ENVIRONMENTAL SUSTAINABILITY OF THE AGRI-FOOD CHAIN AND FOOD MILES: A LITERATURE REVIEW

Marta Biancolin[1, 2], Federico Codato [2],
Federico Nassivera[3], Lucia Rotaris[4]

ABSTRACT

Supply chain sustainability is still a subject of debate. Some researchers believe that it is based on reducing the distances food travels, while others believe that it also relates to other aspects such as production locations, processes, product types, seasonality, direct sales, regional and local transport, and customer preference for local products and carbon labels. In this review, 119 papers address the concepts of food miles (FM) and local food (LF) with the aim of summarising whether the type of product and production process, seasonality, supply chain organisation and consumer preferences affect the environmental footprint of the agri-food chain.
The results show that the environmental impact of the food supply chain (FSC) is influenced by many factors beyond distance travelled, such as energy-intensive production processes, the technology used in production methods, crops and soil characteristics, harvesting time, storage time, the number of intermediaries and consumer choices. Therefore, the sustainability of the FSC relies on a combination of factors rather than just the reduction of FM.
Researchers studying the sustainability of the food chain and companies committed to greening the agri-food sector may find our work useful. Finally, it provides recommendations for local authorities interested in developing policies for the distribution of goods and in guiding the logistics sector and the FSC as a whole towards practices that reduce the impact of climate change.

[1] University School for Advanced Studies IUSS, University of Pavia.

[2] Department of Economic, Business, Mathematical and Statistical Sciences, University of Trieste.

[3] Department of Agricultural, Food, Environmental and Animal Sciences, University of Udine

[4] Department of Economic, Business, Mathematical and Statistical Sciences, University of Trieste.

KEYWORDS
food miles, local food, carbon footprint, logistics, literature review

1. INTRODUCTION

According to the latest IPCC report (2023), 22% of global greenhouse gas (GHG) emissions come from agriculture, forestry and land use. This is expected to rise to 30-40% by 2050 due to the combination of a growing global population and increased demand for food. In addition, non-agricultural activities such as food processing, packaging, transport, household consumption and waste disposal are pushing FSC to the top of the list of GHG emitters (FAO, 2021). Although pre- and post-production processes contribute to twice the emissions of the entire agri-food sector (Tubiello et al., 2022), the transport phase accounts for the lion's share.

Li et al. (2022) estimate that food-related activities worldwide generate 30% of total GHG emissions (15.8 $GtCO_2e$), of which transport accounts for 19%, twice the amount of GHG released during production.

The term 'food miles' generally refers to the distance food travels from the site of production to the point of consumption. This concept is often used to estimate the environmental impact of food transport and is typically measured in tonne-kilometres (tkm), meaning the product of distance travelled and the mass of food transported (Castillo et al., 2024; Van Passel, 2013). Increasing environmental awareness and the need to reduce carbon emissions, particularly from transport, has led to the idea that the further a food product travels, the worse it is for the planet.

Therefore, to address climate impacts and reduce FM, concepts such as LF have emerged, emphasising the sustainability and security of local production (Kemp et al., 2010).

In this context, the Farm to Fork Strategy, which is at the heart of the European Green Deal (European Commission, 2022), represents a commitment to make the food system sustainable and fair, and to achieve carbon neutrality by 2050.

However, the concepts of LF and FM, their applications and definitions are still under debate (Bazzani & Canavari, 2017).

On the one hand, FM focuses on the distance products travel from producers to consumers, ignoring other aspects of the life cycle (Wynen & Vanzetti, 2009). On the other hand, the sustainability of LF is uncertain, firstly because it lacks a clear definition, and secondly because it often overlaps with smallholders, few supply chain intermediaries, direct sales, solidarity purchasing groups and farmers' markets (Martinez et al., 2010).

This literature review sheds light on the ongoing debate on the effectiveness of FMS assessment in reducing the environmental impacts of agri-food supply chains and on the determinants of FMS sustainability.

To this end, 119 papers on FMS were systematically reviewed to determine whether production location and processes, seasonality, supply chain organisation and customer preferences affect environmental impacts.

The paper aims to provide valuable guidance to policy makers, practitioners and researchers on how to effectively mitigate greenhouse gas emissions and promote sustainable food systems. At the same time, the analysis contributes to the broader discussion on how food systems can support a just and efficient transition, balancing environmental goals with social and economic outcomes.

In doing so, the review addresses a set of interrelated questions that underpin the current debate on food sustainability. It explores how production processes, seasonality, and supply chain structures influence the environmental footprint of food systems. It also investigates whether FM alone are a meaningful indicator of sustainability or whether a broader set of lifecycle factors should be considered. Finally, the review considers how consumer preferences and labelling practices contribute to the transition toward more sustainable consumption patterns.

The article is structured as follows: the second sections deal with the definition of FM and LF. On the section it is presented the debate on the two topics, the third section is the research objective and methods, the fourth present the dimensions: product and production processes related factors (4.1), seasonality (4.2), supply chain organization and distribution (4.3), solutions to increase the efficiency of the distributional stage (4.4) and customers preference for local products (4.5). The fifth section includes the conclusion.

2. FOOD MILES (FM)

The term FM refers to the distance that food travels from the farm to the consumer's plate, including the distances travelled during transport from the farm to the processor, from the processor to the storage hub, from the storage hub to the retailer, and finally from the retailer to the consumer (Paxton, 1994). Professor Tim Lang coined the term in 1992 to highlight the origin of food and the different stages it goes through to reach the consumer.

The concept was introduced to address concerns about potential disruptions in the supply chain due to its length, particularly with increasing reliance on international trade and the growing physical distance between food production and consumption (Lang, 2006).

However, the FM has evolved into a CF indicator used to illustrate the 'cradle to plate' distance, that is, the distance from the origin of the food to the consumer's plate (Ghoshal, 2014; Pirog, 2001) (Edwards-Jones et al., 2008), which includes the total amount of CO_2e and other GHG emissions emitted during the entire journey (Coley et al., 2009a). Typically, the calculation of the CF is based on the standardised environmental life cycle assessment (LCA) methodology outlined in ISO14040 and ISO14044. This holistic approach is in line with the principles outlined in the Kyoto Protocol (1997), which emphasise the accounting of GHG emissions over all stages of a product's life cycle. Numerous researchers have raised concerns about the reliability of FM as an indicator of carbon emissions (Coley et al., 2011; Edwards-Jones et al., 2008; Mok et al., 2014; Van Passel, 2013). For example, in the Australian context, the national distribution of red meat contributes only 5% to GHG emissions, while international transport increases this percentage to 14-23% (Wiedemann et al., 2015). Such discrepancies indicate that the CF associated with food varies significantly depending on several factors, including the mode of transport and distribution (Duarte et al., 2019; Marletto & Silling, 2010; Striebig et al., 2019; Torquati et al., 2015), the type of food transported (Farmery et al., 2015), the length and organisation of the supply chain (Schmitt et al., 2018), the distance from the consumer and the loading rates (Loiseau et al., 2020). Furthermore, the magnitude of these impacts also depends on the geographical context and the specific location of food production (Bell & Horvath, 2020; Mundler & Rumpus, 2012). These variations highlight the complexity and multifaceted nature of assessing the environmental impacts of food distribution and emphasise the need for a more comprehensive approach to assessing carbon emissions from agricultural production processes to the activities of the end consumer (Coley et al., 2011). The CF calculation of the agri-food industry should also be supported by the input demand of natural resources, such as water footprint (WF), nitrogen footprint (NF) and energy footprint (EF), to also have an estimate of the resource demand required for cultivation and breeding (Cerutti et al., 2016; Karwacka et al., 2020). Furthermore, as suggested by Smith et al. (2005), a good indicator should include not only transport modes, transport efficiency and differences in food production systems, but also wider economic and social costs and benefits.

2.1. LOCAL FOOD (LF)

According to several EU research programs, in a Local Food System the production, processing, trade and consumption of food takes place in a defined geographical area, within a 20–100 km radius. In addition, LF can often be traced back to a specific place of origin with distinctive qualities or characteristics, either through direct producer-consumer relationships or via institutional mechanisms such as certifications or digital traceability systems. The concept overlaps with Short Food Supply Chains (SFSC), where "the food involved is identified by a farmer and is traceable to that farmer. The number of intermediaries between the farmer and the consumer should be 'minimal' or ideally zero".

However, the concept is very flexible. In the UK, for example, customers identify food as local if it comes from within 50 km of where they live or from the same district (Kneafsey et al., 2013).

Furthermore, as many researchers emphasise, it encompasses geographical and relational dimensions expressed by the proximity between food production and consumption (Eriksen, 2013; Schmitt et al., 2018), as well as value dimensions related to food experience, sense of belonging, traceability, freshness and quality (Eriksen, 2013; Schmitt et al., 2018; Schnell, 2013).

In response to the expansion of large-scale food distribution, many policies have been promulgated to relocalise agricultural and food production, with the aim of not only valuing local resources and typical products but also considering environmental sustainability. Thus, the concept of LF began to oppose that of FM, giving rise to the idea that local is better for the economy, society and the environment. Nevertheless, several scientific papers claim that the resource demand and emissions of LF systems are comparable to long supply chain (Mundler & Rumpus, 2012), thus fuelling the debate on the sustainability of LF (Cappelli et al., 2022). To date, there is no scientific evidence that LF is less polluting than large-scale distribution, which travels kilometres before reaching the consumer's plate.

Several studies contribute to this discussion. Avetisyan et al. (2013), who estimate the global GHG emissions resulting from substituting ruminant livestock exported from the EU and China with domestically bred animals, conclude that the environmental burden is lower only in regions with low-emission and low-intensity production processes. Sim et al. (2007) similarly suggest locating production in areas where renewable fuels and clean energy are predominantly used. In line with these findings, Striebig et al. (2019) show that sourcing lettuce, tomatoes, strawberries, and chicken locally in Virginia - rather than importing them from Arizona, California, and Florida - can significantly reduce CO_2 emissions and pesticide use in university dining services.

2.2. CRITIQUE ON FM AND LF

Criticism of FM has coincided with growing awareness of global warming and sustainable consumption, leading to the idea that higher FM corresponds to more negative environmental impacts (Ballingall & Winchester, 2010). As a result, the focus has shifted from sustainable production to food distribution (Coley et al., 2009a; Costanigro et al., 2015; DuPuis & Goodman, 2005), with the perception that local is better (Schmitt et al., 2017) as it shortens the distance between food origin and final destination, thus reducing pollution from transport (Lee et al., 2015; Li et al., 2022; Malak-Rawlikowska et al., 2019; Michalský & Hooda, 2015; Oliveira et al., 2021). In addition, Li et al. (2022) find that transported fruits and vegetables account for twice (36%) the emissions released during the production phase, suggesting a shift towards locally grown food.

Some researchers have looked at comparing the impacts of FM and local chains and found no strong evidence that the latter are more sustainable. CO_2 savings often come from production efficiency and energy consumption due to favourable climatic conditions (soil crops vs. greenhouses), product processing (sugar cane grown for multiple uses vs. sugar beet grown solely for sugar production), food preservation and storage (e.g. frozen food vs. fresh food), and genetics of autochthonous animals (Edwards-Jones, 2010). Dominance also depends on spatial configurations, product identity, physical distance, farm size, chain management, and technologies and resources (Brunori et al., 2016). In addition, a large proportion of local emissions are generated by consumer travel. Coley et al. (2009) estimate that, for a round trip of 6.7 km, the system of cold storage, packaging, transport to a regional hub and final transport to the customer's door is more polluting.

On the other hand, researchers argue that LF contributes to the socio-economic and health dimension (Schmitt et al., 2017; Vargas et al., 2021) by promoting local or regional economies (El Bilali et al., 2021; Salladarré et al, 2018), strengthening traditions and connections between territories (Bazzani & Canavari, 2017; Schmitt et al., 2018; Schnell, 2013), ensuring food security (Benis & Ferrão, 2017; Lyle et al., 2015) and enabling direct sales from producers (Kiss et al., 2019). As noted by Lulovicova & Bouissou (2023), policies that strengthen direct sales from farms also encourage citizens to shift to a plant-based diet. Local chains often match with urban agriculture (UA) and SFSCs, which are considered two ways to increase the sustainability and development of LF production (Artmann & Sartison, 2018; Jing et al., 2022; Rothwell et al., 2016; Schmutz et al., 2018; Specht et al., 2014). Enthoven & Van den Broeck (2021), while reviewing LF claims, add that participation in local chains mutually enhances farmers' profit motive and consumers' access to healthy and fresh food due to organic and environmentally friendly production. In addition, farmers not only feel more valued for their work, but can also experience cost benefits, although these are very case-specific.

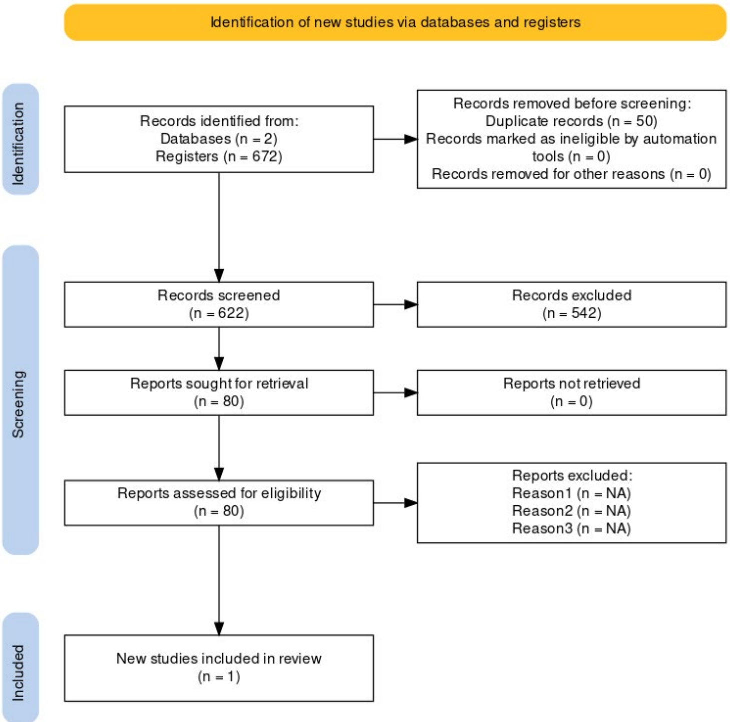
Nevertheless, uncertainties about their sustainability arise from concerns about production and technological inefficiencies that may increase environmental impacts (De Cara et al., 2017). In addition, the significant resource requirements for local cultivation have also been a point of contention (Goldstein et al., 2016; Nicholson et al., 2015; Sanyé-Mengual et al., 2015). Seasonality (Keyes et al., 2015; Tobarra et al., 2018), storage requirements (Blanke & Burdick, 2005; Milà i Canals et al., 2007) and the effectiveness of local distribution networks (Djekic et al., 2018; Marletto & Sillig, 2014; Torquati et al., 2015) further contribute to the ongoing debate on the viability of local production as a sustainable approach.

Nevertheless, the findings for and against local production are often based on the origin of supply sources (Sim et al., 2007), the specialisation of countries in specific crops (Kreidenweis et al., 2016), as well as climate, soil type, natural resources (Brodt et al., 2013), land use, production efficiency and economies of scale in transport (Stein & Santini, 2022).

3. RESEARCH OBJECTIVE AND METHODS

The search for scientific contributions on FSC and its environmental impact follows the guidelines of Tranfield et al. (2003). Once the research questions were defined, scientific papers were collected in the Scopus and Web of Science databases using the keywords "food miles & carbon footprint", "local food & carbon footprint" and "food miles OR local food & logistics & environmental impact" in the title, abstract and keywords. The search for scientific papers took place in April 2023. This phase resulted in 622 articles, which were analysed by title, abstract and main findings. We also checked whether the dimensions structuring the review were presented. After checking the content, 81 articles were included because they were more closely related to the research objective, while 541 articles were not included at this stage because their content was not related to the research topic. The latter were further supplemented by articles cited in the bibliographies of the retrieved papers. The process ended with 119 articles (Figure 1). All articles were classified in an Excel file, highlighting the aspects relevant to our purpose and noting the reasons for exclusion.

Figure 1 - PRISMA Scheme for retrieving the relevant articles



Source: Author's elaboration

4.1. PRODUCT AND PRODUCTION RELATED FACTOR'S

The greater sustainability of LF is not always guaranteed due to 'production-related factors' such as energy-intensive production and storage processes, geographical and climatic advantages, soil characteristics and productivity (Figure 2).

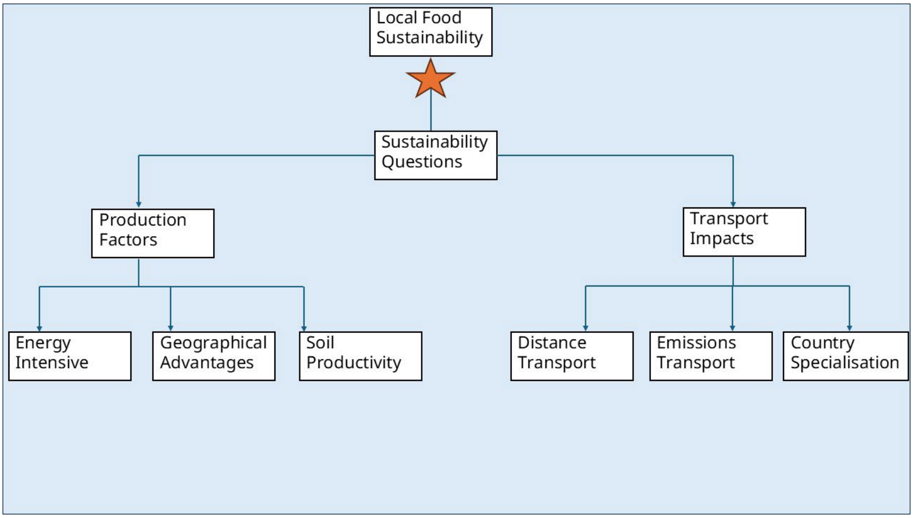
According to Carlsson-Kanyama et al. (2003), energy use ranges from 2 to 220 MJ/kg depending on the type of food (e.g. animal vs. plant), degree and type of processing, technology used, and transport distances. For beef, chicken, pork and lamb, energy levels vary from 35 to 75 MJ/kg depending on species-specific feed efficiency and metabolism. The highest energy input is observed for shrimp (220 MJ/kg), which the authors attribute primarily to fuel-intensive fishing practices in the North Sea, where up to 1.47 kg of fuel is required per kg of catch. The study includes various seafood products, allowing comparisons across the category. In addition, the amount of energy also depends on consumption patterns and dietary choices: sweets, snacks and beverages show a higher amount of energy due to the higher consumption in the Swedish population (18-44 MJ/kg). Webb et al. (2013) point out that energy use and emissions in the ecosystem change according to the productivity of countries, the type of storage required and the tonnes of GHG released in the production process. Importing tomatoes and strawberries to the UK from Spain can result in energy and water savings, as well as a reduction in the negative impacts of land use, acidification and pesticide use, compared. Similarly, lamb from New Zealand and chicken from Brazil require less electricity for the slaughter process, despite the transport distance. On the contrary, potatoes, beef and apples have lower impacts when produced directly in the UK than in Israel, New Zealand and Brazil due to higher yield productivity, shorter transport distances and less need for cold storage. Similarly, Edwards-Jones (2010) argues that the sustainability of local produce should be assessed in terms of climate, yield capacity, soil type and productivity, storage requirements which are closely linked to the seasonality of the food, and transport related factors relating to fuel and vehicle type and transport infrastructure. In fact, New Zealand's lamb production advantages come from a favourable climate, good genetics, efficient slaughter and processes. It also shows that importing tomatoes and lettuce from Spain is less polluting because in the UK both are grown in glasshouses. Conversely, fresh broccoli grown in the UK is more sustainable than broccoli imported and then frozen. It is better to import sugar from the tropics where the pollution associated with sugar production is shared with the production of other sugar cane derivatives.

Saunders and Barber (2007) claim that dairy production in New Zealand requires less energy and emits less CO_2 due to the lower use of direct and indirect energy inputs - such as fuel, diesel, petrol, lubricants, electricity, nitrogen, potassium, phosphorus, and pesticides - as well as the reduced reliance on physical assets like vehicles, dairy sheds, fencing, and water infrastructure. In contrast, for vegetables and bakery products, energy requirements do not significantly differ between organic and conventional production. The former, which aims to respect the ecosystem, is only effective if the products are not subsequently shipped, as the transport phase accounts for the lion's share. In fact, bread made with organic wheat generates 30g CO_2e. less than a conventional loaf, but the impact is the same as that of conventionally produced bread if it is shipped 420 km further from the USA (Meisterling et al., 2009). A similar result is found for organic dark chocolate produced and exported from Brazil (Pérez-Neira et al., 2020). In fact, as suggested by Webb et al. (2013), the burden of transport for a large proportion of production results in a small burden. Instead, the opposite is true for foods such as meat, which require much more energy during the production process than during transport. Kreidenweis et al. (2016) emphasise that the specialisation of countries in the production of certain crops is a crucial factor in assessing the sustainability of LF. By calculating CO_2 emissions from cultivation and harvesting to processing, each transport distance (farm to factory, factory to city/port) is also taken into account. Kreidenweis et al. (2016) demonstrate that for certain crops (barley and maize), imports from Brazil can result in lower GHG emissions than domestic production in Germany, due to more favourable climatic conditions and production efficiencies in the exporting regions. Specifically, producing barley in Germany increases CO_2 emissions by 32%, maize by 56%, oilseed and wheat by more than double, and sugar by 3.6 times compared to importing these crops from Brazil, primarily because of lower yield productivity in domestic systems. Diversified farming systems are seen as a solution for productivity and socio-environmental transition. Urban agriculture (UA), in particular Zero-Acreage Farming, offers potential for providing LF in urban regions. However, the sustainability of UA depends on energy-efficient practices, local resources and social inclusion. Wild edible plants provide affordable food security during food shortages, but their availability is limited by seasonality and climate extremes (Vargas et al., 2021).

Table 1 Selected Studies on Energy Use and GHG Emissions Across Food Products and Supply Chains

Study	Product(s)	Emissions / Energy Use	Key Notes
Carlsson-Kanyama et al. (2003)	Meat, vegetables, shrimp	2–220 MJ/kg	Shrimp: 220 MJ/kg due to fuel-intensive fishing practices
Saunders & Barber (2007)	Milk (NZ vs. UK)	Lower in NZ	Lower direct and indirect energy inputs
Striebig et al. (2019)	Lettuce, tomatoes, chicken	Lower emissions when sourced locally in Virginia	Also lower pesticide use in short supply chains
Rossi et al. (2020)	Tomatoes (transport)	- 125 kg CO_2 per shipment	Emissions reduced using intermodal transport (Bologna–Catania)
Theurl et al. (2014)	Tomatoes	-85% carbon footprint with seasonal production	Better than imports or greenhouse cultivation out of season
Hospido et al. (2009)	Lettuce	0.4–0.5 kg CO_2eq/kg (Spain) vs. 1.5–3.7 (UK)	Imports from Spain more efficient than winter greenhouse in the UK

Figure 2 - Scheme of the key concepts on product and production related factor's



Source: Author's elaboration

4.2. SEASONALITY

Among the six challenges to the food system listed by Wakeland et al. (2012) is the dependence of food on nature. This link is also manifested in the geographical dimension and seasonality, which make some areas more suitable than others for the cultivation of certain products in terms of climatic conditions, soil quality and composition (Figure 3).

In addition, to meet global food demand, fruit and vegetables are either harvested out of season and stored or grown directly in greenhouses. All this increases the demand for natural resources compared to the production of seasonal foods, as well as the emissions associated with the more intensive use of water and energy.

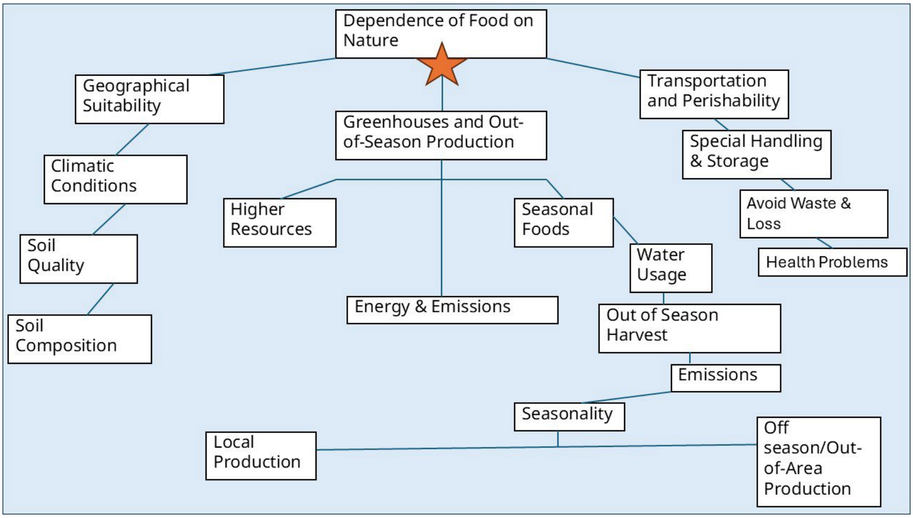
They also stress that these aspects have an impact on transport. In fact, the perishable nature of food requires special handling and storage conditions to avoid waste, losses (e.g. refrigeration, freezing, air conditioning, humidity, hygiene) and health problems, resulting in higher energy requirements and emissions.

In general, it is preferable to source food even over long distances according to the seasonality of the products, which would otherwise require an excessive number of raw materials to simulate the climatic conditions for their growth. The results are the same all over the world.

During the cold season, lettuce from Spain emits between 0.4 - 0.5 CO_2eq/kg compared to lettuce from the UK (1.5 - 3.7 CO_2eq/kg). The energy required for refrigerated transport is offset by the non-heat use in the UK for its cultivation (Hospido et al., 2009).

Tobarra et al. (2018) show that producing seasonal and domestic green beans, peppers, bananas and oranges in Spain is more efficient than importing them from Africa, although the CF of tomatoes, strawberries, apples and potatoes is lower when imported from France and Portugal respectively. Indeed, the impact of a seasonal tomato crop in Austria is 85% lower than those produced domestically out of season or imported from Spain and Italy (Theurl et al., 2014). Similarly, Blanke & Burdick (2005), Milà i Canals et al. (2007), and Keyes et al. (2015) find that in-season apple production allows for a reduction in energy consumption, as it does not require storage and transportation like off-season apple production in Germany, Austria, and Canada. Moreover, the CF of in-season oranges sold in the Atlanta, Chicago, Los Angeles and New York markets decreases by 51%, 46%, 14% and 24% respectively (Bell & Horvath, 2020). Appendix tables 1-3 summarises the literature discussed in this section.

Figure 3 - Scheme of the key concepts for seasonality



Source: Author's elaboration

4.3. SUPPLY CHAIN ORGANIZATION AND DISTRIBUTION

LF distribution takes place both through SFSCs in farmers' markets, farm shops and communities supporting agriculture, where customer interaction is high and the number of intermediaries is low, and through conventional SCs in independent retail outlets, restaurants, canteens, institutions and large supermarkets (Enthoven & Van den Broeck, 2021; Mundler & Rumpus, 2012) (Figure 4; Table 4, 5).

The potential of local distribution to reduce energy consumption due to its simple structure is demonstrated by Accorsi et al. (2022), Marletto & Silling (2014) in Italy. The former study examines the direct sale of potato, nectarine, apple, kiwi, watermelon, peach, pear, asparagus, tomato, apricot, plum, strawberry, pumpkin, and lotus fruit by a few farmers directly to retailers, highlighting the role of product type and short links in the supply chain. In contrast, the other two studies focus on regional supply chains. One illustrates the superiority of the regional supply chain in Sardinia, attributed to high volumes of canned tomatoes shipped, the point-to-point organisation, and the advantages offered by the island context.

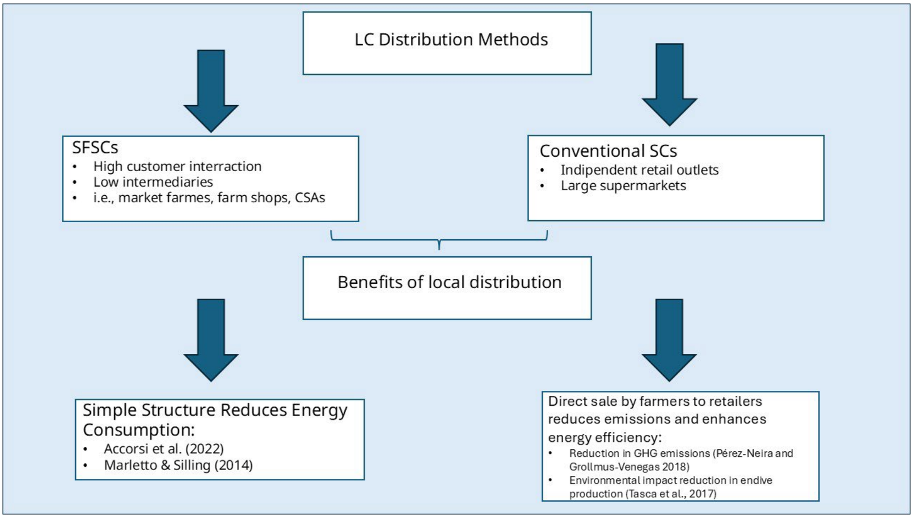
Pérez-Neira and Grollmus-Venegas (2018) find a significant reduction in GHG emissions (up to 91%) by comparing a Spanish organic farm that sells products directly to customers with a farm that uses a local supply chain for distribution. Similarly, Tasca et al. (2017) observe the environmental impact of endive production, both in organic and integrated systems, and find that direct distribution leads to a significant reduction in emissions by 30-40%. McClenaghan et al. (2014) conduct a study on community-supported fisheries (CSF) in the United States, where seafood is distributed within a 65-kilometre radius, resulting in half the emissions caused by the fish industry. Shorter distances are appropriate to preserve food biodiversity (Brunori et al., 2016). Producers and wholesalers benefit from selling their products closer to their customers because they save more fruit that would otherwise be lost over longer distances, reduce fuel costs, and avoid inappropriate packaging and non-refrigerated trucks (Aliotte et al., 2020). Finally, organic extra virgin olive oil shipped and distributed through a short and local supply chain shows a lower impact compared to conventional supply chain distribution (0.044 CO_2eq/kg vs. 0.508 CO_2eq/kg), despite the less efficient transport phase (Torquati et al., 2021).

Nevertheless, much evidence highlights the inefficiency of local and regional supply chain due to the distribution mode and fragmented organisation. Mundler & Rumpus (2012) highlight that the energy consumption of the collective sales point of fruit and vegetables in France is the highest (44.8 GOE/euro) among the different local supply chain of distribution (e.g., community-supported agriculture, employment-insertion farms, a cooperative and a private company; collective sales points and on-farm sales) due to the large amount of energy required in on-farm storage (22 GOE/euro), warehouses and stores (19.5 GOE/euro).These findings suggest that local and regional SCs, while potentially more sustainable from an environmental perspective, may face structural limitations that affect their equity and efficiency. In the context of a just and efficient transition, it is essential to assess how the fragmentation of local systems can lead to higher unit costs, logistical barriers, and unequal access to food. Conversely, larger-scale SCs often benefit from economies of scale and lower prices, which may promote greater affordability. Therefore, environmental performance alone is not sufficient: distributional impacts and social inclusiveness must also be considered when designing sustainable food policies.

Comparing the distribution of dairy products and assessing the sustainability of transport at national and international level, Djekic et al. (2018) show that the distribution of yoghurt and milk in Serbia through an international supply chain is preferable. Schmitt et al. (2016), comparing the performance of local and global supply chain in Switzerland (L'Etivaz vs. Le Gruyère) and the UK (Single Gloucester and Cheddar), underline the efficiency and affordability of the global cheese supply chain compared to local distribution, which performs better in terms of value creation and distribution, animal welfare and biodiversity.

At the transport stage, the amount of product transported, the number of empty return journeys or the mode of transport can sometimes make a difference. For example, although almonds and grapes are sourced from the same area in California, with similar distances and CO_2 emissions, very different emissions emerge when weight is taken into account (Fresán et al. 2018). Meanwhile, Bell and Horvath (2020) find that oranges transported by car from Mexico to New York City are six times more polluting than those transported by container ship from Chile, despite travelling half the distance. Torquati et al. (2015) also find that regionally branded milk marketed through retail channels has reduced environmental impacts, focusing on the transport stages. Finally, Torquati et al. (2015) define lower environmental impacts for regional-branded milk marketed through retail channels but limited to the transportation stages.

Figure 4 - Distribution methods



Source: Author's elaboration

4.4. SOLUTIONS TO INCREASE THE EFFICIENCY OF THE DISTRIBUTIONAL STAGE

To facilitate the transition improving the distribution of local chains, regional transport and delivery services is crucial to facilitate the transition to a more sustainable food system. Day-Farnsworth & Miller (2014) suggest aggregation and cooperation at the farm level (e.g. multi-farm aggregation) to develop local strategic logistics, implementing backhauling logistics to reduce empty miles and less-than-full loads, adding stops to the truck's journey to return goods to their point of origin. Rossi et al. (2021) propose a new transport model called "traveling stock" that promotes intermodal transport of perishable foods, minimising the main barriers associated with the distribution of meat, fruit, vegetables, refrigerated products and dairy products, aiming to address all the existing barriers to intermodal transport of perishable foods, such as the risk of reducing the quality and freshness of food, the need to repeatedly move goods from one vehicle to another, and the need to store products longer and prolong their delivery. The author report that the adoption of an intermodal transportation system between Bologna and Catania reduces CO_2 emissions by approximately 125 kg per shipment[1]. To address the speed of delivery, Jasim et al. (2022) propose drones, although the acceptance of this type of delivery service depends on social influence. Berti & Mulligan (2016) present food hubs as an innovative SFSC organisation to directly connect farmers, small producers and customers, reducing the distances travelled by both. Paciarotti et al. (2022), studying scenarios where farmers are located 30 km from the city centre and food hubs are located between 5 and 10 km away, show that the optimal scenarios are when food hubs manage both product collection at the farmer level and product delivery. Furthermore, the location of logistics facilities within an FSC affects emissions and distribution optimisation, as in the case of Parma ham, where the experience and presence of food logistics hubs are crucial (Morganti & Gonzalez-Feliu, 2015). Finally, Cramer & Fikar (2023) assess the feasibility of Crowd Logistics (CL) in the Bavarian region, a sustainable concept to make the delivery process easier and faster by relying on a collaborative network between people (Table. 6).

4.5. CUSTOMERS PREFERENCE FOR LOCAL PRODUCTS

Customer preference for locally grown products, which are perceived as safer and of higher quality (Onozaka & McFadden, 2011), and their value for lower emissions associated with shorter distances and travel times (Caputo et al., 2013) and

[1] While the absolute figure may appear modest, its impact becomes significant when scaled across multiple shipments. However, the paper does not provide a baseline figure, so the relative percentage reduction cannot be precisely quantified (Rossi et al.; 2021).

other sustainable labels, such as organic certifications for tomatoes (Caputo et al., 2012), is evident. However, the question of customer preference for LF due to its perceived lower environmental impact is still debated. On the one hand, Onozaka & Thilmany (2016) find that supplying apples in season with both origin and carbon labels effectively reduces emissions, unless customers have to travel more than 6.7 km to reach organic food producers (Coley et al., 2009a).

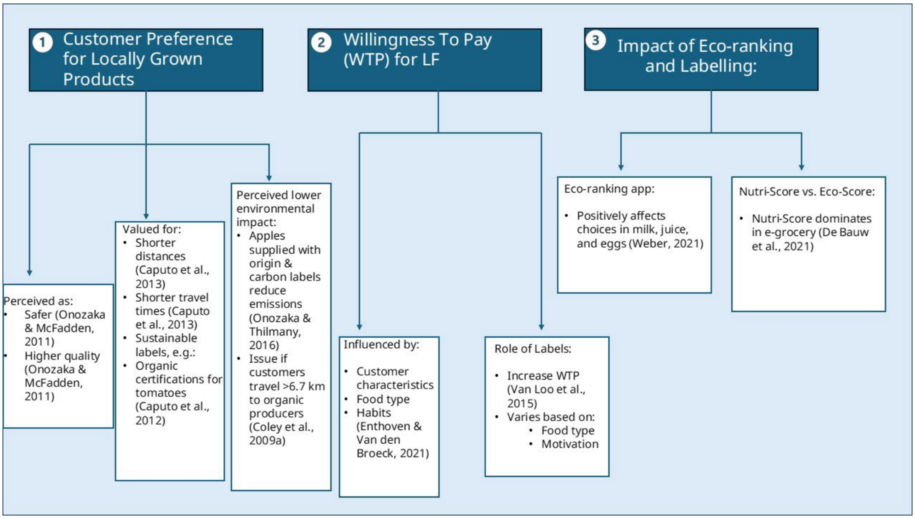
WTP for LF depends on customer characteristics, food type and habits (Enthoven & Van den Broeck, 2021).

Labels also increase the willingness to pay (WTP) (Van Loo et al., 2015), although it varies depending on the type of food and motivation. Grebitus et al. (2013) find that while German consumers are willing to pay more in absolute terms for locally sourced wine than for locally grown apples, the relative price discount due to distance travelled is larger for apples than for wine. This suggests that freshness plays a stronger role in shaping preferences for local apples, whereas wine is less affected by transport distance; instead, the French rely only on the quality of fruit and vegetables, while English customers prefer less FM (Brown et al., 2009). Moreover, labels are most likely to drive people with high environmental concern (Cholette et al., 2013) and low-price sensitivity to buy organic/local products, which are often more expensive (Torquati et al., 2021).

Weber (2021) finds that an eco-ranking app on transport distance and eco-certification in milk, juice and eggs increases sustainable production choices. Instead, combining sustainable labels with nutritional labels leads to small positive effects, as customers prefer nutritional information to environmental information in pizzas (Marette, 2022). Similarly, De Bauw et al. (2021) show that the Nutri-Score dominates the Eco-Score in e-grocery shopping.

According to the studies described above, customer preferences for LF are influenced by a wide range of factors, including perceptions of safety, quality and environmental impact. Labels play an important role in influencing consumer behaviour, as they can increase WTP and attract people who are concerned about the environment. However, the importance of labels varies between countries, with preferences shifting according to cultural and geographical considerations. In this context, further research could benefit from investigating the effectiveness of Eco-Score as a tool for identifying customer preferences and WTP for LF. Eco-Score, which takes into account travel distance and eco-certification, has shown encouraging results in promoting sustainable production options for items such as milk, juice and eggs (A. Weber, 2021). Investigating its use in determining customer preferences for LF, in combination with other sustainable labels and nutritional information, could provide important insights into consumer behaviour and decision-making. In addition, evaluating the influence and dominance of Eco-Score versus other labelling systems, such as Nutri-Score, in e-grocery shopping (De Bauw et al., 2021; Marette, 2022) could provide useful insights into how consumers prioritise environmental considerations when making food choices. Exploring the role of Eco-Score and other sustainable labelling schemes in understanding consumer behaviour and WTP for LF could contribute to a deeper understanding of consumer preferences and guide future strategies to promote sustainable consumption practices. (see Figure 5 and Table. 7)

Figure 5 - Customer preference scheme



Source: Author's elaboration

5. CONCLUSIONS

The literature review addresses the debate on the sustainability of LF and the relevance of FM as an indicator to assess the environmental impact of FSC.

On the one hand, FM is inadequate as it only considers the distance travelled; on the other hand, LF does not reduce the environmental impact of FSC as much as expected. The distance between production and consumption is relevant in determining impacts, but it is not the only factor. Therefore, our study proposes a broad view of the impacts related to the territoriality of production, climatic conditions, seasonality, production processes, local distribution and transport that influence the environmental impact of FSC. The dimension involved are the products and production related factors, seasonality, LF distribution, inefficiency and fragmentation of the supply chain organisation, solution to increase the efficiency of LF distribution and customer preferences for local products and carbon labels.

The overall conclusion is that it is difficult to generalise estimates to different situations and that a context-specific approach is required.

Nevertheless, local production proves to be preferable when local resources are used for cultivation, when economies of scale are available, when the seasonality of products is taken into account, and when climatic and soil conditions are favourable. For perishable products, it is still preferable to reduce the distance between production and consumption. Moreover, many of the advantages of LF are due to the technology used and the efficiency of the production process. The issue of distribution and organisation of the supply chain is more ambiguous. In many cases, large-scale distribution ensures both efficiency and sustainability, despite the greater distances; in some cases, a specific context makes local distribution more appropriate.

In addition, buying directly from farms and producers reduces the environmental impact if the distance travelled by the consumer exceeds a certain threshold, otherwise the emissions are even higher than in a large supply chain with many intermediaries.

In addition, LF is concerned with a territorial dimension, a sense of belonging to an area and food traditions passed down over time - essentially the cultural dimension of food.

According to the authors, the label showing the LF attribute should emphasise support for the local economy and community rather than just reduced environmental impact.

However, the practical implementation of a LF label presents challenges, particularly in informal or bulk-sale contexts such as farmers' markets, where products are often sold unpackaged and without standardised packaging formats. In these cases, the value of a physical label may be limited. Instead, trust - whether interpersonal (between producers and consumers) or institutional (through market reputation or governance systems) - plays a central role in assuring the origin and sustainability of products. Therefore, any labelling strategy should be seen as a complement to, rather than a substitute for, the trust-based mechanisms already embedded in SFSCs.

This literature review contributes to the ongoing debate on the use of FM and LF by highlighting the issues that need to be considered when estimating the CF of FSC.

This review also engages with the broader theme of a just and efficient transition. While LF systems are often promoted as more sustainable, they do not automatically ensure equitable access or systemic efficiency. In fact, the environmental benefits of local production and distribution are highly context-dependent, and in some cases, short supply chains may suffer from inefficiencies, higher per-unit costs, and limited accessibility for lower-income groups. Moreover, a strong emphasis on territoriality and cultural attachment may unintentionally exclude producers and consumers who fall outside defined "local" boundaries, raising issues of fairness and inclusion. Conversely, large-scale systems, despite their environmental drawbacks, often guarantee lower prices and broader access through economies of scale. These tensions highlight the need for food policy and sustainability assessments to move beyond binary distinctions (e.g., local vs. global) and adopt frameworks that integrate environmental, social, and economic dimensions; especially in view of trade-offs that may undermine the fairness of ecological transitions.

Future research perspectives could focus on sustainable mobility at the local level, in particular regarding last mile management at the local/regional level, as well as consumer perceptions of sustainable last mile distribution initiatives. The implementation of appropriate tools for communicating the environmental impact of food products can be useful for public policy makers and the logistics industry in developing strategies for sustainable local distribution of goods. It can also empower consumers to make informed choices.

In conclusion, our paper summarises the literature on FM and LF in order to shed light on the existing debate and clarify which aspects should be considered when assessing the sustainability of FSC. Our work may be useful to researchers working on the sustainability of the food chain and to companies committed to making the agri-food sector more environmentally friendly. Finally, it offers recommendations to local authorities interested in developing policies for the distribution of goods and guiding the logistics sector and the FSC as a whole towards climate change mitigation practices.

REFERENCES

Accorsi, R., Cholette, S., Guidani, B., Manzini, R., & Ronzoni, M. (2022). Sustainability assessment of transport operations in local Food Supply networks. Transportation Research Procedia, 67, 1–11. https://doi.org/10.1016/j.trpro.2022.12.049

Aliotte, J. T. B., Lima, D. M., & Oliveira, A. L. R. de. (2020). Food miles' contribution to papaya transport logistics: From the field to the warehouse. Sistemas & Gestão, 15(2), Articolo 2. https://doi.org/10.20985/1980-5160.2020.v15n2.1646

Artmann, M., & Sartison, K. (2018). The Role of Urban Agriculture as a Nature-Based Solution: A Review for Developing a Systemic Assessment Framework. Sustainability, 10(6), Articolo 6. https://doi.org/10.3390/su10061937

Avetisyan, M., Hertel, T., & Sampson, G. (2014). Is Local Food More Environmentally Friendly? The GHG Emissions Impacts of Consuming Imported versus Domestically Produced Food. Environmental and Resource Economics, 58(3), 415–462. https://doi.org/10.1007/s10640-013-9706-3

Ballingall, J., & Winchester, N. (2010). Food Miles: Starving the Poor? The World Economy, 33(10), 1201–1217. https://doi.org/10.1111/j.1467-9701.2010.01270.x

Bazzani, C., & Canavari, M. (2017). Is local a matter of food miles or food traditions? Italian Journal of Food Science, 29, 505–517. https://doi.org/10.14674/IJFS-733

Bell, E. M., & Horvath, A. (2020). Modeling the carbon footprint of fresh produce: Effects of transportation, localness, and seasonality on US orange markets. Environmental Research Letters, 15(3), 034040. https://doi.org/10.1088/1748-9326/ab6c2f

Benis, K., & Ferrão, P. (2017). Potential mitigation of the environmental impacts of food systems through urban and peri-urban agriculture (UPA) – a life cycle assessment approach. Journal of Cleaner Production, 140, 784–795. https://doi.org/10.1016/j.jclepro.2016.05.176

Berti, G., & Mulligan, C. (2016). Competitiveness of Small Farms and Innovative Food Supply Chains: The Role of Food Hubs in Creating Sustainable Regional and Local Food Systems. Sustainability, 8(7), Articolo 7. https://doi.org/10.3390/su8070616

Blanke, M., & Burdick, B. (2005). Food (Miles) for Thought-Energy Balance for Locally Grown versus Imported Apple Fruit. Environmental science and pollution research international, 12, 125–127. https://doi.org/10.1065/espr2005.05.252

Brodt, S., Kramer, K. J., Kendall, A., & Feenstra, G. (2013). Comparing environmental impacts of regional and national-scale food: A case study of processed tomatoes. Food Policy, 42, 106–114. https://doi.org/10.1016/j.foodpol.2013.07.004

Brown, E., Dury, S., & Holdsworth, M. (2009). Motivations of consumers that use local, organic fruit and vegetable box schemes in Central England and Southern France. Appetite, 53, 183–188. https://doi.org/10.1016/j.appet.2009.06.006

Brunori, G., Galli, F., Barjolle, D., Van Broekhuizen, R., Colombo, L., Giampietro, M., Kirwan, J., Lang, T., Mathijs, E., Maye, D., De Roest, K., Rougoor, C., Schwarz, J., Schmitt, E., Smith, J., Stojanovic, Z., Tisenkopfs, T., & Touzard, J.-M. (2016). Are Local Food Chains More Sustainable than Global Food Chains? Considerations for Assessment. Sustainability, 8(5), Articolo 5. https://doi.org/10.3390/su8050449

Cappelli, L., D'Ascenzo, F., Ruggieri, R., & Gorelova, I. (2022). Is Buying Local Food a Sustainable Practice? A Scoping Review of Consumers' Preference for Local Food. Sustainability, 14(2), Articolo 2. https://doi.org/10.3390/su14020772

Caputo, V., Canavari, M., & Jr, N. (2012). Evaluation of Campania's consumers preferences for a generic food miles labeling system. Economia Agro-Alimentare, 14, 99–115.

Caputo, V., Nayga, R., & Scarpa, R. (2013). Food Miles or Carbon Emissions? Exploring Labelling Preference for Food Transport Footprint with a Stated Choice Study. Australian Journal of Agricultural and Resource Economics, 57. https://doi.org/10.1111/1467-8489.12014

Carlsson-Kanyama, A., Ekström, M., & Shanahan, H. (2003). Food and life cycle energy inputs: Consequences of diet and ways to increase efficiency. Ecological Economics, 44, 293–307. https://doi.org/10.1016/S0921-8009(02)00261-6

Castillo, J. M., González, C. E., Lienert, A., Flórez, J. F., Bravo Parra, A. M., Triana Ángel, N., & Burkart, S. (2024). The carbon footprint of beef transport in Colombia: Market connections and distribution networks. Frontiers in Sustainable Food Systems, 8. https://doi.org/10.3389/fsufs.2024.1416629

Cerutti, A. K., Contu, S., Ardente, F., Donno, D., & Beccaro, G. L. (2016). Carbon footprint in green public procurement: Policy evaluation from a case study in the food sector. Food Policy, 58, 82–93. https://doi.org/10.1016/j.foodpol.2015.12.001

Cholette, S., Ungson, G. R., Özlük, Ö., & Özşen, L. (2013). Exploring purchasing preferences: Local and ecologically labelled foods. Journal of Consumer Marketing, 30(7), 563–572. https://doi.org/10.1108/JCM-04-2013-0544

Coley, D., Howard, M., & Winter, M. (2009a). Local food, food miles and carbon emissions: A comparison of farm shop and mass distribution approaches. Food Policy, 34(2), 150–155. https://doi.org/10.1016/j.foodpol.2008.11.001

Coley, D., Howard, M., & Winter, M. (2009b). Local food, food miles and carbon emissions: A comparison of farm shop and mass distribution approaches. Food Policy, 34(2), 150–155. https://doi.org/10.1016/j.foodpol.2008.11.001

Coley, D., Howard, M., & Winter, M. (2011). Food miles: Time for a re-think? British Food Journal, 113, 919–934. https://doi.org/10.1108/00070701111148432

Costanigro, M., Deselnicu, O., & Kroll, S. (2015). Food Beliefs: Elicitation, Estimation and Implications for Labeling Policy. Journal of Agricultural Economics, 66(1), 108–128. https://doi.org/10.1111/1477-9552.12085

Cramer, F., & Fikar, C. (2023). Investigating crowd logistics platform operations for local food distribution. International Journal of Retail & Distribution Management, ahead-of-print(ahead-of-print). https://doi.org/10.1108/IJRDM-10-2022-0400

Day-Farnsworth, L., & Miller, M. (2014). Networking Across the Supply: Transportation Innovations in Local and Regional Food Systems. University of Wisconsin. https://doi.org/10.9752/TS202.06-2014

De Bauw, M., Matthys, C., Poppe, V., Franssens, S., & Vranken, L. (2021). A combined Nutri-Score and 'Eco-Score' approach for more nutritious and more environmentally friendly food choices? Evidence from a consumer experiment in Belgium. Food Quality and Preference, 93, 104276. https://doi.org/10.1016/j.foodqual.2021.104276

De Cara, S., Fournier, A., & Gaigné, C. (2017). LOCAL FOOD, URBANIZATION, AND TRANSPORT-RELATED GREENHOUSE GAS EMISSIONS. Journal of Regional Science, 57(1), 75–108. https://doi.org/10.1111/jors.12299

Djekic, I., Smigic, N., Glavan, R., Miocinovic, J., & Tomasevic, I. (2018). Transportation sustainability index in dairy industry – Fuzzy logic approach. Journal of Cleaner Production, 180, 107–115. https://doi.org/10.1016/j.jclepro.2018.01.185

Duarte, G. T., de Alencar Nääs, I., Innocencio, C. M., da Silva Cordeiro, A. F., & da Silva, R. B. T. R. (2019). Environmental impact of the on-road transportation distance and product volume from farm to a fresh food distribution center: A case study in Brazil. Environmental Science and Pollution Research, 26(32), 33694–33701. https://doi.org/10.1007/s11356-019-06461-8

DuPuis, E. M., & Goodman, D. (2005). Should we go "home" to eat? Toward a reflexive politics of localism. Journal of Rural Studies, 21(3), 359–371. https://doi.org/10.1016/j.jrurstud.2005.05.011

Edwards-Jones, G. (2010). Does eating local food reduce the environmental impact of food production and enhance consumer health? Proceedings of the Nutrition Society, 69(4), 582–591. https://doi.org/10.1017/S0029665110002004

Edwards-Jones, G., Milà i Canals, L., Hounsome, N., Truninger, M., Koerber, G., Hounsome, B., Cross, P., York, E. H., Hospido, A., Plassmann, K., Harris, I. M., Edwards, R. T., Day, G. A. S., Tomos, A. D., Cowell, S. J., & Jones, D. L. (2008). Testing the assertion that 'local food is best': The challenges of an evidence-based approach. Trends in Food Science & Technology, 19(5), 265–274. https://doi.org/10.1016/j.tifs.2008.01.008

El Bilali, H., Strassner, C., & Ben Hassen, T. (2021). Sustainable Agri-Food Systems: Environment, Economy, Society, and Policy. Sustainability, 13(11), Articolo 11. https://doi.org/10.3390/su13116260

Enthoven, L., & Van den Broeck, G. (2021). Local food systems: Reviewing two decades of research. Agricultural Systems, 193, 103226. https://doi.org/10.1016/j.agsy.2021.103226

Eriksen, S. N. (2013). Defining local food: Constructing a new taxonomy – three domains of proximity. Acta Agriculturae Scandinavica, Section B — Soil & Plant Science, 63(sup1), 47–55. https://doi.org/10.1080/09064710.2013.789123

European Commission. (2022). Farm to Fork Strategy. https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en

FAO. (2021). Emissions due to agriculture.

Farmery, A. K., Gardner, C., Green, B. S., Jennings, S., & Watson, R. A. (2015). Domestic or imported? An assessment of carbon footprints and sustainability of seafood consumed in Australia. Environmental Science and Policy, 54, 35–43. https://doi.org/10.1016/j.envsci.2015.06.007

Fresán, U., Harwatt, H., & Sabaté, J. (2018). Developing a Methodology for Estimating Transport-Related CO_2 Emissions for Food Commodities. Journal of Sustainable Development, 11, 47. https://doi.org/10.5539/jsd.v11n6p47

Ghoshal, S. (2014). Understanding Food Mile: A Qualitative Study on the Concept of Food Mile. 2, 56.

Goldstein, B., Hauschild, M., Fernández, J., & Birkved, M. (2016). Testing the environmental performance of urban agriculture as a food supply in northern climates. Journal of Cleaner Production, 135, 984–994. https://doi.org/10.1016/j.jclepro.2016.07.004

Grebitus, C., Lusk, J. L., & Nayga, R. M. (2013). Effect of distance of transportation on willingness to pay for food. Ecological Economics, 88, 67–75. https://doi.org/10.1016/j.ecolecon.2013.01.006

Hospido, A., Milà i Canals, L., Mclaren, S., Truninger, M., Edwards-Jones, G., & Clift, R. (2009). The role of seasonality in lettuce consumption: A case study of environmental and social aspects. The International Journal of Life Cycle Assessment, 14, 381–391. https://doi.org/10.1007/s11367-009-0091-7

Jasim, N. I., Kasim, H., & Mahmoud, M. A. (2022). Towards the Development of Smart and Sustainable Transportation System for Foodservice Industry: Modelling Factors Influencing Customer's Intention to Adopt Drone Food Delivery (DFD) Services. Sustainability, 14(5), Articolo 5. https://doi.org/10.3390/su14052852

Jing, R., Hua, W., Lin, J., Lin, J., Zhao, Y., Zhou, Y., & Wu, J. (2022). Cost-efficient decarbonization of local energy systems by whole-system based design optimization. Applied Energy, 326. https://doi.org/10.1016/j.apenergy.2022.119921

Karwacka, M., Ciurzyńska, A., Lenart, A., & Janowicz, M. (2020). Sustainable Development in the Agri-Food Sector in Terms of the Carbon Footprint: A Review. Sustainability, 12(16), Articolo 16. https://doi.org/10.3390/su12166463

Kemp, K., Insch, A., Holdsworth, D. K., & Knight, J. G. (2010). Food miles: Do UK consumers actually care? Food Policy, 35(6), 504–513. https://doi.org/10.1016/j.foodpol.2010.05.011

Keyes, S., Tyedmers, P., & Beazley, K. (2015). Evaluating the environmental impacts of conventional and organic apple production in Nova Scotia, Canada, through life cycle assessment. Journal of Cleaner Production, 104, 40–51. https://doi.org/10.1016/j.jclepro.2015.05.037

Kim, S.-H., & Huang, R. (2021). Understanding local food consumption from an ideological perspective: Locavorism, authenticity, pride, and willingness to visit. Journal of Retailing and Consumer Services, 58, 102330. https://doi.org/10.1016/j.jretconser.2020.102330

Kiss, K., Ruszkai, C., & Takács-György, K. (2019). Examination of short based on circular economy and sustainability aspects. Resources, 4. https://doi.org/10.3390/resources8040161

Kreidenweis, U., Lautenbach, S., & Koellner, T. (2016). Regional or global? The question of low-emission food sourcing addressed with spatial optimization modelling. Environmental Modelling and Software, 82, 128–141. https://doi.org/10.1016/j.envsoft.2016.04.020

Kühl, S., Busch, G., & Gauly, M. (2020). How should beef be produced? Consumer expectations and views on local beef production in South Tyrol (Italy). British Food Journal, 123(4), 1578–1595. https://doi.org/10.1108/BFJ-07-2020-0571

Kyoto Protocol. (1997). 1997 Kyoto Protocol to the United Nations Framework Convention on Climate Change. Centre for International Law. https://cil.nus.edu.sg/databasecil/1997-kyoto-protocol-to-the-united-nations-framework-convention-on-climate-change/

Lang, T. (2006). Slow-Food-fd-miles-final-16-02-06.pdf. https://www.city.ac.uk/__data/assets/pdf_file/0007/167893/Slow-Food-fd-miles-final-16-02-06.pdf

Loiseau, E., Colin, M., Alaphilippe, A., Coste, G., & Roux, P. (2020). To what extent are short food (SFSCs) environmentally friendly? Application to French apple distribution using Life Cycle Assessment. Journal of Cleaner Production, 276, 124166. https://doi.org/10.1016/j.jclepro.2020.124166

Lulovicova, A., & Bouissou, S. (2023). Environmental Assessment of Local Food Policies through a Territorial Life Cycle Approach. 15. https://doi.org/10.3390/su15064740

Lyle, P., Choi, J. H., & Foth, M. (2015). Growing food in the city: Design ideations for urban residential gardeners. Proceedings of the 7th International Conference on Communities and Technologies, 89–97. https://doi.org/10.1145/2768545.2768549

Malak-Rawlikowska, A., Majewski, E., Was, A., Borgen, S. O., Csillag, P., Donati, M., Freeman, R., Hoàng, V., Lecoeur, J.-L., Mancini, M. C., Nguyen, A., Saïdi, M., Tocco, B., Török, Á., Veneziani, M., Vittersø, G., & Wavresky, P. (2019). Measuring the economic, environmental, and social sustainability of short food Sustainability (Switzerland), 11(15). https://doi.org/10.3390/su11154004

Marette, S. (2022). Ecological and/or Nutritional Scores for Food Traffic-Lights: Results of an Online Survey Conducted on Pizza in France. Sustainability, 14(1), Articolo 1. https://doi.org/10.3390/su14010247

Marletto, G., & Sillig, C. (2014). Environmental impact of Italian canned tomato logistics: National vs. regional. Journal of Transport Geography, 34, 131–141. https://doi.org/10.1016/j.jtrangeo.2013.12.002

Marletto, G., & Silling, C. (2010). Distance matters – The environmental impact of regional and national of canned tomatoes.

Martinez, S., Hand, M., da Pra, M., Pollack, S., Ralston, K., Smith, T., Vogel, S., Clark, S., Lohr, L., Low, S., & Newman, C. (2010). Local food systems: Concepts, impacts, and issues. In Local Food Systems: Background and Issues. Nova Science Publishers, Inc. https://www.scopus.com/inward/record.uri?eid=2-s2.0-85029651743&partnerID=40&md5=565ae38c0a68903505be77f0ea7cf005

Meisterling, K., Samaras, C., & Schweizer, V. (2009). Decisions to reduce greenhouse gases from agriculture and product transport: LCA case study of organic and conventional wheat. Journal of Cleaner Production, 17(2), 222–230. https://doi.org/10.1016/j.jclepro.2008.04.009

Michalský, M., & Hooda, P. S. (2015). Greenhouse gas emissions of imported and locally produced fruit and vegetable commodities: A quantitative assessment. Environmental Science and Policy, 48, 32–43. https://doi.org/10.1016/j.envsci.2014.12.018

Milà i Canals, L., Bauer, C., Depestele, J., Dubreuil, A., Freiermuth Knuchel, R., Gaillard, G., Michelsen, O., Müller-Wenk, R., & Rydgren, B. (2007). Key Elements in a Framework for Land Use Impact Assessment Within LCA (11 pp). The International Journal of Life Cycle Assessment, 12(1), 5–15. https://doi.org/10.1065/lca2006.05.250

Mok, H.-F., Williamson, V. G., Grove, J. R., Burry, K., Barker, S. F., & Hamilton, A. J. (2014). Strawberry fields forever? Urban agriculture in developed countries: A review. Agronomy for Sustainable Development, 34(1), 21–43. https://doi.org/10.1007/s13593-013-0156-7

Morganti, E., & Gonzalez-Feliu, J. (2015). The last food mile concept as a city logistics solution for perishable products (pp. 202–207).

Mundler, P., & Rumpus, L. (2012). The energy efficiency of local food systems: A comparison between different modes of distribution. Food Policy, 37(6), 609–615. https://doi.org/10.1016/j.foodpol.2012.07.006

Nicholson, C., He, X., Gómez, M., Gao, H., & Hill, E. (2015). Environmental and Economic Impacts of Localizing Food Systems: The Case of Dairy in the Northeastern U.S. Environmental science & technology, 49. https://doi.org/10.1021/acs.est.5b02892

Oliveira, R. L. M. de, Santos, I. V., Graciano, G. F., Cunha Libânio, A. A., Kelli de Oliveira, L., & Bracarense, L. dos S. F. P. (2021). A sustainable approach for urban farming based on city logistics concepts for local production and consumption of vegetables. Research in Transportation Economics, 87, 101038. https://doi.org/10.1016/j.retrec.2021.101038

Onozaka, Y., Hu, W., & Thilmany, D. D. (2016). Can eco-labels reduce carbon emissions? Market-wide analysis of carbon labeling and locally grown fresh apples. Renewable Agriculture and Food Systems, 31(2), 122–138. https://doi.org/10.1017/S174217051500006X

Onozaka, Y., & McFadden, D. T. (2011). Does local labeling complement or compete with other sustainable labels? A conjoint analysis of direct and joint values for fresh produce claim. American Journal of Agricultural Economics, 93(3), 689–702. https://doi.org/10.1093/ajae/aar005

Paciarotti, C., Mazzuto, G., Torregiani, F., & Fikar, C. (2022). Locally produced food for restaurants: A theoretical approach for the network design. International Journal of Retail & Distribution Management, 50(13), 164–183. https://doi.org/10.1108/IJRDM-10-2021-0477

Paxton, A. (1994). The Food Miles Report: The Dangers of Long-Distance Food Transport. SAFE Alliance.

Pérez-Neira, D., Copena, D., Armengot, L., & Simón, X. (2020). Transportation can cancel out the ecological advantages of producing organic cacao: The carbon footprint of the globalized agrifood system of ecuadorian chocolate. Journal of Environmental Management, 276. https://doi.org/10.1016/j.jenvman.2020.111306

Pérez-Neira, D., & Grollmus-Venegas, A. (2018). Life-cycle energy assessment and carbon footprint of peri-urban horticulture. A comparative case study of local food systems in Spain. Landscape and Urban Planning, 172, 60–68. https://doi.org/10.1016/j.landurbplan.2018.01.001

Pirog, R. (2001). Food, Fuel and Freeways: An Iowa Perspective on how Far Food Travels, Fuel Usage, and Greenhouse Gas Emissions. Iowa State University, Leopold Center for Sustainable Agriculture.

Rossi, T., Pozzi, R., Pirovano, G., Cigolini, R., & Pero, M. (2021). A new logistics model for increasing economic sustainability of perishable food through intermodal transportation. International Journal of Logistics Research and Applications, 24(4), 346–363. https://doi.org/10.1080/13675567.2020.1758047

Rothwell, A., Ridoutt, B., Page, G., & Bellotti, W. (2016). Environmental performance of local food: Trade-offs and implications for climate resilience in a developed city. Journal of Cleaner Production, 114, 420–430. https://doi.org/10.1016/j.jclepro.2015.04.096

Salladarré, F., Guillotreau, P., Debucquet, G., & Lazuech, G. (2018). Some Good Reasons for Buying Fish Exclusively from Community-Supported Fisheries: The Case of Yeu Island in France. Ecological Economics, 153, 172–180. https://doi.org/10.1016/j.ecolecon.2018.07.017

Sanyé-Mengual, E., Oliver-Solà, J., Montero, J., & Rieradevall, J. (2015). An environmental and economic life cycle assessment of rooftop greenhouse (RTG) implementation in Barcelona, Spain. Assessing new forms of urban agriculture from the greenhouse structure to the final product level. The International Journal of Life Cycle Assessment, 20. https://doi.org/10.1007/s11367-014-0836-9

Saunders, C., & Barber, A. (2007). Comparative energy and greenhouse gas emissions of New Zealand's and the UK's dairy industry.

Schmitt, E., Dominique, B., & Six, J. (2018). Assessing the degree of localness of food value chains. Agroecology and Sustainable Food Systems, 42(5), 573–598. https://doi.org/10.1080/21683565.2017.1365800

Schmitt, E., Galli, F., Menozzi, D., Maye, D., Touzard, J.-M., Marescotti, A., Six, J., & Brunori, G. (2017). Comparing the sustainability of local and global food products in Europe. Journal of Cleaner Production, 165, 346–359. https://doi.org/10.1016/j.jclepro.2017.07.039

Schmitt, E., Keech, D., Maye, D., Barjolle, D., & Kirwan, J. (2016). Comparing the Sustainability of Local and Global Food Chains: A Case Study of Cheese Products in Switzerland and the UK. Sustainability, 8(5), Articolo 5. https://doi.org/10.3390/su8050419

Schmutz, U., Kneafsey, M., Kay, C. S., Doernberg, A., & Zasada, I. (2018). Sustainability impact assessments of different urban short food: Examples from London, UK. Renewable Agriculture and Food Systems, 33(6), 518–529. https://doi.org/10.1017/S1742170517000564

Schnell, S. (2013). Food miles, local eating, and community supported agriculture: Putting local food in its place. Agriculture and Human Values, 30. https://doi.org/10.1007/s10460-013-9436-8

Sim, S., Barry, M., Clift, R., & Cowell, S. (2007). The relative importance of transport in determining an appropriate sustainability strategy for food sourcing. INTERNATIONAL JOURNAL OF LIFE CYCLE ASSESSMENT, 12(6), 422–431.

Smith, A., Watkiss, P., Tweddle, G., & McKinnon, A. C. (2005). The Validity of Food Miles as an Indicator of Sustainable Development: Final Report for DEFRA. AEA Technology.

Specht, K., Siebert, R., Opitz, I., Freisinger, U., Sawicka, M., Werner, A., Thomaier, S., Henckel, D., Walk, H., & Dierich, A. (2014). Urban agriculture of the future: An overview of sustainability aspects of food production in and on buildings. Agriculture and Human Values, 31. https://doi.org/10.1007/s10460-013-9448-4

Stein, A. J., & Santini, F. (2022). The sustainability of "local" food: A review for policymakers. Review of Agricultural, Food and Environmental Studies, 103(1), 77–89. https://doi.org/10.1007/s41130-021-00148-w

Striebig, B., Smitts, E., & Morton, S. (2019). Impact of transportation on carbon dioxide emissions from locally vs. non-locally sourced food. Emerging Science Journal, 3(4), 222–234. https://doi.org/10.28991/esj-2019-01184

Tasca, A. L., Nessi, S., & Rigamonti, L. (2017). Environmental sustainability of agri-food: An LCA comparison between two alternative forms of production and distribution of endive in northern Italy. Journal of Cleaner Production, 140, 725–741. https://doi.org/10.1016/j.jclepro.2016.06.170

Theurl, M. C., Haberl, H., Erb, K.-H., & Lindenthal, T. (2014). Contrasted greenhouse gas emissions from local versus long-range tomato production. Agronomy for Sustainable Development, 34(3), 593–602. https://doi.org/10.1007/s13593-013-0171-8

Tobarra, M.-Á., Santiago, L., Cadarso, M., Gómez, N., & Cazcarro, I. (2018). Is Seasonal Households' Consumption Good for the Nexus Carbon/Water Footprint? The Spanish Fruits and Vegetables Case. Environmental Science & Technology, 52. https://doi.org/10.1021/acs.est.8b00221

Torquati, B., Cecchini, L., Paffarini, C., & Chiorri, M. (2021). The economic and environmental sustainability of extra virgin olive oil: An analysis based on food miles and value chains. Economia Agro-Alimentare/Food Economy - Open Access, 23(1), Articolo 1. https://doi.org/10.3280/ecag1-2021oa11391

Torquati, B., Taglioni, C., & Cavicchi, A. (2015). Evaluating the CO_2 Emission of the Milk in Italy: An Exploratory Study. Sustainability, 7(6), Articolo 6. https://doi.org/10.3390/su7067245

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a Methodology for Developing Evidence-Informed Management Knowledge by Means of Systematic Review. British Journal of Management, 14(3), 207–222. https://doi.org/10.1111/1467-8551.00375

Tubiello, F. N., Karl, K., Flammini, A., Gütschow, J., Obli-Laryea, G., Conchedda, G., Pan, X., Qi, S. Y., Halldórudóttir Heiðarsdóttir, H., Wanner, N., Quadrelli, R., Rocha Souza, L., Benoit, P., Hayek, M., Sandalow, D., Mencos Contreras, E., Rosenzweig, C., Rosero Moncayo, J., Conforti, P., & Torero, M. (2022). Pre- and post-production processes increasingly dominate greenhouse gas emissions from agri-food systems. Earth System Science Data, 14(4), 1795–1809. https://doi.org/10.5194/essd-14-1795-2022

Van Loo, E. J., Caputo, V., Nayga, R. M., Seo, H.-S., Zhang, B., & Verbeke, W. (2015). Sustainability labels on coffee: Consumer preferences, willingness-to-pay and visual attention to attributes. Ecological Economics, 118, 215–225. https://doi.org/10.1016/j.ecolecon.2015.07.011

Van Passel, S. (2013). Food miles to assess sustainability: A revision. Sustainable Development, 21(1), 1–17. https://doi.org/10.1002/sd.485

Vargas, A. M., de Moura, A. P., Deliza, R., & Cunha, L. M. (2021). The Role of Local Seasonal Foods in Enhancing Sustainable Food Consumption: A Systematic Literature Review. Foods, 10(9), Articolo 9. https://doi.org/10.3390/foods10092206

Wakeland, W., Cholette, S., & Venkat, K. (2012). Food Transportation Issues and Reducing Carbon Footprint. In Food Engineering Series (pp. 211–236). https://doi.org/10.1007/978-1-4614-1587-9_9

Webb, J., Williams, A., Hope, E., Evans, D., & Moorhouse, E. (2013). Do foods imported into the UK have a greater environmental impact than the same foods produced within the UK? The International Journal of Life Cycle Assessment, 18. https://doi.org/10.1007/s11367-013-0576-2

Weber, A. (2021). Mobile apps as a sustainable shopping guide: The effect of eco-score rankings on sustainable food choice. Appetite, 167, 105616. https://doi.org/10.1016/j.appet.2021.105616

Weber, C. L., & Matthews, H. S. (2008). Food-Miles and the Relative Climate Impacts of Food Choices in the United States. Environmental Science & Technology, 42(10), 3508–3513. https://doi.org/10.1021/es702969f

Wiedemann, S. G., Ledgard, S. F., Henry, B. K., Yan, M.-J., Mao, N., & Russell, S. J. (2015). Application of life cycle assessment to sheep production systems: Investigating co-production of wool and meat using case studies from major global producers. The International Journal of Life Cycle Assessment, 20(4), 463–476. https://doi.org/10.1007/s11367-015-0849-z

Wynen, E., & Vanzetti, D. (2009). No Through Road: The Limitations of Food Miles. esocialsciences.com, Working Papers.