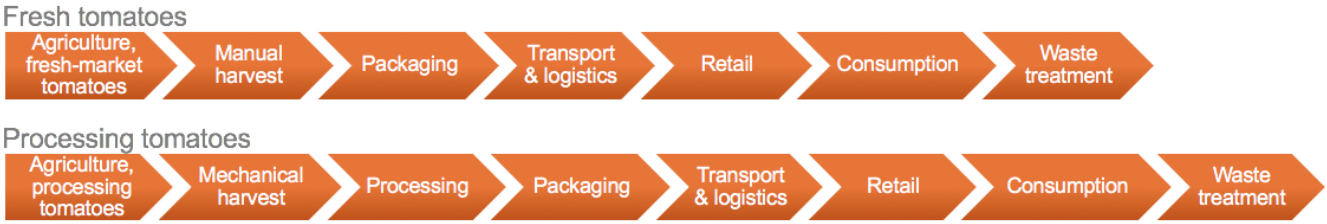
Executive Summary: Environmental Footprint Literature Review

Tomatoes

Tomatoes are ubiquitous in the U.S. diet: in terms of per-capita consumption, they are the fourth most popular fresh-market vegetable, and the U.S. is second only to China in tomato production. But as any backyard gardener knows, not all tomatoes are created equal, and this holds true for their environmental footprint as well. How, when, and where tomatoes are grown, processed and distributed all affect the overall footprint. The purpose of this summary is to highlight what is known about the environmental impacts of tomato production, processing, distribution and consumption based on a review of publicly available life cycle assessment (LCA) studies. This summary does not provide information that is specific to Oregon tomato production, but nevertheless may be useful to both producers and users of tomatoes and tomato products in Oregon as well as other locations.



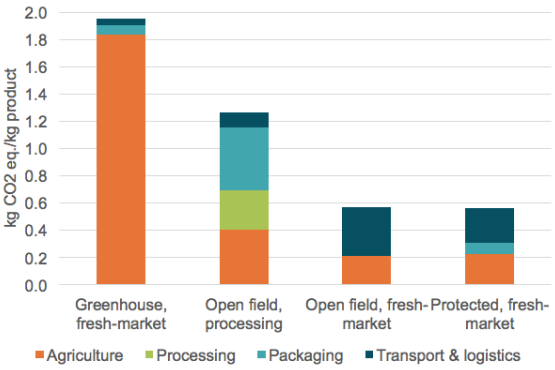
Tomatoes are produced in the U.S. for two distinctly different markets: fresh consumption and processing. The life cycle of the two tomato categories is depicted in the image above. Fresh-market tomato varieties are juicier and, in commercial production, often harvested prior to being ripe in order to tolerate shipping and extend shelf life. Processing varieties contain higher percentages of soluble solids, are vine ripened, and typically have a thicker skin in order to withstand mechanical harvesting and bulk transport. Processing tomatoes are converted to tomato pastes, sauces, juices and canned tomato products. The total U.S. production of fresh-market tomatoes in 2015 was 1.3 billion kilograms; 13.4 billion kilograms of processing tomatoes were also produced. California accounts for 96% of U.S. processing tomato output. Fresh-market tomatoes are produced in every state in the country, but two-thirds to three-fourths of commercial scale production occurs in California and Florida. Fresh-market tomatoes sold in Oregon that are not produced locally likely come from Mexico, California and British Columbia.

Key Findings

Four types of production methods were identified in the literature:

- **Greenhouse, fresh market tomatoes:** Enclosed structures with supplemental heating and/or lighting for off-season production in cold climate regions are common. Many use soilless media, hydroponics or other above-ground growing approaches, and may apply carbon dioxide (CO_2) enrichment to promote higher yields.
- **Open field, processing tomatoes:** They are often grown in open field conditions as seasonality and appearance are less of a concern. They are mechanically harvested, then undergo processing to make purée, sauce, paste, juice, etc.
- **Open field, fresh-market tomatoes:** This category includes in-ground production without overhead protection. Open field production is seasonal in nearly all locations in the U.S. Fertilization and irrigation methods can vary widely. Tomatoes grown for fresh market are typically hand-harvested.
- **Protected, fresh-market tomatoes:** Low- or high-tech “greenhouse,” shade-house or tunnel structures are used to as protection from weather and pests, but supplemental heat or light is not used. Production can be in the ground, in soilless media, or hydroponic. The added protection offers higher yield and more consistent quality than open field production.

Average greenhouse gas emissions by tomato production type



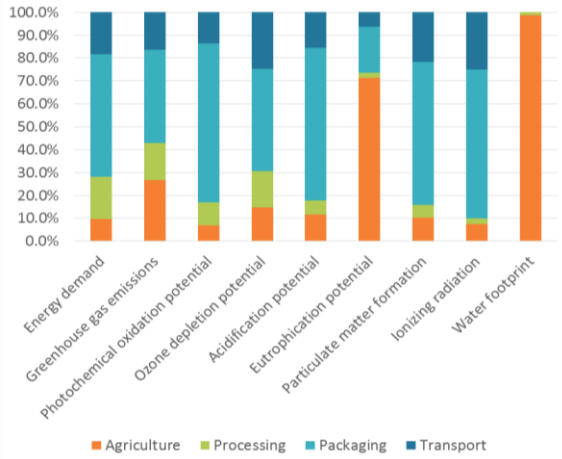
Agricultural Production

The life cycle phases that were consistently represented in the LCA literature include agriculture, processing, packaging, and transport and logistics. Retail, storage, consumption and waste handling after use were less frequently evaluated. Focusing only on the agricultural production of tomatoes, there is a distinct difference in carbon footprint per kilogram of tomatoes between heated greenhouse production and other production categories as depicted above. Often greenhouses are heated with natural gas or other fossil fuels.

The dominant contributions to the agricultural stage for protected, fresh market production are (on average) from agrochemicals – primarily fertilizer production – and subsequent field emissions (37%), and the greenhouse infrastructure (22%). One study in Florida of open field, fresh-market tomato production shows that pesticide production contributes 39% of agricultural related greenhouse gas emissions, followed by a 17% contribution from fertilizer production and 17% from field emissions, and an additional 7% from field machinery emissions. Irrigation in the same study contributed between 3 and 27% of agricultural production, depending on the irrigation method.

Different life cycle phases contribute to the different impact categories for processed tomato purée, as shown to the right. Packaging plays a dominant role.

Distribution of life cycle impacts of Italian tomato purée production



Packaging Matters

Across the 21 processing tomato studies reviewed, agricultural production and processing represent significant contributions to greenhouse gas emissions, but packaging format can also contribute significantly to the total. This is notable because greenhouse gas reductions can readily be achieved by considering alternative packaging formats. One study demonstrated that when steel cans were used, packaging represented 50% or more of the overall life cycle greenhouse gas emissions; with glass, packaging is 40-45%; with carton-based containers, packaging is around 5% of the total.

Conclusions

This summary of literature review of the life cycle of tomato production offers a number of valuable conclusions:

- Heating greenhouses for out-of-season tomato production adds a significant contribution to greenhouse gas emissions and other environmental impacts, and this contribution typically outweighs the impacts of long distance transport from warmer production regions. Local hot-house tomatoes grown in colder seasons may be more impactful than field-grown tomatoes shipped long distances.
- Agrichemicals - both fertilizer and pesticide production - and fertilizer-related field emissions are important contributors to the greenhouse gas emissions of open-field and protected tomato production. Insufficient data are available to determine whether organic production reduces greenhouse gas emissions per kilogram of tomato produced.
- Packaging is an important component of the life cycle impacts of processed tomato products, and efforts to reduce packaging impacts (lighter glass jars, paper carton containers, etc.) can significantly influence the overall life cycle performance.
- Growing fresh-market tomatoes under (unheated) protected structures appears to offer considerable benefit in terms of yield and quality without adding a notable environmental impact burden.
- Trade-offs between different environmental burdens can be an important consideration when comparing different systems.

The full report created by Center for Sustainable Systems - University of Michigan can be downloaded from http://www.oregon.gov/deq/mm/food/Pages/Product-Category-Level-Footprints.aspx.