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More Than Food Miles: Rethinking How We Measure Sustainable Food Systems

Jungman Choi and K. Aleks Schaefer

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On August 14, 2025, US Secretary of State Marco Rubio, alongside senior administration officials, reignited debates over a proposed global shipping emissions fee. These debates mirror the controversies surrounding food miles, a metric that captures the distance over which food travels from production to consumption. Much like the shipping fee debate, the popular concept of food miles has been celebrated for its simplicity and criticized for oversimplifying sustainability complexities. While the concept has been widely used to raise awareness among consumers and policymakers about the carbon emissions associated with food transport (Avetisyan, Hertel, and Sampson, 2014; Schnell, 2013), it often falls short of capturing the full environmental and economic realities of global food systems.

Figure 1 presents the Google Trends data on interest in the term “food miles” from its introduction in 2004 through 2024. Interest rose steadily until 2010, plateaued in the following decade, and then peaked sharply again in 2022. Most of this attention originated in high-income countries, reflecting places where consumer awareness and policy discussions have been most active. Yet, despite the visibility, the food miles metric remains limited. It often overlooks production efficiency, underrepresents the role of small or developing countries, and oversimplifies the complexities of consumer decision-making and policy formation (Wynen and Vanzetti, 2008; Avetisyan, Hertel, and Sampson, 2014; Schmitt et al., 2017). Moreover, research shows that shorter food travel distances do not always translate into lower greenhouse gas (GHG) emissions, as inefficiencies in local agricultural systems can offset the benefits of reduced transportation (Clark et al., 2020; Baylis, Heckelei, and Hertel, 2021).

This article examines the socioeconomic and environmental dimensions of food miles and discusses the limitations of using distance as a proxy for sustainability. At the end, this paper suggests a refined metric such as a kilometers-per-dollar index (KM/$) to better capture the complexities of global food systems.

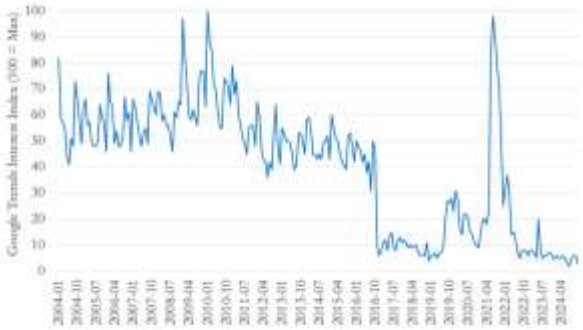
Socioeconomic Impacts of Food Miles

Consumers in wealthier nations are increasingly concerned about their carbon footprint and often use food miles as a proxy for environmental sustainability when making purchasing decisions (DEFRA, 2013; Avetisyan, Hertel, and Sampson, 2014). Consumers are willing to pay (WTP) a premium for locally grown food, which they associate with environmental benefits, freshness, and safety (Darby et al., 2008; Dunne et al., 2011). However, recent analyses reveal that consumer responses to carbon labeling and food miles vary across demographics, regions, and product categories, with the average WTP premium reaching 29.5% (Li and Kallas, 2021). While food miles labeling raises awareness, it also has limitations. Locally produced goods often require higher inputs, energy, and labor, making them less efficient and more expensive (Kiss, Ruszkai, and Takács-György, 2019). Additionally, international trade expands consumer choice and ensures year-round availability of diverse products (Wynen and Vanzetti, 2008; Huang, von Lampe, and van Tongeren, 2011). From a food miles perspective, this underscores a key limitation of the metric: Shorter distances do not always equate to greater efficiency or sustainability, as international trade often leverages economies of scale and optimal production conditions that can offset transportation-related emissions. However, even though consumers tend to favor certified products with recognizable labels, a majority of consumers remain uncertain or misinformed about the meaning and credibility of various labeling and certification schemes (McCallum et al., 2022; Scott and Sesmero, 2022).

Government responses to food miles vary significantly across regions. In Europe, initiatives such as carbon taxes and food miles labeling aim to reduce emissions from long-distance food transport (Lewis and Mitchell, 2014). However, these measures have faced criticism

Figure 1. Google Trends Interest in "Food Miles" Topic, Jan-2004 to Dec-2024

(a) Interest in "Food Miles" Over Time



(b) Interest in "Food Miles" by Country

Source: Google Trends (2024).

Notes: Figure 1 shows "Google Trends" interest in the "Food Miles" between January 2004 and December 2024, as measured by the number of Google searches on the topic. Panel (a) plots interest over time, and panel (b) shows interest across countries.

for disproportionately targeting air-freighted imports, which account for a small fraction of total trade (Schnell, 2013). Moreover, mandatory labeling has raised concerns about compliance with World Trade Organization (WTO) rules (Waye, 2008), since overly restrictive labeling requirements may violate the principle of nondiscrimination and be regarded as a disguised restriction on international trade. In North America, governments have implemented policies to support local food systems. For instance, Ontario introduced the Local Food Act to boost regional economies and encourage residents to buy locally produced goods. Similarly, the USDA runs initiatives such as the Local Food Promotion Program (LFPP), which aims to improve access to local food, reduce socioeconomic inequalities, and lower environmental impacts associated with long-distance food transportation (Government of Ontario, 2013; USDA-AMS, 2024).

The private sector has played a pivotal role in advancing sustainability efforts by leveraging food miles as a marketing and operational tool. Major retailers and multinational corporations have integrated food miles into their sustainability strategies to align with consumer demand and regulatory expectations. For example, Walmart sources 20% of its fresh produce locally, reducing transportation costs and carbon emissions while responding to consumer preferences for locally grown products (Walmart, 2014). Similarly, Whole Foods has launched initiatives such as the Local Producer Loan Program (LPL) and the Local and Emerging Accelerator Program (LEAP), which support small-scale producers in becoming suppliers, thereby enhancing regional food systems (Whole Foods Market, 2022). These efforts underscore the private sector's potential to positively influence sustainable food systems. However, challenges remain. Large firms often dominate supply chains, capturing the economic benefits of initiatives focused on food miles while smaller producers struggle to compete. This imbalance may exacerbate inequities in market access and revenue distribution. Additionally, some companies engage in greenwashing, marketing practices that overstate the environmental benefits of their actions, thereby diluting the credibility of sustainability claims and misleading consumers (Enthoven and Van den Broeck, 2021).

Another critical factor is the transparency of supply chains. While food miles can highlight the transportation-related environmental impacts, they often fail to account for upstream practices such as production methods, labor conditions, and resource use (Shimizu and Desrochers, 2008). This presents an opportunity for private-sector actors to lead in developing standardized metrics that go beyond food miles, incorporating broader sustainability indicators. The private sector's role is not limited to addressing consumer preferences. The private sector can significantly reduce emissions across supply chains by fostering innovation in logistics, packaging, and agricultural practices. For example, investments in transportation powered by renewable energy sources or more efficient packaging can mitigate the environmental costs associated with long-distance trade (Veloso et al., 2025). However, achieving such advancements requires collaboration among stakeholders, including governments, research institutions, and civil society organizations (Parmesan, Morecroft, and Trisurat, 2022). Also, policies and programs should focus on supporting smallholder farmers, particularly in developing regions, by integrating them into global supply chains while maintaining fair pricing structures (Huang, von Lampe, and van Tongeren, 2011; Kanter et al., 2018). Education

campaigns aimed at empowering consumers with accurate information can also help mitigate misconceptions about food miles and encourage informed decision-making (Hill, 2008; Kissinger, 2012).

Moreover, food miles research often emphasizes environmental over economic effects, focusing on transportation distance rather than broader environmental and economic impacts. A majority of studies agree that local food systems can enhance regional economies by creating value chains and supporting agricultural land preservation (Jenet, 2016). However, localized production can increase costs, disproportionately affecting low-income households and excluding them from sustainability benefits (Dunne et al., 2011). Shifts toward local consumption in developed regions, often driven by food miles awareness campaigns, may adversely affect developing countries that depend on agricultural exports. For instance, a decline in European imports could result in substantial welfare losses for farmers in Sub-Saharan Africa who are heavily reliant on access to European Union (EU) markets (Ballingall and Winchester, 2010), highlighting the unintended economic consequences of relying solely on distance-based sustainability indicators. Distance-focused policies can shift sourcing patterns in ways that change both emissions and welfare. For example, discouraging long-haul imports may reduce transport distances yet raise production-stage emissions if output shifts to regions with less efficient systems. This could also narrow consumer access and affect trading partners' livelihoods. These examples show that environmental goals tied to food miles cannot be separated from trade policy considerations: This underscores the need for policy frameworks that integrate transportation metrics with production efficiency, effects on stakeholders, and broader sustainability goals.

Environmental Impacts of Food Miles

Because transport is only one component of food system emissions, evidence derived from life-cycle assessments (LCAs) shows why distance alone often fails to predict total impacts, especially when production- and processing-stage differences dominate. Over the past 2 decades, research on food miles has produced inconsistent findings due to variations in methodology and scope. LCAs, a primary tool for measuring GHG emissions, yield conflicting results depending on their inclusion of production, transportation, and processing stages (Li et al., 2022; McWilliams, 2009; Schnell, 2013). Transportation, while central to the food miles metric, typically accounts for less than 15% of total agricultural emissions, with production and processing contributing up to 85% (Hill, 2008; Lewis and Mitchell, 2014; Poore and Nemecek, 2018). Longer food travel distances deplete natural resources such as fossil fuels and packaging materials (Mosammam et al., 2018). Moreover, suboptimal growing conditions may result in higher resource use and emissions than importing goods from more efficient regions (Ferguson Aikins and Ramanathan, 2020). This imbalance makes it clear that distance, by itself, is not a reliable proxy for sustainability.

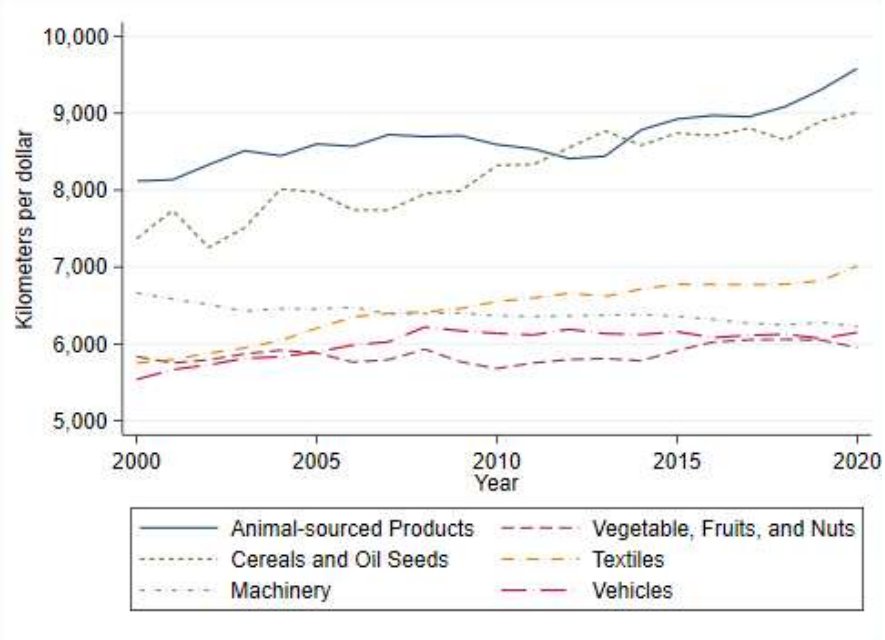
While reducing food miles through organic farming for local production is often assumed to lower emissions and improve sustainability, evidence suggests this is not always the case. Large-scale supply chains usually achieve greater efficiency through economies of scale, reducing overall per-unit emissions compared to localized systems (Schmitt et al., 2017; Malak-Rawlikowska et al., 2019). Conversely, local systems can increase operational costs and consumer prices, limiting access for low-income households (Hinrichs, 2003; Dunne et al., 2011). Agricultural trade plays a vital role in enhancing food security, promoting sustainability, and supporting economic growth. By facilitating specialization and the exchange of efficient farming practices, trade helps mitigate climate-related risks and reduce emissions (Anderson, 2002; Aksoy and Beghin, 2004; Baylis, Heckelei, and Hertel, 2021). However, trade also introduces environmental challenges, particularly through long-distance transportation.

While agriculture contributes significantly to GHG emissions, focusing solely on this sector overlooks the broader food system's environmental impacts. Emissions from packaging, retailing, and transportation stages often rival or exceed those from farming (Mundler and Laughrea, 2016; Clark et al., 2020; Ferguson Aikins and Ramanathan, 2020). A comprehensive approach to food miles research should include emissions from all stages of the food system and recognize the positive contributions of agriculture, such as soil carbon sequestration and renewable energy adoption (Poore and Nemecek, 2018). Expanding the focus beyond agriculture will align food miles research with broader climate and sustainability objectives.

Refining the Food Miles Metric Can Enhance Its Relevance and Utility

One such refinement is the value-weighted distance index, which measures the average distance traveled by each dollar of trade. By incorporating trade value into the calculation, the index highlights not just the physical distance of food transport but also the economic intensity of those trade flows. In doing so, it better reflects trade efficiency and environmental implications, recognizing that a dollar of high-value goods transported over a certain distance differs from a dollar associated with lower-value, bulkier commodities. For example, if a $1,000 shipment of Product A travels 5,000 km, while a $1,000 shipment of Product B travels 10,000 km, the latter indicates less efficiency in value terms. The index can be expressed as

Figure 2. Kilometers-per-Dollar of Ag and Non-ag Commodities in 2020



Source: CEPII (2022) and United Nations (2022).
Notes: The index, kilometers-per-dollar, is a trade value-weighted average distance calculated.

$$Value-weighted\ Distance\ per\ Value\ (km/\$) = \frac{\sum_i (Distance_i \times Trade\ Value_i)}{\sum_i (Trade\ Value_i)},$$

where $Distance_i$ is measured in kilometers that product *i* travels from the exporter to the importing country and $Trade\ Value_i$ represents the value of product *i* traded in US dollars. KM/$ becomes policy useful when paired with stage-specific emissions intensities. For example, using emission computation units such $\mathrm{kgCO_2}e$ per ton-km by region enables a quick appraisal of whether distance reductions are likely to reduce emissions for a given product and how such changes affect overall environmental and economic outcomes.

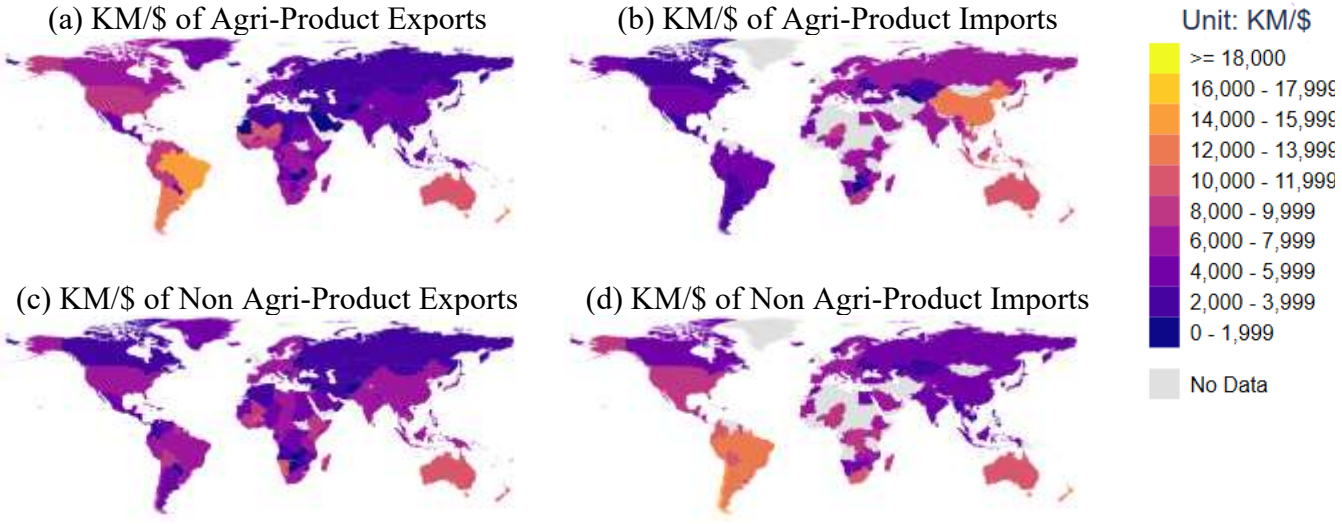
Figure 2 illustrates the kilometers-per-dollar for various agricultural and nonagricultural commodities. Animal-sourced products and cereals exhibit higher kilometers per dollar, reflecting longer transport distances relative to their economic value. In contrast, fruits, vegetables, and nuts travel shorter distances per dollar, signaling more efficient trade flows. This metric highlights inefficiencies and provides a more nuanced understanding of how trade flows by product category contribute to environmental and economic outcomes. By examining kilometers-per-dollar, policymakers can identify specific trade patterns where interventions including improving logistics infrastructure or promoting regional value chains could enhance trade efficiency and environmental performance.

Significant regional and commodity-based variations further complicate the application of food miles as a universal sustainability metric. Figure 3 illustrates kilometers-per-dollar across agricultural and nonagricultural exports and imports for various global regions. For example, North America, South America,

West and South Africa, and Oceania exhibit the highest kilometers-per-dollar for agricultural exports, suggesting that agricultural products from these regions travel farther to reach consumers (Figure 3a). Conversely, import-heavy countries such as China, Australia, and South Korea also rank high in kilometers-per-dollar for agricultural imports (Figure 3b). For nonagricultural goods, countries like the United States, parts of South America, and many Asian nations exhibit high kilometers-per-dollar for exports (Figure 3c). However, the same metric for nonagricultural imports is markedly higher for North and South America compared to Asian nations, indicating differing trade dynamics (Figure 3d). These differences highlight why applying a single, distance-only metric like food miles can misrepresent the environmental efficiency of certain trade flows.

The integration of refined metrics like kilometers-per-dollar into food miles research offers a pathway for more actionable and equitable policy development. By combining such indicators with life-cycle assessment methodologies, future research can better address the complexities of trade, environmental impacts, and

Figure 3. Kilometers-per-Dollar of Agricultural and Nonagricultural Products by Exporters and Importers in 2020



Source: CEPII (2022) and United Nations (2022).

socioeconomic outcomes. Policymakers should leverage these insights to design region- and commodity-specific interventions that balance local sustainability goals with global trade efficiency. This approach ensures that food miles policies promote environmental and economic resilience without imposing undue burdens on specific regions or sectors.

Conclusion

To conclude, food miles have emerged as a prominent metric in discussions about sustainable food systems, reflecting growing concerns about environmental impacts, consumer behavior, and global trade. While the concept has raised awareness about carbon emissions and local food systems, this review highlights its limitations as a standalone measure of sustainability. Transportation accounts for a small fraction of total food system emissions, with the majority arising from production and processing. Additionally, when food miles are reduced, local food systems do not always guarantee environmental or economic efficiency, particularly in regions with suboptimal growing conditions. Efforts to promote food miles-focused policies must consider their broader implications. These policies can benefit local economies but may also increase costs for consumers, exclude low-income households, and disrupt global trade flows. Ultimately, incorporating complementary measures such as the KM/$ index and life-cycle assessments can provide a fuller picture of environmental and economic impacts, helping policymakers and stakeholders move beyond one-dimensional indicators toward more sustainable and equitable food systems.

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About the Authors: Jungman Choi (jmjmjm51004@snu.ac.kr) is a Senior Researcher with the Center for International Agricultural Development with the Institutes of Green-Bio Science and Technology at Seoul National University. Corresponding Author: K. Aleks Schaefer (aleks.schaefer@okstate.edu) is an Associate Professor with the Department of Agricultural Economics at Oklahoma State University.

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