Quantifying sustainability transition

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Why do we need quantitative modelling of sustainability transition?

Sustainability transition necessitates thorough changes in the ways we consume and produce various goods and services

This generates a need for system-level models that

- quantify consumption and production of various goods and services *simultaneously*
- together address *relevant aspects of sustainability*: environmental, social and economic
- recognize *different environmental burdens*; climate change, eutrophication, depletion of water resources, loss of biodiversity…
- help to understand *complex systems and interdependencies, trade-offs etc*. within them and to find leverage points by *differentiating relevant from irrelevant*
- *inform* stakeholders, and planning and monitoring of transitional policies

Our approach to modelling of systems and their sustainability

Environmentally extended input-output (EE-IO) models are economic models that

- describe economic activities and interactions in a definite scale (regional, national, global)
- link environmental burdens to the production and consumption of goods and services
  - Use of natural resources, energy, water and land; GHG emissions, eutrophying emission to water, biodiversity

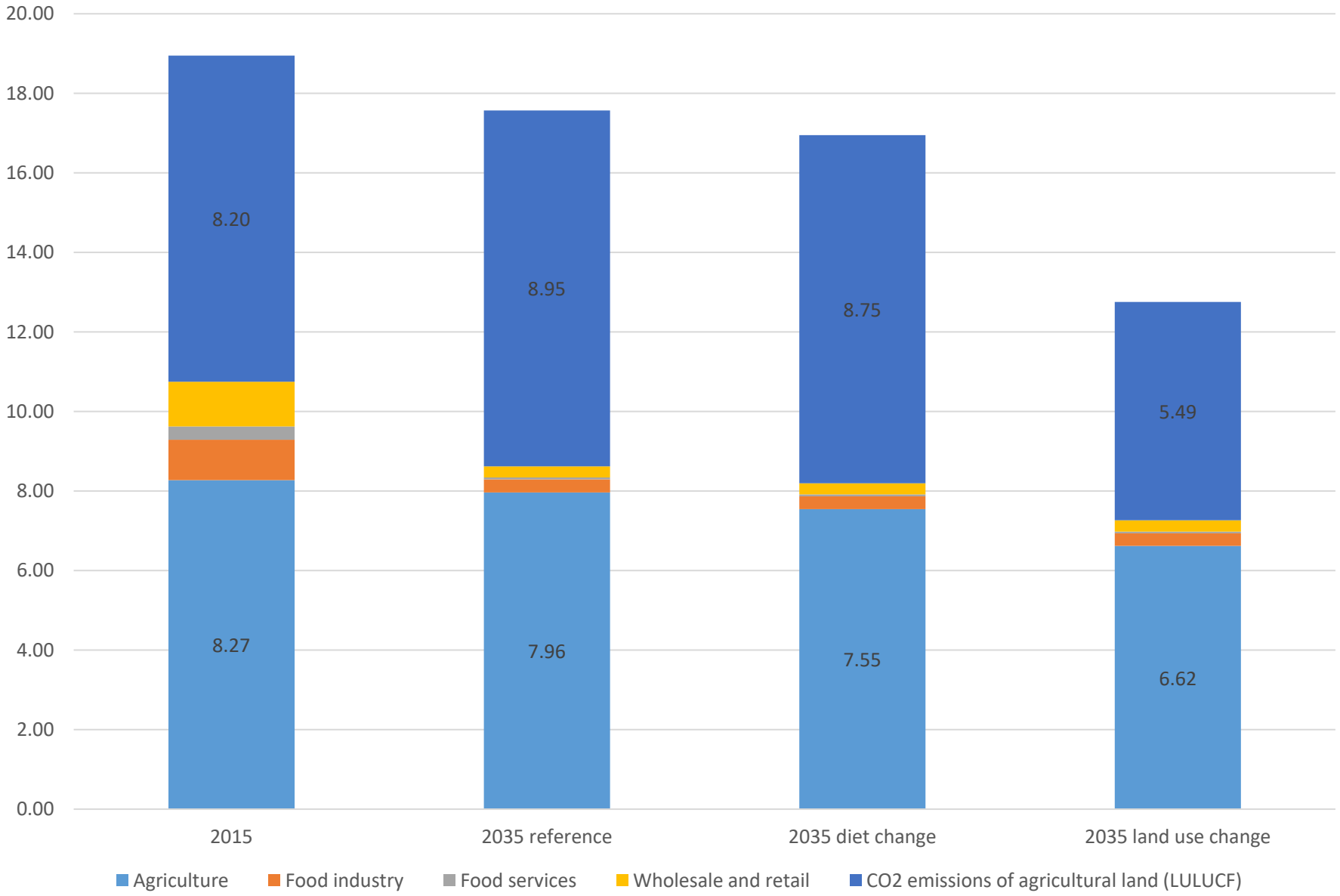
Rather than a single model, we have a set of models for different purposes

- ENVIMAT is an EE-IO model for the Finnish economy, base years 2015, 2019, (2022)
- ENVIMATfood is a highly disaggregated food system model for Finland; 2015, (2019)
- ENVIMATmaakunta contain models for each of the counties in Finland
- ENVIMATscen is a scenario model containing dynamic elements unlike the above static models

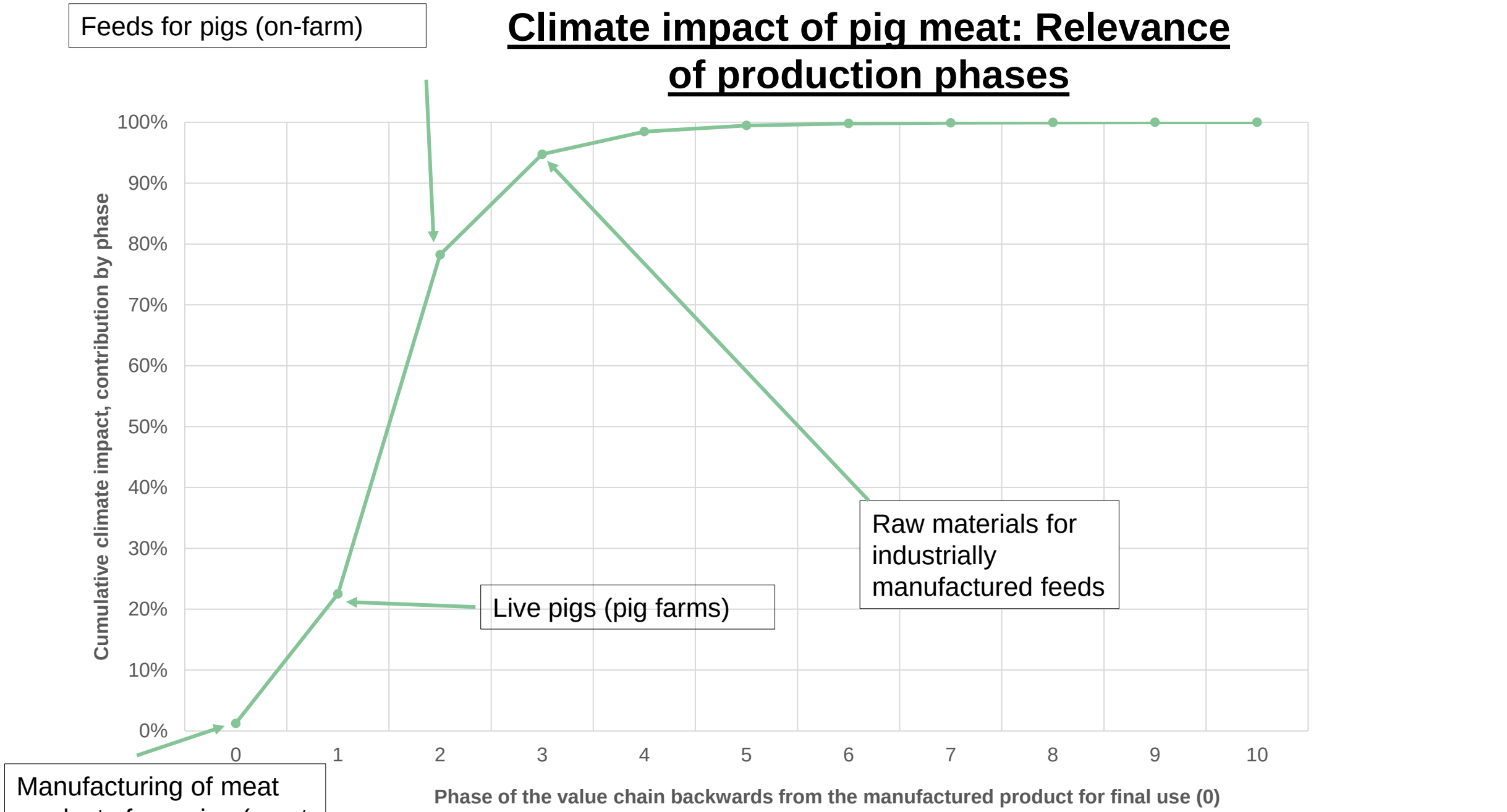
Examples of research questions that can be answered with our models

1) How large are the various environmental footprints of different goods and services?
2) How do the different phases of value chains contribute to these footprints? (Structural pathway analysis)
3) How large is the consumption-based total carbon/water footprint of Finland and how large part of these footprints are related to imported commodities?
4) How large is the production-based carbon/water footprint of Finland and how large part of these footprints are related to exported commodities?
5) What industries have the highest/lowest environmental footprints per value of output?
6) What is the number of farms that are heavily dependent on GHG-emission-intensive organic soils and which value chains and products are they associated to?
7) Static what-if-scenarios:
   - How much the environmental burdens of the Finnish food system would change if the diets of the Finnish population adhered to the nutrition recommendations? How would this change affect Finnish primary production and food industry?
8) Scenarios that contain anticipated changes in the Finnish economy by the end year:
   - How are the greenhouse gas emissions of the Finnish food system affected by 2035 by the on-going energy transition?

Total emissions of food system (million tons CO_2-eq)



Climate impact of pig meat: Relevance of production phases



What should be done to reduce environmental burdens of the Finnish food system?

1) As for climate impacts, dietary changes are effective only when accompanied with measures that mitigate land-use and land-use-change-related emissions from organic agricultural land
2) Energy transition is expected to reduce the GHG emission substantially by 2035/2050 increasing the share of agriculture and its land use – much like the case of eutrophying emissions to waterbodies
3) As for eutrophying loads to waterbodies, (centralized) poultry production and egg farms are troubled by excess manure. While white meat might be promoted as a more sustainable substitute for red meat for climate impact, this is not the case for eutrophying emissions.
4) Ca. 70% of farms are quite independent on organic fields. By contrast, 230 farms (0.4% of all farms) cultivate almost entirely such fields making them the most vulnerable to policies that restrict cultivation of organic fields. Here, dairy and cattle chains are clearly the most affected value chains.

Thank you!

Contacts:

ENVIMAT: Hannu Savolainen, Mari Heikkinen

ENVIMATmaakunta: Hannu Savolainen, Mari Heikkinen, Santtu Karhinen

ENVIMATfood: Jani Salminen, Henri Virkkunen (land use, agriculture)

ENVIMATscen: Mari Heikkinen

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