Dairy in a sustainable diet

A question of balance

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Nordic Dairy Meeting 290614

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Content

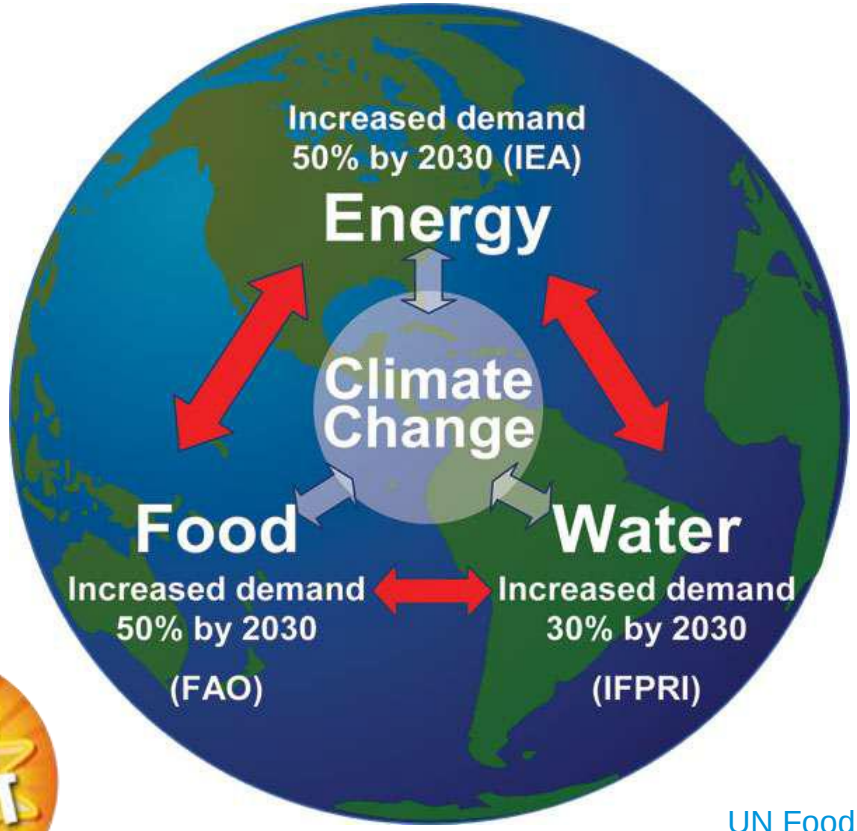
- What is the expected future demand for dairy?
- What is the contribution of dairy in the diet?
- What is the contribution of dairy to global warming and do cows compete with human food?
- Is dairy a solution for food and nutrition security?

Nutrient security

Environmental footprint

Affordability

Food security: A massive challenge



UN Food & Agriculture Organisation (FAO)
Int Energy Agency (IEA)
Int Food Policy Research

Developments in Dutch Dairy farming

	1910	1960	1983	2010	2020
Number of dairy cows (x million)	1,1	1,3	2,3	1,4	1,4
Milk production (billion kg/year)	2,7	5,9	13,1	11,6	14,0

Number of farms (x thousand)	193	194	60	20	10
Cows per farm	5,7	7,7	42	75	140
% Robots	0	0	0	12	35

100 years of breeding

MRIJ

1914

Friesian-Holland

Holstein-Friesian

2014

Groninger Blaarkop

100 years of breeding

	1910	1960	1983	1993	2010	2020
Milk yield per cow (kg/year)	2.500*	4.400	5.600	7.200	8.300	(10.000)
Fat %	(3.20)	3.85	4.12	4.46	4.38	↘
Protein %		3.34	3.38	3.49	3.53	↗
Fat/Protein		1.15	1.21	1.28	1.24	↓

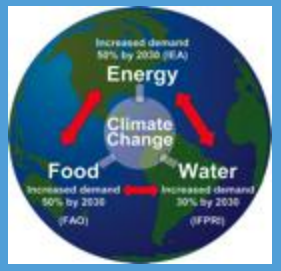
Sources: *de Bie 2001, Vroeger en NU
CRV 1960-2010, year statistics

World food demand in 2050

Population growth (+2 billion) and rise of income in emerging markets increases the demand for food by 50%

Milk from 720 billion kg to 1077 kg in 2050

Source: FAO 2012



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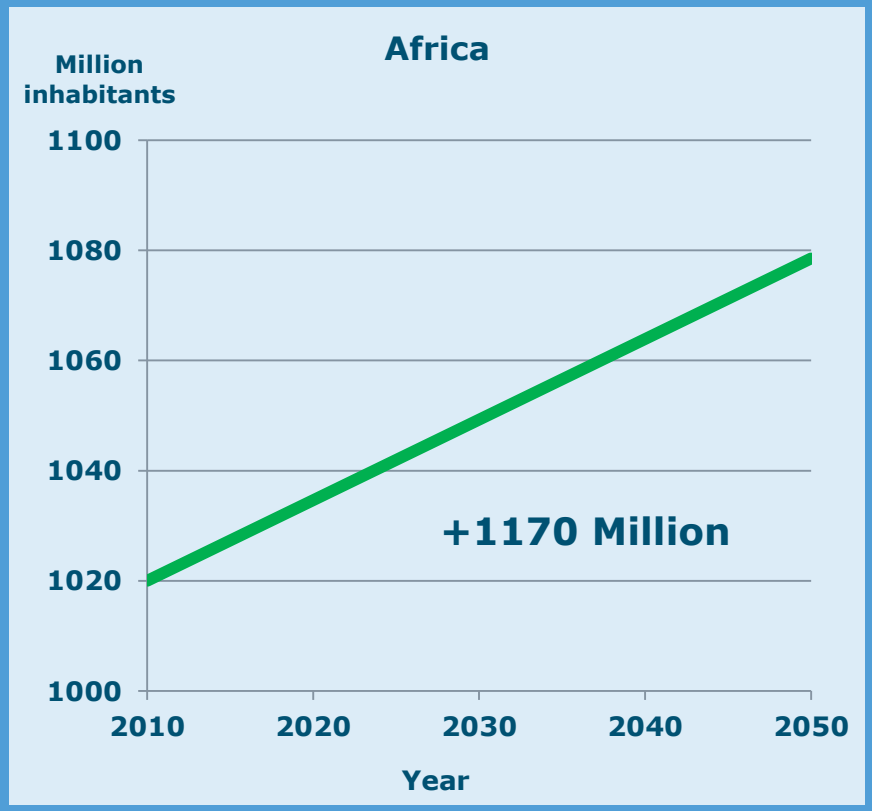
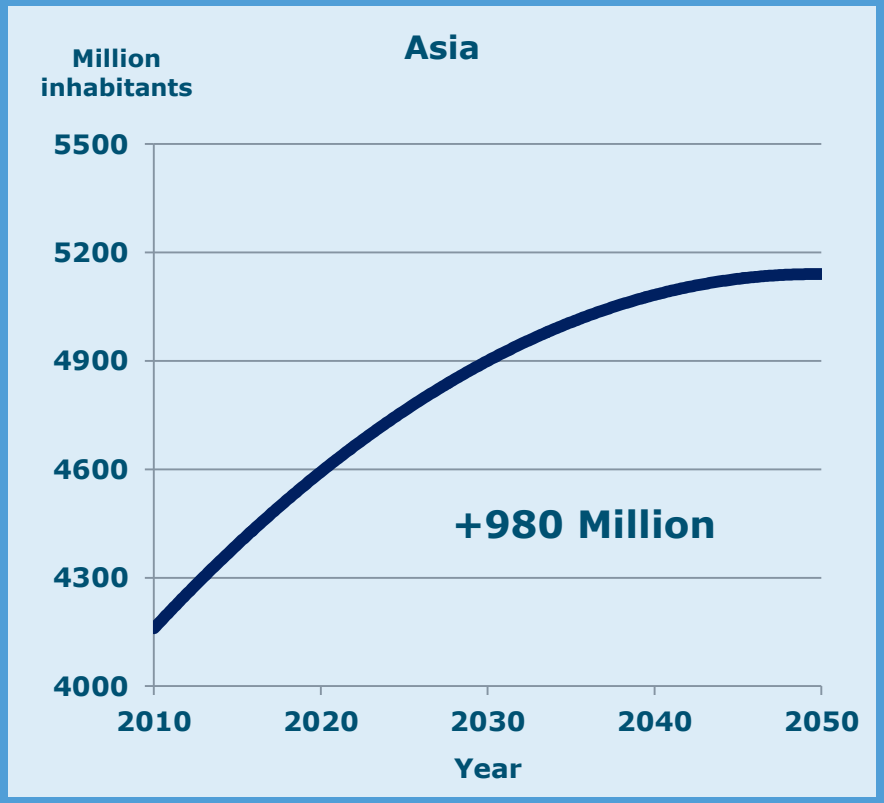
In 2050 there are more than 2 billion people extra to feed; 90% will life in Africa and Asia





Source: UN 2010

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The devil is local

The good news

"Based on our assessment of world agricultural resources, it seems that at the global level there should be no major constraints to increasing agricultural produce by the amounts required to satisfy the additional demand generated by population and income growth to 2050"

(FAO 2012, World Agriculture Towards 2030/2050)

The bad news

In 2050 still more than 350 million people will be undernourished *(FAO 2012)*

Without successful interventions it is estimated that more than 50% of the adults will be obese in the UK *(Foresight 2007)*

Milk production towards 2050

The larger part of the "new" milk will be produced and consumed in developing countries

	Milk production (billion kg)		Increase (billion kg)	Growth rate (%/year)
	2006	2050		
World	664	1077	413	1.1
Developing countries	305	662	357	1.8
- Sub-Saharan Africa	22	59	37	2.3
- North East- North Africa	36	76	40	1.7
- Latin America & Caribbean	71	125	54	1.3
- South Asia	135	319	184	2.0
- East Asia	42	82	40	1.5
Developed countries	358	412	54	0.3

Source: FAO 2011

World dairy sector is highly fragmented and diversified in all parts of the chain.

- There are about 145 million "dairy" farms with a world average of 3 cows per farm.
- Milk production per cow ranges considerably with a world average of 2000 kg/year
- Only 62% of the milk is delivered to processors
- The 20 world leading dairy companies process not more than 24% of all milk
- Average per capita milk consumption is 107 kg/year: 202 kg in developed countries and 52 kg in developing countries

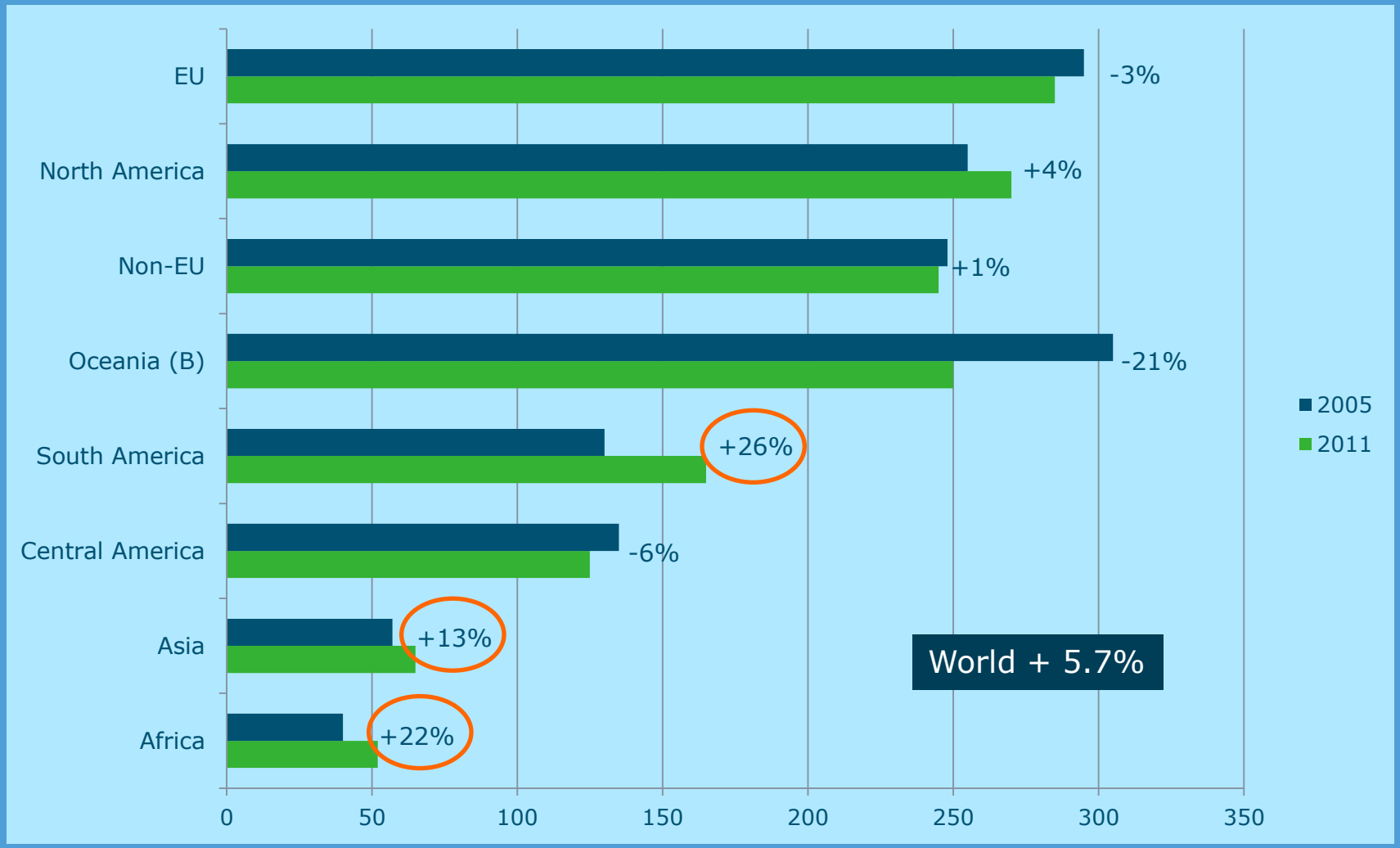
Sources: IFCN 2012, FAO 2012

Milk intake by the 20 largest dairy companies.

Rank	Company	Country	Milk Intake (billion kg)	Share % of world Production
1	Fonterra	New Zealand	21,6	3,0
2	Dairy Farmers of America	USA	17,1	2,4
3	Lactalis	France	15,0	2,1
4	Nestle	Switzerland	14,9	2,1
5	Dean Foods	USA	12,0	1,7
6	Arla Foods	Denmark	12,0	1,7
7	FrieslandCampina	Netherlands	10,1	1,4
8	Danone	France	8,2	1,1
9	Kraft Foods	USA	7,8	1,1
10	DMK	Germany	6,9	1,0
11	Saputo	Canada	6,3	0,9
12	Glanbia	Ireland	6,0	0,8
13	Land O' Lakes	USA	5,9	0,8
14	California Dairies	USA	4,6	0,6
15	Müller	Germany	4,4	0,6
16	Sodiaal	France	4,1	0,6
17	Mengniu	China	4,1	0,6
18	GCMMF (Amul)	India	4,0	0,6
19	Yili	China	4,0	0,6
20	Bongrain	France	3,6	0,5
Sum of top 20			172,8	24,0

Source: Hemme, IFCN 2012

Change in dairy consumption by region



Source: IDF-WDS 2012

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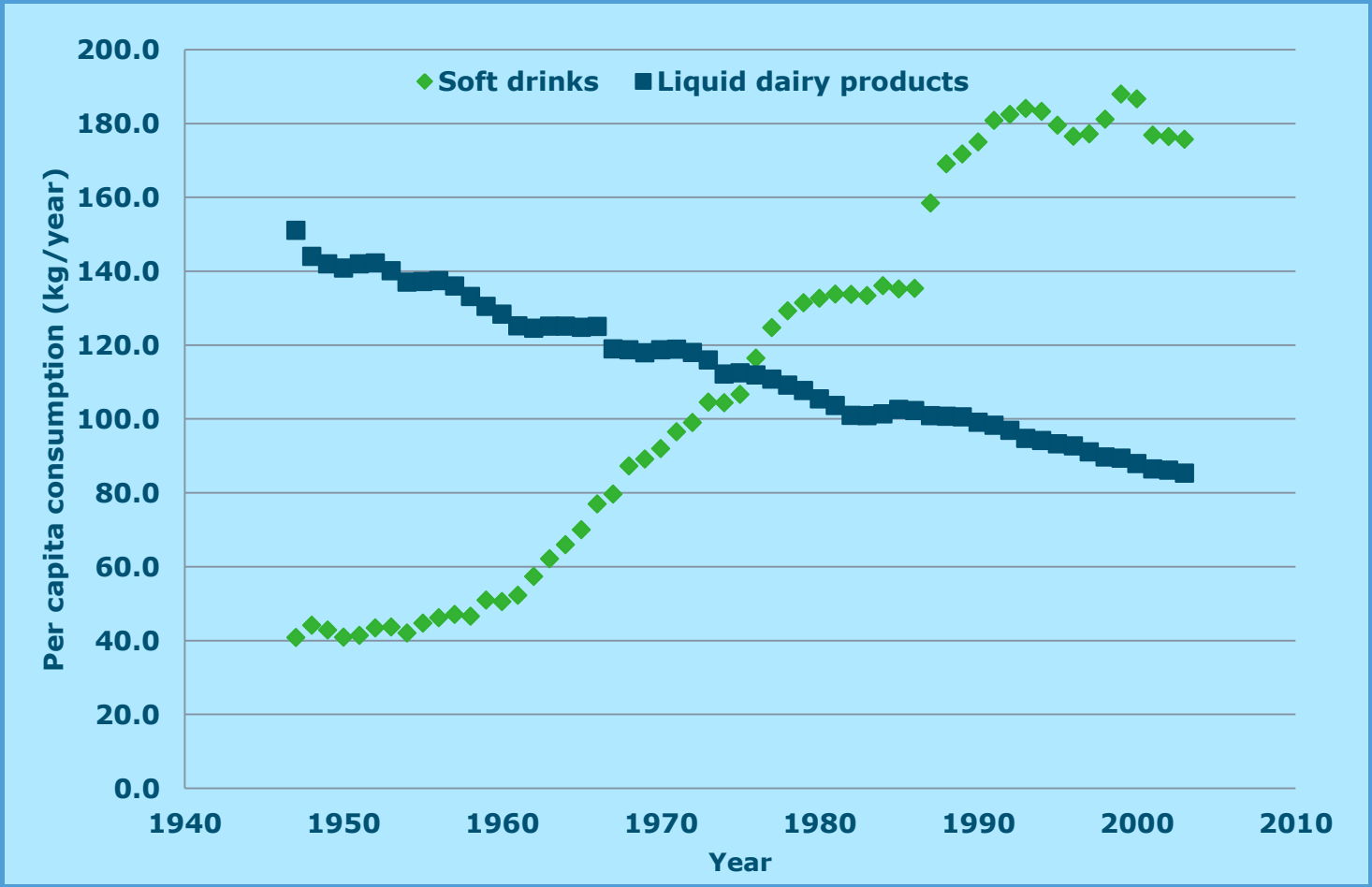
In most developed countries liquid milk is steadily losing position in the drinks category



Source: USDA 2013

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Nutrient security

Environmental footprint

Affordability

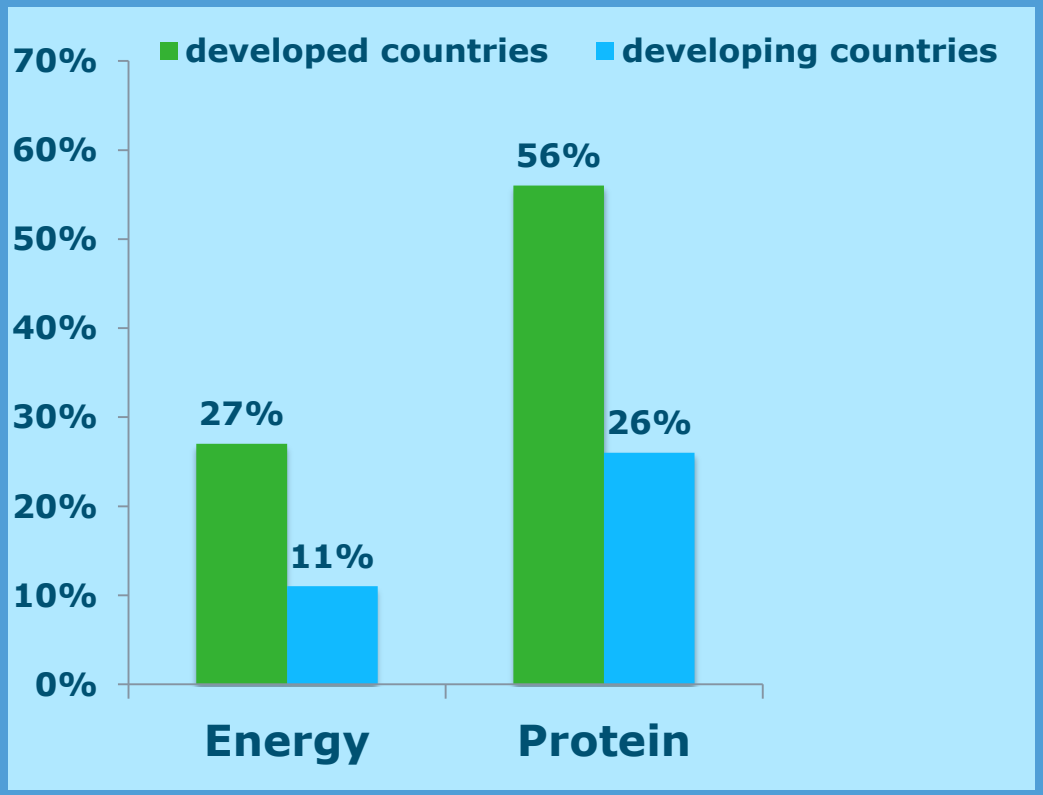
Animal products are important for food and nutrition security

- On global basis livestock products provide 17% of the energy and 35% of the protein in the human diet

- But, large variation per region
  - More animal products in the diet of low intake countries leads to an improved growth, cognitive development and health
  - In high intake countries animal products also contribute to adverse effects, mainly caused by excessive energy intake

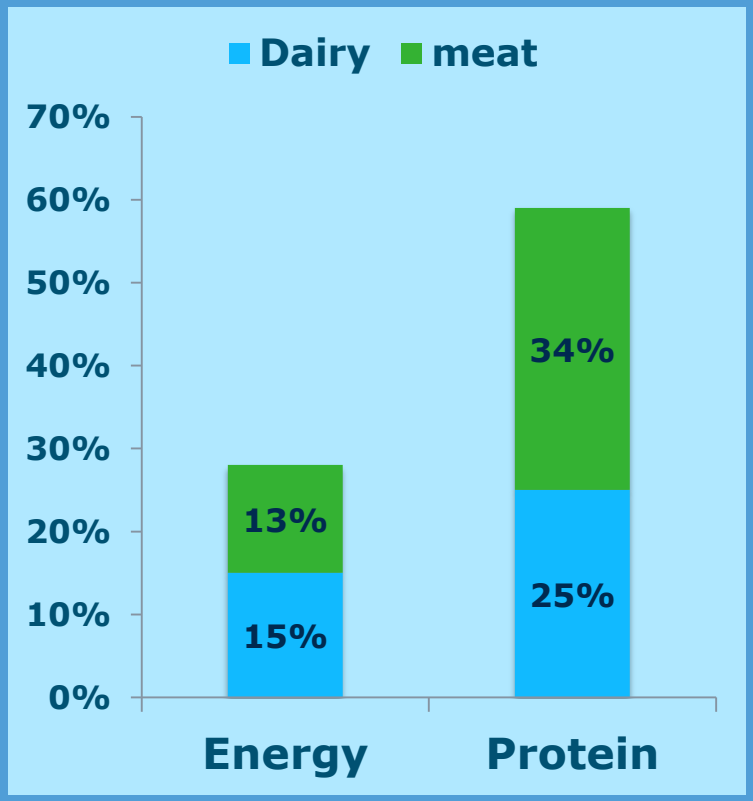
Animal products are an important source of protein

Energy and protein supply by animal products



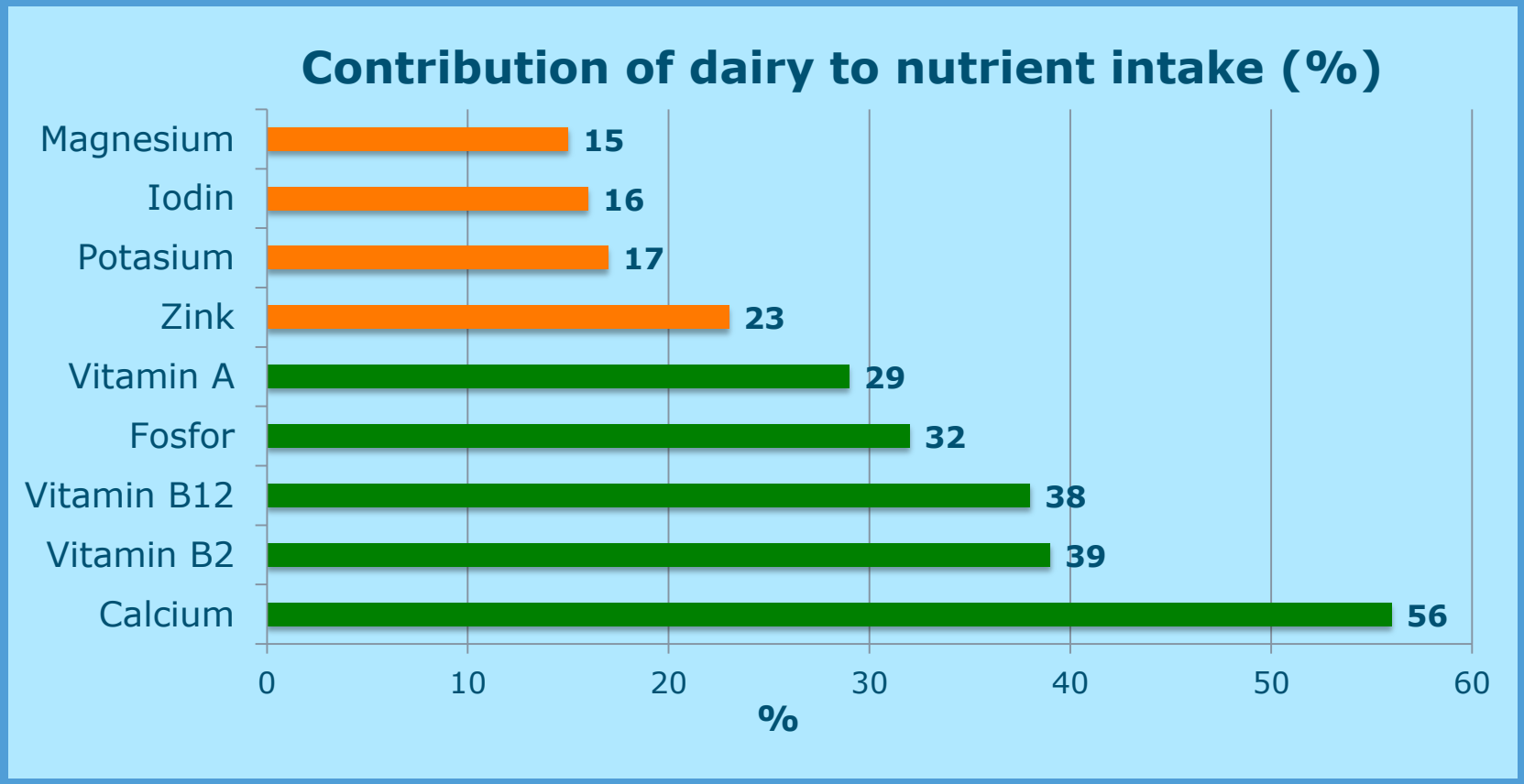
Source: FAO, 2011

Dairy and meat products in the Dutch diet



Source: Voedingscentrum, VCP 2003

Contribution of dairy to the intake of nutrients in NL (% of total)



Dairy ranked first Dairy ranked second

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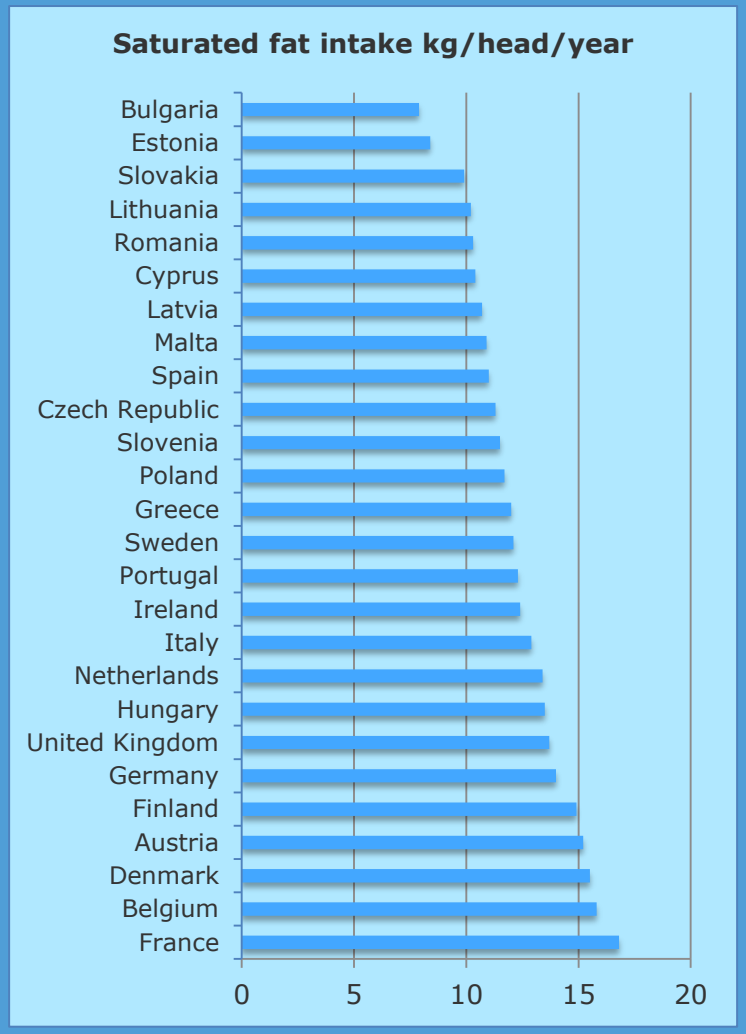
Sources: VCP 2007-2010

Is the scientific debate about adverse effects of saturated fat in the diet ending?

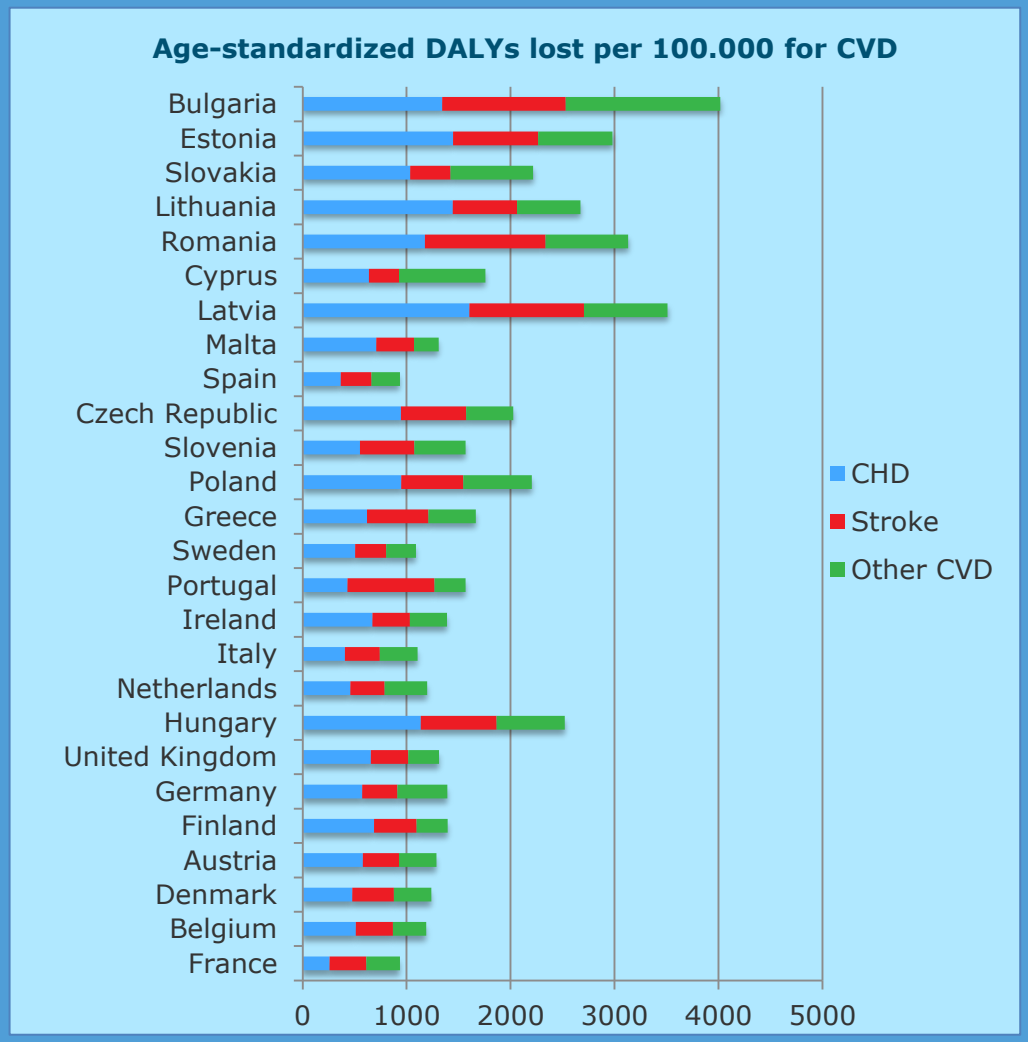
The relationship between high-fat dairy consumption and obesity, cardiovascular, and metabolic disease. (Kratz et al, Eur J Nutr. (2013) 52:1-24)

"The observational evidence does not support the hypothesis that dairy fat or high-fat dairy foods contribute to obesity or cardiometabolic risk, and suggests that high-fat dairy consumption within typical dietary patterns is inversely associated with obesity risk."

Also the EU statistics do not support an adverse association between saturated fat intake and CVD



Source: Adapted from The protein puzzle, PBL, 2011



Source: European cardiovascular disease statistics, 2008 edition

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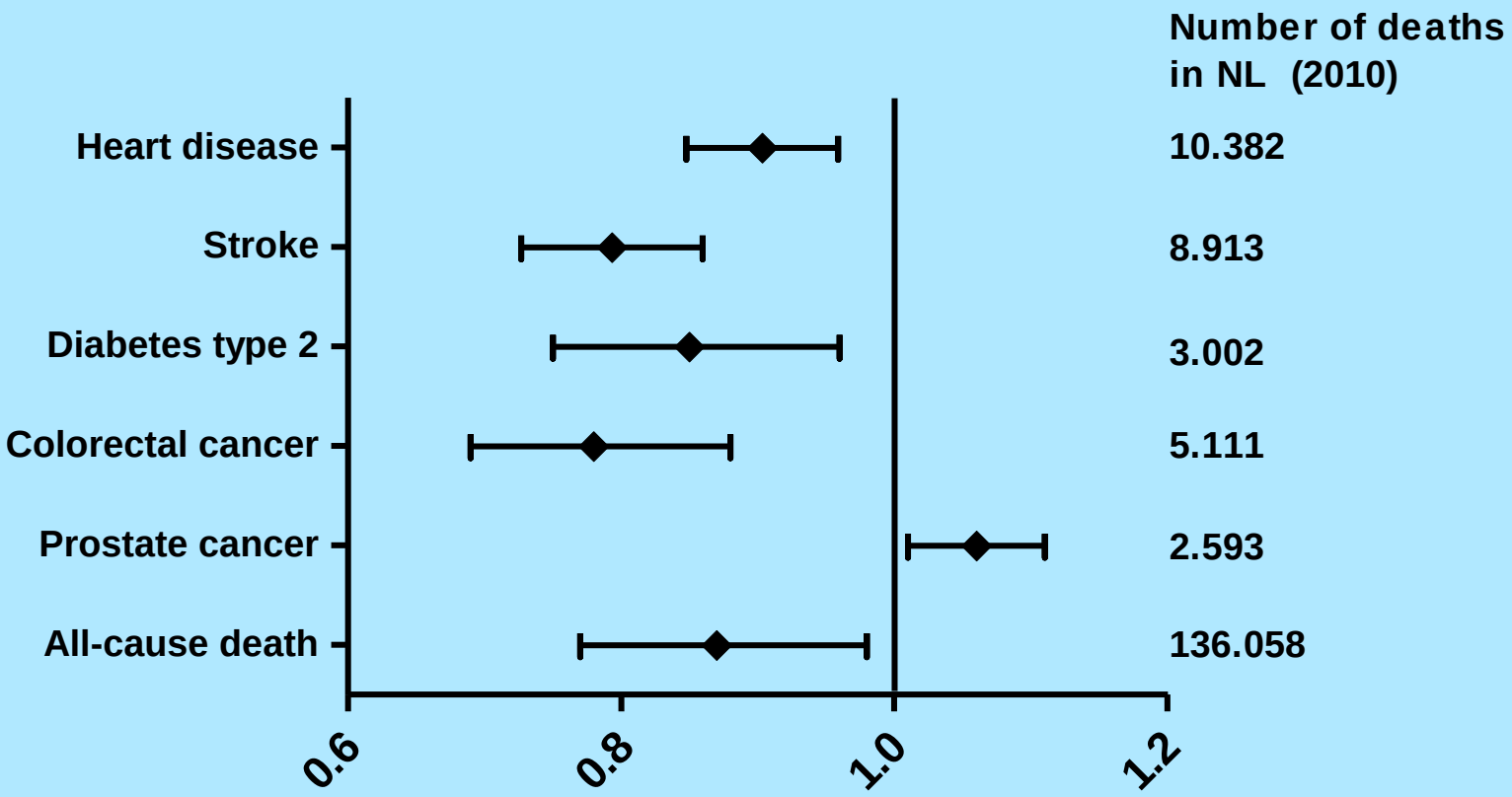
Risk of chronic diseases: high versus low dairy intake



Source: Elwood 2008/2010
Source: CBS 2010

….and, furthermore, dairy seems to be good for your brain

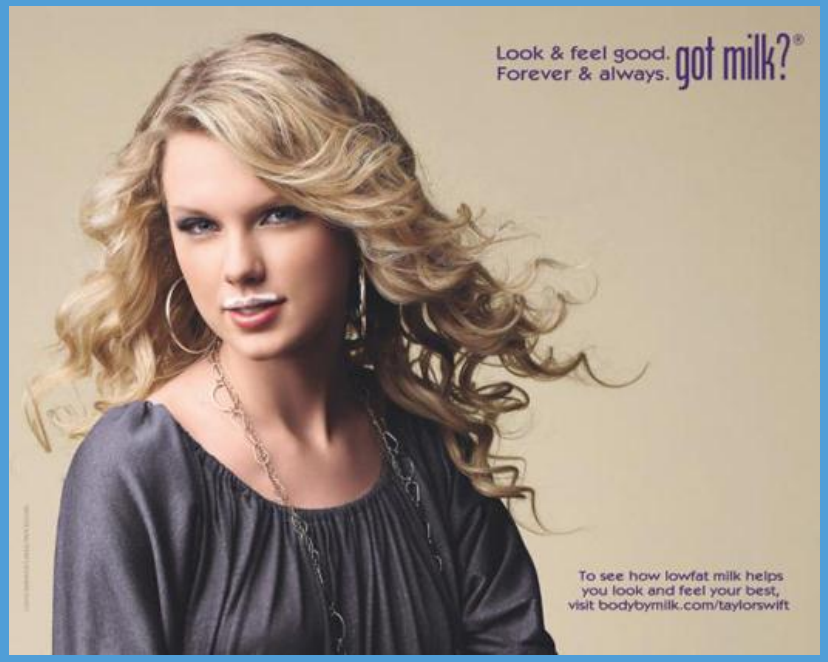
Relation between dairy food intake and cognitive function: The Maine-Syracuse Longitudinal Study

G.E. Crichton[a,], M.F. Elias[b, c], G.A. Dore[b], M.A. Robbins[b, c]

International Dairy Journal, 22, 1, 15-21, 2012

"Frequent dairy food intake is associated with better cognitive performance but underlying causal mechanisms are still to be determined".

Do you drink milk because you're smart or are you smart because you drink milk ?



Effect of adequate dairy consumption on healthcare costs

If Americans consumed more dairy, healthcare costs in the US would decline drastically. *(McCarron & Heaney in American Journal of Hypertension, 2004)*

Savings over a period of 5 years

Obesity	37,5
Hypertension	70
Stroke	20
Coronary artery disease	16,5
Type 2 diabetes	37,5
Osteoporosis	14
Nephrolithiasis	2,5
Pregnancy outcomes	15
Colorectal cancer	0,75
Total	**$ 209 billion**

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Affordability

The Perception:
Animal foods = inefficient use of resources

"The production of meat and dairy forms the biggest food related burden. This is because of the inefficient production: the production of a single kilo of meat protein requires six kilos of vegetable protein"*

**Guidelines for a healthy diet: the ecological perspective*. Health Council of The Netherlands. 2011

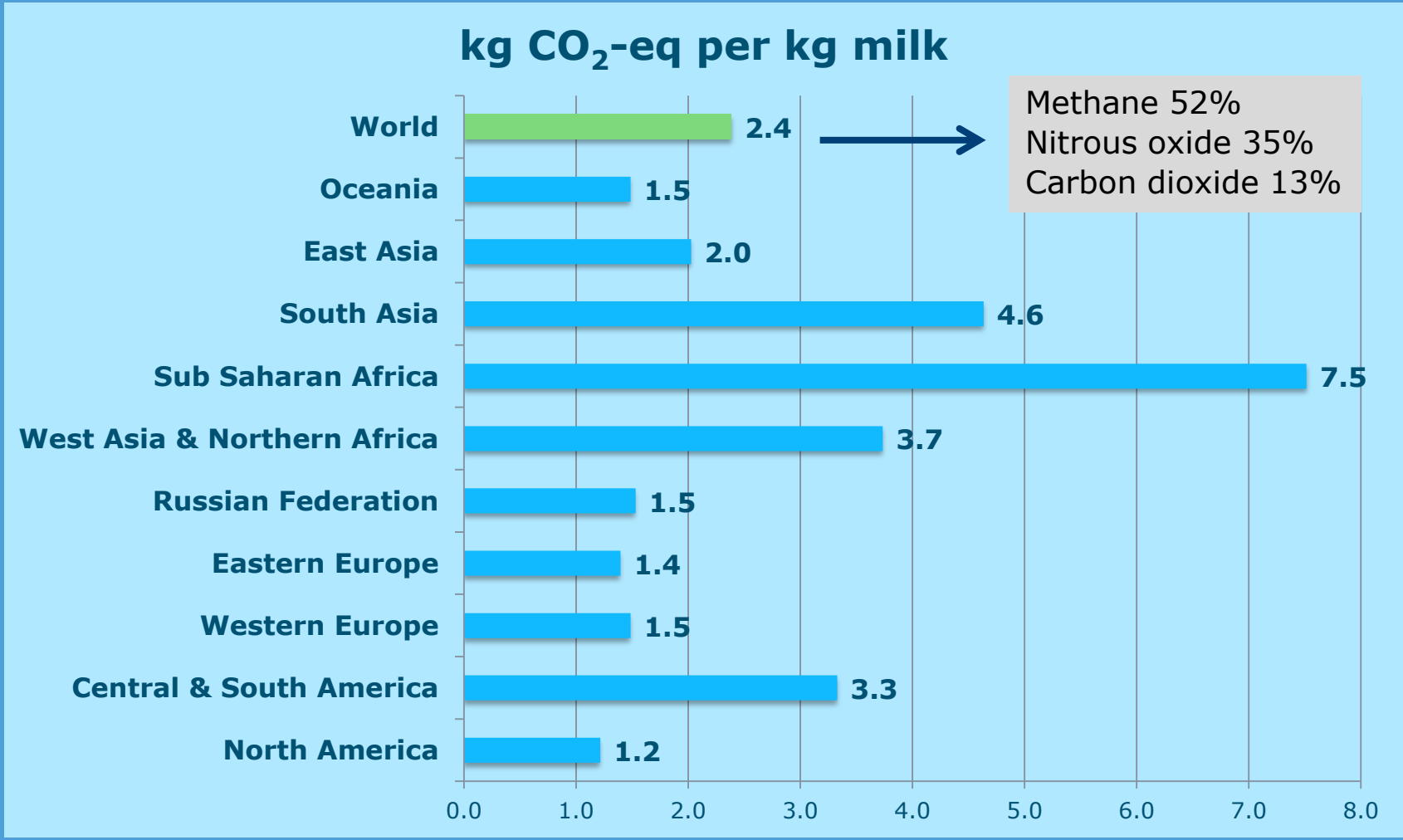
Dairy and global warming

FAO 2013:

- *The contribution of livestock production systems to total emissions of GHG is estimated at 14,5%*

- *The overall contribution of the global milk production, processing and transportation to total emissions of GHG is estimated at 2,9 %*

Greenhouse gas emission per kg milk (cradle to retail)



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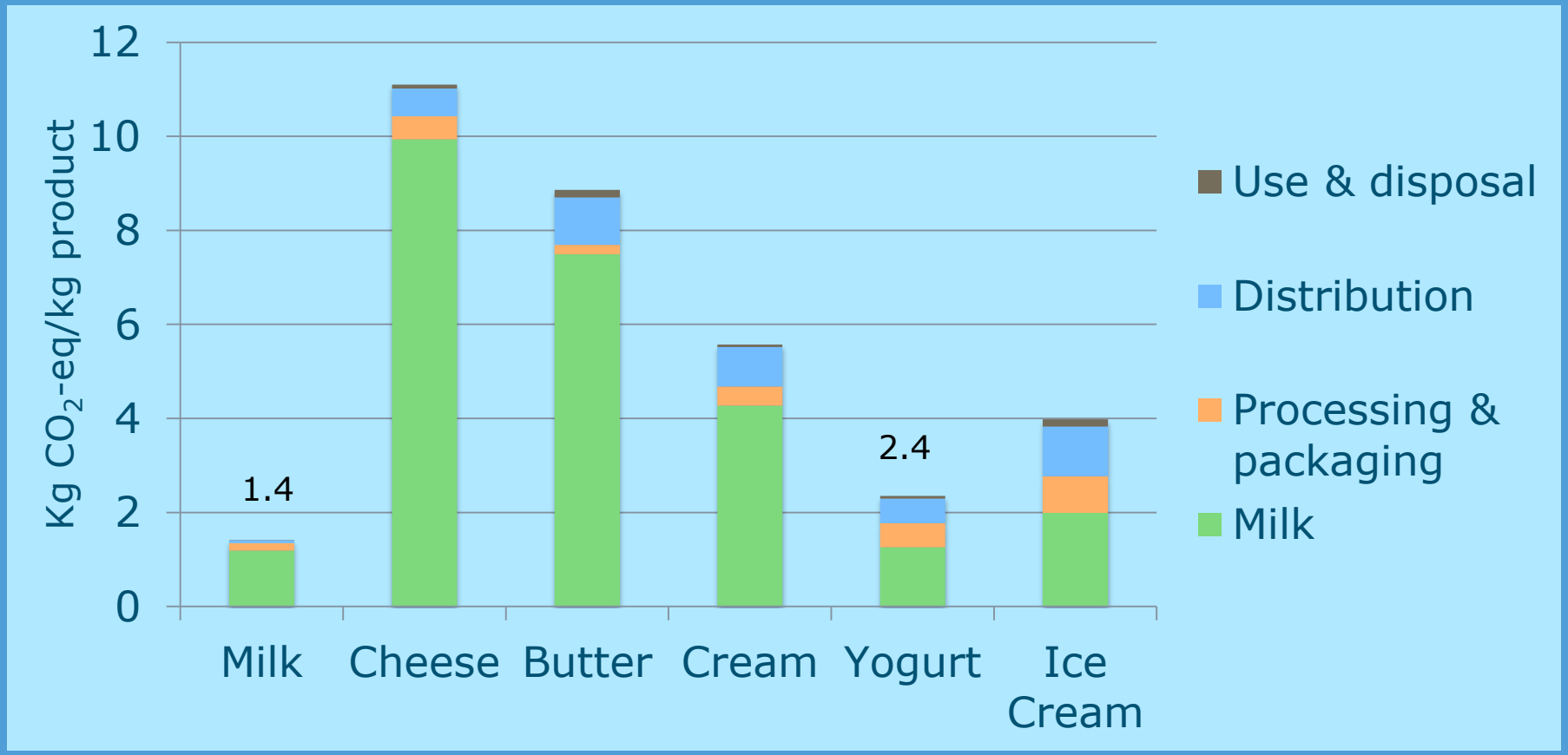
Source: FAO 2010

GHG emissions of dairy products (cradle-to-grave)



Sheane et al. 2011

http://www.scotland.gov.uk/Resource/Doc/342351/0113918.pdf

Fossil energy use and GHG's in the Dutch dairy chain

Fossil energy use			
34%	12%	31%	23%
			
Feed + Fertilizer ➢Energy ➢N_2O emission	Farm ➢Rumen ➢Soil denitrification ➢Energy	Processing ➢Energy	Consumer + Waste ➢Energy
18%	68%	6%	8%
Green house gas emission			

Source: CLM 2008, Zuivelketen en klimaat

Does the feed of a dairy cow compete with human food?

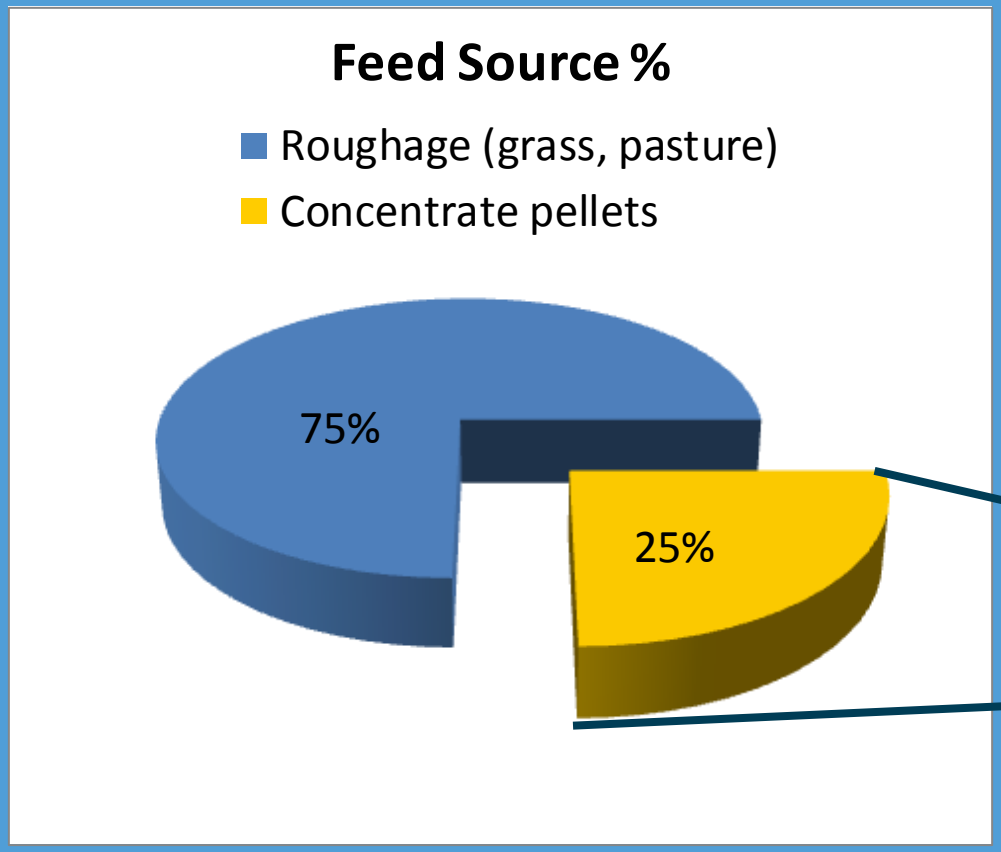
The average feed ration for a Dutch cow

Feed ration per cow per year	Dry Matter kg	Energy MJ	Protein kg	Human-edible fraction
Concentrates	1616	29901	299	≈ 0,25
Fresh grass (grazing)	1301	24069	260	0
Grass silage	1818	33624	295	0
Maize silage	1563	28911	115	0
Wet byproducts[1]	200	3695	27	0
Total	6497	**120199**	**996**	≈ 0,06
Milk Yield (kg milk)	7779	**24890**	**271**	

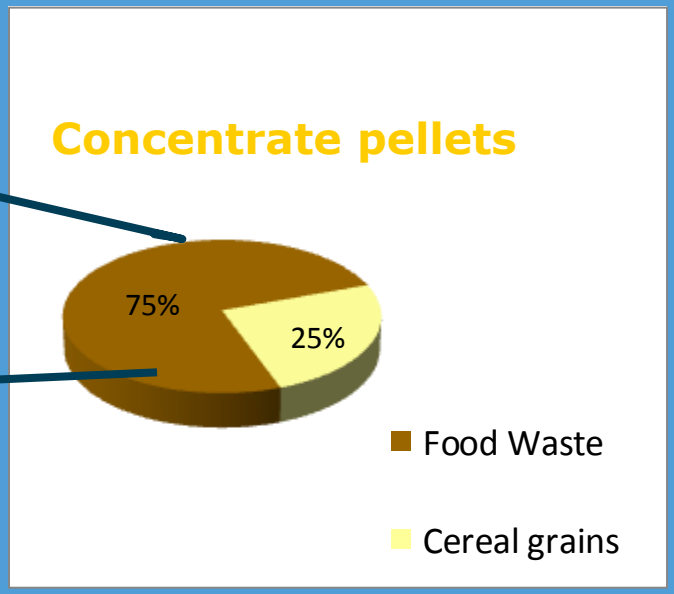
[1]Mainly brewers grains, potato byproducts, beet pulp

Source: Bannink et al. 2011
Dijkstra 2012

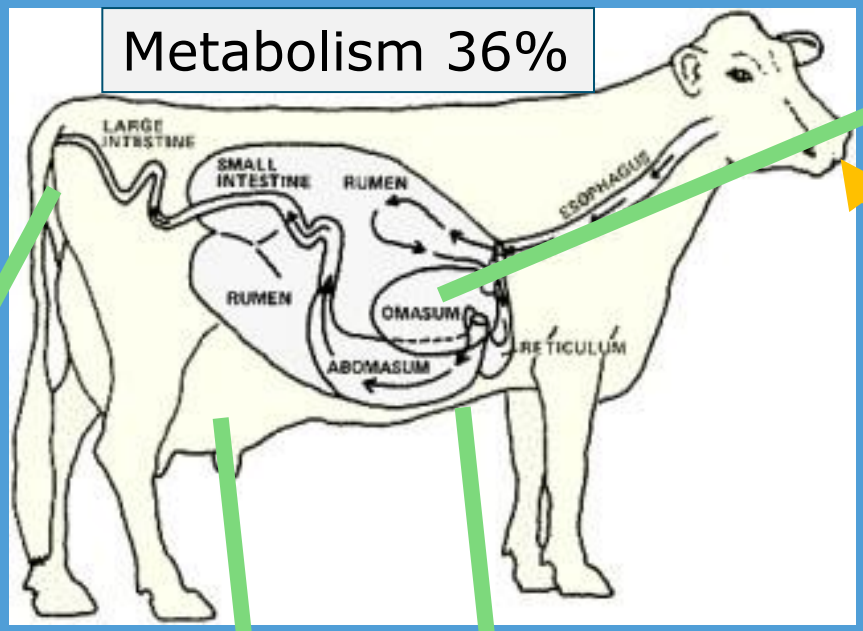
Does animal feed compete with human food?



Less than 10 % of the cow's feed is edible for humans



Energy conversion by dairy cows



Metabolism 36%

Methane 6%

Energy 120 GJ

Manure 35%

Milk 21%

Meat 2%

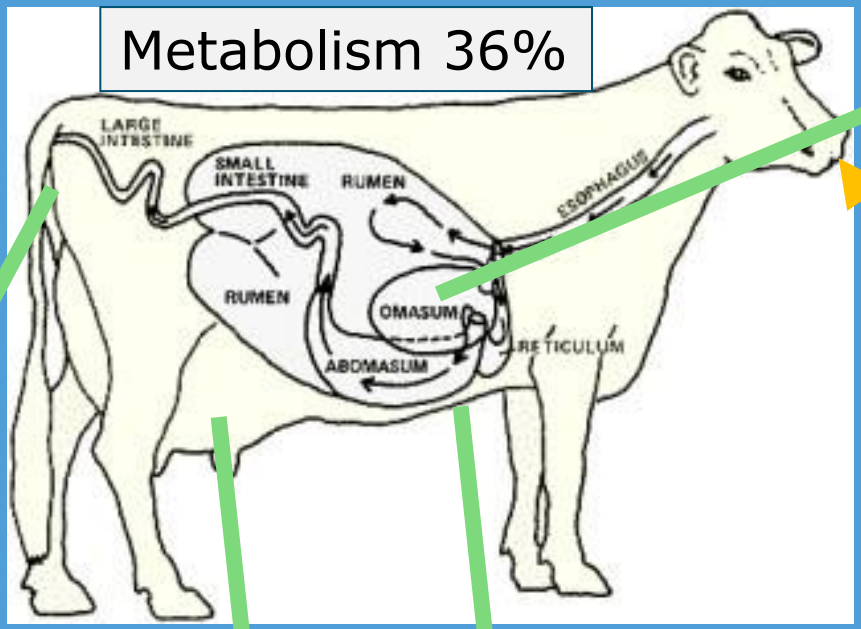
Human edible fraction is 6%

Data from: Dijkstra 2013

Energy and protein (nitrogen) conversion by dairy cows

Methane 6%

Metabolism 36%



Energy 120 GJ

Protein 996 kg

Human edible fraction is 6%

Manure 35%

Manure 71%

Milk 21%

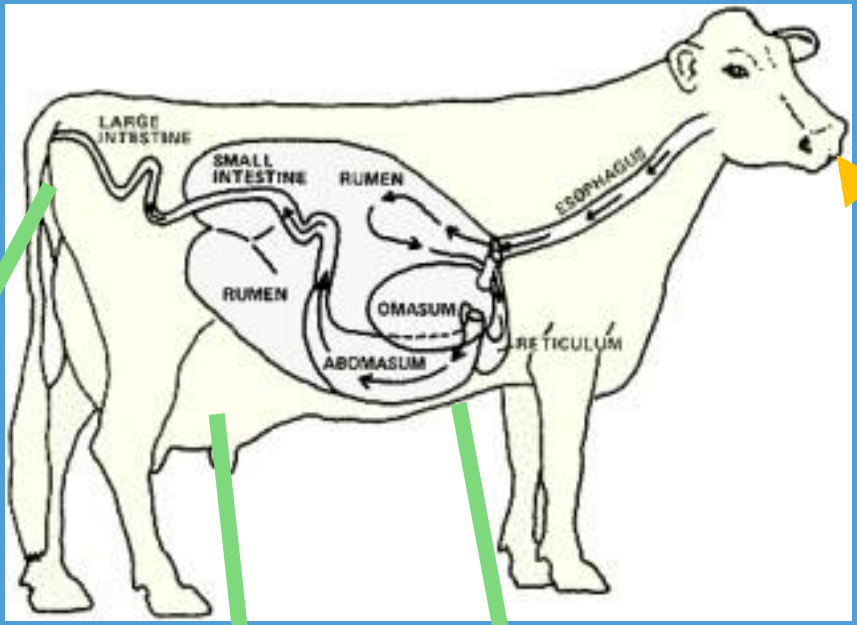
Milk 27%

Meat 2%

Meat 2%

Data from: Dijkstra 2013

Protein (nitrogen) conversion by dairy cows



Human edible fraction is 6%

Protein 996 kg

Manure 71%

Milk 27%

Meat 2%

Milk 438%

Human edible conversion rate

Data from: Dijkstra 2013

Conversion rates for energy and protein

		Conversion rates milk output / feed input
Total	Energy	21%
	Protein	27%
Human-edible	Energy	357%
	Protein	438%

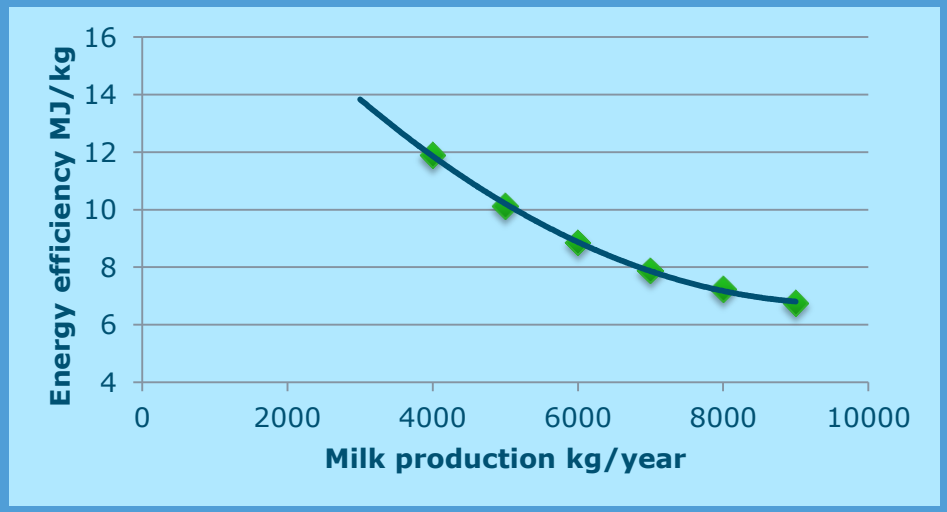
Energy and protein efficiency depends on farming system

		Conversion rates: milk output / feed input	
		Kenya*	NL**
Total	Energy	7%	21%
	Protein	9%	27%
Human-edible	Energy	(∞)	357%
	Protein	(∞)	438%

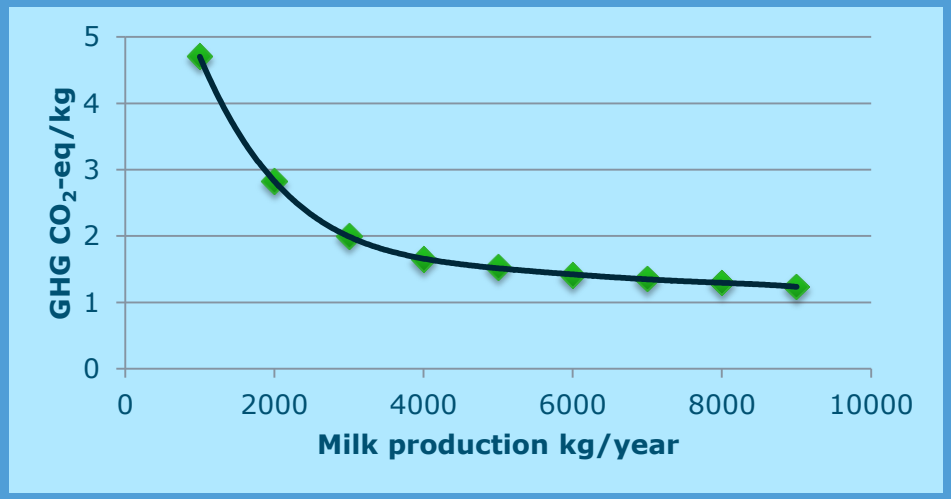
*Source: CAST 1999
**Source: Dijkstra 2013

Increase in productivity improves resource efficiency and reduces GHG emission

- The global average milk yield per cow is less than 3000 kg/year
- Good breeding and feeding increases milk yield, improves resource efficiency and reduces GHG per kg of milk.



Source: Thomas, 2004



Source: Gerber et al, 2011

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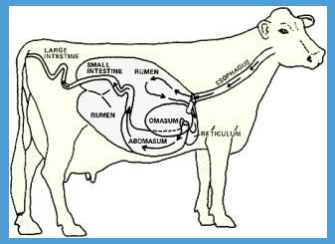
And protein quality counts

The quality of the input proteins is less than that of the output proteins

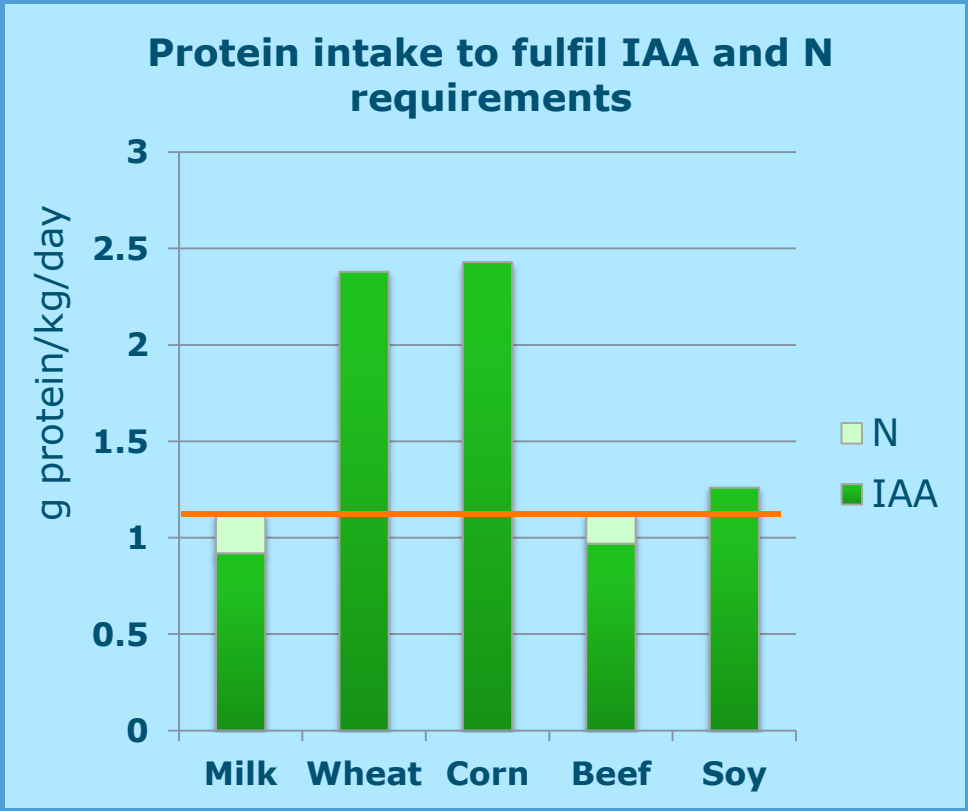
Cows upgrade inferior feed proteins to high quality food proteins. Even the nitrogen from urea is utilized by the rumen microbes and ultimately converted to milk protein



Protein quality counts in the resource efficiency equation

Calculation based on:

- Protein requirement 1.12 g/kg/day
- Reference IAA scoring pattern for age category 0.5 - 3 years



Data sources: FAO (2013)
Schaafsma (2000)

Effective mitigation strategies

- Increased productivity of the cow => less energy and protein intake per kg milk and less GHG per kg milk.
- Reducing the number of cows => less culling through improved cow health
- Capturing the potential energy at the farm => towards a fossil energy free dairy chain
- Reduction of losses and waste
- Optimize diets with respect to nutrient adequacy and minimum environmental impact

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How to balance nutritional benefits against ecological impact?

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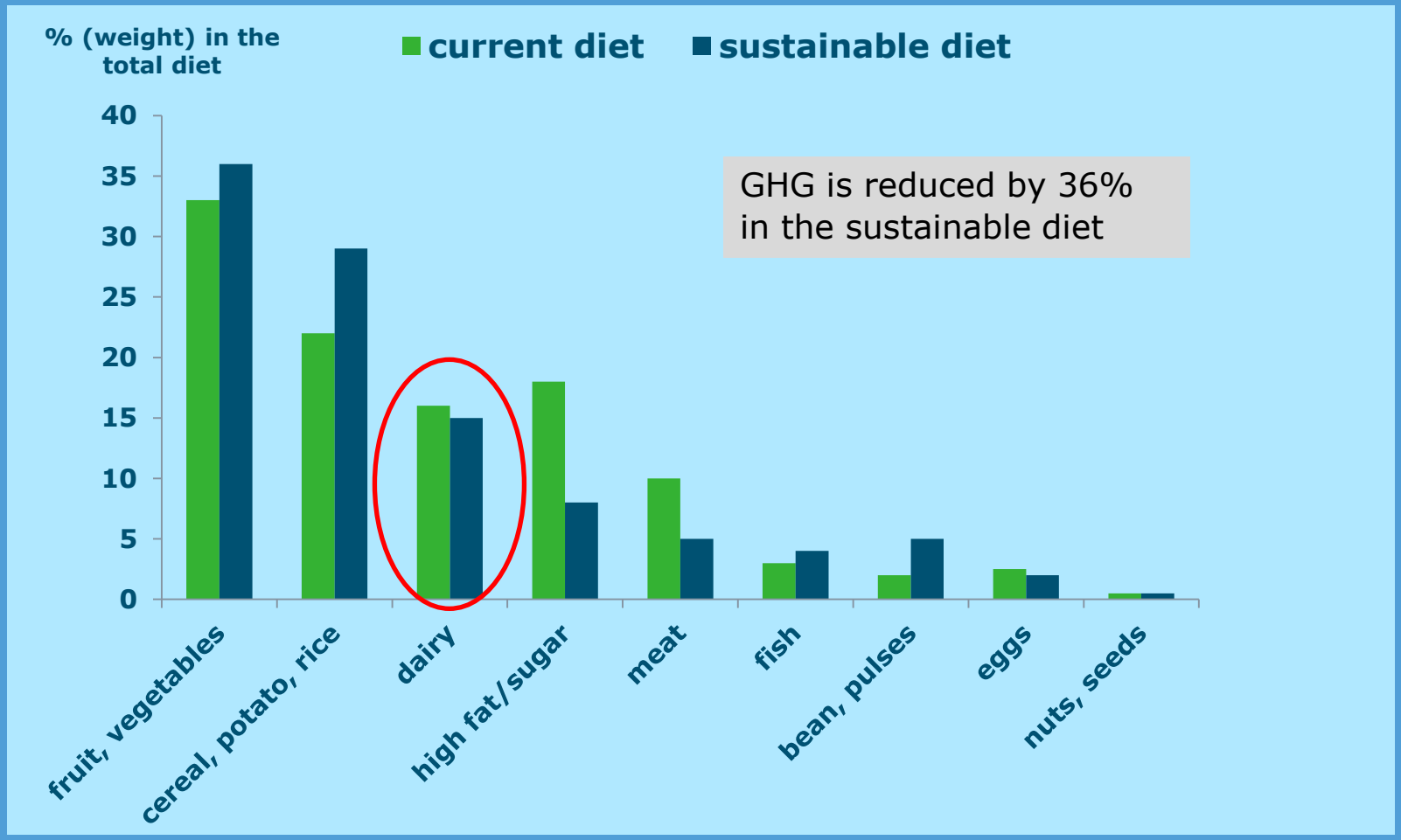
Nutrient density to climate impact index

	Nutrient Density	GHG g CO_2-eq per 100g	NDCI index
Milk	53,8	99	0,54
Orange juice	17,2	61	0,28
Soy drink	7,6	30	0,25
Soft drink	0	109	0

NDCI index: Nutrient Density / GHG emission

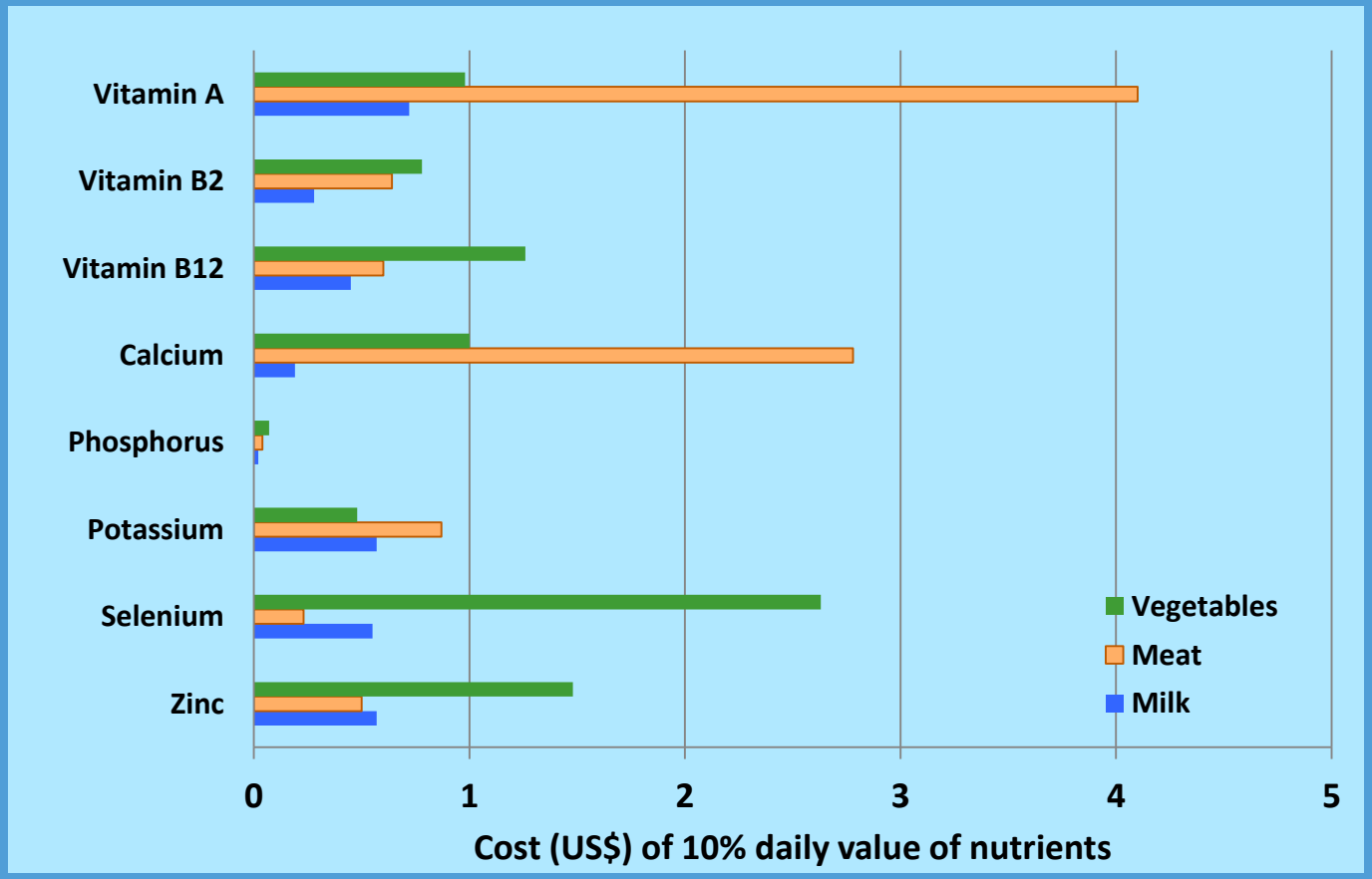
Source: Smedman et al, 2010

Modeling nutrient adequacy and greenhouse gas emission



Source: Macdiarmid et al, 2011

Affordability: for several important nutrients dairy is the cheapest source



Source: Drewnowski 2011

Conclusions

- The world milk demand will grow by more than 50% towards 2050, and most of the "new" milk is produced and consumed in developing countries.
- Milk is nutrient rich and contributes to nutrient security for healthy growing and ageing.
- Increased productivity (milk per cow) is required to obtain the highest contribution to nutrient security with the lowest environmental impact (land use, global warming).
- Ruminants are effective converters of human-inedible resources into a nutrient dense food
- Modeling diets with respect to nutrient adequacy and minimal environmental impact is a promising tool to optimize diets

Thank you for your attention!

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