Background and Aims

Increasingly, scientists and consumers alike are concerned about the environmental costs of food, such as greenhouse gas emissions generated by transportation. Food miles, the distance food travels from farm to plate, are used to gauge the environmental impact of food transport. Previous studies have merely assessed transportation distance, fuel consumption, or CO_2 emissions at the aggregate level. We developed a comprehensive method for assessing CO_2 emissions per weight of the edible portion of different types of foods, transported from farm to consumer in California.

Methods

We identified the food distribution networks from production farms to processing plants, to central regional markets/distribution centers of three different food commodity types: produce (grapes), meat (beef), and dry groceries (almonds). Using GIS we mapped the transportation pathways of the trucks for each food and computed CO_2 emissions according to specific fuel efficiencies, payload standards, and distribution practices of a supermarket chain in southern California. Fuel efficiencies were customized as payload changes throughout the distribution network, including empty-truck distance. Additionally, we accounted for commodity-specific changes in weight from source to customer.

Results

Grapes, beef, and almonds travel by road from production farms to southern California consumers 899, 1348, and 1291 miles, respectively. This results in 161, 92, and 400 g of CO_2 emissions per kg of grapes, beef, and almonds, respectively. When adjusting for distance differences from farms to distribution center, the emissions are 130, 110, and 380 g of CO_2 per kg of grapes, beef, and almonds, respectively. These transportation emissions represent 38% for grapes, <1% for beef, and 29% for almonds of the respective production-related greenhouse gas emissions calculated in our previous work.

Conclusions

The presented methodology is a comprehensive approach for assessing the impact of food transportation on climate change. Independent of food mileage, there are commodity-specific transportation emissions.

We tested our model by using three foods: almonds, grapes, and beef.

Although, these studies examined different levels of food transportation systems (e.g., local *vs.* conventional sourcing) and parameters (e.g., fuel efficiency), other important elements were not investigated. Food miles were calculated by modeling distances from sources to central or institutional markets, instead of to the point of purchase; ~~fuel efficiencies were assumed not vary with payload; and weight losses due to spoilage and food processing were not taken into account~~. In this study we developed a methodological framework for comprehensively assessing the CO_2 emissions of food transportation from farm to consumer. We tested our model by using three foods: almonds, grapes, and beef.

First, we identified the geographic source areas in California for the food items of interest using county-level production statistics. A food distribution expert provided information on the locations of the main processing facilities (PF) as well as on the distribution patterns from farm to consumers, locations of distribution centers (DC) and logistics specifics pertaining to one the largest food retailers in southern California. Food-specific distribution pathways were constructed by connecting PFs with consumer point of purchase (POP). Each pathway is delineated through a series of nodes (PF, DC, and POP) and links (the intervening distance vectors). Emissions were quantified for transportation of commodities from agricultural source areas to PFs using midsize trucks, and of processed foods to DCs and to POP by large trailer trucks. Truck and fuel economy data for the U.S. and CO_2 emission factors for transportation fuels were obtained from the EPA, DOT, and DOE. A GIS was used to geocode the food distribution nodes and then to estimate the mileage between them. After the mileage for all truck categories was computed, emissions were calculated according to pre-specified truck- and food-specific maximum freight weights.

Fuel efficiencies were adjusted according to payload variation across the distribution pathways. Empty miles as well as weight losses due to spoilage and food processing were also modeled. Results are summed by means of a common functional unit of grams of CO_2 per Kg of food product at the POP.