Does Re-Regionalizing Our Food System Reduce Our Climate Footprint?

A Case Study of Tomato Production, Processing, and Transport

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.

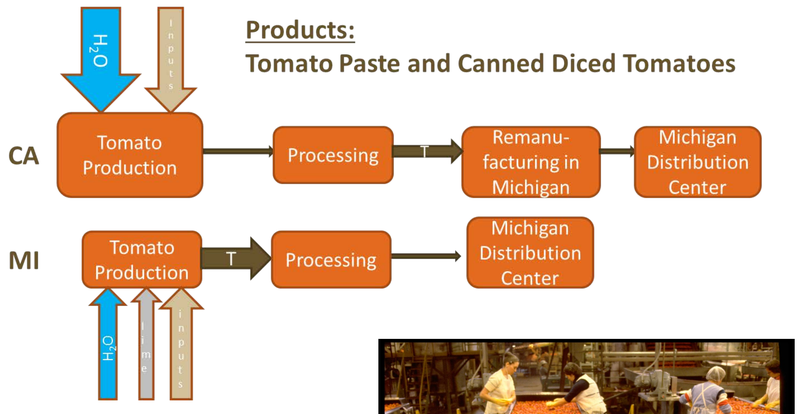

Photo courtesy of R. Paul Singh, UC Davis

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Study Questions

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

Methods:

Life cycle assessment 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**.

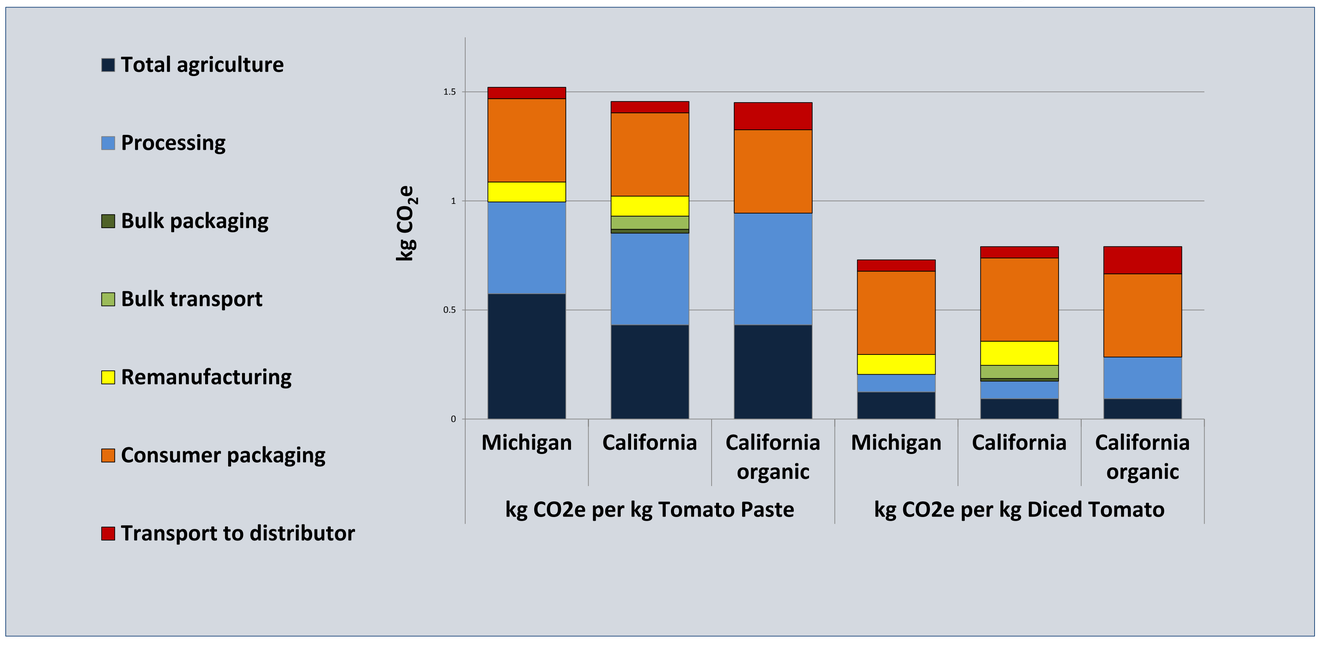
- Data for **energy** and **material inputs, yields**, and **transport distances** from UC Davis Cost of Production studies, other literature, and interviews with Cooperative Extension and processing plant managers in both CA and MI.
- **Net greenhouse gas emissions** (CO_2, N_2O, CH_4), **energy use**, 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

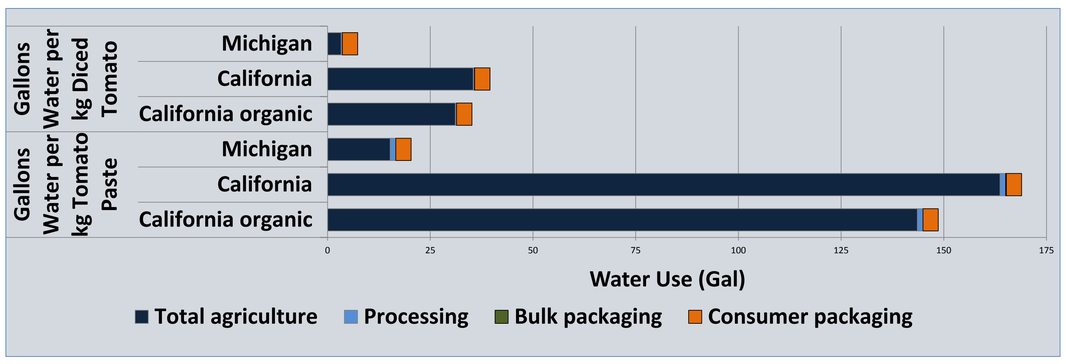
- Shipping California-produced products to Michigan consumers does **not substantially increase the climate footprint** compared to Michigan products, because
  - **CA production is highly efficient** per unit of yield
  - **lime soil amendment** needed for acid soils in MI **releases CO_2**
  - **rail 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.***

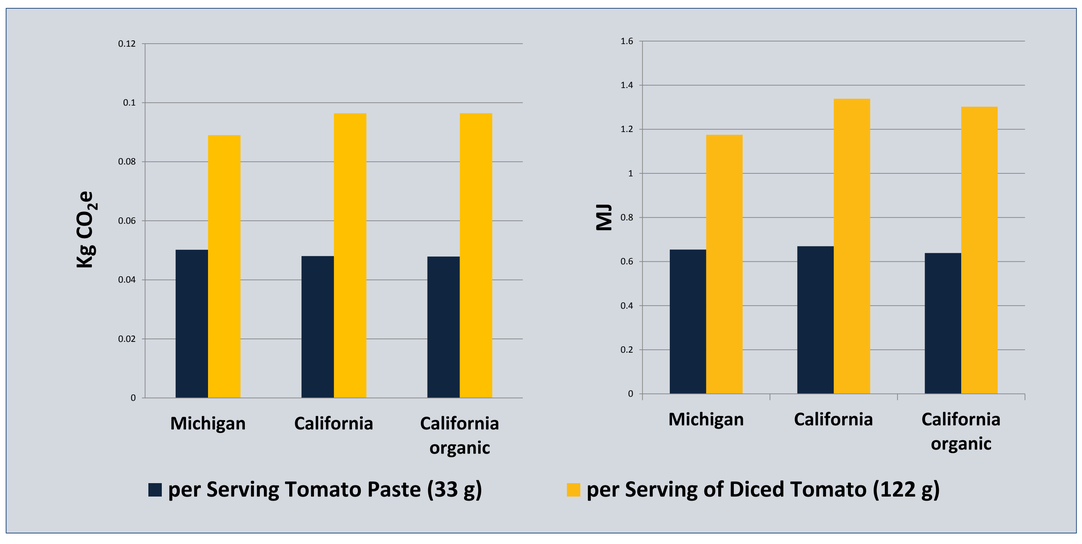
Life Cycle Greenhouse Gas Emissions (Climate Footprint) of Paste and Diced Tomatoes by Location of Origin



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



When serving size is used as the functional unit, paste is a more efficient product than diced tomatoes:



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.

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