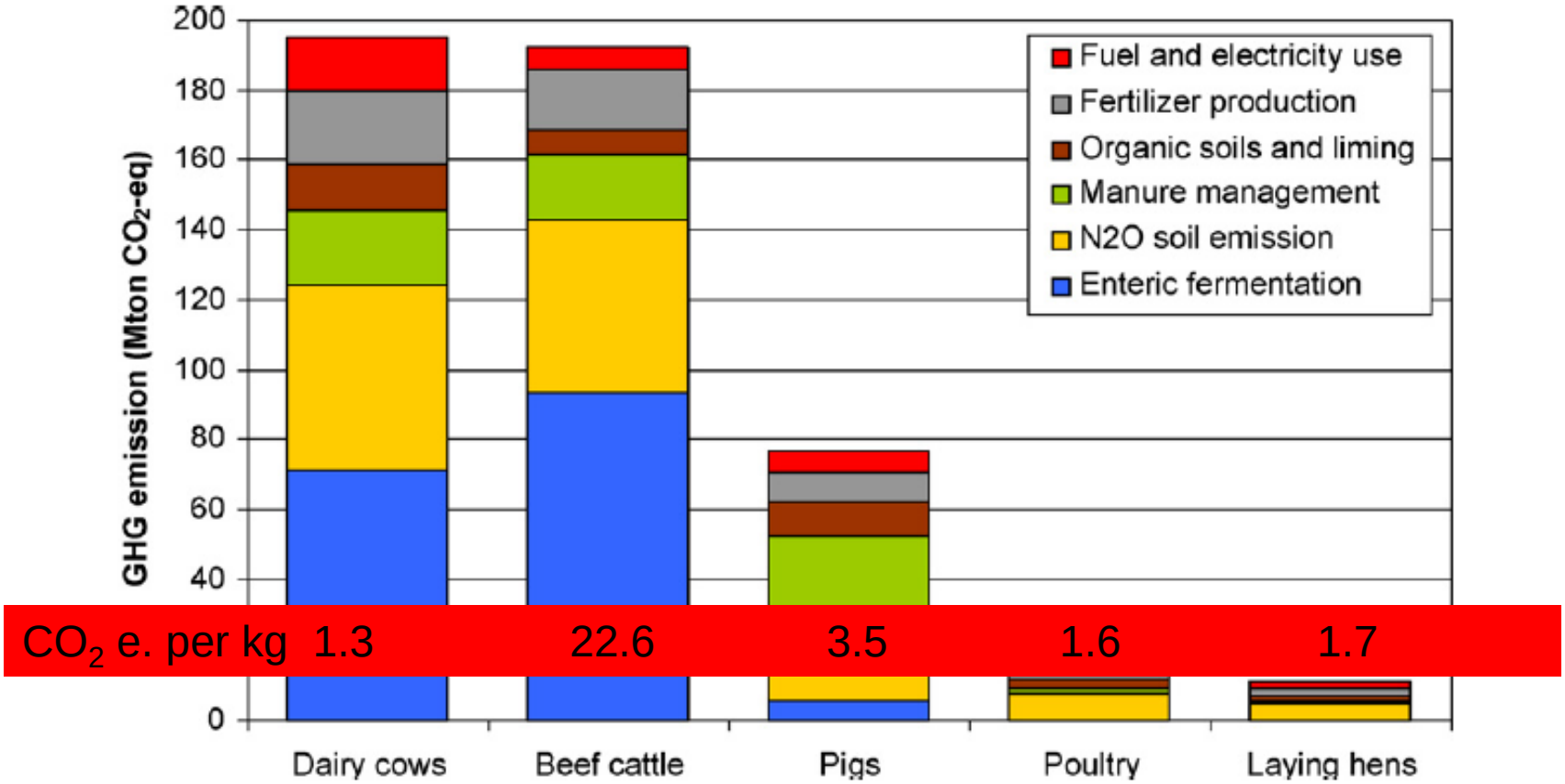
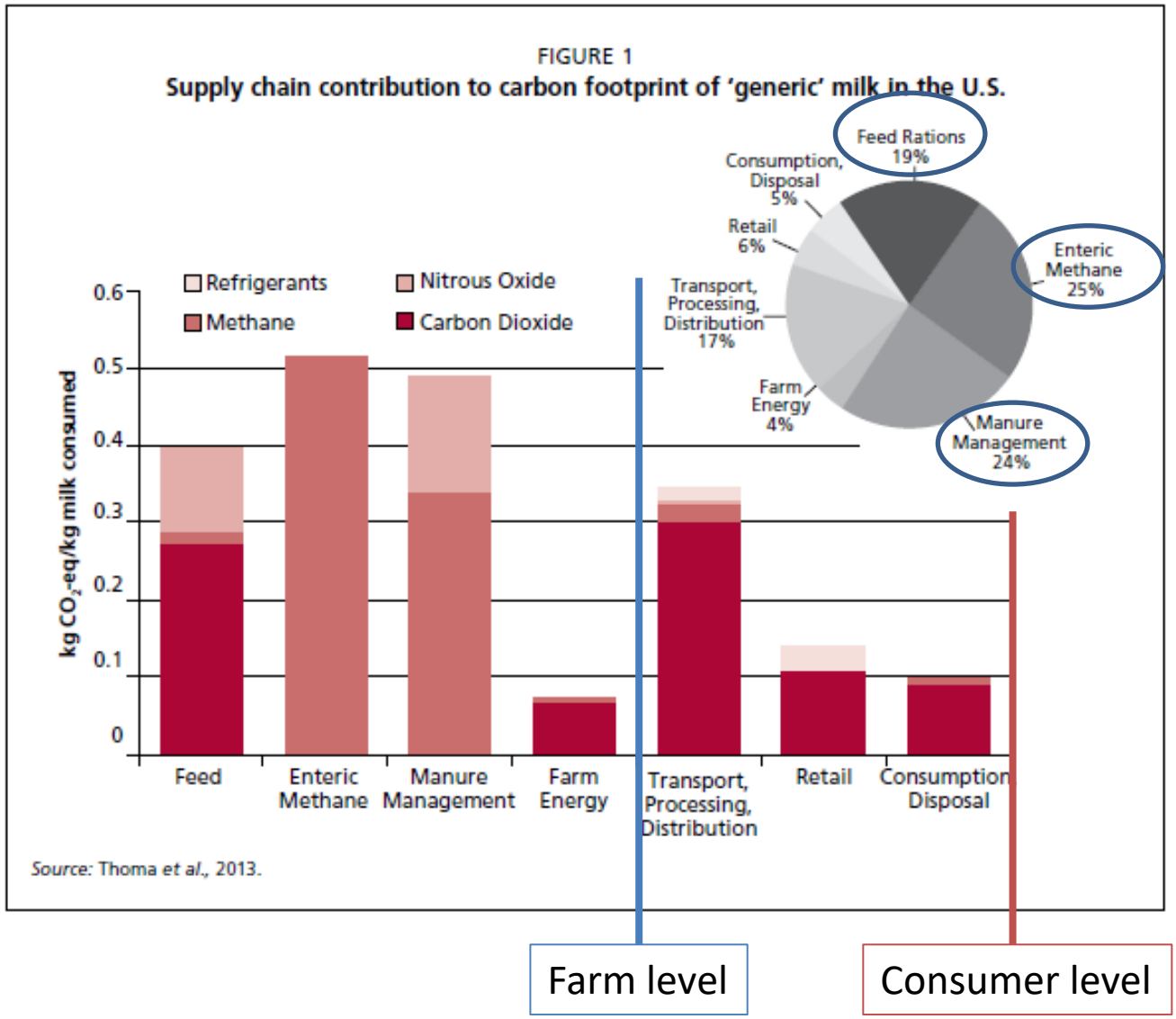


Fig. 7. Total greenhouse gas emissions from the various emission sources associated with livestock production in the EU-27.

Dairy production – emissions in the supply chain

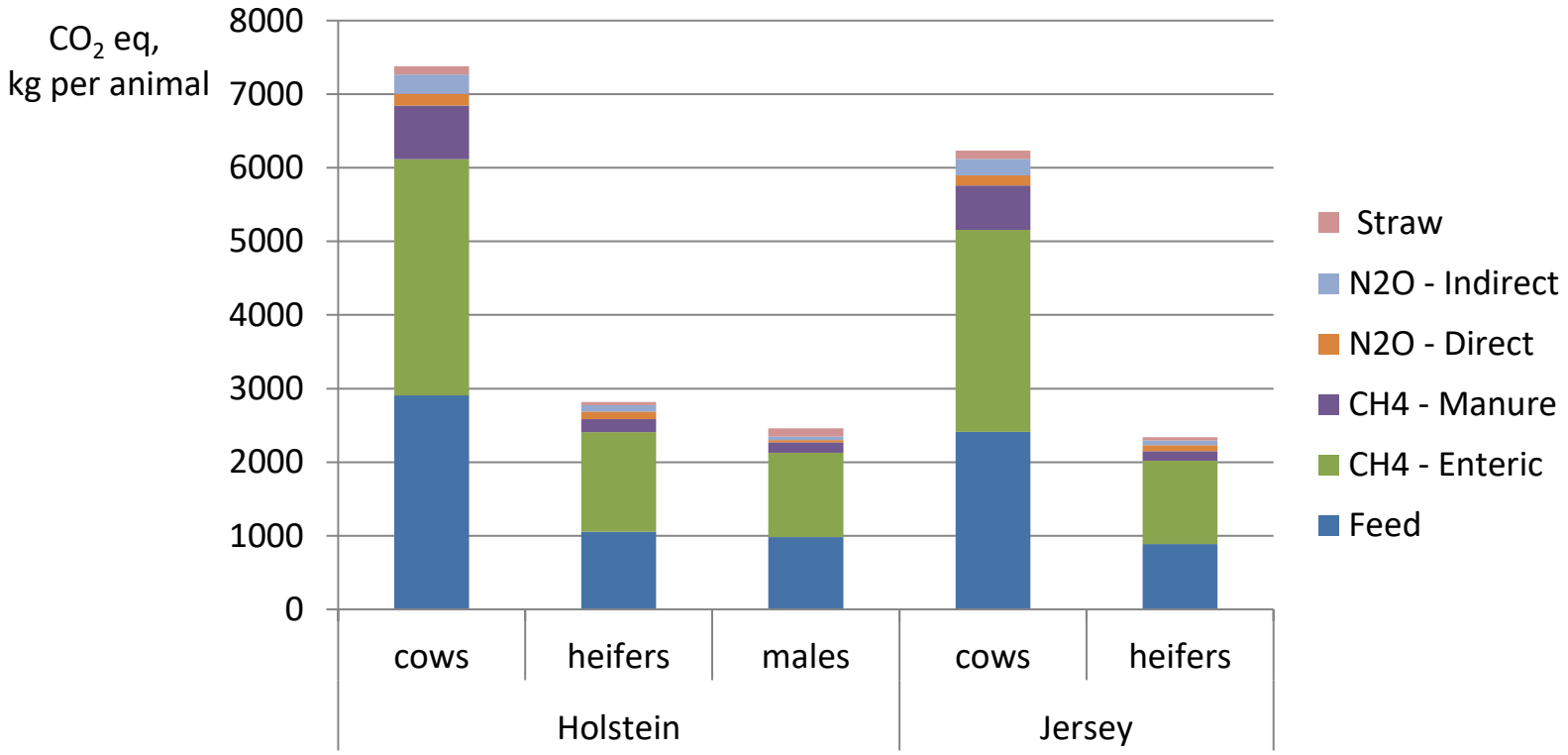


The 3 big ones

Farm level

Consumer level

Emissions from each group of animals and breed
DK standard herd data

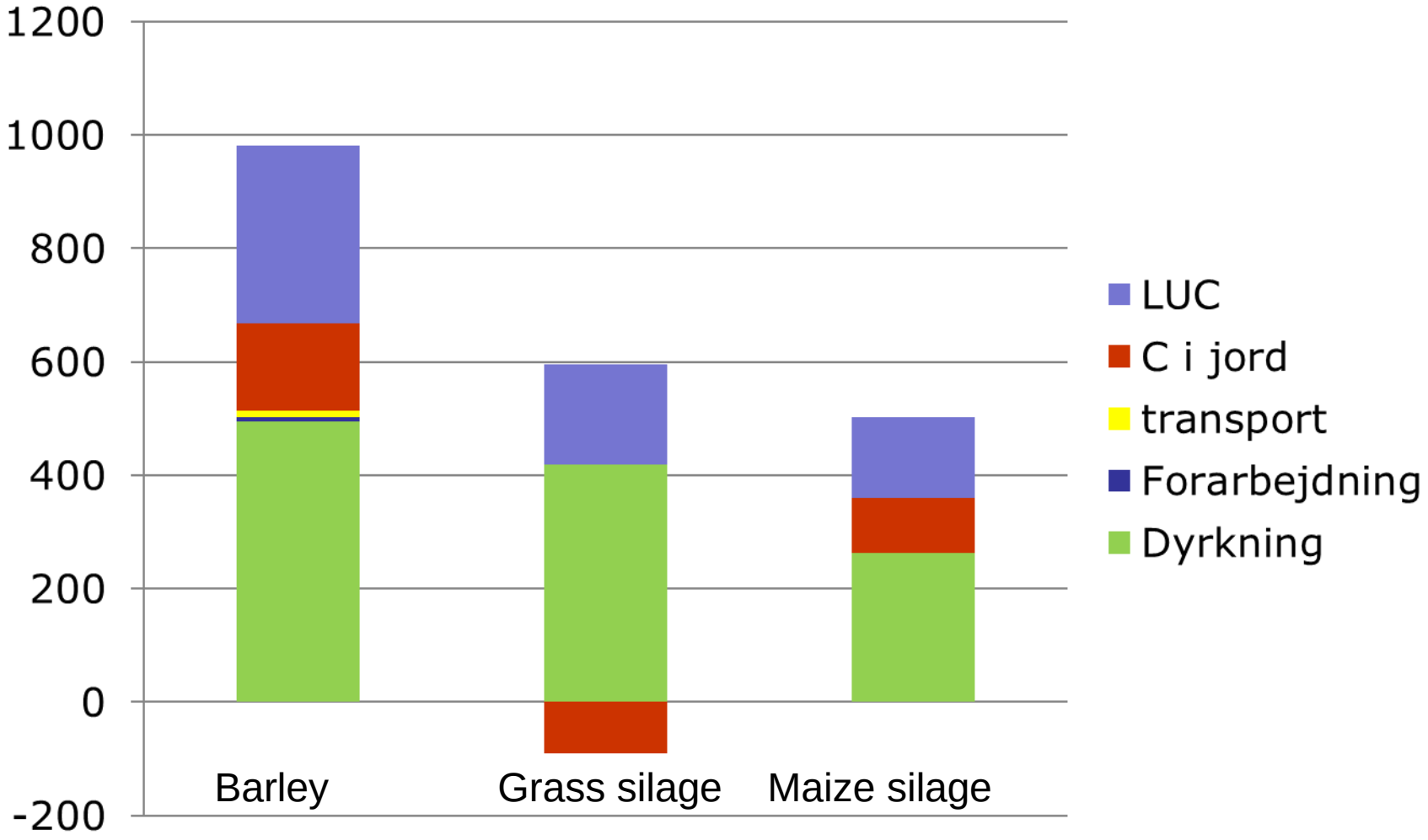


CO_2 eq, % of herd	67	24	9	75	25
CO_2 eq. per kg ECM	0.82			0.86	
CO_2 eq. per kg LWG [1]		6.83			5.08

Note 1) Farm emission allocated by economic value of milk and beef

Riva et al. 2013

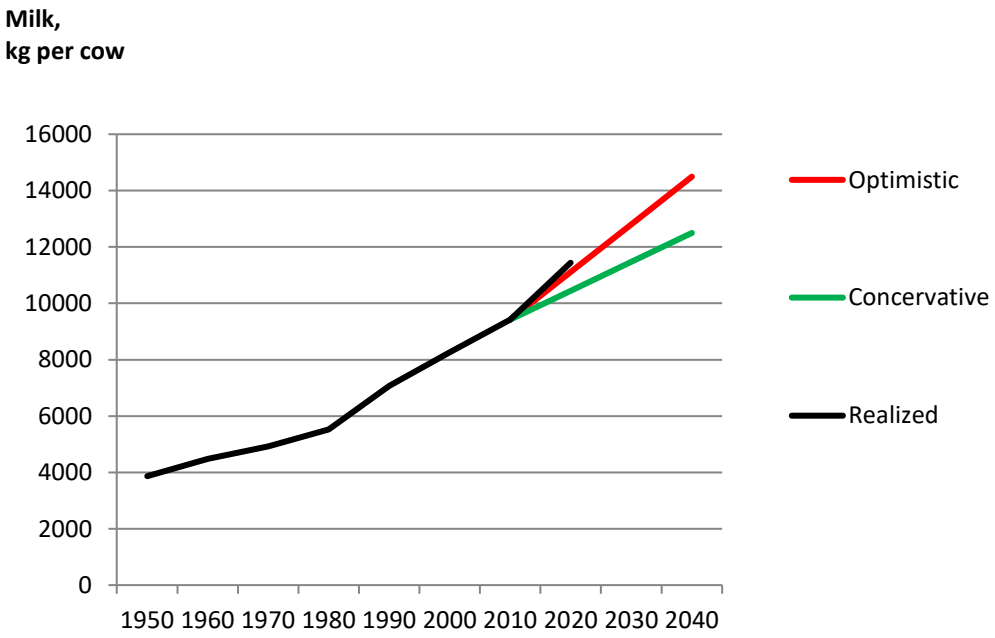
Feed production – CF, g per kg drymatter



Mogensen et al., 2018, DCA rapport 116

Herd production in 2040 ????

Milk recording Holstein in Denmark 1950-2020



Optimistic = reality??

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

Kristensen & Weisbjerg, 2015. DCA rapport 60 https://dcapub.au.dk/djfpublikation/index.asp?action=show&id=1198

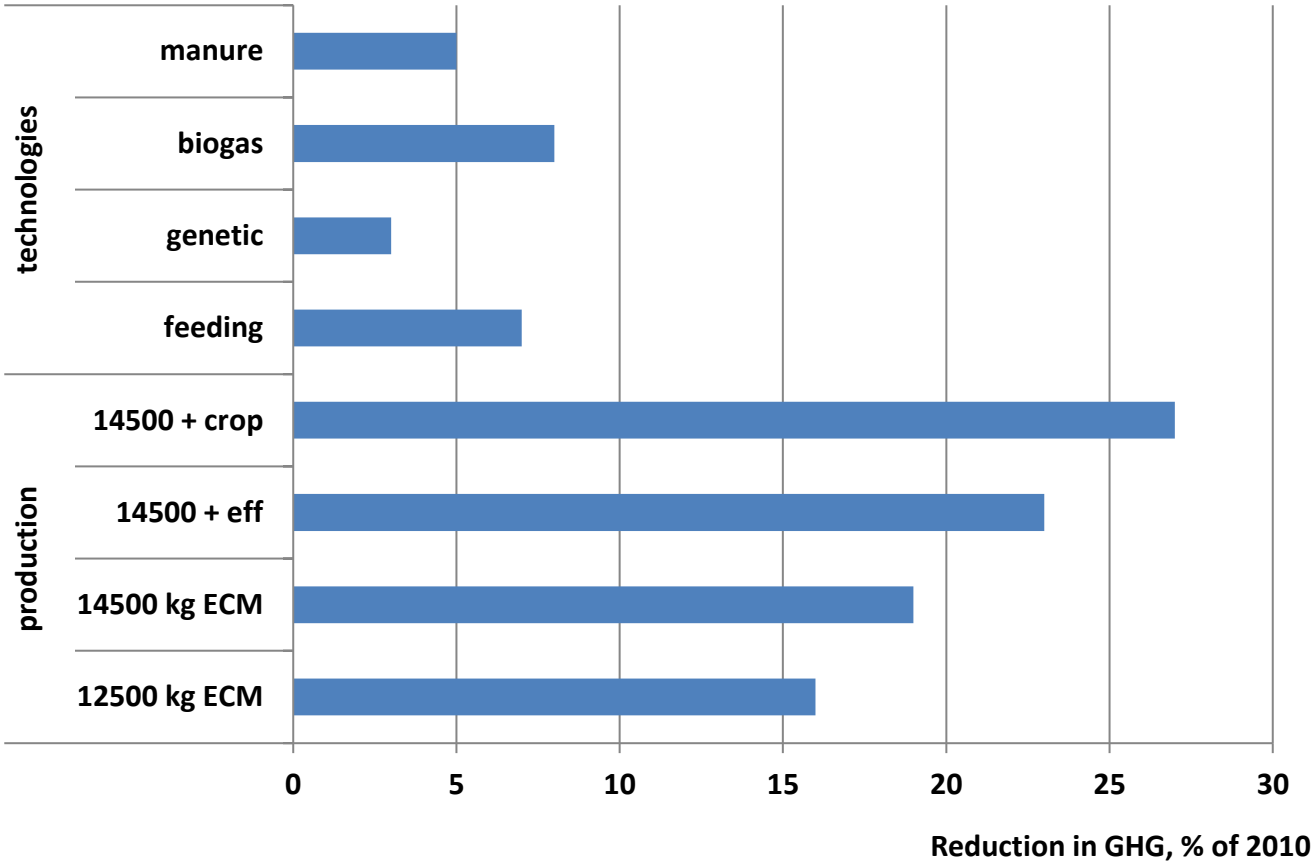
Emission in 2040 – different scenarios for dairy farming

	Present (2010)		I: Conservative	II: Optimis-tic	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

Kristensen & Weisbjerg, 2015. DCA rapport 60

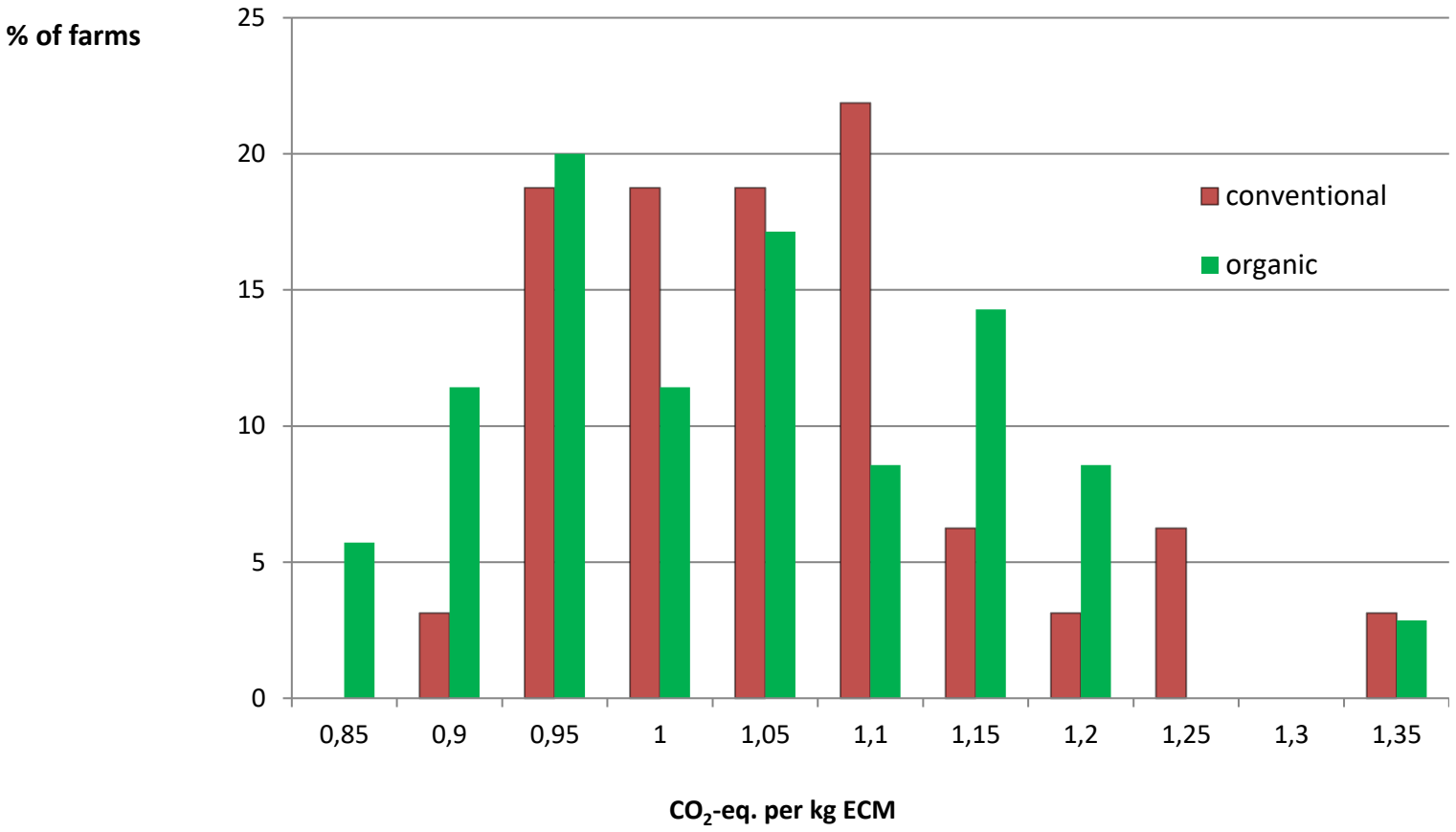
Potential reduction in GHG per kg milk in 2040 compared to 2010
Dairy productivity and different technologies



More milk – less meat per dairy cow - same milk and beef consumption effect on GHG

	Present (2010)		I: Conservative	II: Optimistic
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

Variation in CF between farms with organic and conventional milk production



Kristensen et al, 2011- Livest Prod Sci

Mitigations options – Dairy

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???

Breeding goal trait related to climate impact

- Yield
- Feed efficiency
- Methane production
- Health → longevity
- Beef production

Why beef production?

	Present (2010)	I: Conservative	II: Optimist
Year	2010	2040	
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Meat per 1000 kg ECM	23.4	16.4	14.1
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In case the relative production of milk and meat could have been kept stable, then the CO_2 level would have been 1042 instead of 1153 at a production level of 14.500 – a reduction of 10%

Even with a production of 12.500 kg milk and keeping the relative weights between milk and beef stable then the CO_2 level will only be 1086
- A reduction of 6% compared to the optimistic situation

Interest in climate have increased dramatically
-The climate cows

Moving both people and goods

A partner may be preferred

Producing both milk and beef

A dual purpose cow may be preferred

Improving the beef production from dairy cattle with 10%
(while keeping the same number of cows and the same milk production)
and reducing the amount of beef from suckler cows with the same amount
will
Reduce the CO_2 from Danish cattle production with 205.000 ton of CO_2
Corresponding to 1.8 % of CO_2 emission from Danish Agriculture

Economic comparison: Dairy type vs. Dual-purpose breeds

Average annual income and costs (in Euro per cow) under production conditions in Northern Germany

		Dairy type		Dual-purpose
		German Holstein	German Angler	Red and White Dual Purpose
Income	Milk sales	2926	2766	2325
	Slaughter cows	285	304	367
	Sold calves	66	58	120
	Surplus heifers	106	128	146
	Slaughter heifers	23	21	16
	Total income	**3406**	**3277**	2974
Costs	Feeding cows	1244	1199	1018
	Feeding heifers	355	394	403
	Insemination	43	37	31
	Disease treatments	45	38	36
	Total costs	1687	1668	**1488**
	Net return (€/cow)	**1719**	**1609**	**1486**
	Net return (€/kg ECM)	**0.20**	**0.19**	**0.21**

- Higher income of dairy type breeds
- DP-breeds have clear advantages regarding production costs
- DP-breeds might be more important in the future
  - Increased beef from dairy production systems → Environmental impact
  - DP-breeds as valuable partners for crossbreeding

Schmidtman et al., 2021

NTM – weight factors (11.8.2020)

	Nordic red breeds	Holstein	Jersey
Yield	1.02 / 0.93*	0.90 / 0.81*	0.83 / 0.75*
Growth	0.10	0.08	0.00
Fertility	0.36	0.36	0.26
Birth index	0.11	0.14	0.04
Calving index	0.10	0.14	0.07
Udder health	0.26	0.30	0.44
General health	0.11	0.14	0.14
Claw health	0.07	0.10	0.04
Frame	0.00	0.00	0.00
Feet&Legs	0.06	0.05	0.07
Udder	0.26	0.18	0.15
Milkability	0.11	0.09	0.09
Temperament	0.03	0.04	0.03
Longevity	0.06	0.06	0.09
Youngstock survival	0.19	0.13	0.10
Saved feed	0.13	0.08	0.18

www.nordicebv.info

Correlations between NTM and sub-indices August 2020

	Nordic red breeds	Holstein	Jersey
Yield	0,70	0,69	0,65
Growth	-0,05	0,07	0,14
Fertility	0,20	0,24	0,06
Birth index	0,26	0,18	0,05

www.nordicebv.info

Meaning really small genetic gain for beef traits

But it can be different!

Different genetic gains in breeding programs with substantial differences in

	Energi corrected milk (kg)	Daily meat gain (g) 1)	Number of mastitis treatments
Plan 1	**+ 200**	**+ 3,5 g (0,3)**	**- 0,005**
Plan 2	**+ 125**	**+ 9 g (0,8)**	**- 0,012**
Plan 3	**+27**	**+ 15 g (1,2)**	**- 0,017**

1) Yearly gain in percentage

Our hypothesis is that a co-production of milk and beef is the most efficient from a climate point of view

- Therefore dual purpose breeds will gain interest again, since:
  - These breeds produce more beef per kg of milk produced in the dairy population
  - At a given consumption of beef (given the consumption is larger that the present beef production from dairy populations) the dual purpose breeds can
    - Help reducing the number of suckler cows corresponding to large reductions of climate impact from cattle production
  - Beef*dairy(dual purposes) heifers or steers can handle the majority of nature preservation (biodiversity)

To find the right level of economic weights we needs improved methods for breeding goal definition

- To consider systems effects of dairy breeding life cycle analyses at farm level need to be used
- To avoid double counting the program Simherd can be used (Østergård et al., 2016
  - Used to derive EV in Schmidtman et al., 2021 and others places

Future BG's also needs to consider

- G*E interactions
- Lines for specific productions systems
  - Brito et al., Animal 15 (2021)
  - Britt et al., Animal 15 (2021)
- Lines to be used when systematic crossbreeding will increase
  - Kargo et al., 2022, WCGALP
- Continued focus on health and welfare traits

- EXAMPLE to follow

Ideas for lines

Dairy type

- Higher yielding cluster
- Considering fertility and health
- Kept in intensive housing systems
- Intensive feeding

→High yielding but healthy and fertile dairy breed

Grass type

- Moderate yielding cluster
- Better health and fertility compared to higher yielding cluster
- High longevity
- Kept outside, pasture-based

→Resilient breed suitable for „low-input“ conditions

Dual purpose type

- „Climate friendly“ cluster
- High focus on beef traits (average daily gain, meat quality)
- Economic benefits when milk price is low
- Good functional traits
- Metabolic robustness

→Special emphasis on climate

Overall conclusions

- No production system or type of management is superior

Low carbon emission 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 (milk and Beef) and internal relations at farm level are needed

To coop with this genetically more breeds or lines of breeds (including crossbreeding) will be needed in the future