## Towards sustainable food system in China: transformation options and their connections to the food-land-water-climate nexus

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Sep 10, 2024







## Food system transformation is critical for respecting PBs and achieving SDGs

#### Planetary boundaries (PBs)





Sustainable Development Goals (SDGs)



### Problem statement

- Food, land, water, and climate have, in the past, often been treated as individual and disconnected sectors (Johnson et al., 2019).
- Pathways and measures to achieve one or more specific PBs/SDGs may cause trade-offs or unexpected changes for other PBs/SDGs and/or for other sectors/regions in our society.
- It remains unclear how solutions to one PB/SDG affect other PBs/SDGs in the food-land-water-climate nexus.



## Central research questions

- What are the environmental and economic impacts of food transformation options?
- How will these options cause trade-offs and synergies in the foodland-water-climate nexus?





An integrated environmental-economic framework based on applied general equilibrium (AGE) models

#### Database:

- 1) GTAP version 10 database (2014 as the base year)
- 2) Region- and sector-specific environmental impact database



**Global Trade Analysis Project** 

- Regions: China and its main food and feed trading partners (MTP, including Brazil, the United States, and Canada)
- Sectors: Detailed food-related sectors and aggregated non-food sector



## PhD research outline





**Paper 1:** Exploring sustainable food system transformation options in China: An integrated environmental-economic modelling approach based on the applied general equilibrium framework





#### (Long et al., 2024, Sustainable Production and Consumption, Accepted)

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### Scenarios of paper 1



**Paper 2:** A modest mitigation target could address rebound effects of upcycling food waste as feed in China while safeguarding global food security

Global food waste drive greenhouse gas (GHG) emissions	Environmental benefits of feeding animals with food waste	Contribution to Sustainable Development Goals (SDGs)	Indirect and spillover effects not covered in previous studies	Why C	China?		
• Around 1.3 billion tonnes of food waste are produced in the world, which are mainly disposed in landfills and incinerators, and are a significant source of greenhouse gas (GHG) emissions (Gustavsson et al., 2011).	• Feeding animals with food waste can possibly reduce GHG emissions, mitigate land pressures, and alleviate food-feed competition (Van Zanten et al., 2018; Van Hal et al., 2019; Fang et al., 2023).	<ul> <li>It may to achieving Sustainable Development Goals (SDGs), including SDG 2 (zero hunger), SDG 6 (clean water and sanitation), SDG 12 (responsible consumption and production), SDG 13 (climate action), and SDG 15 (life on land) (UN, 2025).</li> </ul>	<ul> <li>Rebound effect: Lower feed costs may expand livestock production and increase emissions.</li> <li>Knock-on effects: It may exacerbate emissions further.</li> <li>Food security: Addressing rebound effects while ensuring food security remains unclear.</li> </ul>	46% of global pork production 13% of global poultry meat production	34% of global egg production 27% of food produced is wasted		

## Applied general equilibrium models with food waste



## Scenarios of paper 2

Scenarios	Food waste as feed	Emission mitigation target
S1: Partial use of food waste as feed	Food waste: 54% By-products: 100%	No
S2: Full use of food waste as feed	Food waste: 100% By-products: 100%	No
S3: S1 + A modest emission mitigation target	Food waste: 54% By-products: 100%	Implementing economy-wide emission taxes to ensure that emissions of greenhouse gases, acidification pollutants, and eutrophication pollutants in both China and its trading partners do not exceed their baseline (S0) levels.
S4: S1 + An ambitious emission mitigation target	Food waste: 54% By-products: 100%	Implementing economy-wide emission taxes to meet their annual mitigation target of the Intended Nationally Determined Contributions (INDC) under the Paris Agreement and the "13th Five-Year Plan".



## **Paper 3:** Food system transformation is key to achieving food security and environmental sustainability in China

Scenarios	Descriptions			
S1: Crop supply-side option	<ul> <li>Improving crop production efficiency through Integrated Soil-crop System Management technology (ISSM).</li> </ul>			
S2: Livestock supply- side option	<ul> <li>Upcycling food waste as feed in monogastric livestock production.</li> </ul>			
S3: Demand-side option	<ul> <li>Shifting towards less meat-intensive diets based on the EAT-Lancet diet recommendation.</li> </ul>	-		
S4: S1+S2+S3	<ul> <li>Combing crop and livestock supply-side as well as demand-side measures.</li> </ul>			



# **Paper 4:** Exploring transformation options in the food-land-water-climate nexus: towards achieving multiple SDGs in China

Scenarios	Descriptions
Food scenario	Shifting towards less meat-intensive diets based on the EAT-Lancet diet recommendation in line with SDG 2 (zero hunger).
Land scenario	An afforestation policy based on China's National Forest Management Plan (2016–2050) in line with SDG 15 (life on land).
Climate scenario	A carbon tax in line with the Paris Agreement as well as the PB on climate change and SDG13 (climate action).
Water scenario	Improving crop production efficiency up to the levels of developed countries in line with SDG 6 (clean water and sanitation).
Combined scenario	Combining food, land, water, and climate scenarios.

