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AGRICULTURAL SUSTAINABILITY INSTITUTE

Measuring Energy Intensity and Greenhouse Gas Emissions in the Food System

Using a Life Cycle Assessment Approach

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ITS UCDAVIS INSTITUTE OF TRANSPORTATION STUDIES

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UCDAVIS ENERGY EFFICIENCY CENTER

Agricultural Sustainability Institute, UC Davis

- Founded 2006
- 24 full and part-time staff in various programs
- 150+ faculty primarily interested in sustainable agriculture
- 150+ members of Students for Sustainable Agriculture
- UC Cooperative Extension

ASI Research and Outreach Initiative

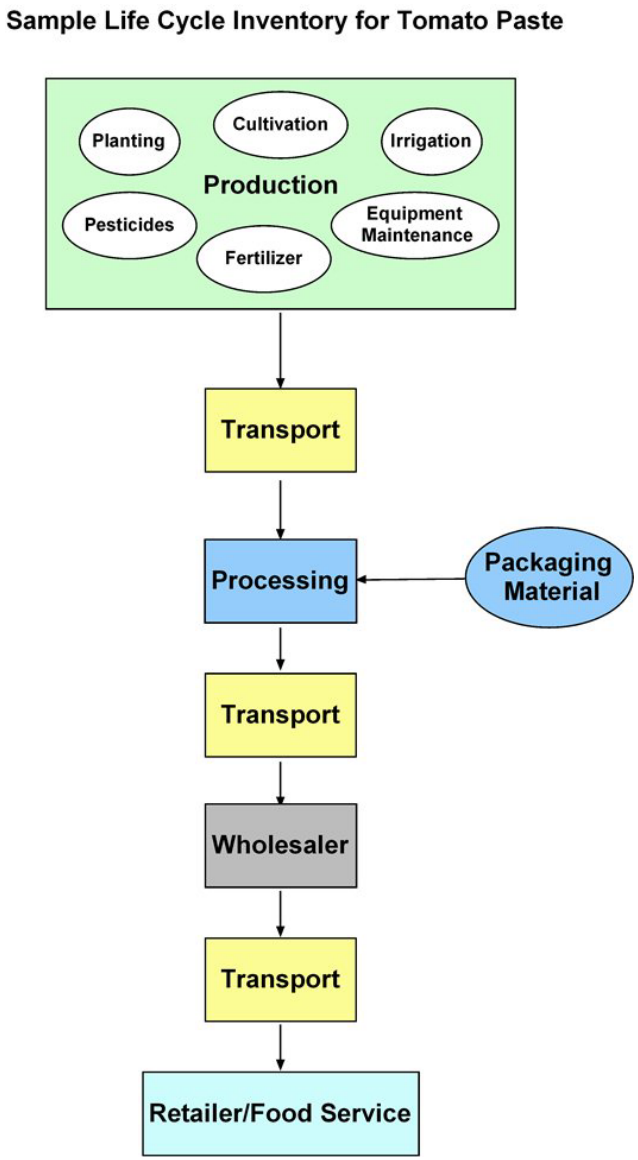
Ultimate Goal:

Steer consumers and other members of the food supply chain towards a “low-carbon diet”.

Program Objectives:

- Research – using a life cycle assessment framework
- Outreach
- Industry implementation

Life Cycle Assessment



Research Framework: Five Key Questions

- Embody typical dilemmas facing consumers concerning energy use and GHG emissions in the food system
- Distill key issues that span the whole food supply chain

Key Question #1

Tradeoffs Between Type of Production System and Transport Distance

How do fresh foods grown locally under conventional production systems compare* to fresh foods grown in alternative production systems (e.g. organic, conservation tillage, etc.) but imported from distant locations?

*in terms of energy use and greenhouse gas emissions

Sample question from a consumer's perspective:

Is it better to buy organic vegetables that are imported from out of state or conventionally-grown vegetables sourced locally?

Key Question #1: Production System vs Transport

Organic systems often have lower energy inputs than conventional systems, primarily due to **fertilizers**.

Corn production experiments in Canada:
(McLaughlin et al. 2000)

- Energy embodied in fertilizer: 33-54% of total energy input of conventional system.

- Substitution of manure ⟶ saved 31-34% of total energy inputs.*

*did not include transport of manure from storage to field, assumed it has to be disposed of anyway

But how does yield compare?

Key Questions #2

Scale of the Food System

How do:

small-scale local food systems, involving small farms, short distribution distances, direct marketing

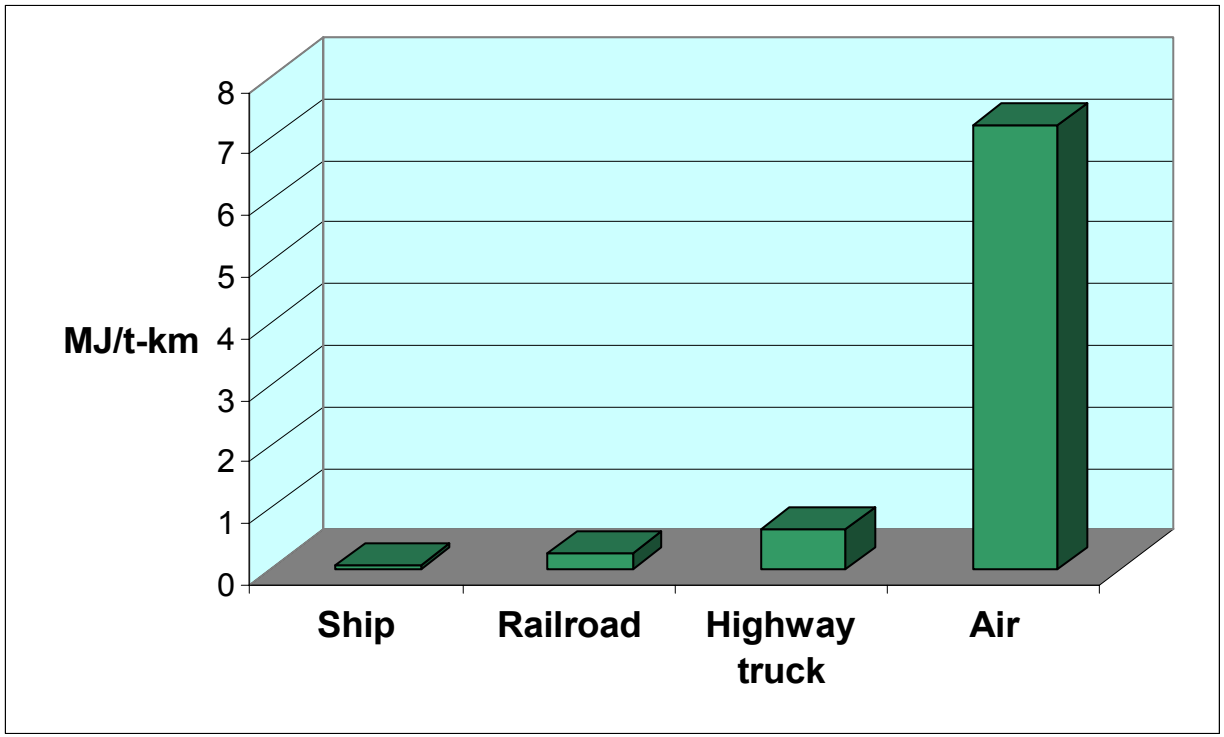
compare to

regional-scale food systems, involving regional distribution networks

compare to

global-scale food systems involving global distribution networks?

Key Question #2: Scale of the Food System

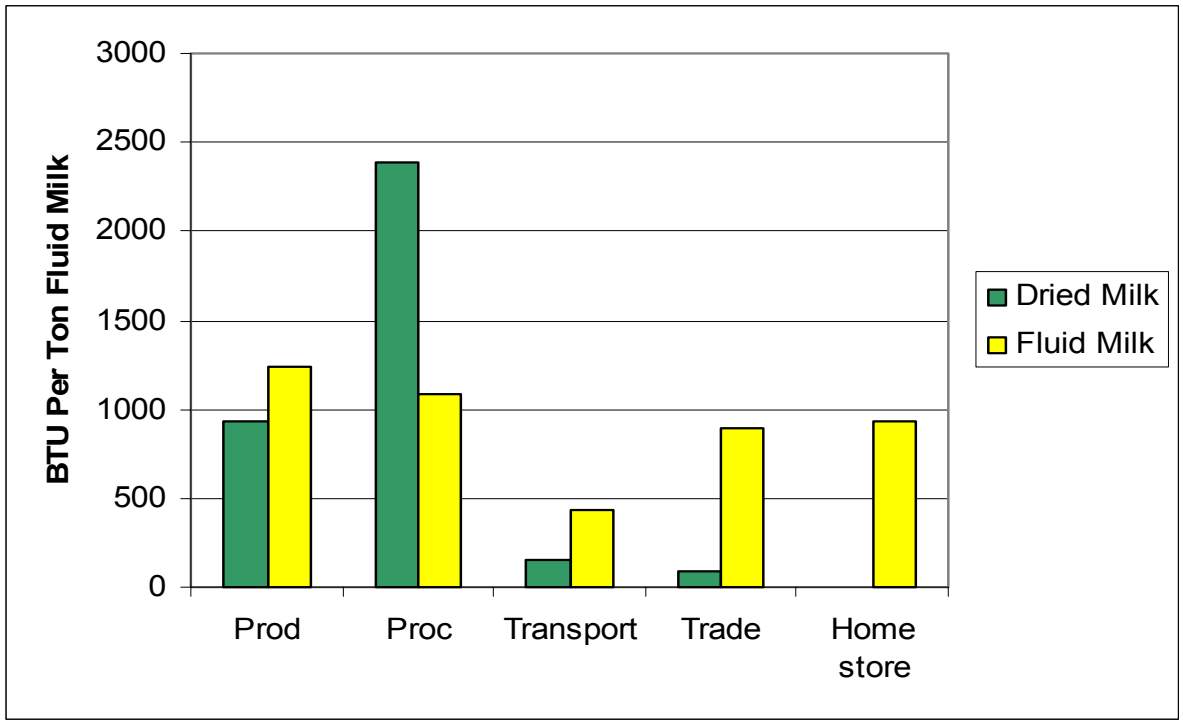


Key Question #3

Seasonality of Production, Processing, and Transport

How do processed foods transported through a national- or global-scale distribution network compare to fresh foods transported locally or regionally?

Key Question #3: Seasonality, Processing and Transport



Total Life Cycle Energy Use

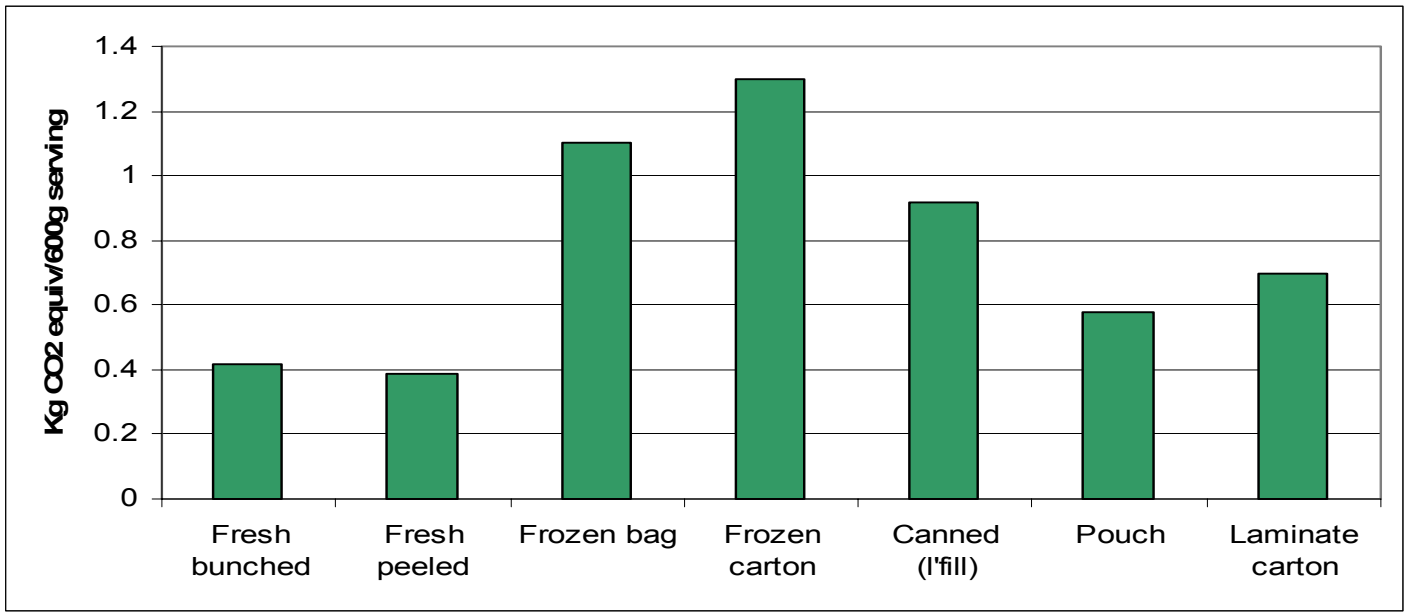
Fluid Milk: 4,574.35 BTU

Dried Milk: 3,862.40 BTU

Whittlesey and Lee, 1981, WSU

Key Question #3: Seasonality, Processing and Transport

Example of Dutch carrots:



For **frozen carrots**: storage in distribution, retail, home are main contributors.
For **canned carrots**: recycling the steel can make a big impact.
For **fresh carrots**: higher waste levels may result in 15% higher impacts, compared to 5% for preserved forms.

Based on Lighart, Ansems, and Jetten 2005

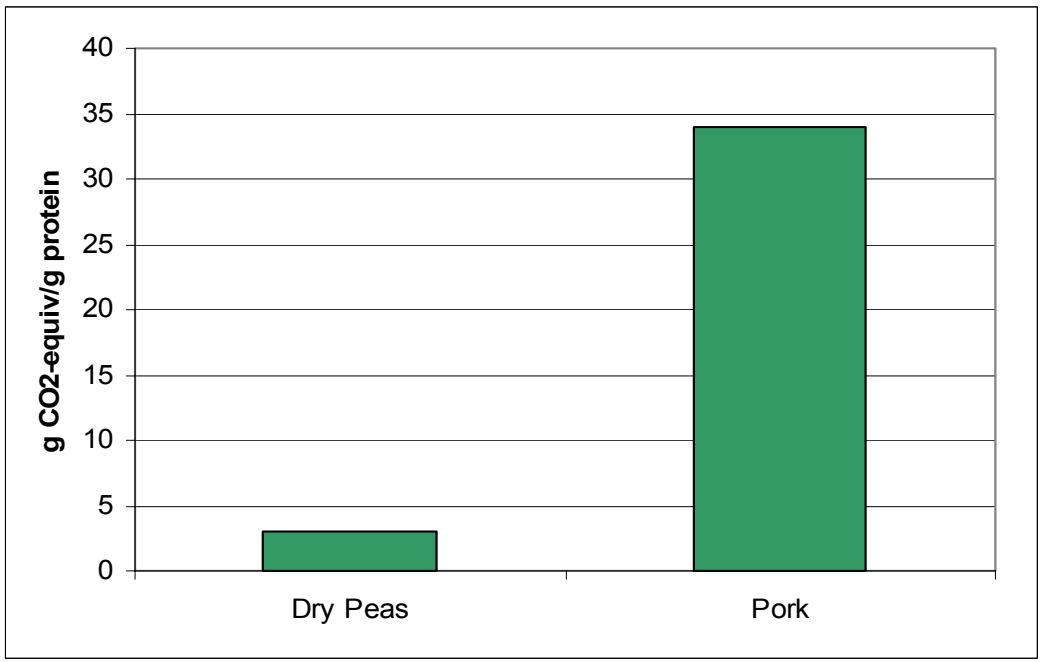
Key Question #4

Livestock Production Systems

How do different livestock products compare to one another (eggs versus chicken, milk versus beef, etc.) and how do livestock products compare to plant-derived protein foods?

Key Question #4: Livestock

- Meat and dairy products: **half** of all food-related emissions in EU study (Environmental Impact of Products Report 2006)
  - Methane, Nitrous Oxide, Carbon dioxide
- Animal-based protein foods are 2-100 times more energy-intensive than plant-based protein foods.



Source: Swedish Nat'l Food Admin 1996, cited by Carlsson-Kanyama 1998

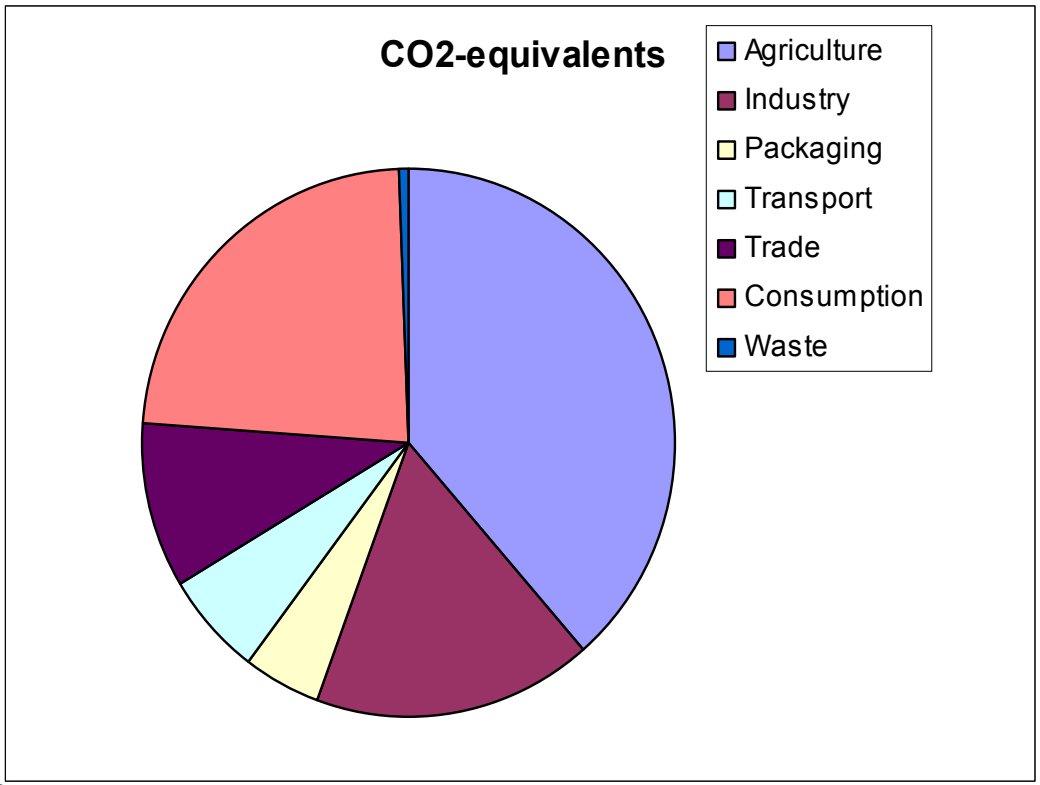
Key Question #5

Pre-retail versus post-retail

How large are consumer-level energy and climate impacts compared to all the pre-retail sectors of the food system?

Key Question #5: Post-Retail

Netherlands study: Consumption accounts for ¼ of GHG emissions of the Dutch food supply chain (Kramer 2000)



Kitchen appliances

Choice of cooking method

Transportation for shopping