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Nutritional Life Cycle Assessment of substitutes for meat and milk: are they sustainable alternatives?

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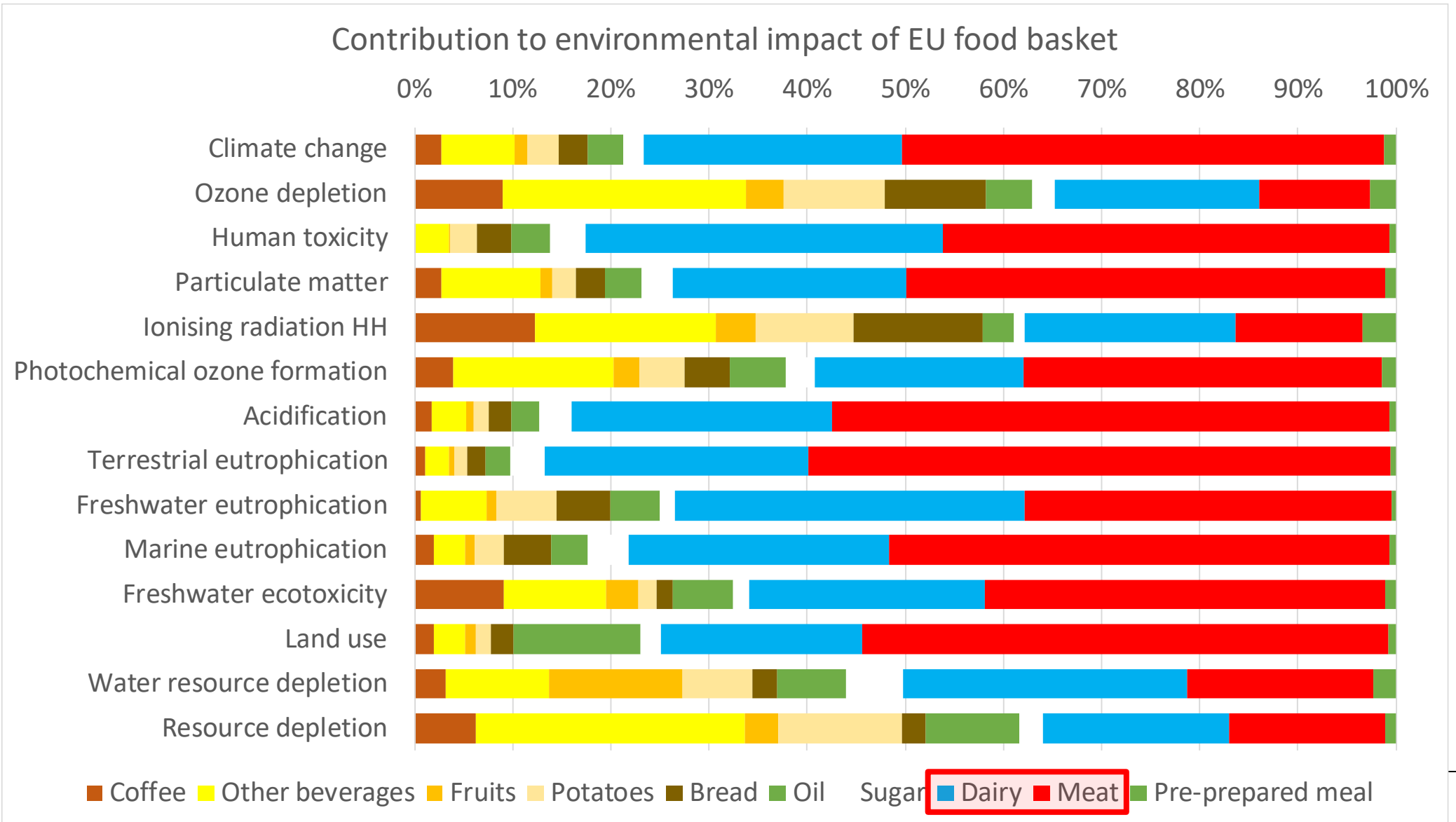
Overview

- Environmental impacts of meat and milk
- Evaluation of meat and dairy alternative **products**:
 - Nutritional values
 - Environmental impacts
 - Focus on protein quality for soya-based alternatives
- Evaluation of meat and dairy alternatives in **diets**:
 - Nutritional adequacy
 - Environmental impacts
- Take-home messages





High impacts of meat and dairy products



B. Notarnicola et al. / Journal of Cleaner Production 140 (2017) 753–765



Evaluation of alternatives to meat and milk



Reference Products

- Animal products with high relevance for the Swiss food industry

Meat		Dairy	
Pork	Poultry	Cheese	Milk
Beef	Veal	Cream	Yoghurt

Alternative Products

- Novel or newly introduced products intended to replace the references
- Differentiation according to: **Production, Processing, Ingredients**

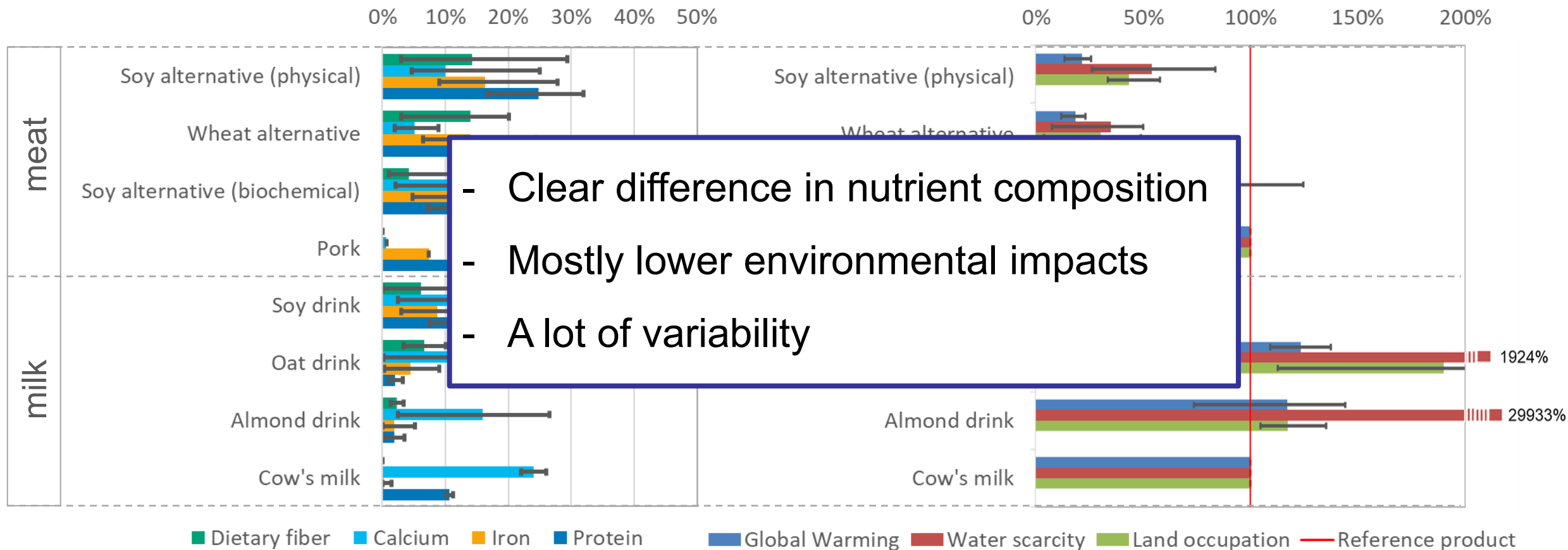




Nutritional values and environmental impacts of alternative products

Nutrient content per portion in relation to the dietary reference intake

Comparison between product and reference environmental impact per kg protein





Focus on protein quality of soya-based alternatives

Table 1: The *in vitro* DIAAS values. Limiting amino acids in parentheses. The corresponding **qc-protein** is calculated by multiplying the protein content with the DIAAS.

Food item	Protein content [g/100g]	DIAAS [%]	qc-protein [g/100g]
Soybeans, cooked	16.3	51 (Trp)	8.3
Tofu, plain, fresh	14.4	84 (SAA)	12.0
SBMA, grilled	13.9	94 (SAA)	13.0
Beef, minced, grilled	32.6	124	40.6
Chicken breast, grilled	30.1	113	34.0
Soy drink, UHT	2.6	85 (SAA)	2.2
Cow milk, 3.5%, UHT	3.3	121	4.0

DIAAS = Digestible Indispensable Amino Acid Score

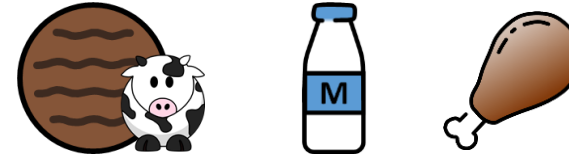
SAA = Sulphur-containing amino acids (Methionine, Cysteine)

Trp = Tryptophan

SBMA = soya-based meat alternative

fully digestible

Excellent DIAAS Score (≥ 100)



Good DIAAS Score (75 - 99)



Poor DIAAS Score (< 75)



Processing

Protein Quality

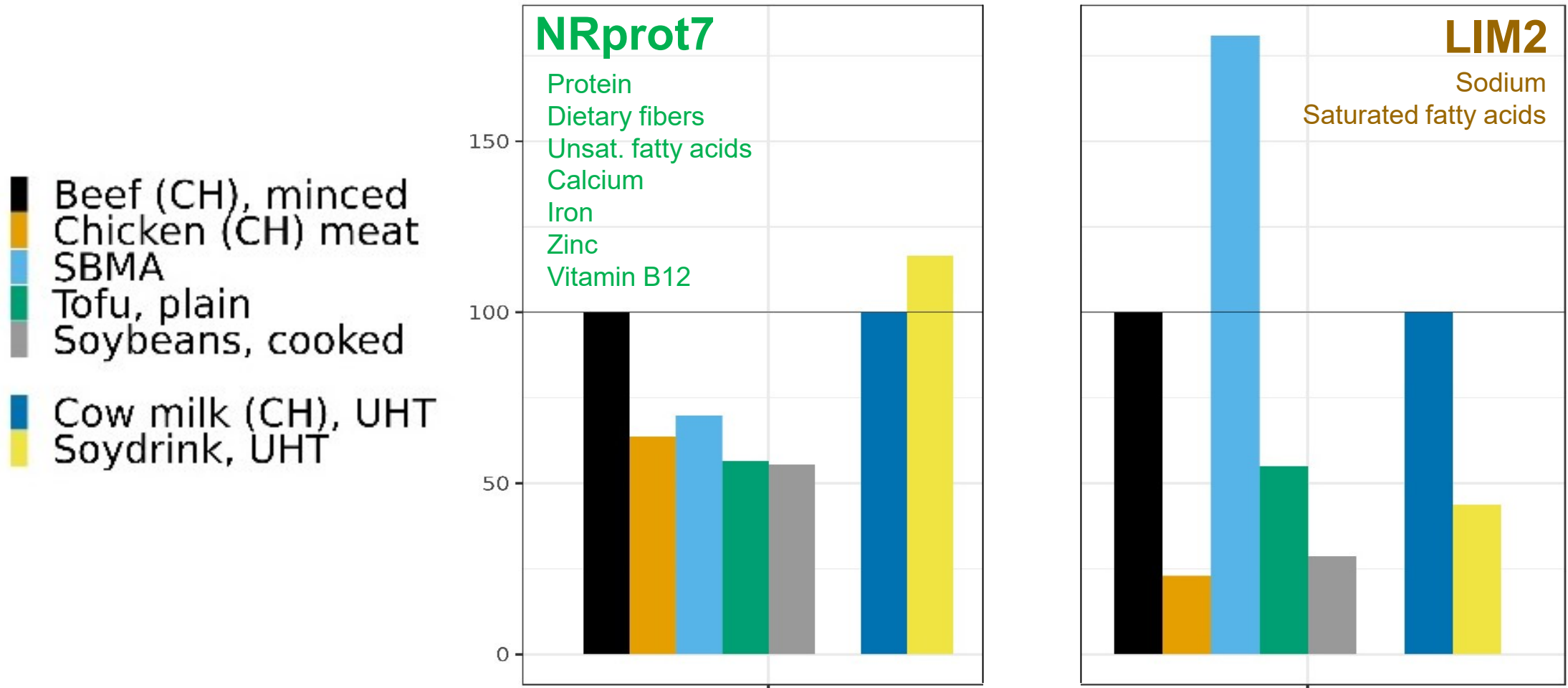


13.11.25 | Nutritional Life Cycle Assessment of substitutes for meat and milk: are they sustainable alternatives?
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Herrmann M. et al., 2024. A Comparative Nutritional Life Cycle Assessment of Processed and Unprocessed Soy-Based Meat and Milk Alternatives Including Protein Quality Adjustment. Frontiers in Sustainable Food Systems, 8, 1413802. <https://doi.org/10.3389/fsufs.2024.1413802>

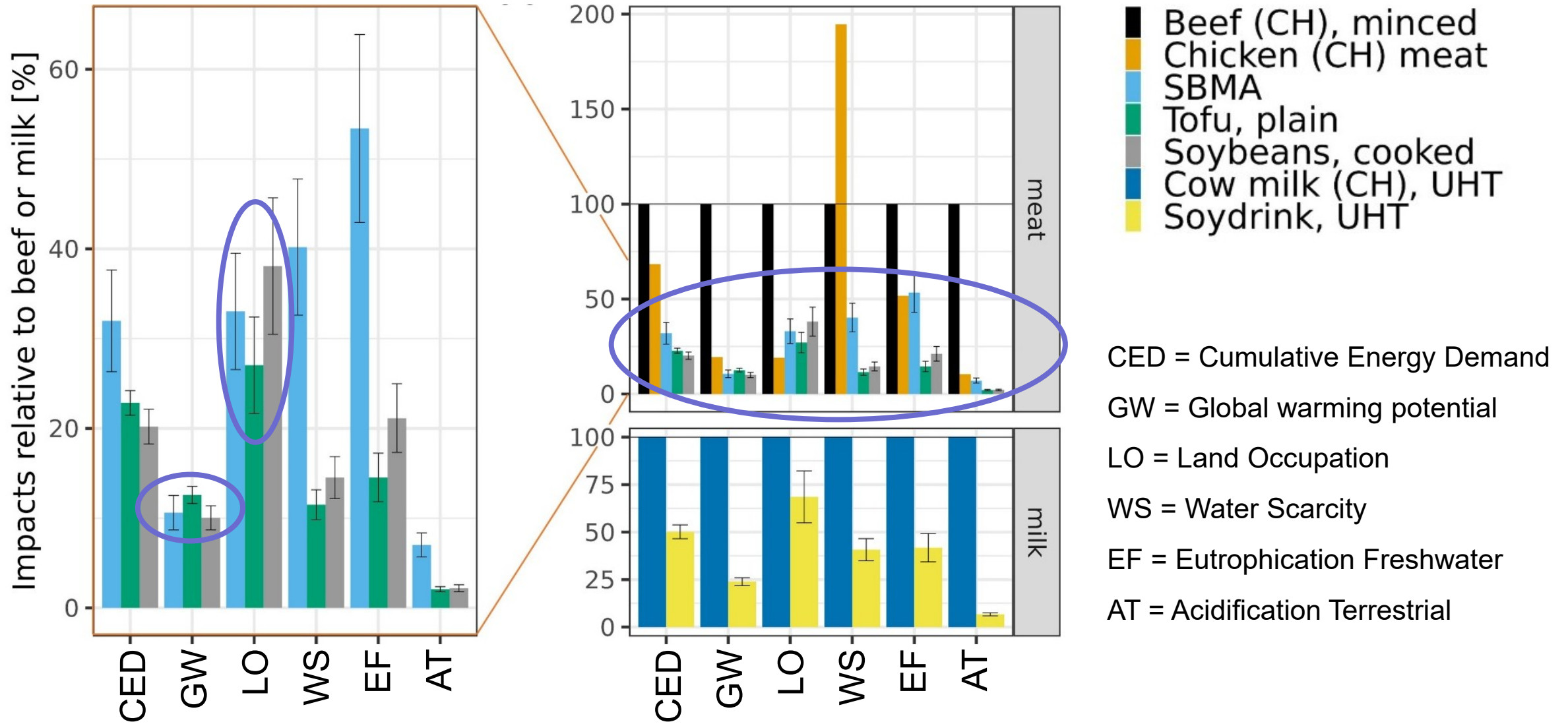


Nutrient Density - Comparison of the **NRprot7** and **LIM2** sub-scores relative to beef and cow milk [%]





Environmental impacts per quality corr. protein



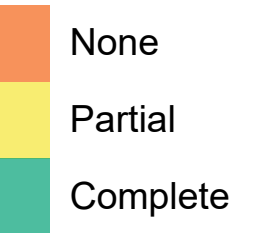


Alternatives in diets: nutritional adequacy



Nutrient	Self-selected diet			Recommended diet		
	Reference	No meat	No meat, no dairy	Reference	No meat	No meat, no dairy
Fibre	Partial	Partial	Partial	Complete	Complete	Complete
Protein	Complete	Complete	Complete	Complete	Complete	Complete
Calcium	Partial	Partial	Partial	Complete	Complete	Complete
Iron	Partial	Partial	Partial	Complete	Complete	Complete
Iodine	None	None	None	None	None	None
Potassium	Partial	Partial	Partial	Complete	Complete	Complete
Zinc	Complete	Complete	Partial	Complete	Complete	Complete
Folic acid	Partial	Partial	Partial	Complete	Complete	Complete
Vitamin B5	Complete	Complete	Partial	Complete	Complete	Complete
Vitamin B12	Complete	Partial	Partial	None	None	None
Sodium	Partial	Partial	Partial	Complete	Complete	Partial
Saturated fatty acids	None	None	Partial	None	None	Complete
Added Sugar	None	None	None	Complete	Complete	Complete

Compliance with DRI





Alternatives in diets: environmental impacts

Environmental impact categories	Self-selected diet			Recommended diet			Comparison to self-selected diet
	Reference [/pers*day]	No meat	No meat, no dairy	Reference	No meat	No meat, no dairy	
Land occupation, agricultural	4.8 m ² a						> 100%
Water scarcity	6.4 m ³						≈ 100%
Global warming	3.7 kg CO ₂ -eq						< 100%
Acidification, terrestrial	38 g SO ₂ -eq						< 90%
Eutrophication, freshwater	0.93 g P-eq						< 80%
							< 70%
							< 60%
							< 50%

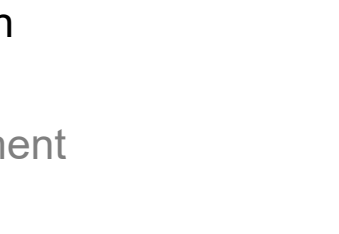
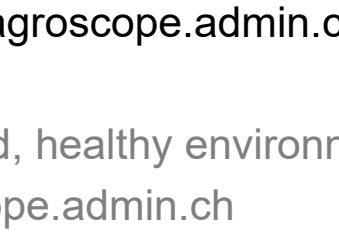
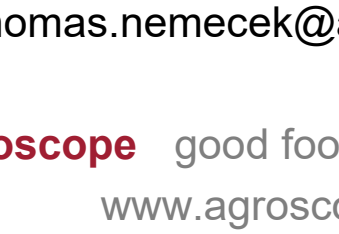
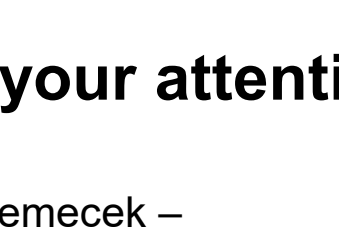
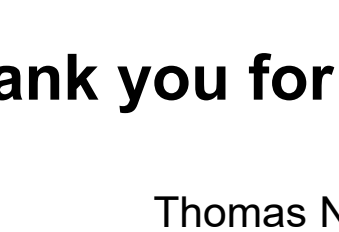
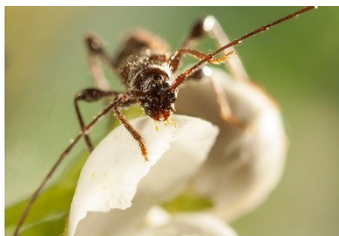
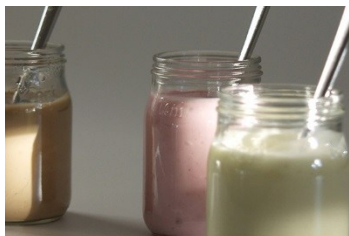
- **Meat alternatives:** (almost) always lower impacts
- **Dairy alternatives:** increase water scarcity and eutrophication



Conclusion and take home message

	Nutritional quality	Environmental impacts	Incorporation in diet recommended?
Meat alternatives	✓ Similar	😊 Lower	Generally yes
Milk alternatives	😞 Lower (except soy drink)	😊 Most lower 😞 Water scarcity higher	Rather to complement the diet

- Critical aspects:
 - Contents of some micronutrients (calcium, iodine, vitamin B12)
 - Protein quality
 - Reduction of disqualifying nutrients (e.g. salt)
 - Environmental burdens of raw materials
- Variability should be communicated transparently



Thank you for your attention

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