Environmental impacts of meat and meat replacements

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14. Environmental Impacts of Meat and Meat Replacements (chapter summary)

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Abstract

Agriculture, especially the livestock sector, hugely stresses the environment through its climate change, land use, and water use impacts, among others. Hence, reducing meat consumption can greatly reduce agriculture's heavy environmental burden. Meat replacements can deliver similar nutrients, and some even mimic meat to facilitate substitution. However, replacements come with their own environmental impacts, which can be highly uncertain, particularly for emerging replacements. This chapter synthesizes the environmental impacts of meat (poultry, pork, and beef) compared to conventional (seafood, eggs, tofu and tempeh, pulses, and nuts) and emerging (plant-based meat analogs, algae, mycoprotein, insects, and cultured meat) meat replacements. We compare their environmental impacts based on life cycle assessment and highlight impact hotspots, opportunities for improvement, and key research gaps. Overall, while conventional replacements already offer more sustainable alternatives to meat, emerging replacements often result in trade-offs that we can proactively tackle today to reduce environmental impacts in the future.

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Reducing meat consumption is essential for a more sustainable food system. Conventional meat replacements like tofu, pulses, and nuts already offer more environmentally friendly alternatives (Figure 1). Emerging replacements also hold the potential to reduce impacts while facilitating the change of consumer choices. For example, cultured meat and plant-based analogs (some are already penetrating the market) can closely replicate meat taste and texture. Therefore, a sustainable food transition can benefit from a dual strategy: promoting the adoption of conventional meat replacements while tackling key challenges of emerging meat replacements.

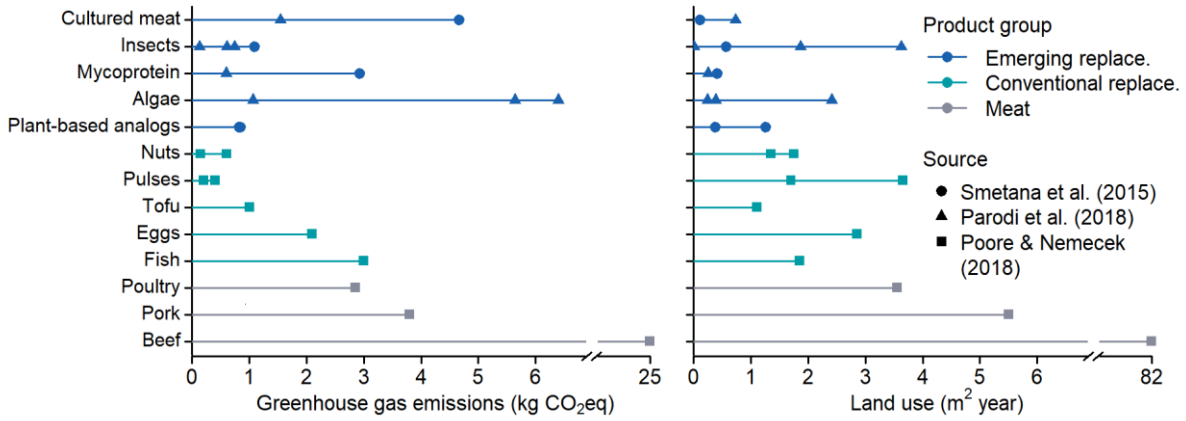

Figure 1: Environmental impacts of meat and meat replacements per 50 g proteins.

Adopting emerging meat replacements entails transitioning from inefficient biological systems to potentially more sustainable technological systems. Diverse practices in livestock production systems can certainly help reduce their environmental impact, but their potential is usually limited. As an established market, the livestock sector has sought to improve operations for many years; emerging meat replacements, in contrast, hold the potential to improve production systems considerably. Remarkably, transitioning toward a cleaner energy supply is essential to achieve significant reductions in environmental impacts for new energy-intensive processes.

The performance of meat and meat replacements can vary greatly. Broadly, beef stands out for its extremely high land use and greenhouse gas emissions (Figure 1). Nuts require caution in some locations with water scarcity. Depending on the production design of cultured meat and the algae species, the greenhouse gas emissions of cultured meat and algae may exceed those of pork and poultry. Likewise, depending on the pulse type and the species and production design of insect-based foods, the land use of pulses and insects may be similar to poultry. The greenhouse gas emissions and land use of most meat replacements are considerably lower than that of meat.

To avoid burden-shifting, future research on meat replacements can more routinely assess a broad range of environmental impacts, besides land use and greenhouse gas emissions. Often, the assessments are mass-based, although mass does not represent the function of food. The choice of functional unit, 50 g proteins in Figure 1, influences comparative assessments. So, the functional unit must be chosen carefully, and, at best, impacts for multiple functional units are compared. Next to meat, milk could be replaced with plant-based alternatives. Soy and almond milk show environmental benefits over dairy milk, although trade-offs exist again (Grant & Hicks, 2018).

Besides environmental impacts based on life cycle assessment (covered in this chapter), considering broader implications can help define a truly sustainable food system. Life cycle sustainability assessment (LCSA) broadens the impacts assessed from the environmental to social and economic dimensions (Guinée, 2016). Furthermore, the public increasingly recognizes the importance of considering the welfare of the animals used for producing meat products. (Scherer et al., 2018) suggested animal welfare as a fourth dimension in LCSA, which is especially relevant to animal-based foods, including some meat

replacements like eggs and insects. Chapters 8-11 of this book discuss animal welfare and other ethical aspects of meat and meat replacements.

While emerging meat replacements are improved and scaled up, conventional meat replacements, such as tofu and pulses, can already now greatly increase the sustainability of our food systems. Switching from a typical European diet to a diet without meat and other animal products can reduce greenhouse gas emissions and land use by up to 50% (Hallström et al., 2015). Reduced meat consumption also plays a key role in tackling biodiversity loss (Machovina et al., 2015) and other major environmental challenges.

References (of conclusions and outlook)

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