

Assessment of the environmental sustainability of plant-based meat and pork

OPPORTUNITIES FOR IMPROVED SUSTAINABILITY PRACTICES IN THE INDUSTRY

Outline

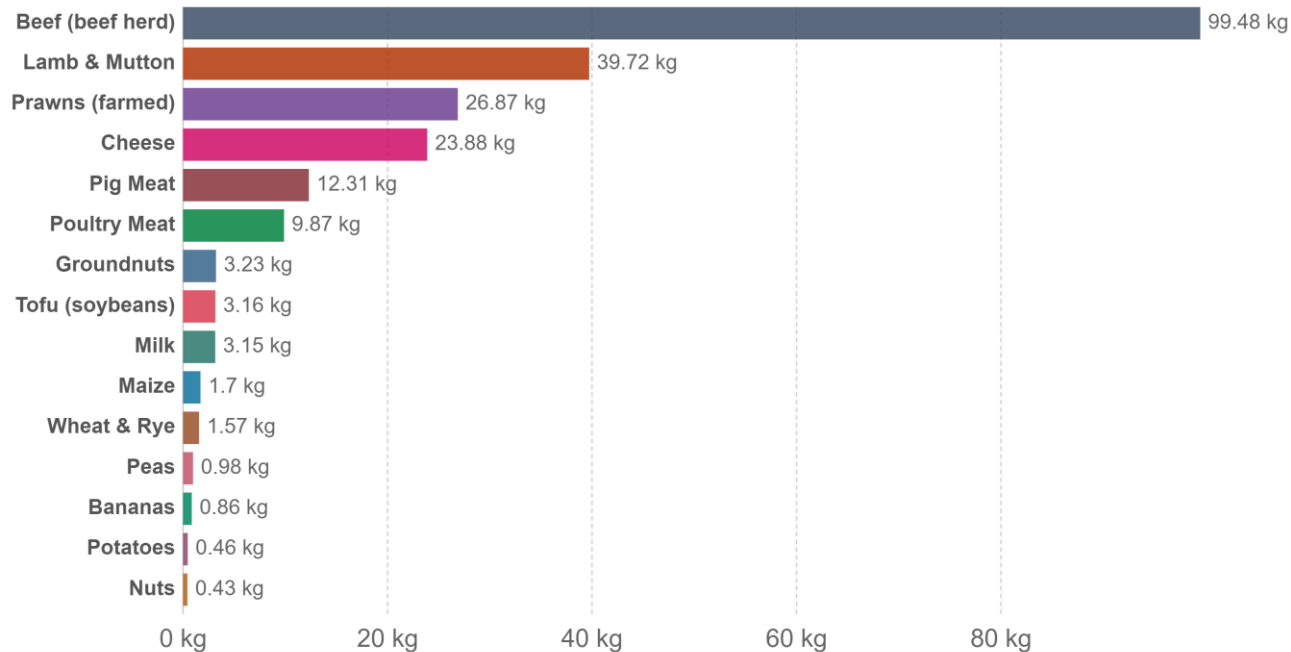
- Why? – The sustainability challenge
- What? – Foods selected for comparison
- How? – Data & methods
- Results
 - Ingredient sustainability: proteins
 - Ingredient sustainability: oils
 - Plant-based meat sustainability
- Guidelines for environmentally-friendly plant-based meats

The Sustainability Challenge

Greenhouse gas emissions per kilogram of food product

Greenhouse gas emissions are measured in kilograms of carbon dioxide equivalents (kgCO₂eq) per kilogram of food product. This means non-CO₂ greenhouse gases are included and weighted by their relative warming impact.

Our World
in Data



Source: Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers.

Note: Data represents the global average greenhouse gas emissions from food products based on a large meta-analysis of food production covering 38,700 commercially viable farms in 119 countries.

OurWorldInData.org/environmental-impacts-of-food • CC BY

By 2050, to meet food security and climate mitigation goals, society must:

1. Double food production
2. Reduce agricultural greenhouse gas (GHG) emissions by 73%

Foods Compared

Main ingredients for formulations of plant-based meat in China

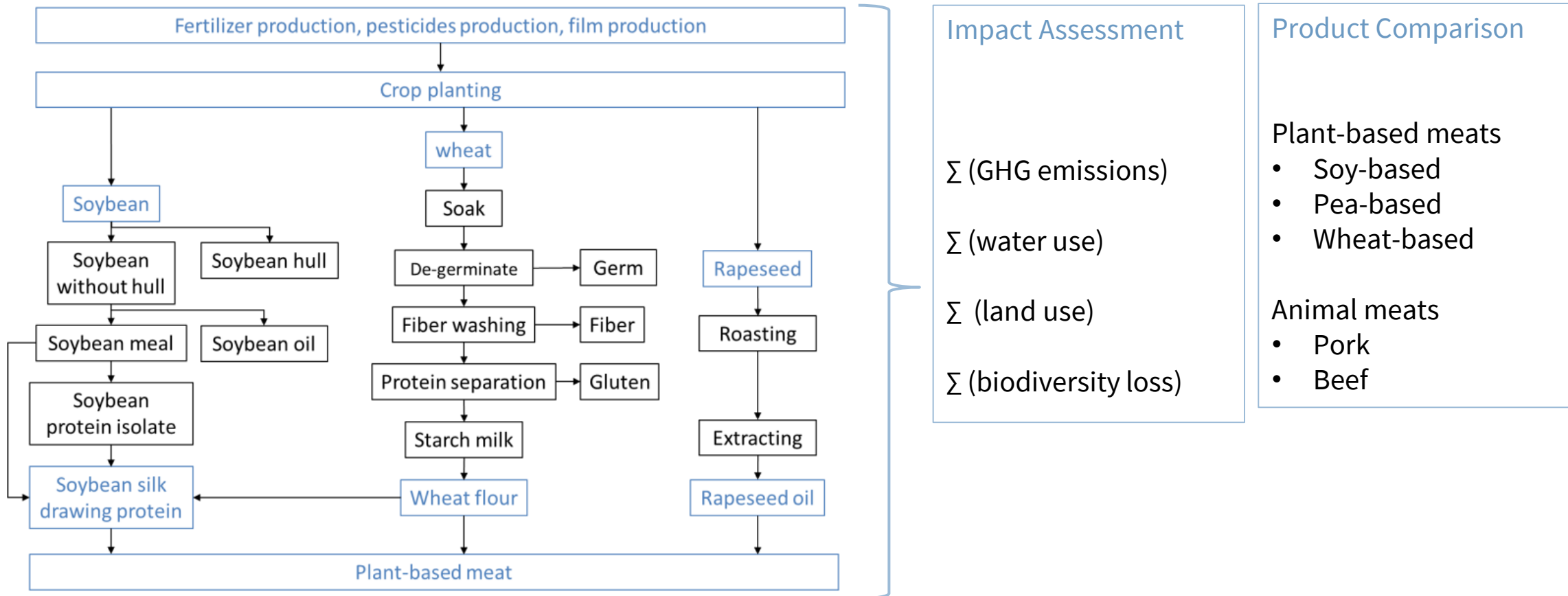
Composition	Representative ingredient	Other ingredients
Plant protein	Soy (concentrate, isolate), pea (concentrate, isolate), wheat (gluten)	
Fat	Rapeseed oil, corn oil, coconut oil	Sunflower oil, palm oil
Carbohydrate	Wheat starch, sugars	
Flavor	Salt, soy sauce, garlic powder, black pepper, rosemary and other spices	
Adhesive material	Methyl cellulose, inulin, starch, carrageenan, xanthan gum	
Colorant	Beet juice extract, caramel pigment, bean hemoglobin	

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Life Cycle Assessment Method



Data Sources

Production Data

Crop production (China):

- China: CAAS review of national statistics
- International: Agrifootprint 5 LCA database

Ingredient processing:

- China: CAAS review of industry reports
- International: Agrifootprint 5 LCA database

Plant-based meat processing:

- Meija et al. 2018, Berardy et al. 2020

Energy and fuels production and use:

- IEA (2018 Chinese electric generation mix)
- Agrifootprint 5 LCA database
- Ecoinvent LCA database

Impact Assessment

ReCiPe 2016:

- Σ GHG emissions
- Σ water use
- Σ land use

Chaudhary et al. 2018

- Σ biodiversity loss (crop production only)

Product Comparison

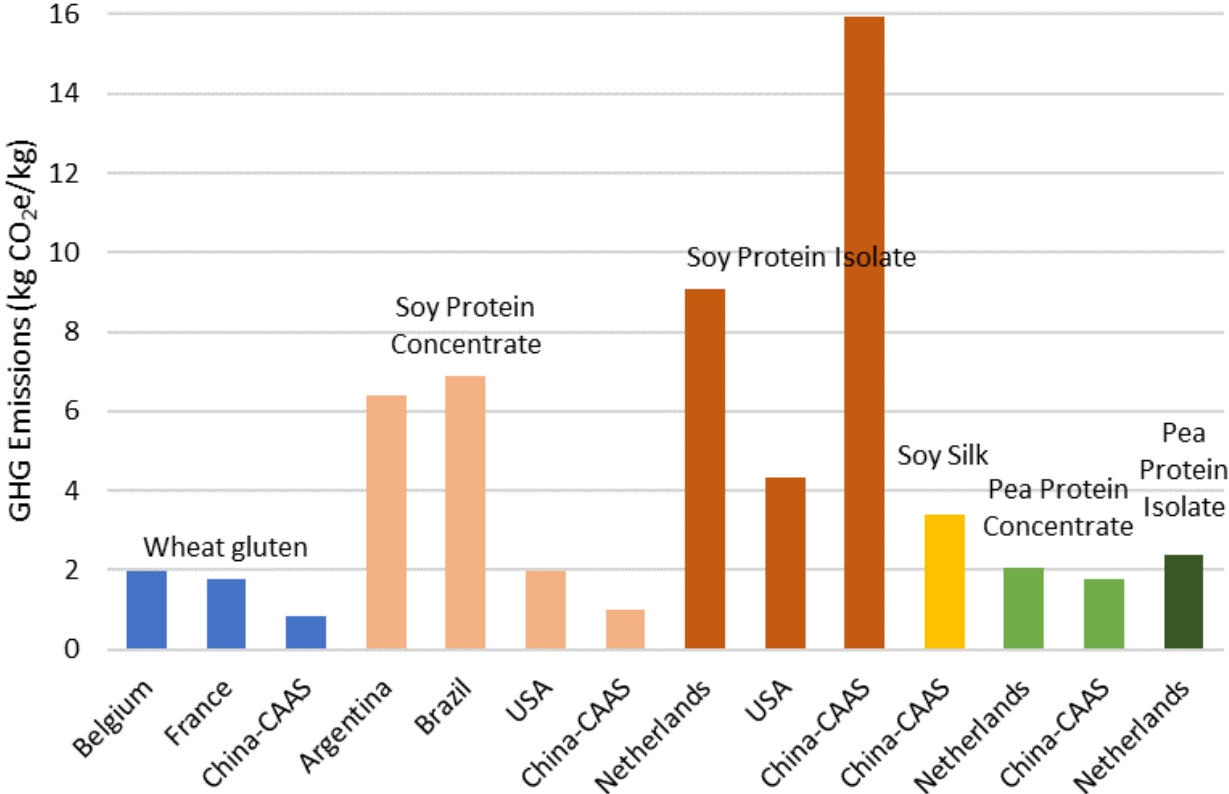
Plant-based meats

- Current study

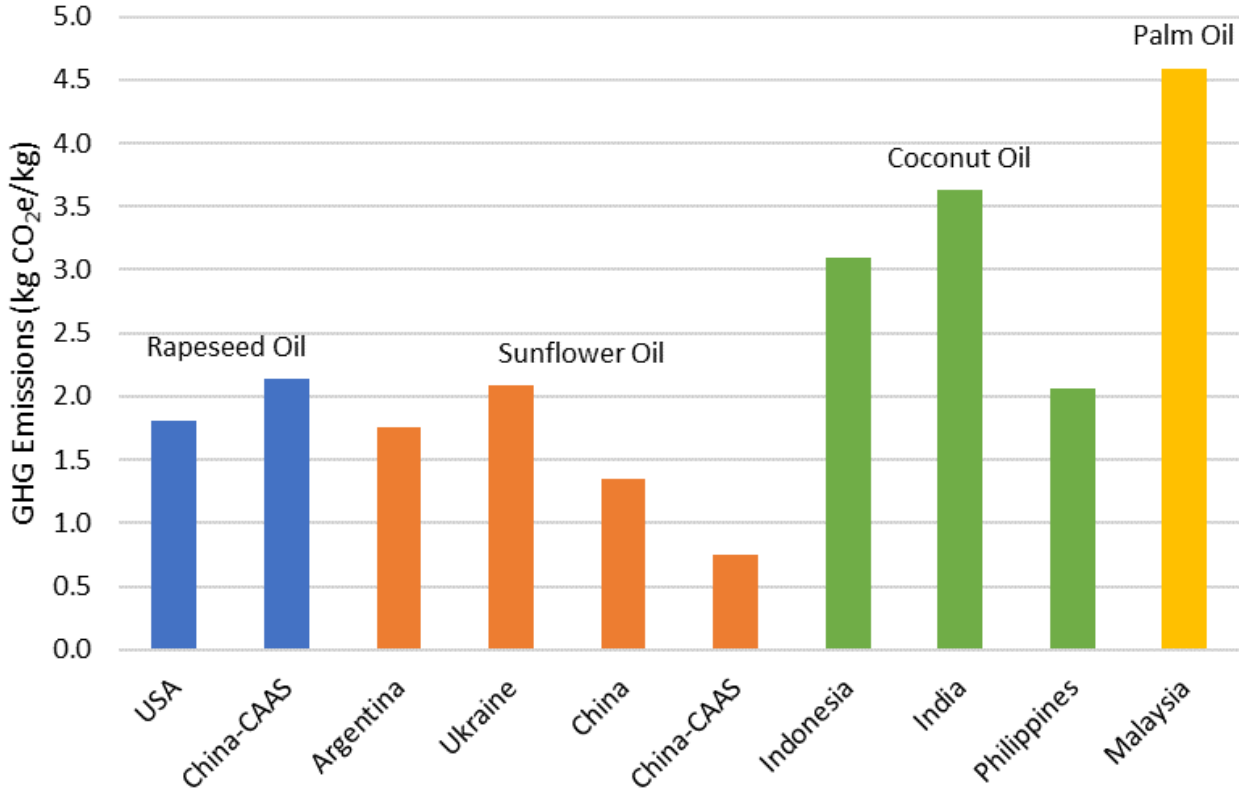
Animal meats

- Pork
 - CAAS carbon footprint
 - Literature review
- Beef
 - Literature review

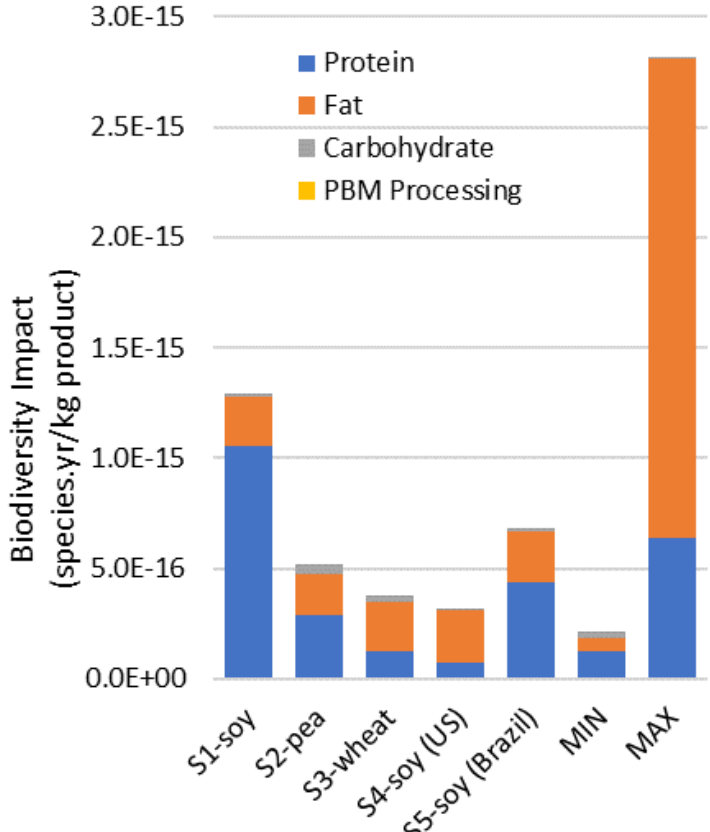
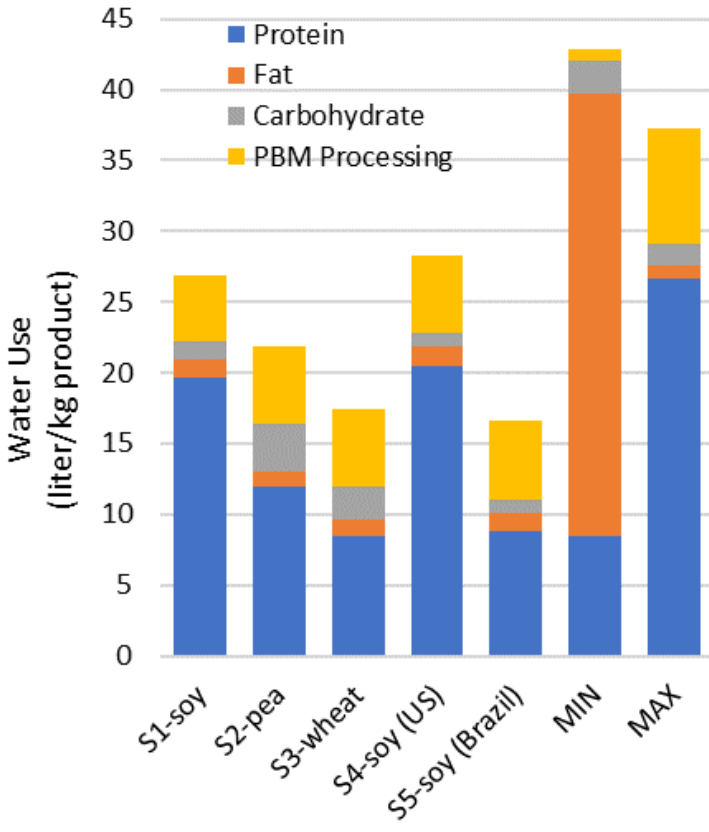
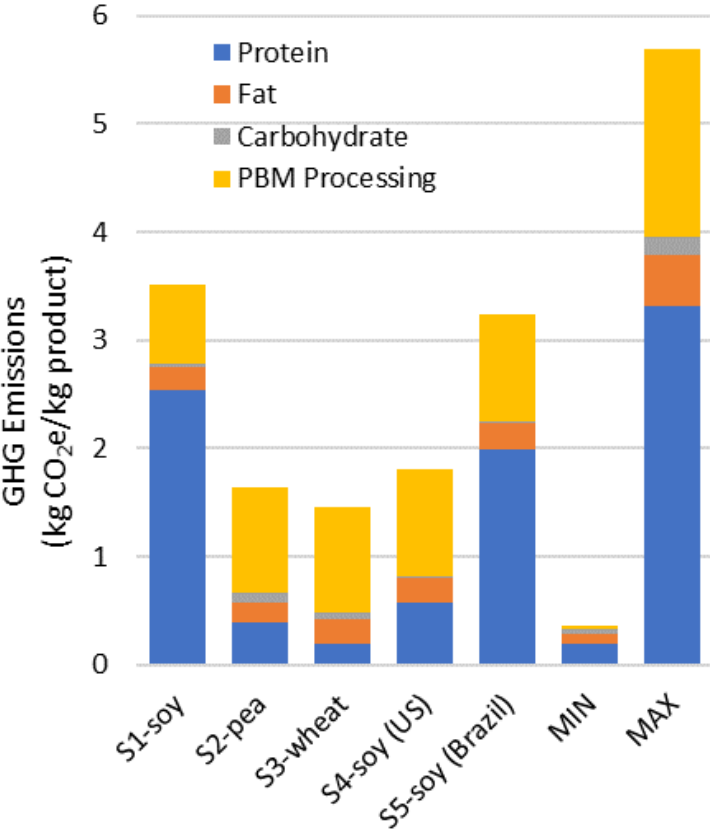
Results: protein ingredients



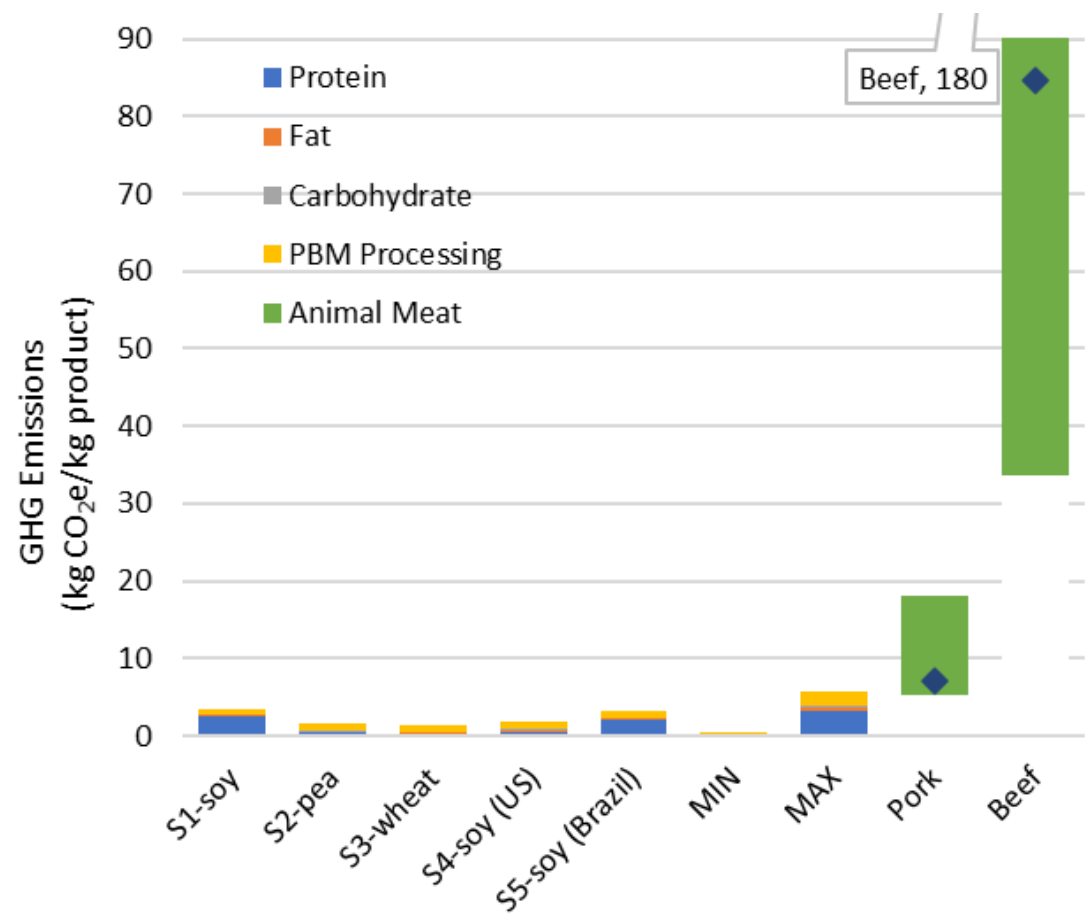
Results: oil ingredients



Results: plant-based meats



Results: plant-based meats



Sustainability Guidelines

Ingredient Guidelines:

- The crop type and source country of the core protein ingredient drives plant-based meat performance
- Source protein and oil ingredients from regions with minimal risk of deforestation
- Source ingredients from producers with low irrigation needs

Energy Guidelines

- Source renewable energy at the plant-based meat factory
- Source ingredients from producers who utilize renewable energy and avoid producers who utilize coal power