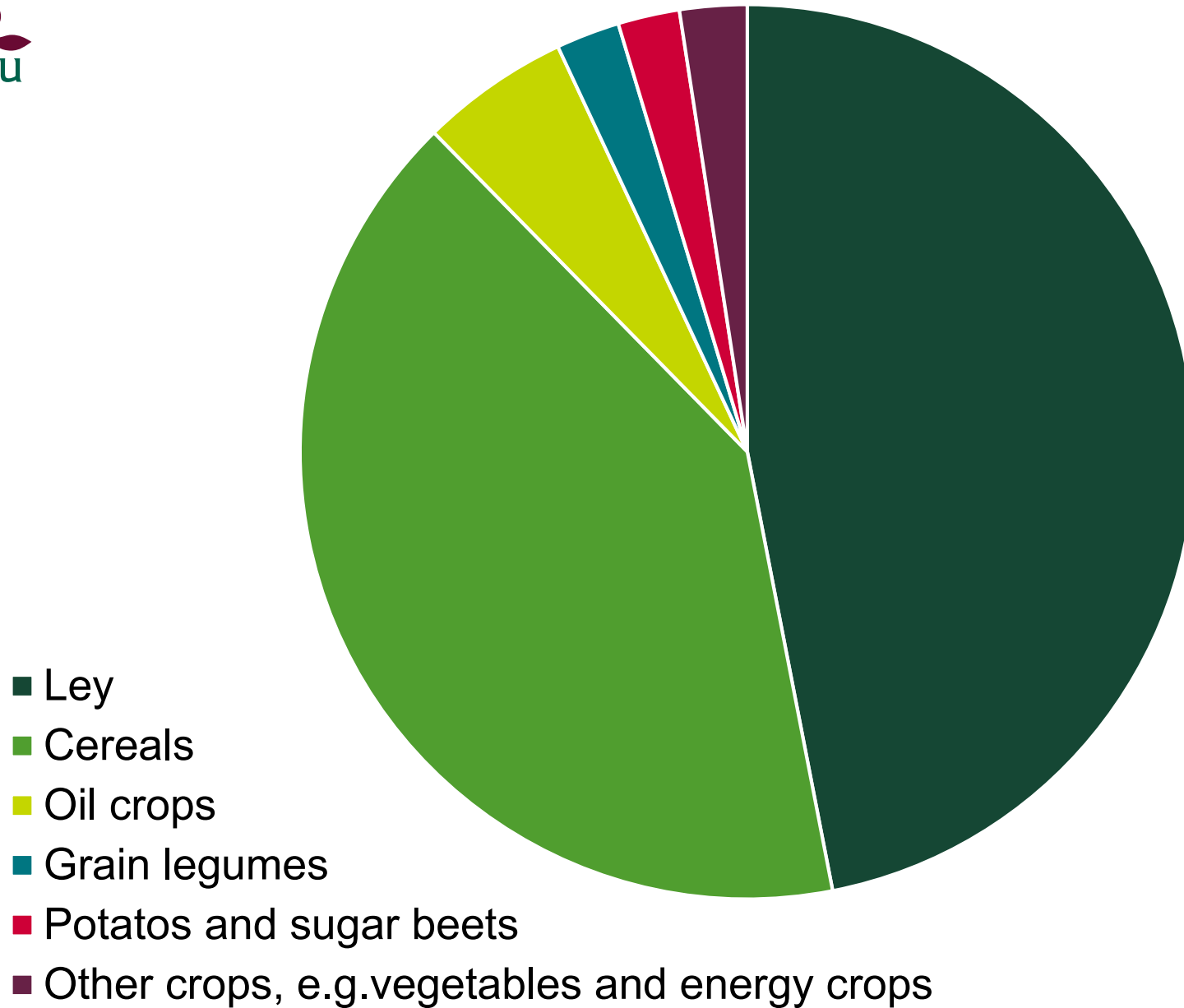


An agroecological perspective on sustainable food systems based on integrated crop-livestock production

Georg Carlsson
Professor of Sustainable Cropping Systems
SLU, Department of Biosystems and Technology, Alnarp

Use of Swedish arable land for different crops, 2022

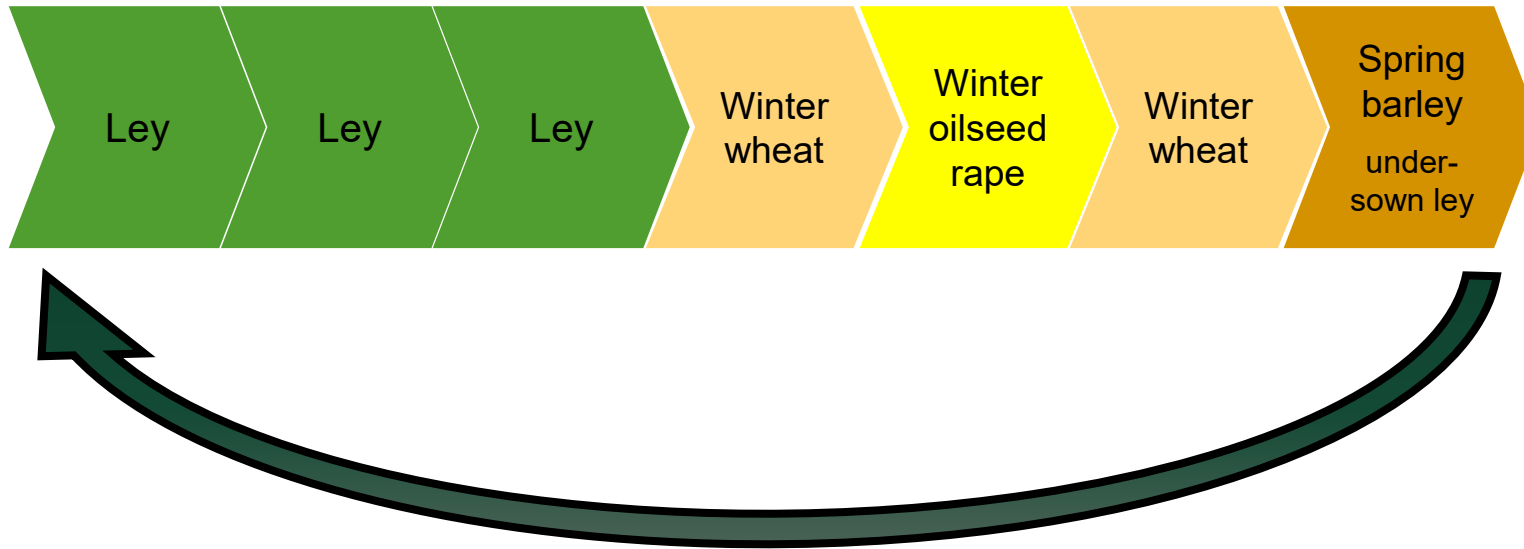


- Ley
- Cereals
- Oil crops
- Grain legumes
- Potatos and sugar beets
- Other crops, e.g. vegetables and energy crops



Many benefits of ley in crop rotations

- Deep roots, good for soil structure and fertility
- Low risk of soil erosion and nutrient losses
- Inputs of biological N₂ fixation (ley with legumes)
- Break disease cycles
- Avoid soil disturbance (perennial soil cover)
- Reduction of annual weeds
- Nutrient cycling via manure from grass-fed animals



Perennial grass field

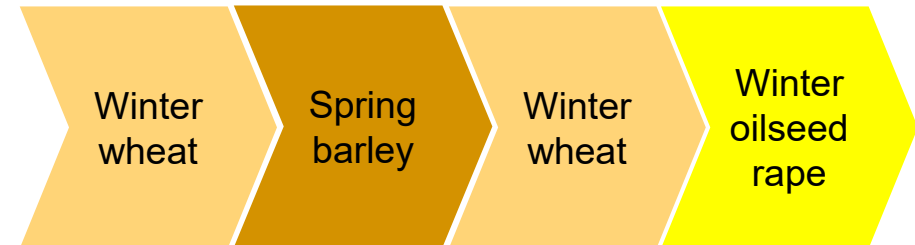
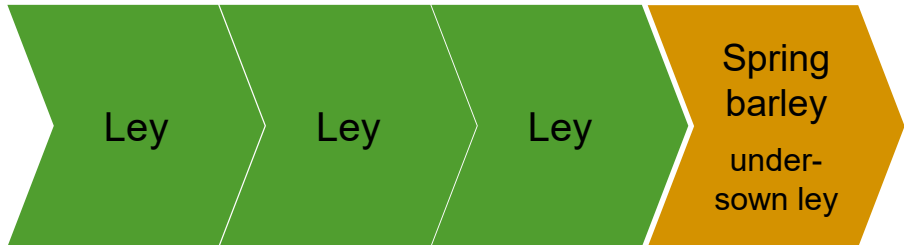
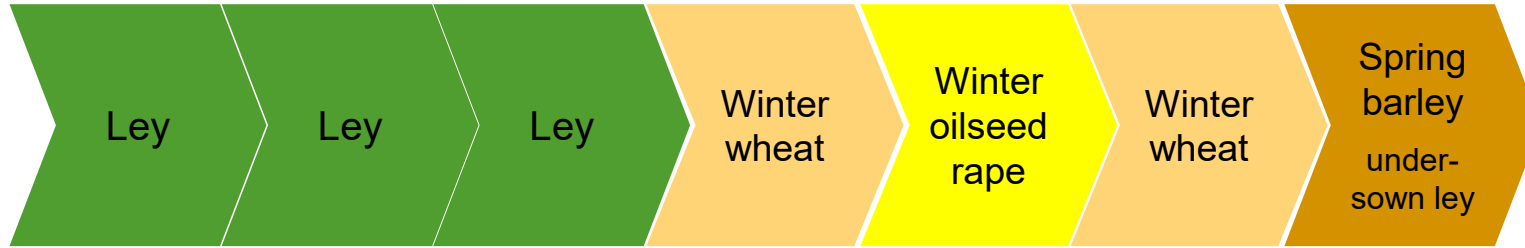


Annual wheat field



Glover et al. 2010. Agriculture, Ecosystems and Environment 137, 3-12





Few crops, large homogeneous fields – high dependency on external inputs

Photo: Reija Danielsson

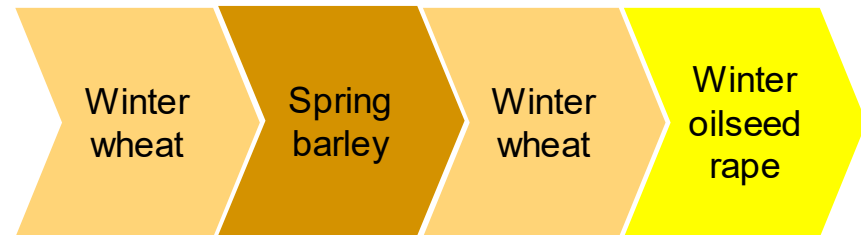


Ley with perennial grass (timothy)



Photo: Jenny Svennås-Gillner

Winter wheat



Environmental Sustainability problems in modern (Swedish) agriculture

- **Loss of biodiversity**
 - homogeneous fields
 - intensive pesticide use
- **Nutrient losses, eutrophication**
 - intensive fertilizer use
 - repeated soil tillage
 - periods of bare soil
- **Climate impact**
 - intensive fertilizer use
 - livestock production
 - losses of soil carbon



Campus Alnarp and surroundings. Photo: SLU

Sustainability problems in modern (Swedish) agriculture

- **Loss of biodiversity**
 - homogeneous fields
 - intensive pesticide use
- **Nutrient losses, eutrophication**
 - intensive fertilizer use
 - repeated soil tillage
 - periods of bare soil
- **Climate impact**
 - intensive fertilizer use
 - livestock production
 - losses of soil carbon
- **Profitability?**
 - large investments, expensive labor, low payment, competition from imports, ...
- **Attractive landscapes, rural livelihood?**
 - recreational values
 - work conditions
- **Fair use of limited resources?**
 - land, nutrients, energy
- **Meeting societal needs?**
 - producing food for healthy diets?

Kött och mjölk från djur uppfödda på bete och restprodukter – ger det en hållbar kost?

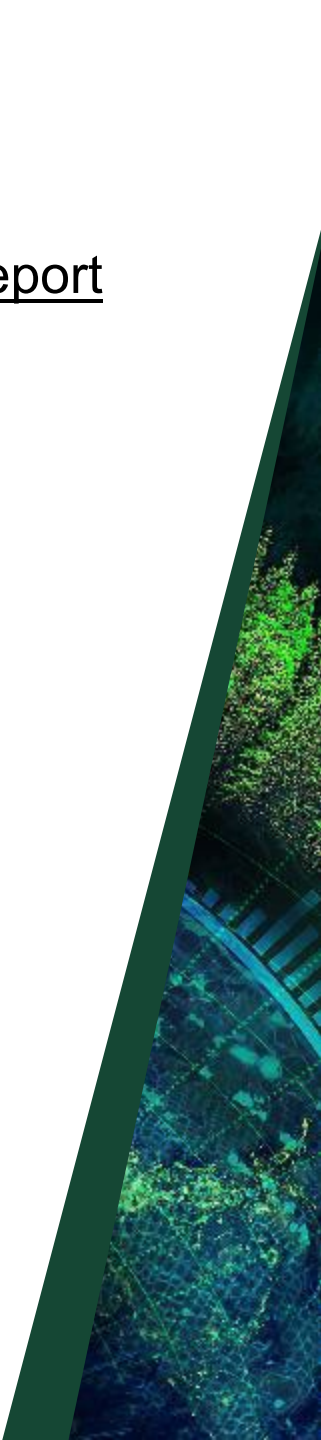
Resultat från projektet *Hållbar svensk proteinkonsumtion*



Elin Rööf, Mikaela Patel, Johanna Spångberg,
Georg Carlsson, Lotta Rydhmer

Future Agriculture
**FRAMTIDENS
LANTBRUK**

[Link to the report](#)
(in Swedish)





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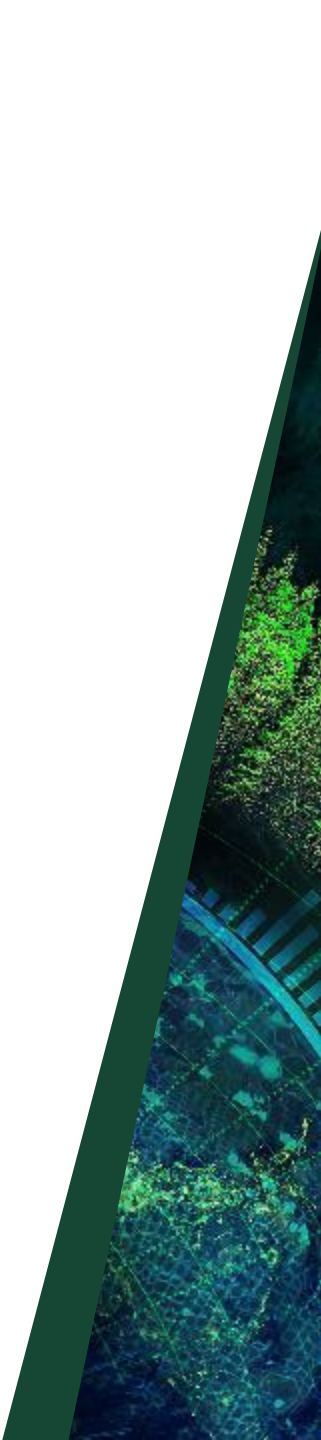
Limiting livestock production to pasture and by-products in a search for sustainable diets

Elin Rööös ^{a,*}, Mikaela Patel ^b, Johanna Spångberg ^a, Georg Carlsson ^c, Lotta Rydhmer ^d

Three scenarios for the Swedish food system, the 'Ecoleft' diets, based on normative principles:

- As much as possible of the food should be produced domestically
- Arable land should primarily be used for the production of plant-based food for humans.
- Livestock should be fed biomass not suitable for or wanted by humans; *ecological leftovers*.
- The current area of seminatural grasslands should be preserved (maintained grazing by livestock).

Röös et al. 2016. Food Policy 58, 1-13.



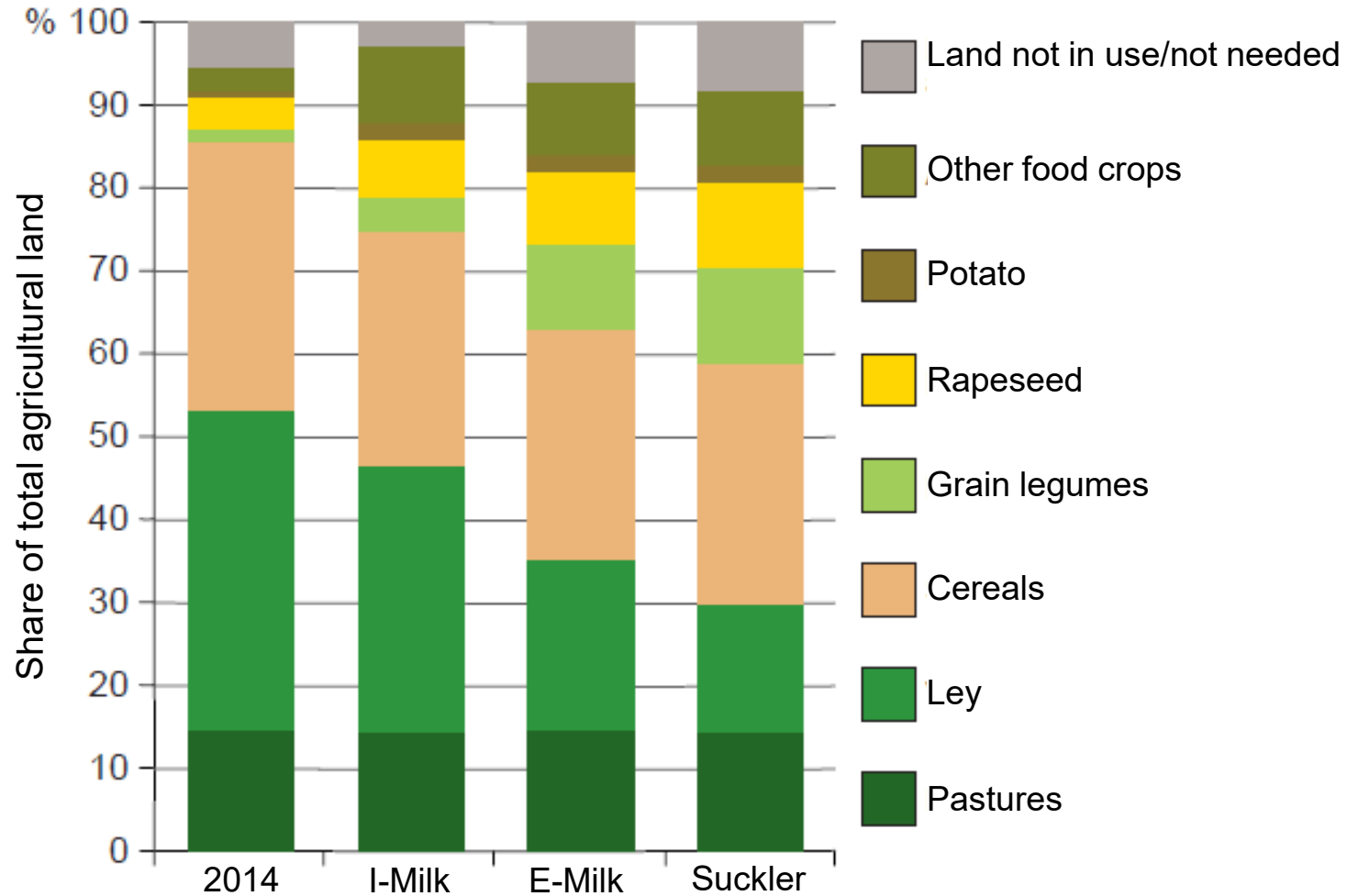
Three Ecoleft diets compared to current and recommended consumption

The 'Ecoleft' diets

	Current consumption	Rec.diet (SNÖ)	I-Milk diet	E-Milk diet	Suckler diet
Servings of meat per week (100 g bone-free per serving)	10	8	2	4	4
Servings of seafood per week (100 g bone-free per serving)	4	4	4	4	4
Servings of legumes per week (60 g dry weight per serving)	0.5	1.5	1.5	2.5	3.5
Servings of cereals per week (60 g dry weight per serving)	20	32	31	35	37
Eggs per week	4	3	0	3	3
Slices of cheese per day (10 g per slice)	5	3	3 ¹	1	0
Millilitres of milk per day	300	350	350 ¹	150	0
Total protein per day (g)	Approx. 100 ²	59-118 ³	82	81	77
Total protein % of total energy	Approx. 17%	10-20%	13%	13%	12%

Röös et al. 2016. Food Policy 58, 1-13.

Land use in the three Ecoleft diets compared to current (2014) production

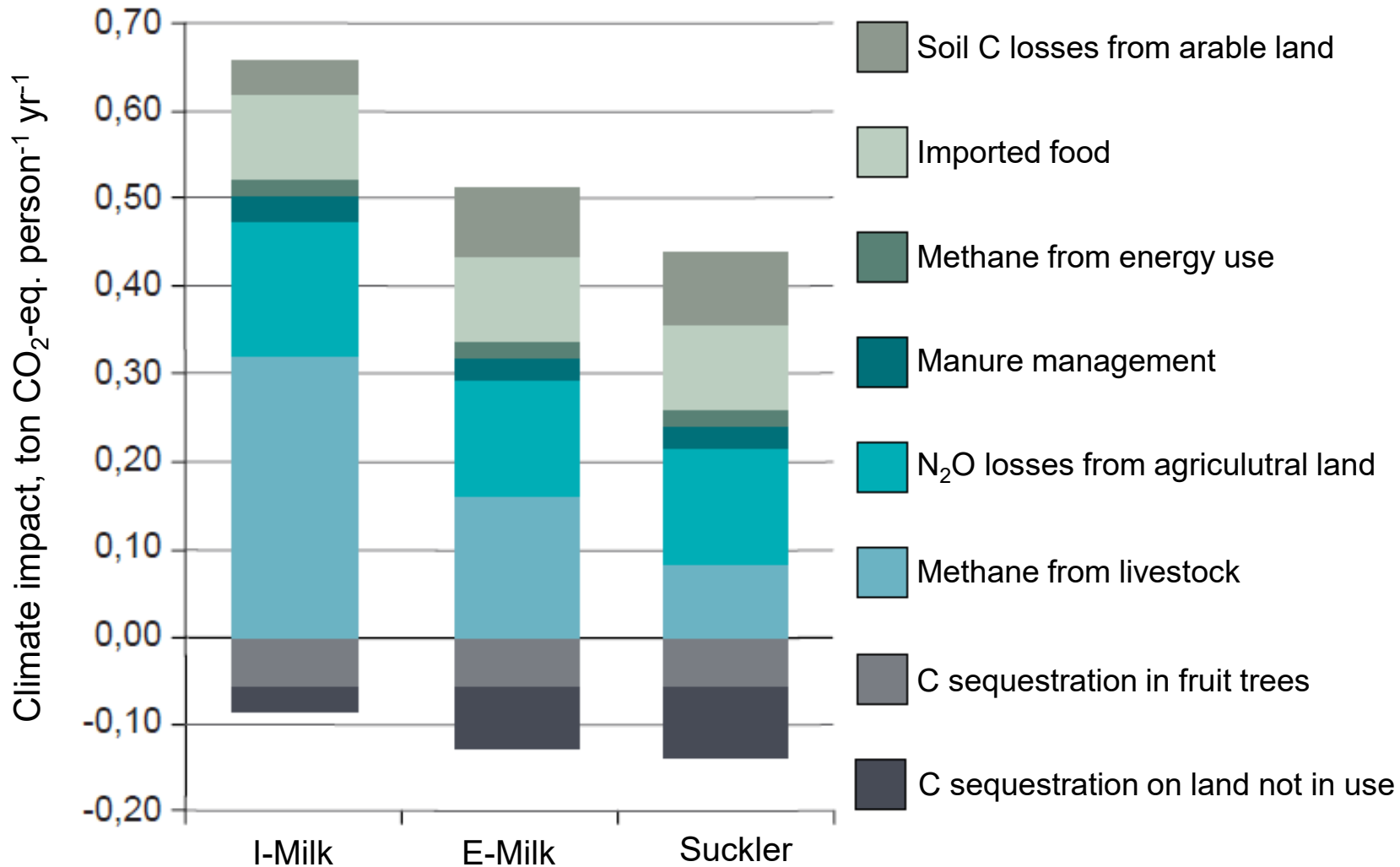


Röös et al. 2016. Food Policy 58, 1-13.



Climate impact in the three Ecoleft diets compared to current production

Currently approx. 1.9 ton



Röös et al. 2016. Food Policy 58, 1-13.

	Normative decisions
Food consumption oriented	Future diets should be based on the type of food currently consumed and seek to fulfil Nordic nutrient recommendations.
	Food waste should be reduced compared to current levels.
	Future diets should facilitate equitable consumption based on local resources.
Production oriented	Food should be produced locally, but food not possible* to produce locally should be imported.
	The food should be produced in an organic farming system acknowledging agroecological principles.
	More durable breeds of grazing animals should be used to be able to graze in rough terrain.
	Some land currently used for annual cropping is unsuited for this and should be left for nature conservation.
Resource use oriented	Semi-natural pastures should be grazed by livestock to promote biodiversity and preserve the cultural landscape.
	Arable land should primarily be used to grow food for humans, not livestock feed or bioenergy crops.
	By-products from food production should be used to feed livestock.
	Agriculture should be self-sufficient in renewable energy, but should not provide energy for other parts of society.

Designing a future food vision for the Nordics through a participatory modeling approach

Karlsson et al. 2018 Agron Sustain Dev 38: 59.

<https://doi.org/10.1007/s13593-018-0528-0>

Normative choices according to participating environmental and small-scale farmers' organizations:

Reduced food waste

Nordic self-sufficiency (as far as possible)

Organic agriculture

Seminatural grasslands preserved by grazing animals

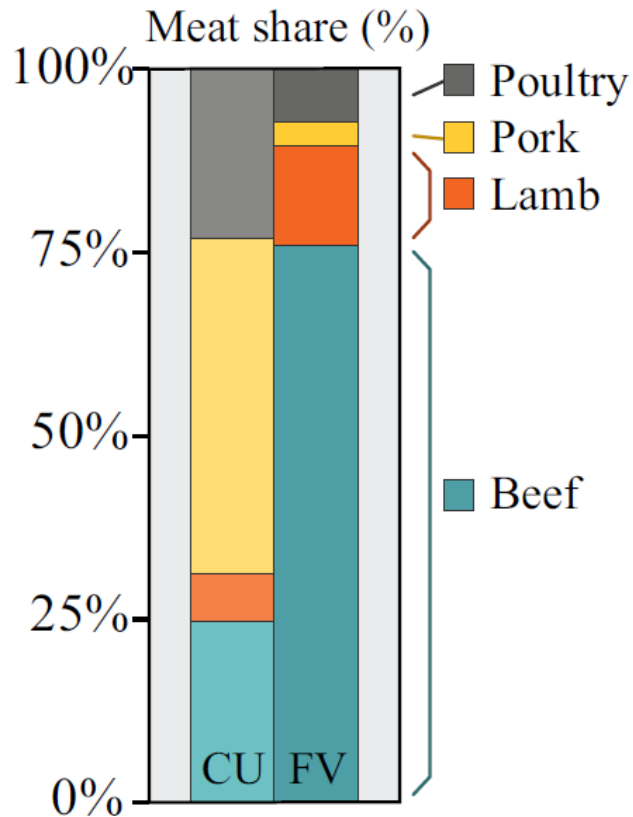
Arable land primarily used for food crops

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<https://doi.org/10.1007/s13593-018-0528-0>

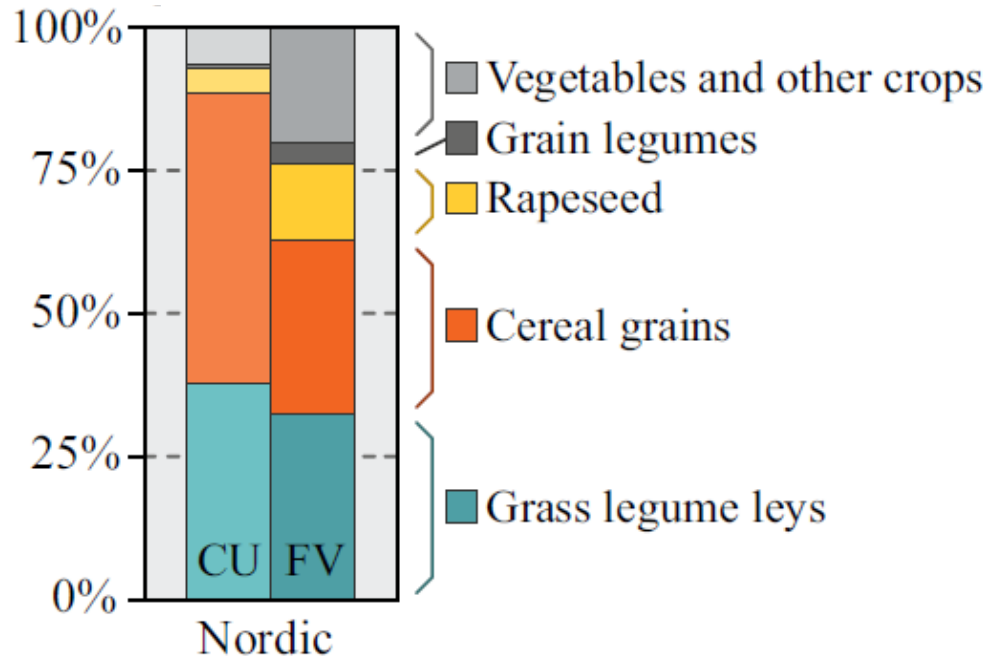
81 % reduction in meat consumption



Reduced and diversified land use

0.19 ha arable land per capita;
current Swedish average diet requires 0.34 ha

Use of arable land (%)



Less meat, more legumes – prospects and challenges in the transition towards sustainable diets in Sweden

Elin Rööös, Georg Carlsson, Ferawati Ferawati, Mohammed Hefni, Andreas Stephan, Pernilla Tidåker, Cornelia Witthöft

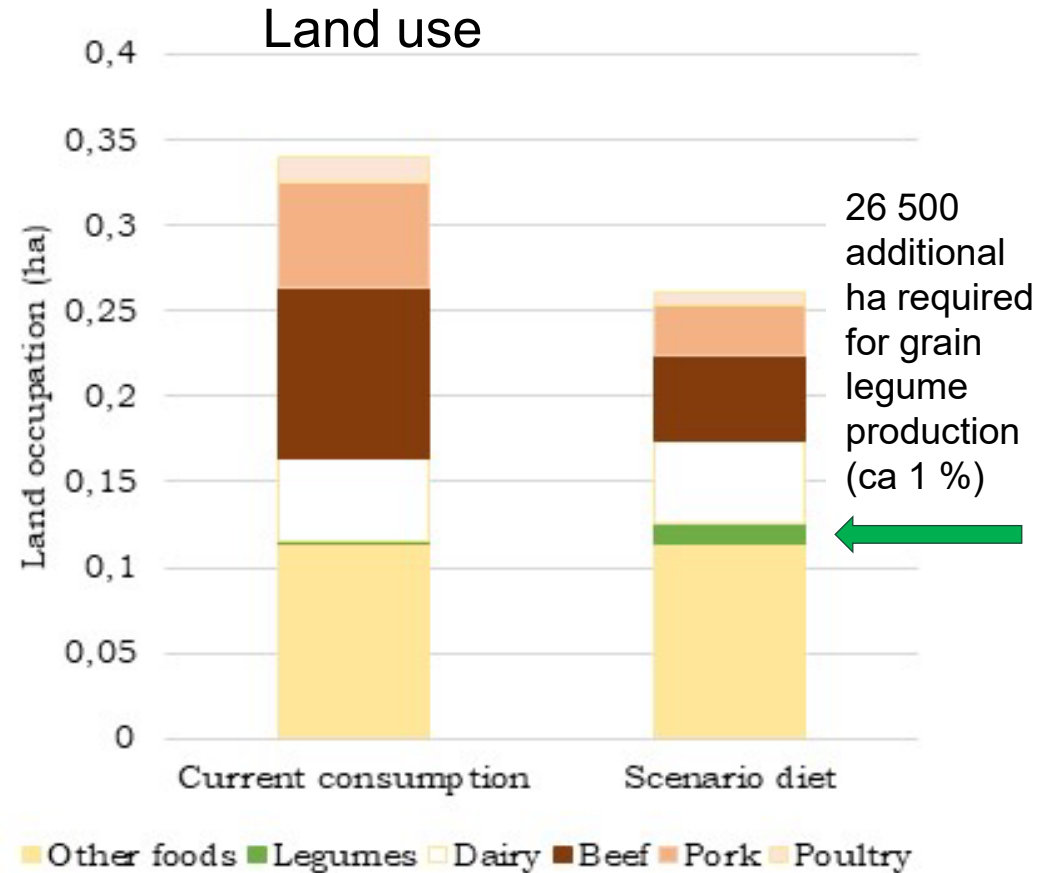
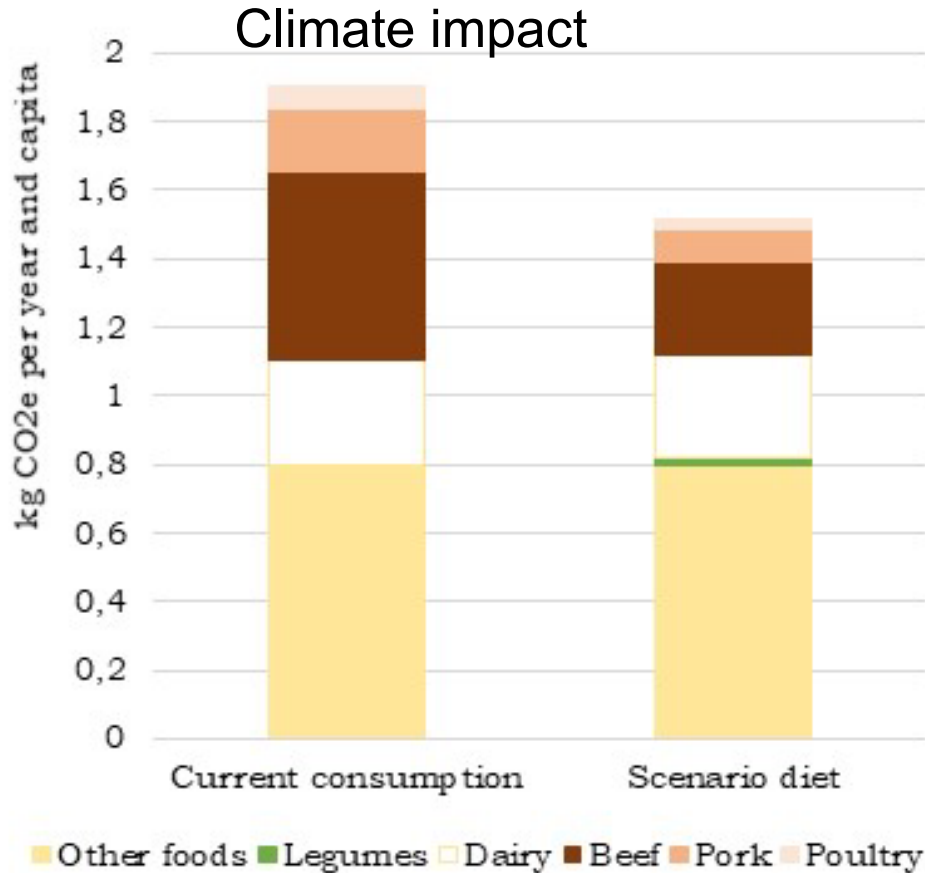
Renewable Agriculture and Food Systems
(2020). 35, 192–205.
<https://doi.org/10.1017/S1742170518000443>

The scenario:
Swedish meat consumption reduced by half
And replaced by domestically grown beans,
lentils and peas



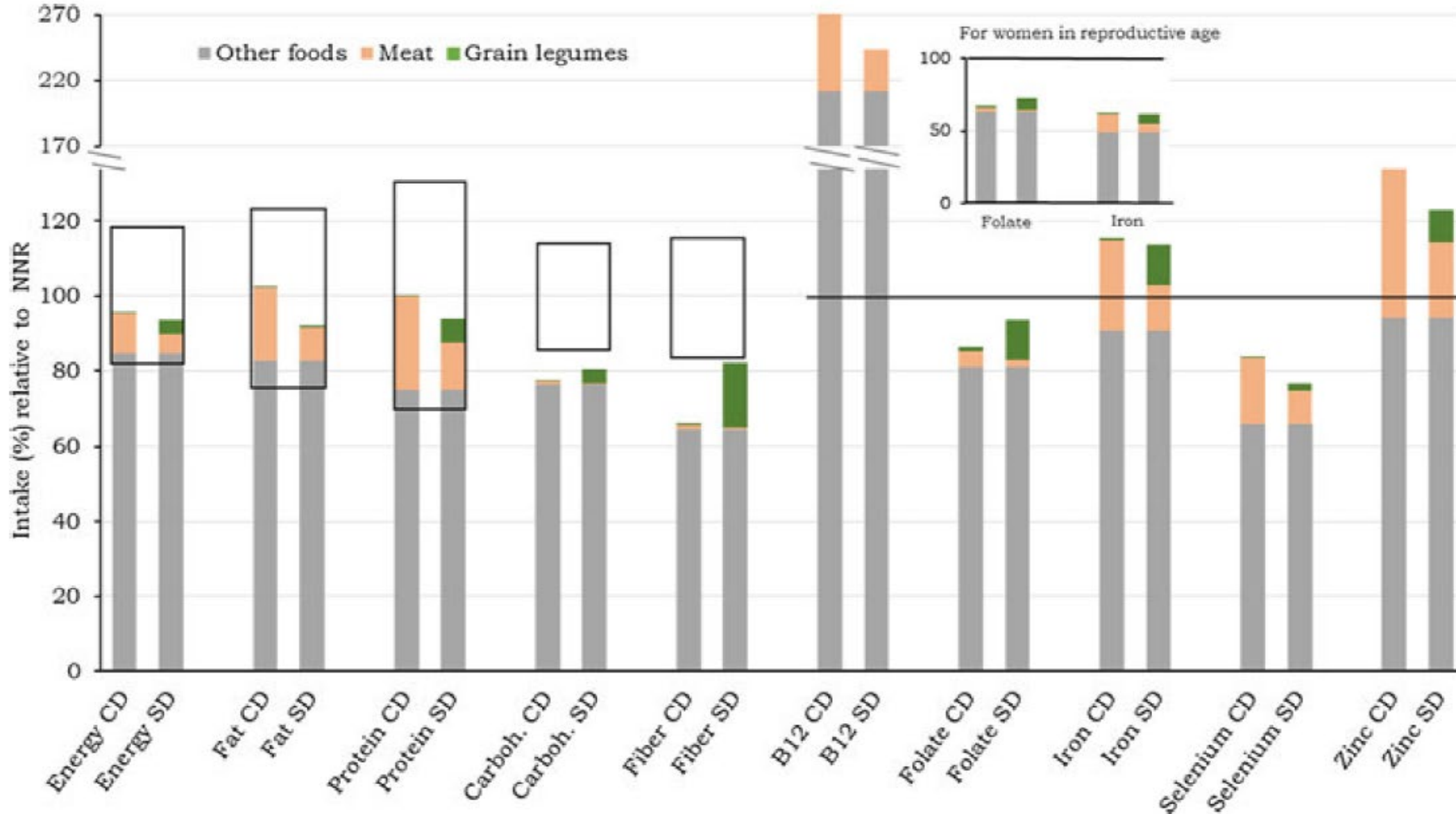
Photo: P Konfor

Less meat, more legumes – prospects and challenges in the transition towards sustainable diets in Sweden



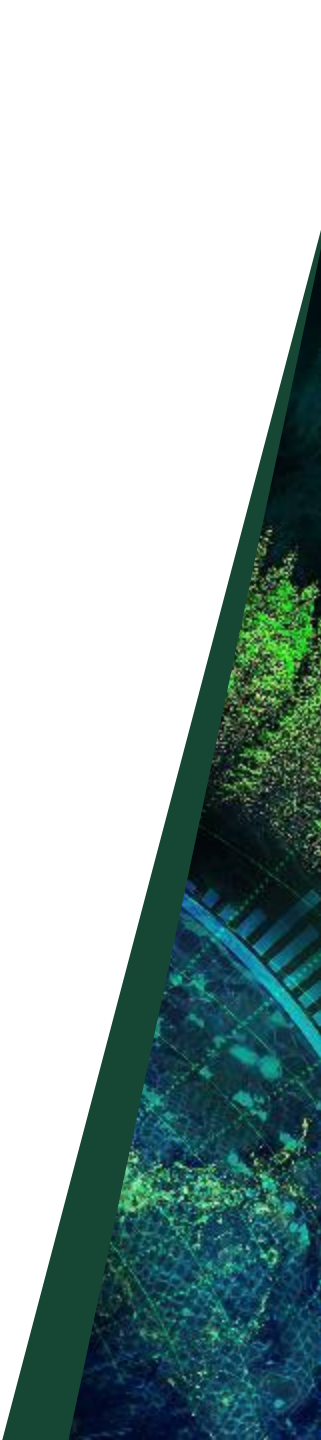
Röös et al. *Renewable Agric. Food Syst.* <https://doi.org/10.1017/S1742170518000443>

Less meat, more legumes – prospects and challenges in the transition towards sustainable diets in Sweden



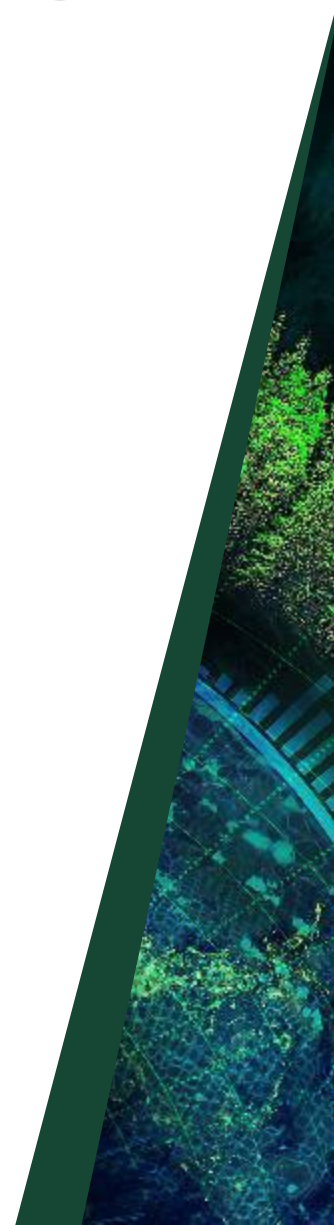
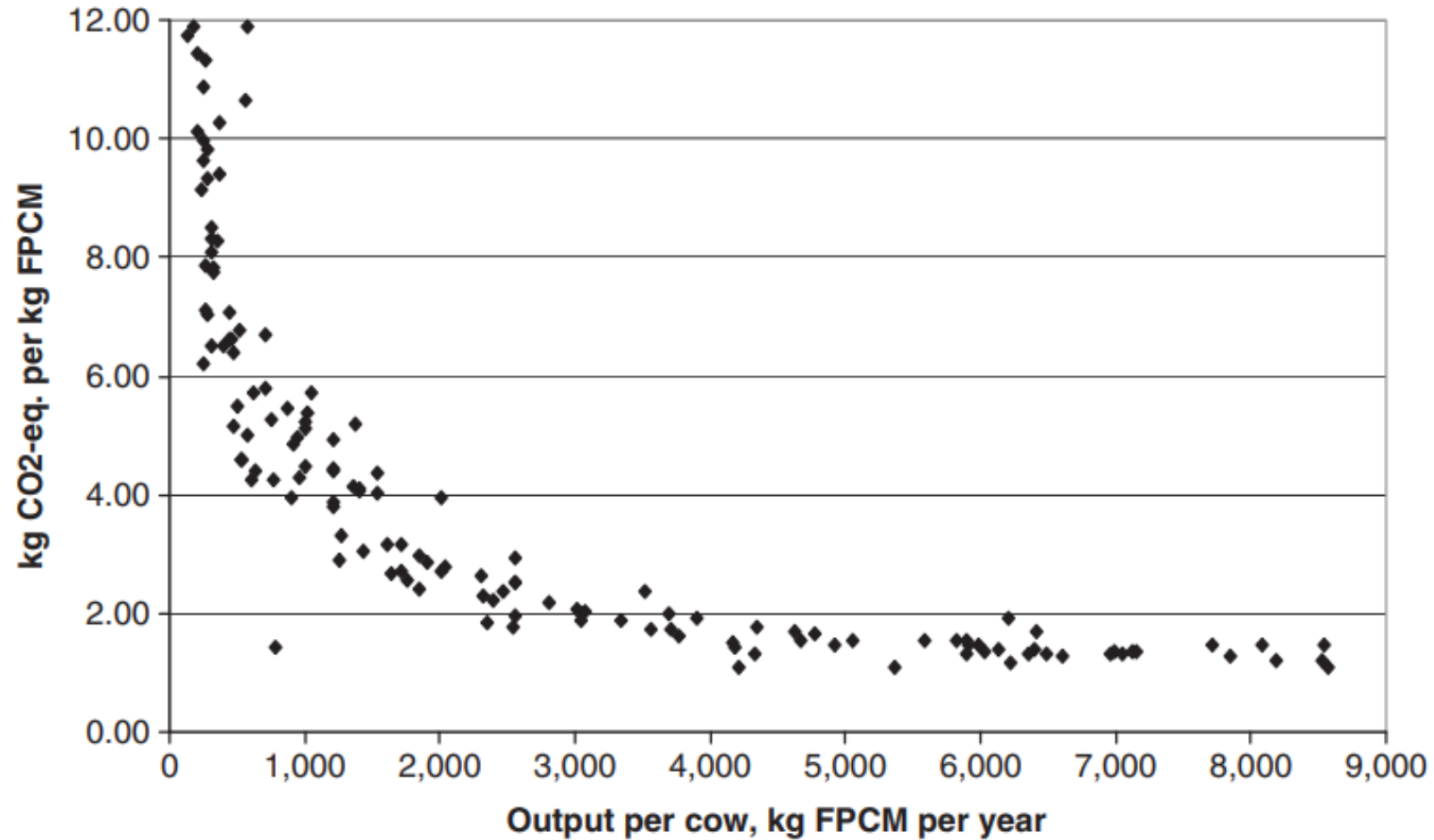
Recommendations for sustainable food systems based on integrated crop-livestock production

- arable land mainly used to grow crops for human consumption – but with leys included for beneficial crop rotation effects
- animal feed mainly from pastures and rotational leys
- animal productivity adapted to maximize animal welfare, resource use efficiency and environmental impact?



Productivity gains and greenhouse gas emissions intensity in dairy systems

Pierre Gerber ^{a,*}, Theun Vellinga ^b, Carolyn Opio ^a, Henning Steinfeld ^a



Thank you for your attention!

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