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Overall sustainability impact of agricultural production on land and other resources and the link with diets

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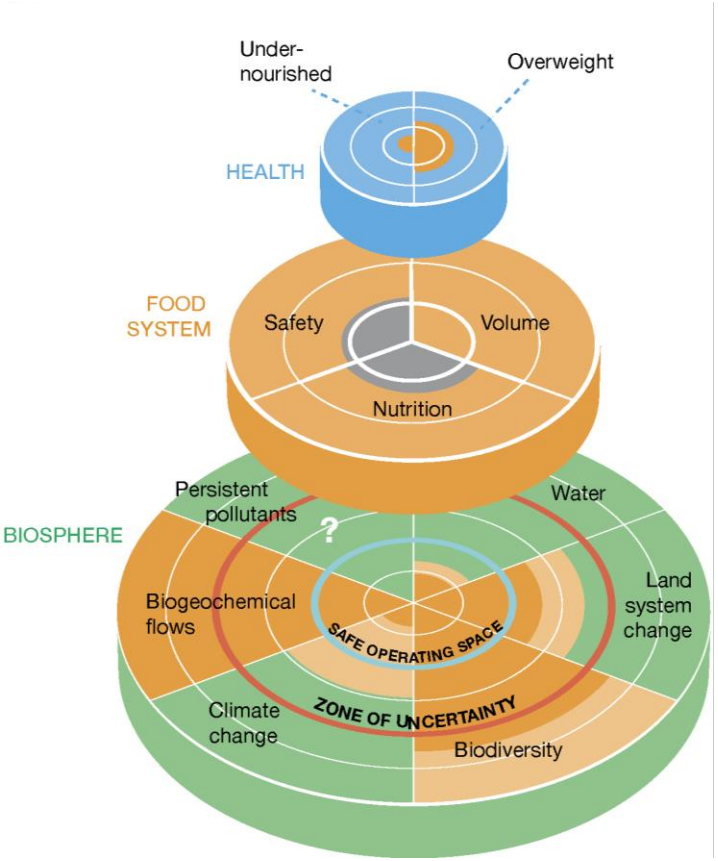
Impacts on human health and the biosphere from food production



Source: Gordon et al (2017) Rewiring food systems to enhance human health and biosphere stewardship. Environmental Research Letters.

Solutions to decrease climate impacts

- Increases in productivity and efficiency
- Implementation of technological solutions
- Dietary change towards more plant based diets
- Reduction of losses and waste in all steps

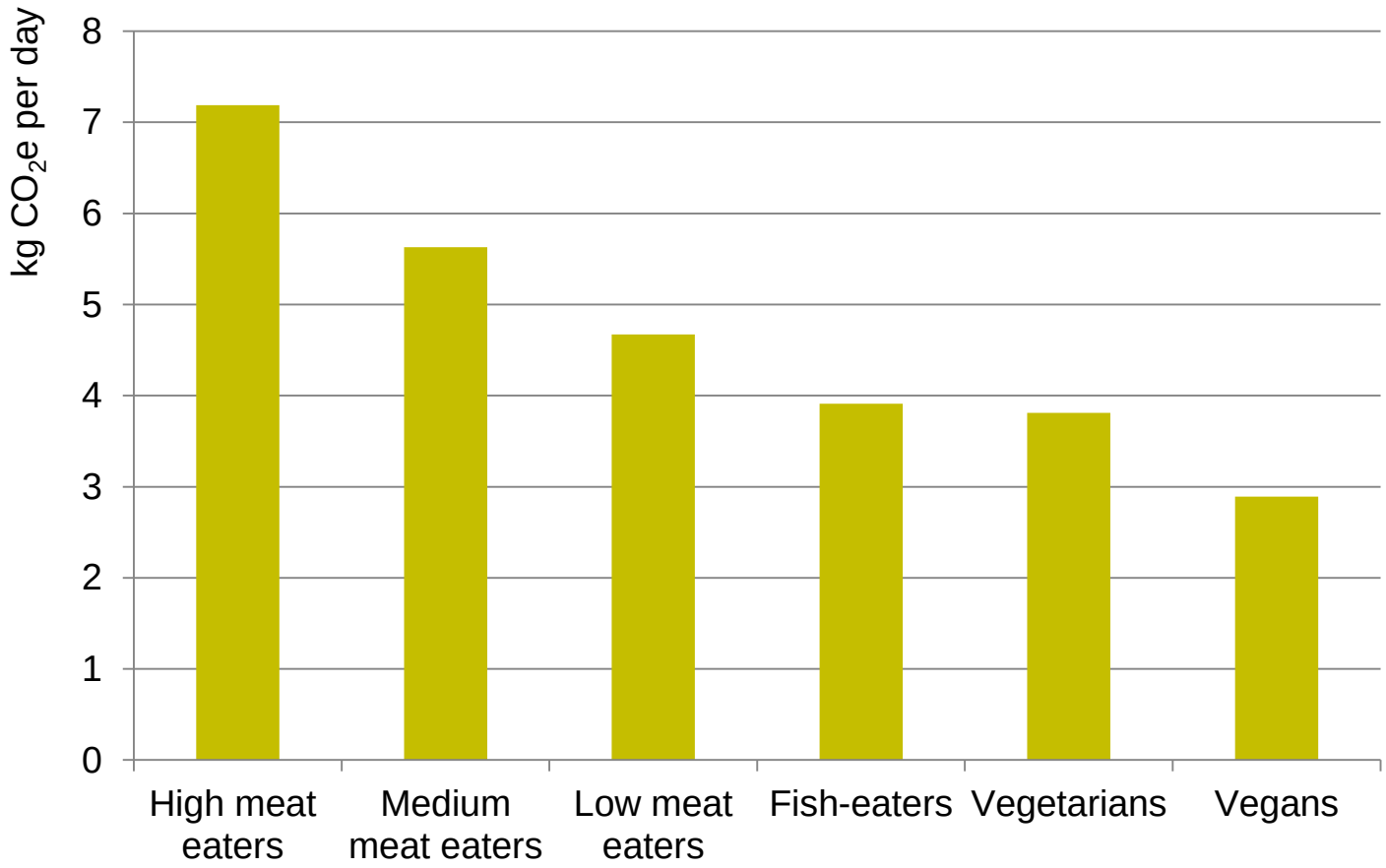
Source: Bryngelsson et al (2017), Foley et al (2011).

Potential of different options

Mitigation option	Reduction in land use	Reduction in GHG emissions
Food waste reduced by 50%	11%	9%
Yield gaps closed by 50%	15%	1%
Livestock intensification	31%	22%
Livestock intensification and dietary shift to a healthy diet	45%	46%
Dietary shift to plant-based diet	64%	73%

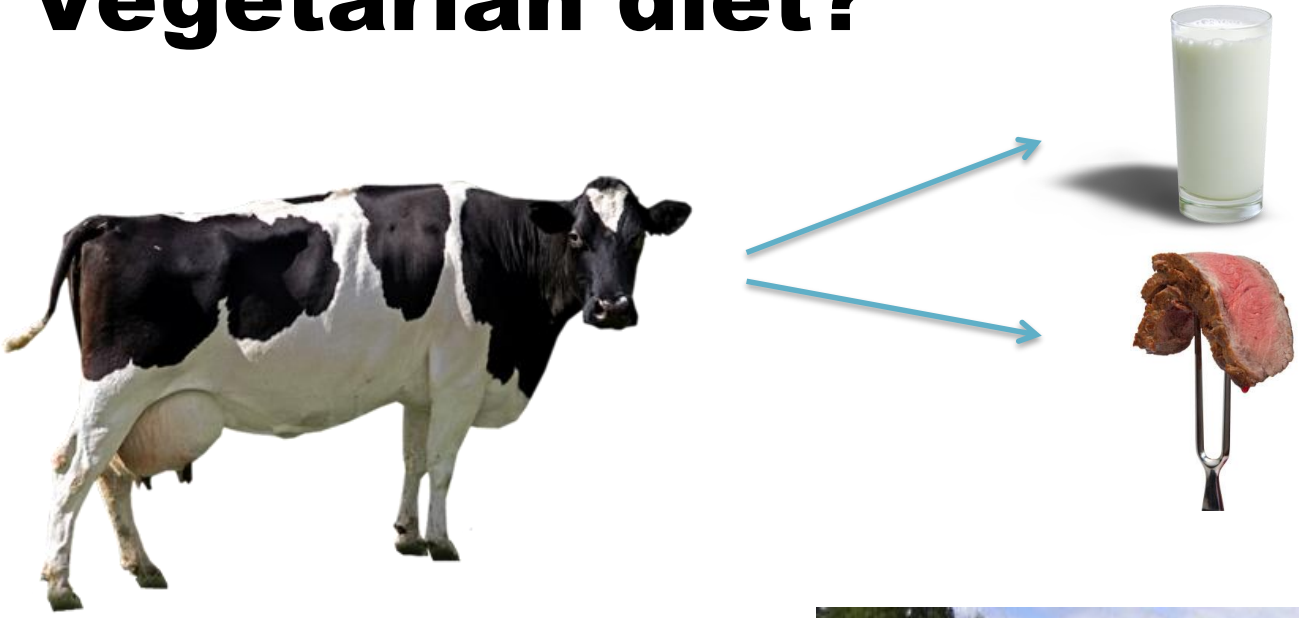
Source: Röös et al (2017) Greedy or needy? Land use and climate impacts of food in 2050 under different livestock futures. GEC 71:1-12.

Climate impact from *actual* diets



Source: Scarborough et al (2014) Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK. CC 125, 179-192

Vegetarian diet?



Vegan diet?

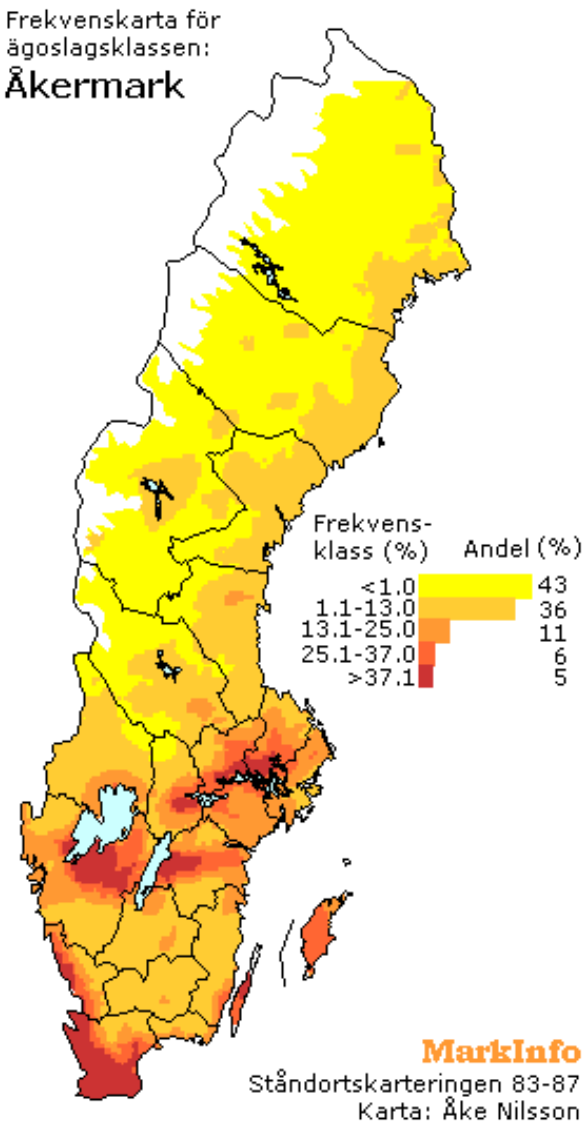
Proposed principles for sustainable livestock production

1. Arable land should be used for the production of plant based food for humans
2. Livestock should be fed biomass not suitable or not wanted by humans
3. Grasslands should be used for livestock production if grazing can be justified by other reasons than meat and milk production e.g. for biodiversity conservation or providing livelihood for poor

Source: Röös et al (2016) Limiting livestock production to pasture and by-products in a search for sustainable diets. Food Policy 58, 1-13

Applying this concept to Sweden

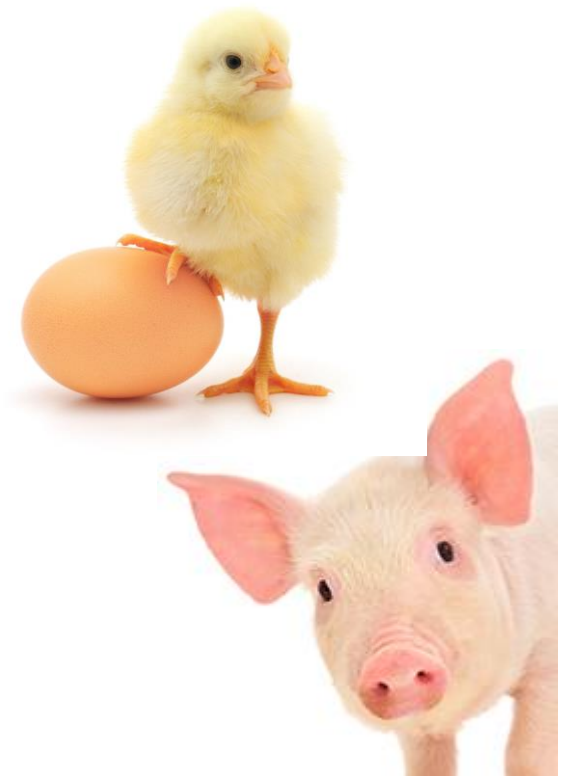
- 400,000 ha of semi-natural grasslands – approximately 1% of total land
- 2.5 million ha of cropland used for mainly food production
- Feed 13.6 million people (0.22 ha cropland per person)
- Import only tropical fruit, coffee, tea and cocoa



Source: Röös et al (2016) Limiting livestock production to pasture and by-products in a search for sustainable diets. Food Policy 58, 1-13

Agri-by-products used for feed

- Wheat bran and bakery waste
- Whey
- Rape seed cake
- Beet fibre
- Potatoes and other roots
- Brewers grain
- Legume residues



Source: Röös et al (2016) Limiting livestock production to pasture and by-products in a search for sustainable diets. Food Policy 58, 1-13

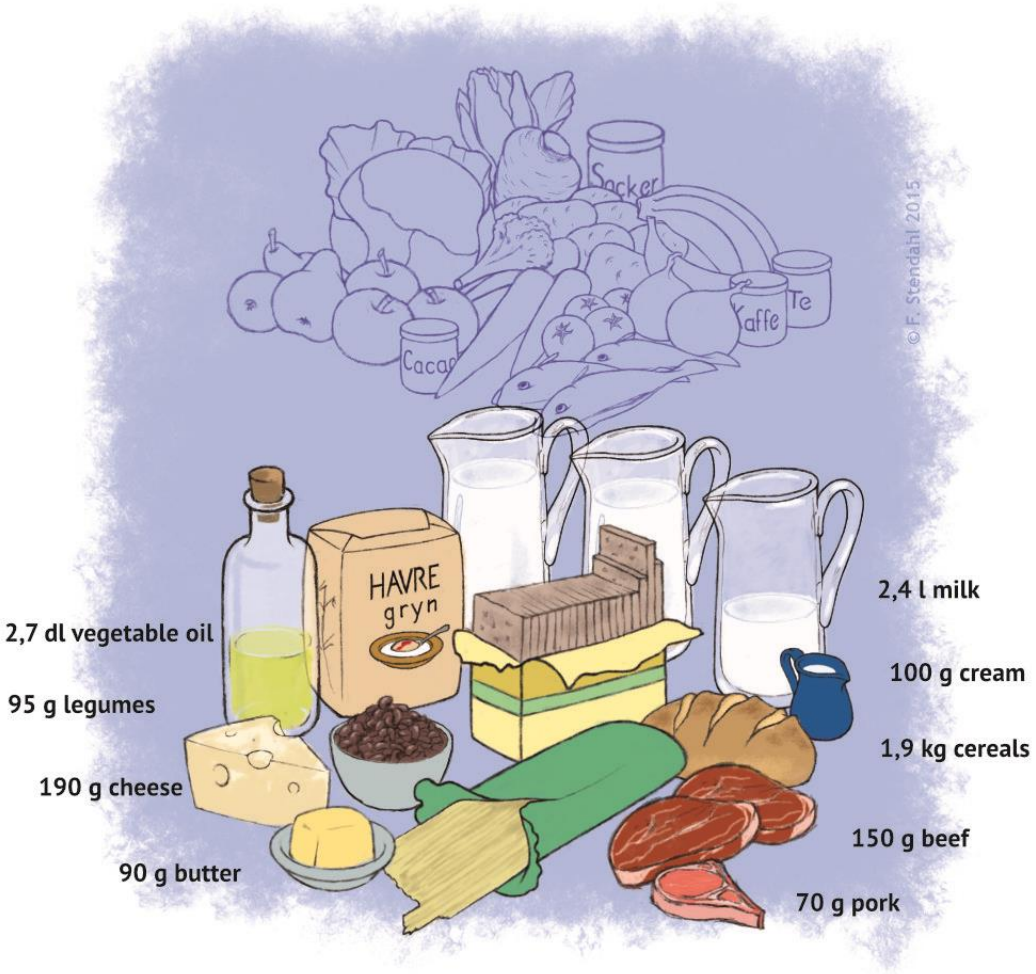
Three scenarios for using pastures

1. Intensive dairy – more milk and more cattle, fewer pigs
2. Extensive dairy – less milk and less cattle, more pigs
3. Suckler herds – no milk and less cattle, more pigs

Source: Röös et al (2016) Limiting livestock production to pasture and by-products in a search for sustainable diets. Food Policy 58, 1-13

Gives three different diets

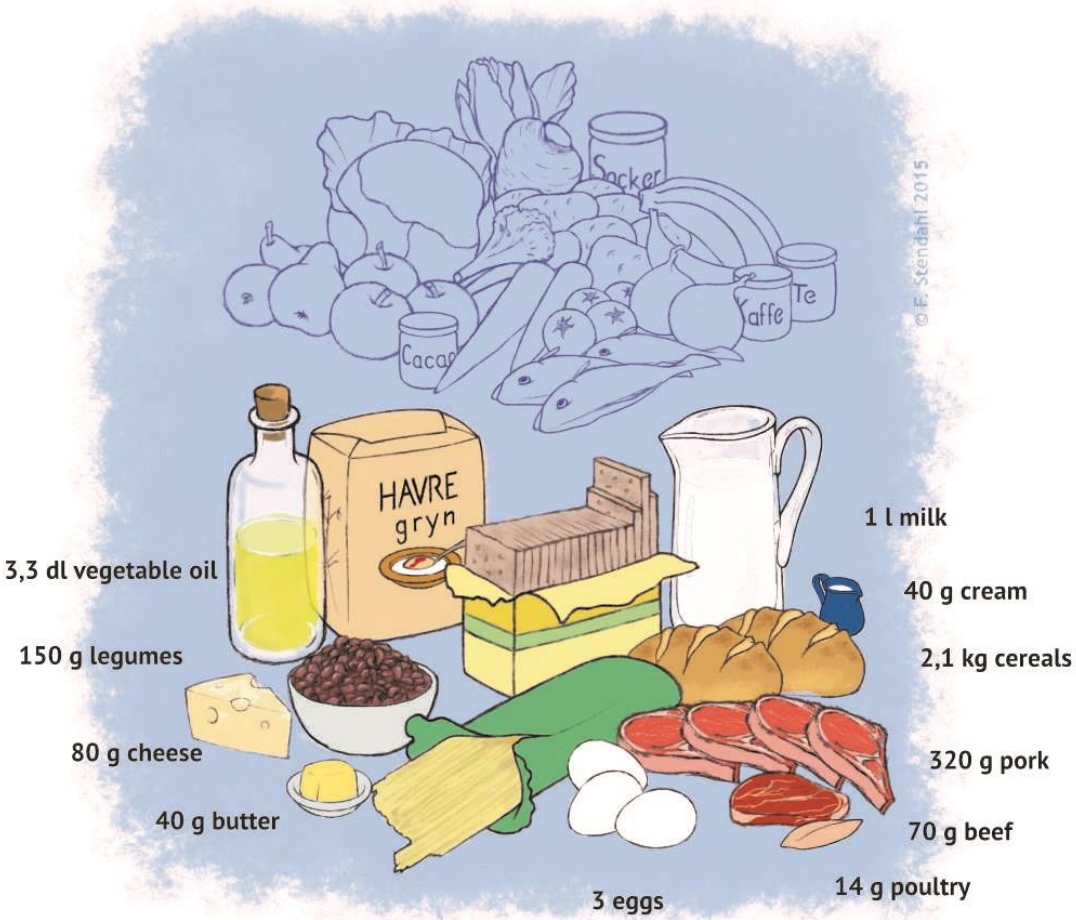
Intensive dairy – weekly diet



Source: Röös et al (2016) Limiting livestock production to pasture and by-products in a search for sustainable diets. Food Policy 58, 1-13

Gives three different diets

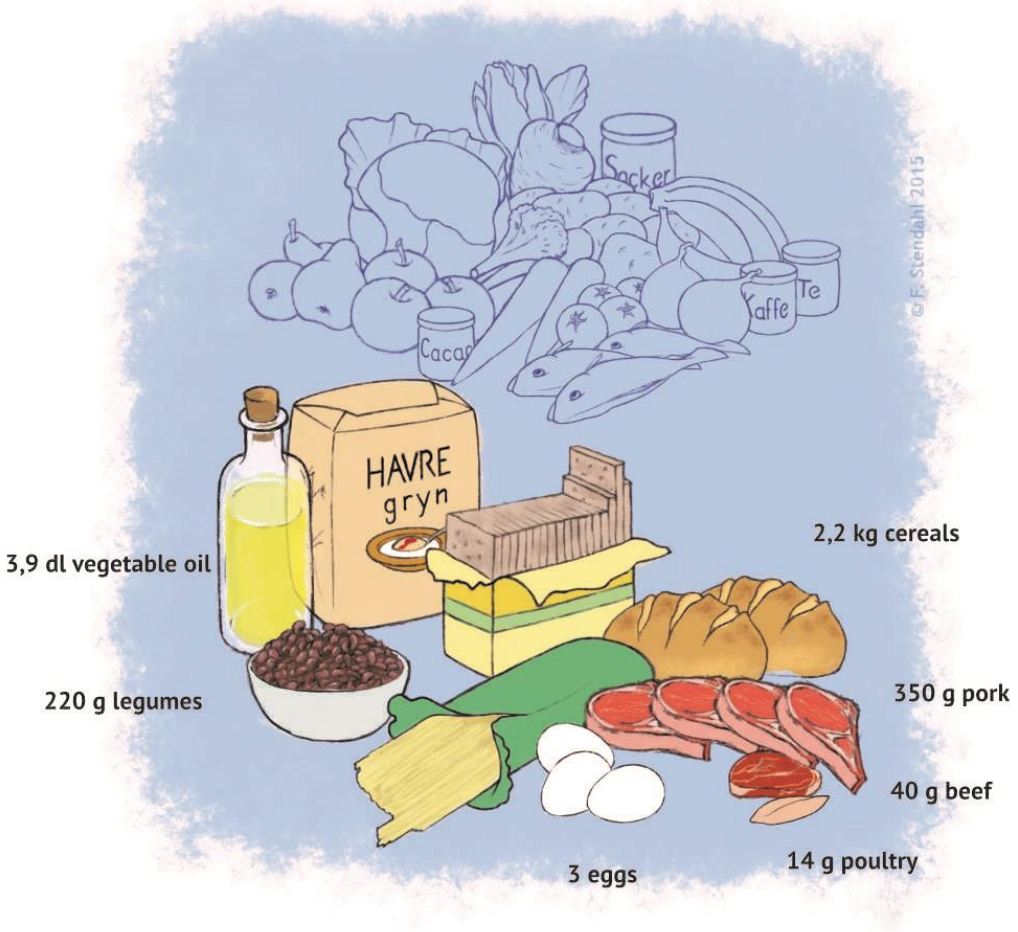
Extensive dairy – weekly diet



Source: Röös et al (2016) Limiting livestock production to pasture and by-products in a search for sustainable diets. Food Policy 58, 1-13

Gives three different diets

Suckler herds – weekly diet



Source: Röös et al (2016) Limiting livestock production to pasture and by-products in a search for sustainable diets. Food Policy 58, 1-13

Climate impact

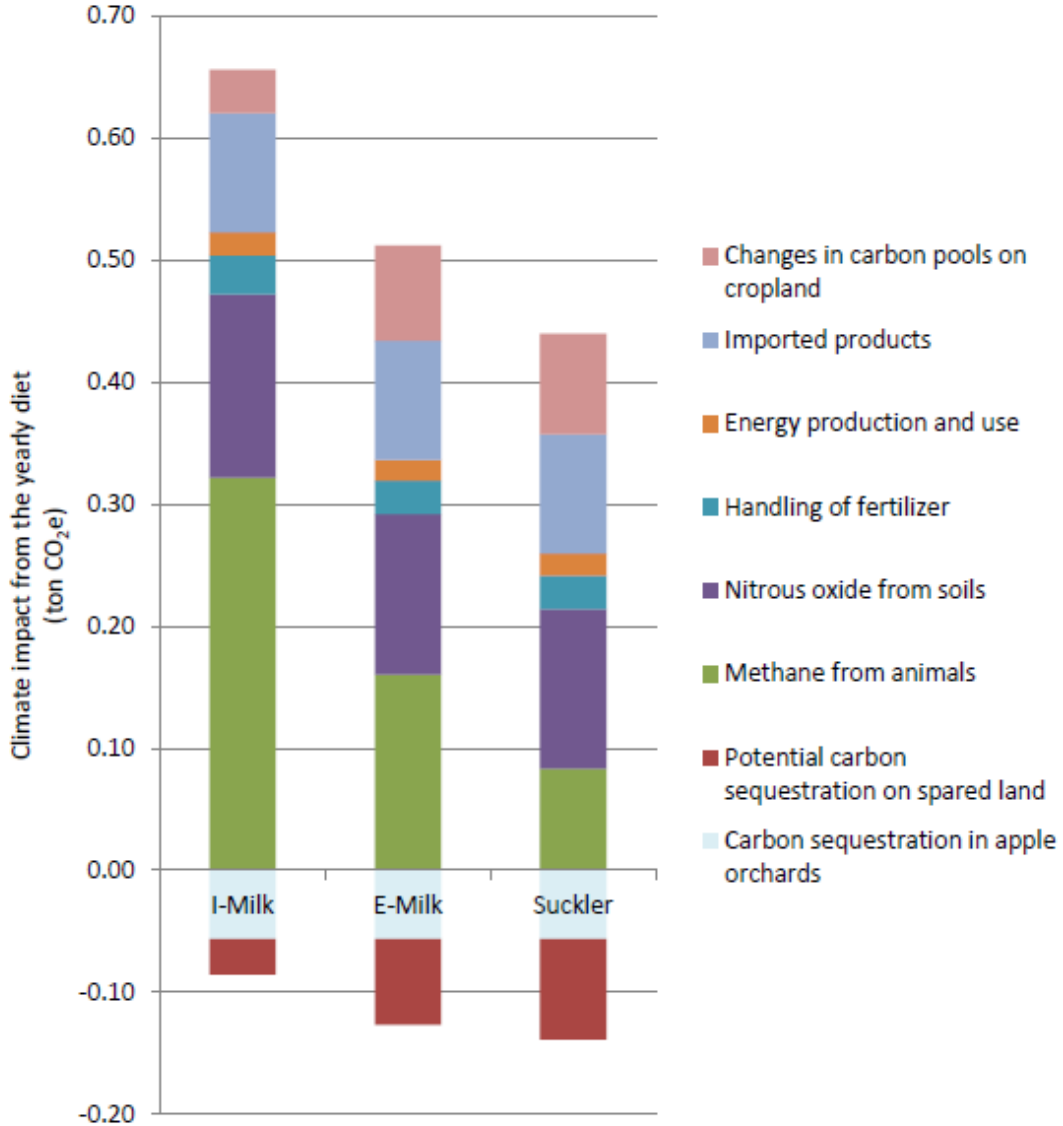


Fig. S7.1. Climate impact from the production of the food in the diets.

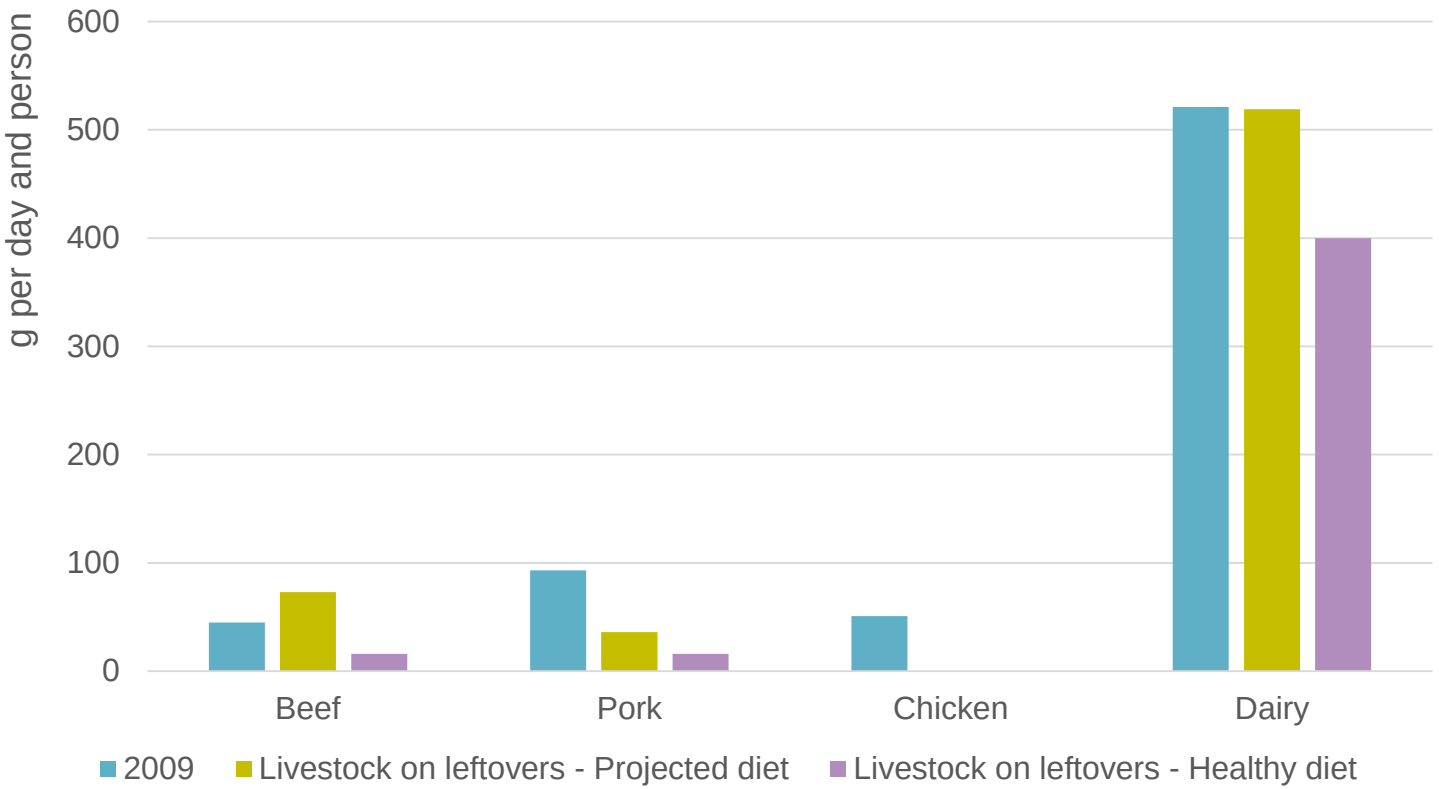
Source: Röös et al (2016) Limiting livestock production to pasture and by-products in a search for sustainable diets. Food Policy 58, 1-13

Repeated the exercise for Western Europe

- 62 Mha of grasslands and 94 Mha of cropland
- Including both a projected diet and a healthy diet for eight different livestock futures (one being the ’Livestock on Leftovers’)
- Feed 460 million people (projected population in 2050) exclusively from land in the region (no import)

Source: Röös et al (2016) Protein futures for Western Europe: potential land use and climate impacts in 2050. Reg Env Change 17(2), 367-377.

Meat and dairy in diets – ’Livestock-on-Leftovers’ scenario



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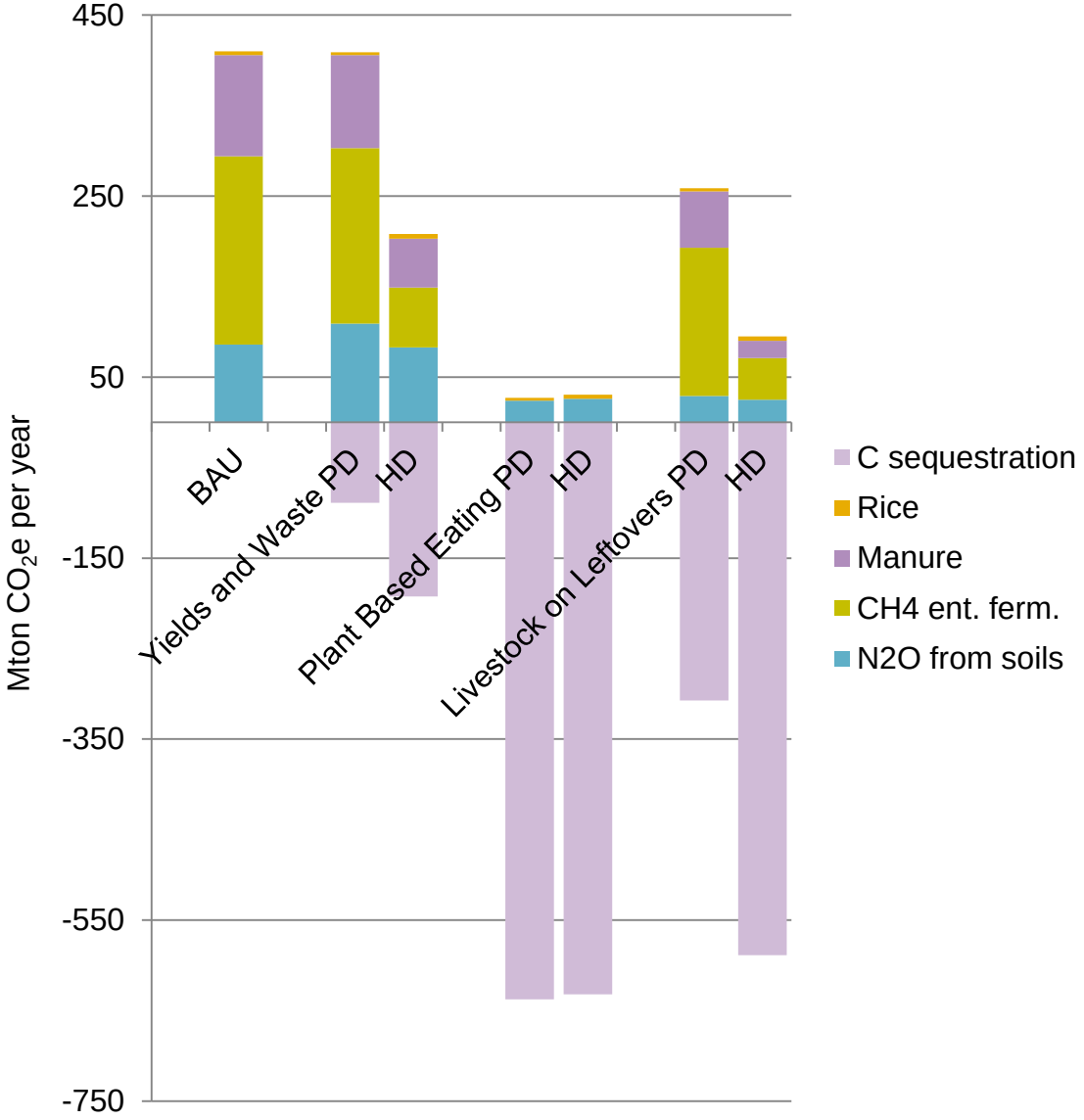
Emissions of greenhouse gases



Source: Röös et al (2016) Protein futures for Western Europe: potential land use and climate impacts in 2050. Reg Env Change 17(2), 367-377.

Using ’leftover streams’ to feed livestock avoids *feed-food competition* and provide a land boundary to livestock production

Which of these are true ’leftovers’?

- Grass from marginal land
- By-products from food and bioenergy industry
- Food waste?
- Grass in crop rotations in mixed farming systems?

What are the effects on other sustainability goals?

What are effective policies to steer in this direction?

Source: Röös et al (2015; 2017a, 2017b); Schader et al (2015); van Zanten et al (2018)

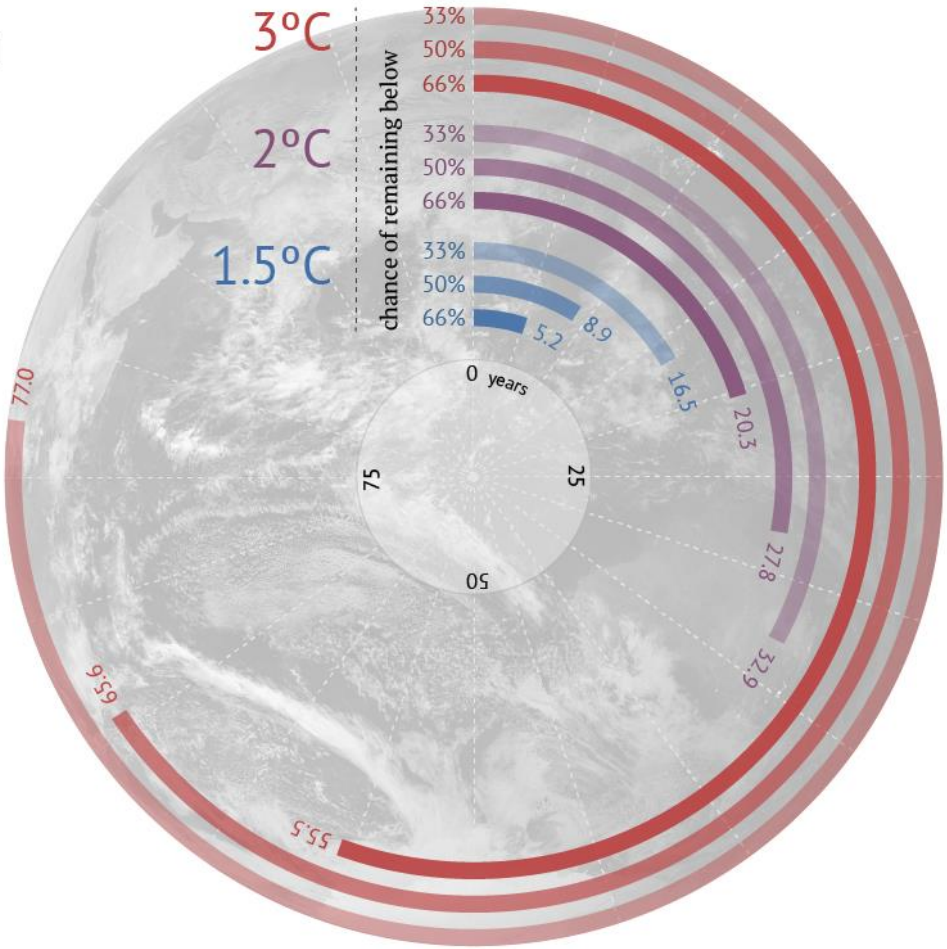
R&I priorities

- Development of resource efficient multifunctional livestock systems with high animal welfare standards
- Design of sustainable cropping systems that deliver a wide variety of plant-based foods and commodities that can be processed into healthy and attractive food products
- Further develop multidisciplinary system level approaches to identify and handle goal conflicts
- Walk the talk – perform low-carbon research!

The urgency!

Carbon Countdown

How many years of current emissions would use up the IPCC's carbon budgets for different levels of warming?



CarbonBrief
CLEAR ON CLIMATE

Photo credit: NASA Goddard Space Flight Center
Stopwatch icon: T-Kot/Shutterstock.com

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Thank you!

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The potential depends on:

- Available pasture biomass
- Food waste as a feed source or not
- Level of food waste
- What we consider non-edible by-product
- Amount of by-products from bioenergy production
- Feed conversion efficiencies
- Purely ’ecological leftovers’ or livestock diets supplemented with *e.g.* cereals for pigs or roughage feed for ruminants in *e.g.* winter