A Baseline Life Cycle Assessment of Greenhouse Gas Emissions for Almond Processing and Distribution

Project No.: **13-AIR8-Kendall**

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Objectives:

The objective of this project is to apply life cycle assessment (LCA) to model greenhouse gas (GHG) emissions, criteria air pollutants, and energy consumption resulting from California almond processing and distribution, and link these LCA outcomes to previous modeling of almond production and hulling and shelling. Linking these previous modeling results will provide life cycle results for almond products at their point of entry to major importing regions, allowing retailers or consumers to understand the energy and environmental footprint of almonds at their point of entry to markets around the world.

This research will not calculate average or total almond processing and distribution values, but instead will provide a simple calculation tool or matrix to allow estimation of processing and distribution for a particular set of supply chain steps, leading to specific end products. For example, a user of the tool could examine the footprint of roasted California Almonds delivered to the port of Hamburg. A life cycle approach means that inputs and outputs are tracked at each life cycle stage of production, processing and transportation. The upstream burdens associated with inputs to the life cycle (e.g. production and delivery of diesel as well as diesel combustion in vehicles) are included.

Interpretive Summary:

LCA is a well-established methodology to examine the energy and environmental impacts of products from “cradle to grave”. This project builds on two completed projects that examined the life cycle energy and air emissions of California almond production from orchard establishment through hulling and shelling operations. At the conclusion of this current project the almond supply chain will be characterized from orchard establishment through distribution to major ports of entry for international shipments or distribution terminals in the US.

The earlier projects that characterized almond production up to hulling and shelling operations illustrated that, compared to other nutrient-dense foods, almonds typically have lower life cycle energy and emissions. The results of the analysis were strongly affected by how orchard biomass is used; namely use of biomass for energy production, as well as value-added uses of

hulling and shelling biproducts, reduce the energy and emissions attributable to almonds. This current project will take the analysis further down the supply chain to provide information relevant to retailers and consumers.

Materials and Methods:

A computer-based LCA model for processing and distribution will be developed. The life cycle model will account for energy and resource inputs at every stage, and the upstream burdens associated with inputs. In the context of this study, upstream burdens refer to the investments of resources and energy, and the emissions of pollution and waste associated with the production of a fuel, energy carrier, or material. The following steps, including Scoping, Data Collection, Analysis and Reporting, describe the research process:

- Scoping: Key scoping questions include; (i) final product(s) that will be included in the analysis (currently brown skin almonds that are pasteurized or fumigated, roasted, blanched, or sliced), which may change based on surveying of stakeholders; (ii) the final transport step included in the analysis (which may hinge on available data); and (iii), which is closely related to (ii), the geographic specificity of reporting for final results.

- Data collection: Data collection will be performed through surveying and interview of almond processors. The content of these surveys will depend on the scoping process. This will include the movements of raw brown skin almonds to processors, material and energy balances for processing operations, and the destination of products post-processing.

- Analysis: Computer modeling will include the development of a spreadsheet or matrix-based model for the LCA; transport network analysis for simulating the movements of almond products domestically and internationally (we expect geographic information system software will be required for this work); and where needed or appropriate, sensitivity and uncertainty analysis.

- The results will be generated such that each step in the supply chain process can be examined independently, permitting a producer, retailer, or consumer to estimate the energy or emissions footprint for a specific scenario of final end product, transport mode, and destination. . For example, a blanched almond consumed in China could be calculated by assembly of the appropriate supply chain steps which would include blanching, transport to the Port of Long Beach, and transport via ocean freighter to China.

Results and Discussion:

We anticipate the following research questions will be answered:

(1) What is the relative contribution of processing and distribution compared to production in the LCA of almonds?

(2) Are there substantial differences for particular supply chain steps depending on processing and mode choice for delivery?

Research Effort Recent Publications:

As this research project is just starting, no publications are available.