Does Re-Regionalizing Our Food System Reduce Our Climate Footprint? A Case Study of Tomato Production, Processing, and Transport

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Study Design
The study takes the perspective of a hypothetical Michigan consumer who can choose between tomato products originating either in California or in Michigan. We compared two distinct production and supply chains for canned tomato paste and canned diced tomatoes, each ending at a retail distribution center in Michigan.

Study Questions
- How does location of production and long-distance shipment affect the climate footprint as well as energy and water impacts of food supply chains?
- Can processing foods in different ways prior to shipment lower the environmental impacts of long-distance shipment?
- Which life cycle stages - production, processing, or transport - are most responsible for climate, energy, and water impacts?
- How do organic and conventional production and processing systems compare?

Methods
Life cycle assessment (LCA) evaluates the environmental flows (energy and material inputs and product and pollution outputs) over a product's life cycle, in this case from field production through transport to retail distribution centers. This LCA study has the following features:

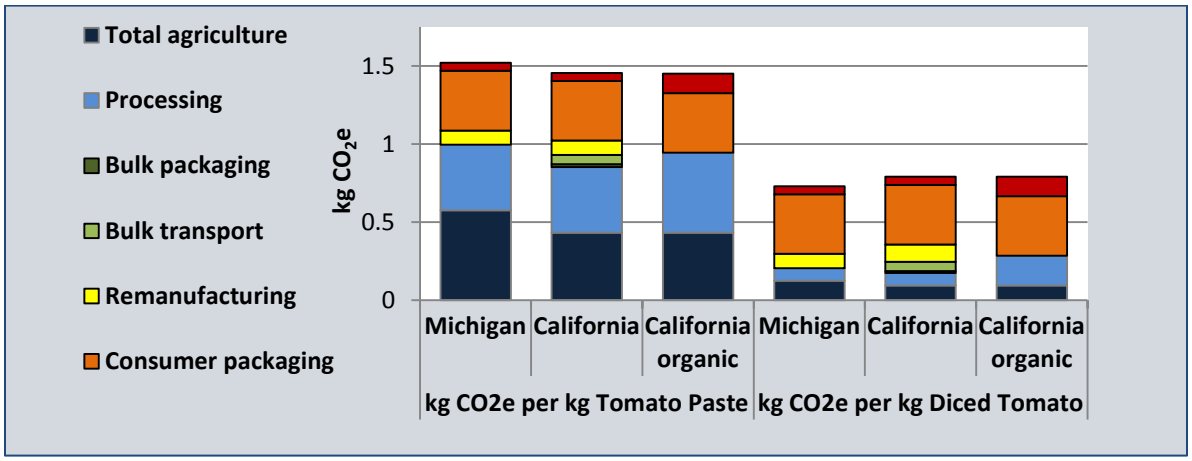
- Data for energy and material inputs, yields, and transport distances from UC Davis Cost of Production studies, other literature, and interviews with Cooperative Extension and processing plant managers in both CA and MI.
- Net greenhouse gas emissions (CO_2, N_2O, CH_4), energy use, and use of developed water resources quantified for each system using the Ecoinvent database, other published databases, and government reports.
- Greenhouse gas emissions expressed as 100-yr Global Warming Potential (GWP) according to Intergovernmental Panel on Climate Change (IPCC) guidelines.

Results
- Shipping California-produced products to Michigan consumers does not substantially increase the climate footprint compared to Michigan products, because
    - CA production is highly efficient per unit of yield
    - lime soil amendment needed for acid soils in MI releases CO_2
    - rail transport from CA to MI is very fuel-efficient.
- Switching from rail to truck transport between CA and MI would result in almost 50% higher life cycle energy use and 25% higher GHG emissions for CA-produced products, giving them 20% to 50% larger footprints than MI products.
- Greater energy inputs and concentration of product make the production and processing stages a larger relative share of the total footprint in paste than in diced tomatoes.
- Consumer packaging (canning) constitutes the largest share in diced tomatoes.
- Highly concentrated products (e.g. paste) create a larger total footprint per kg than less concentrated products, but also amplify existing energy and GHG efficiencies in field production of the raw product. Therefore, CA diced tomatoes have a slightly larger total climate footprint than MI diced, but CA paste has a smaller footprint than MI paste.

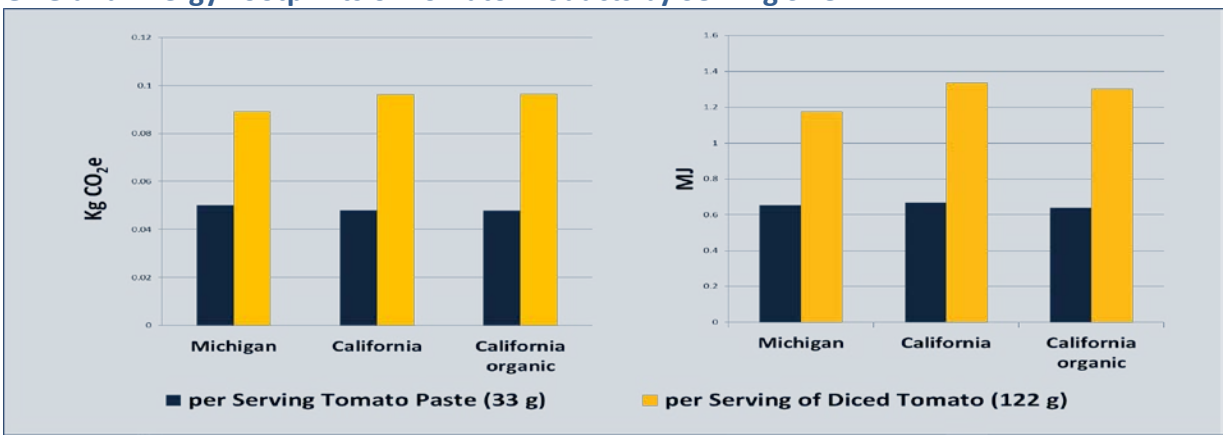
Tradeoffs:

- CA production uses substantially more irrigation water than MI production, with implications for environmental and socio-economic externalities.
- Organic production offers energy and water use advantages that can offset the higher energy requirements of chemical-free processing methods, but only when organic crop yields are similar to conventional yields (which they can be in processing tomatoes).

Life Cycle Greenhouse Gas Emissions of Paste and Diced Tomatoes by Location of Origin



GHG and Energy Footprints of Tomato Products by Serving Size



Life Cycle Water Use of Paste and Diced Tomatoes by Location of Origin