A Life Cycle Assessment of Energy and Greenhouse Gas Emissions for Almond Processing and Distribution in California

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Research Objective

To quantify net life cycle greenhouse gas (GHG) **emissions** and **energy** use in California almond processing and distribution

Why do these calculations matter?

- Consumer and retailer demand, particularly in Europe for "carbon footprints" (another phrase for life cycle GHG assessment)
- Potential AB32 Carbon Offsets
- Understand energy use over the production life cycle to improve efficiency and mitigate energy-related costs
- Completes previous ABC life cycle assessment (LCA) of almond production from nursery to farm gate, as well as preliminarily findings for hulling and shelling processes

What is LCA? A quantitative analysis of the environmental impacts of a product or system "from cradle to grave." Because we have already modeled almond production from nursery to orchard gate, we now need to complete the analysis to report almonds ready for retail or consumption

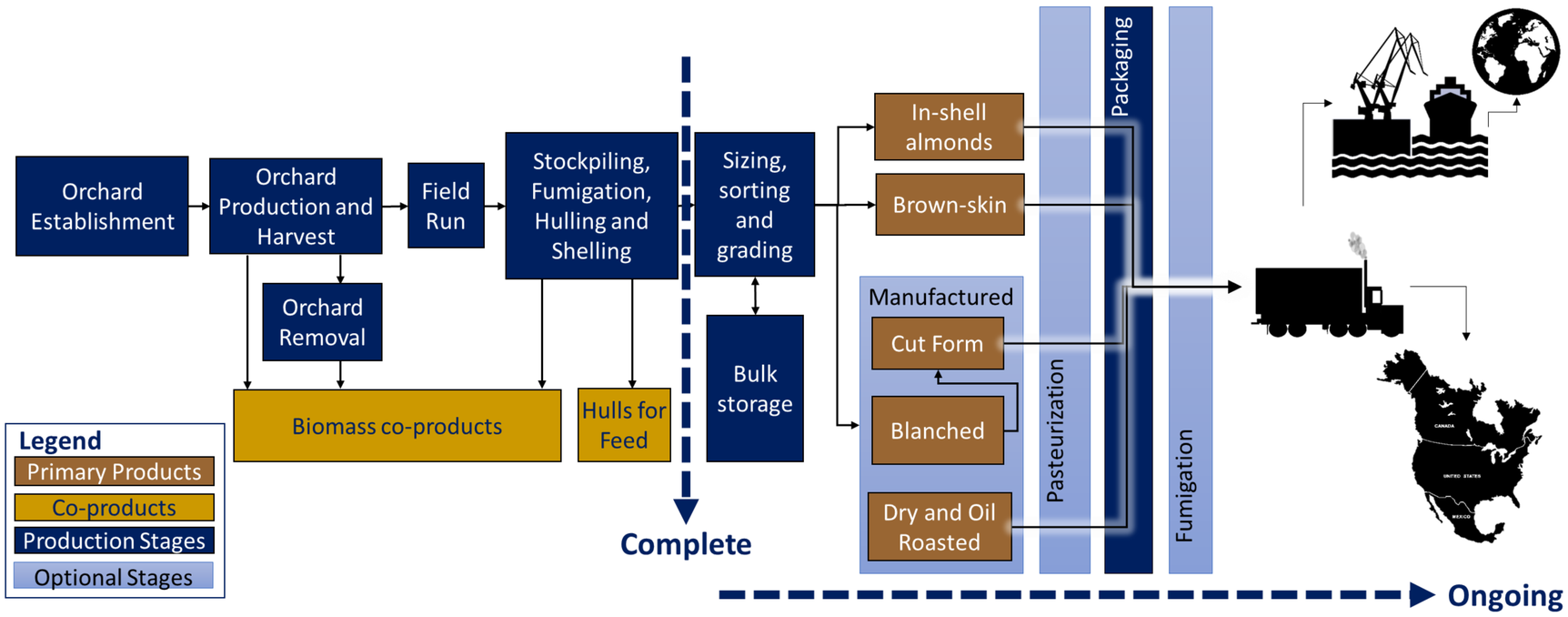

Figure 1. Life cycle flow diagram illustrating completed and ongoing research.

- Completed results for hulling and shelling stage will be updated with new data collected during ongoing research.
- Distribution calculations are nearly complete and are based on data for export shipment destinations by country. Exported products are modeled to their first port of entry for countries with major ports, and to major population centers for land-locked countries with no ocean ports.

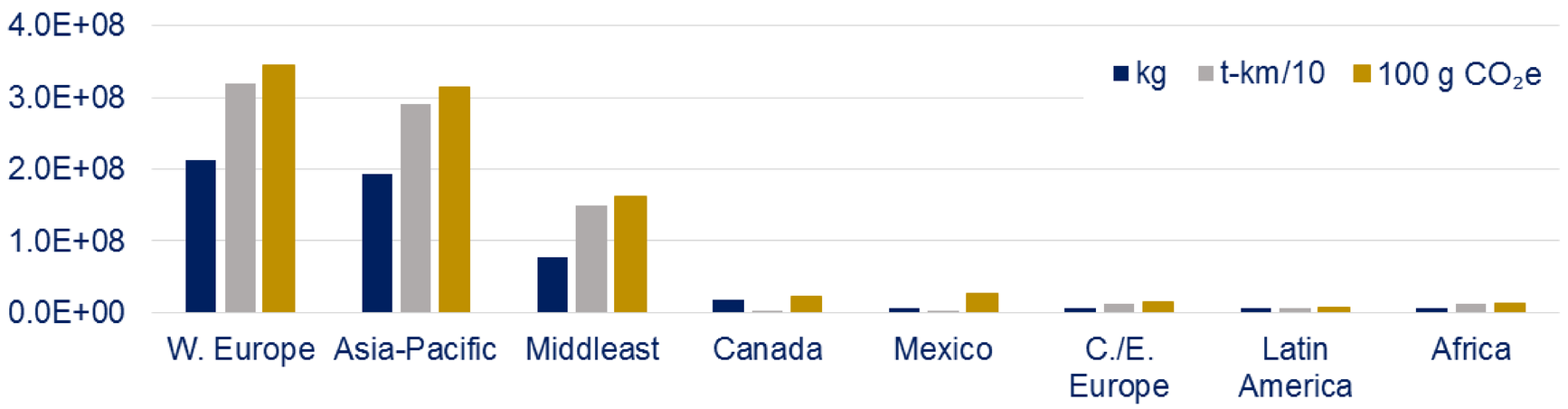

Figure 2. Preliminary results for quantity, weighted distance of travel, and CO_2e of Almond Exportation

- These are very preliminary results, but they suggest that distribution could add, on average 0.2 kg CO_2e per kg of almond.
- Transport emissions are tightly correlated with distance, however specific routes which rely on overland rather than oceanic shipping cause disproportionately high emissions.

Results from Previous Research: From field through hulling and shelling

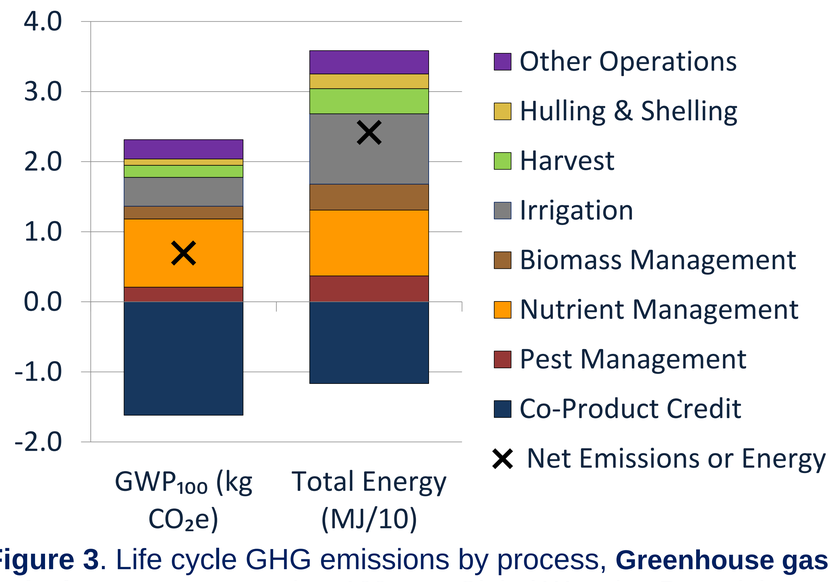

Figure 3. Life cycle GHG emissions by process, **Greenhouse gas emissions** are expressed as 100-year Global Warming Potential (GWP), calculated according to Intergovernmental Panel on Climate Change (IPCC) guidelines.

•Co-Products include electricity generated from waste orchard biomass and shells, and from hulls used as dairy cattle feed. Co-product credits are estimated by modeling the GWP and energy use of the substitutable products that would be used in the absence of almond production.

- •These credits are important for determining the net environmental and energy impacts of almonds.

• The bulk of energy use and emissions are derived from nutrient management – particularly from production of nitrogen fertilizers, and from irrigation. These are hotspots and can be targeted for improvements in energy efficiency, and resource efficiency actions.

•Almonds compare favorably from the standpoint of global warming and energy use to many other nutrient rich and energy dense foods when compared on a nutrient or calorie basis. Note Figure 3 is presented on a mass-basis, which is suitable for comparing the processes that occur within the almond life cycle, but is not appropriate for comparing different crops or foods.