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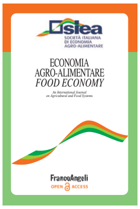

The economic and environmental sustainability of extra virgin olive oil supply chains: An analysis based on food miles and value chains

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Abstract

Following the growing trend towards globalisation of the agri-food system over the last few years, a number of scientific publications with different aims and methodological approaches have addressed the issue of the progressive link loss between the place of consumption and production of food. In part, the scientific debate has focused on the various agri-food production commercial outlets, highlighting the strengths and weaknesses of both the dominant models like mass market retail, as well as emerging models like solidarity purchasing groups
The present study can be classified as concerning the sustainability of agri-food supply chains. It compares five different extra virgin olive oil (EVOO) supply chains in terms of the distance between the agricultural producer and end consumer, from both an economic perspective (the number of intermediaries) and a geographical one (production and consumption places). The examined aspects are 1) all the supply chain segments in which value is added to what will be the final food product purchased by the consumer, with a focus on trade and the transport cost estimated in relation to food miles; 2) the environmental impact of transport along the entire supply chain

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up to the distribution of EVOO to the final consumer; and 3) the trade-offs between the environmental impact and economic results.
The results obtained confirm some existing general evidence in the literature, such as the greater enhancement of agricultural products through short supply chains, and they emphasize as combining the value chain results with the environmental impact based on food miles, no real trade-offs, but rather trends, emerge.

Introduction

Several studies on supply chains have recently focused on sustainability issues in response to the growing concern for the environmental impact of food supply chains (Training and Research Institute for Transport [ISFORT in Italian], 2013; Cicatiello *et al.*, 2012b). This growing consumer environmental attention results in an increase in the demand for locally produced food that is considered safer for health, and towards more social and environmental sustainability (Akaichi *et al.*, 2016; Cecchini *et al.*, 2018; Polenzani *et al.*, 2020).

The concept of sustainability is very broad and defining it in the context of an agri-food chain is not an easy task. Generally, three dimensions are used: environmental, economic, and social. Specifically, the economic dimension refers to economic growth, investments in human and social capital, changes in consumption patterns, price stability and transparency, and the strengthening of the farmers' role. On the other hand, the social dimension refers to food safety, human health and nutrition, animal welfare, the increase in jobs, equity conditions, and ethical principles. Therefore, sustainability can be understood as a particular quality exhibited by the supply chain, while the sustainability condition as the capability to maintain satisfactory environmental, social, and economic conditions over time.

The not-easy explanation of the concept of agri-food supply chain sustainability, the growing consumer's request towards sustainable food production, and excessive proliferation of standards and labels not always clear and easily understood (Abitabile, 2015), lead to a risk to confuse the consumer. On the other side, however, empirical evidence underlines the benefits of a label that indicates the environmental effects of transport, as underlined by Caputo *et al.* (2013a, 2013b) in studies concerning consumers' responses to two types of food miles (FMs) labelling, one with CO_2eq emissions information, and a second with the kilometres travelled by the product and travel times information.

As a consequence, more empirical research is needed to provide scientific value to the intuitive concepts of FMs and local production, allowing consumers to make informed consumption choices and public decision-makers to develop policies capable of integrating agricultural, environmental, and nutritional objectives (Garnett, 2011).

The present study tried to go one step further this research need: the analysis of the different organisational methods of the supply chains made it possible to compare the environmental impact of transport with the allocation of the economic benefits.

In particular, this study focuses on assessing the environmental sustainability of the FMs of EVOO supply chains, the consumption patterns of conventional and organic EVOO, and the economic sustainability of the agricultural sector, which is considered the weakest link in the supply chain.

The environmental sustainability was measured as the carbon footprint generated by the FMs compared to the flow of raw materials, semi-finished and finished products of agricultural origin in the different supply chain phases; the carbon footprint of the FMs is determined through a life cycle assessment (LCA). The economic sustainability was calculated as the added value (AV) generated in each exchange along the supply chain, with regard to the money flows, which, starting from consumers, reach the farmers.

1. Background

1.1. *Food miles*

The food system globalisation has increased the distance between the food production place and the food consumption places (Hendrickson, 1996; Pretty *et al.*, 2005; Kissinger, 2012). This phenomenon has led scholars to examine how local distribution chains can contribute to reducing energy consumption and greenhouse gases (GHGs) emissions (Pirog *et al.*, 2001; Smith *et al.*, 2005; Mariola, 2008; Cholette & Venkat, 2009; Blanquart *et al.*, 2010; Mundler & Rumpus, 2012; López *et al.*, 2015). FMs, defined as 'the distance that food travels between primary producer and end consumer' (Lang *et al.*, 2001, p. 539), have rapidly become the subject of a wide debate on local food and local eating issues, which are often described as systems capable of reducing FMs (Coley *et al.*, 2009; Edwards-Jones *et al.*, 2008).

These results are often conflicting, and some of them underline that an FM reduction linked to a local supply does not necessarily lead to an improvement in agri-food systems' sustainability. The reason is that the economies of scale and the logistical organisation improvement of the supply systems operating in mass market retail (MMR) offset the impact generated by the average increase in the distance covered by food (Smith *et al.*, 2005; Cairns, 2005; Coley *et al.*, 2009; Schilich *et al.*, 2006; Rizet *et al.*, 2010; Malak-Rawlikowska *et al.*, 2019). In contrast, some authors state that the reduction in the distances travelled and the number of intermediaries allow for a reduction in energy consumption (Pretty *et al.*, 2005; Blanke & Burdick, 2005; Torquati *et al.*, 2015). Other authors indicate that focusing attention solely on FMs could result in losing sight of the several other types of value and meanings that consumers attribute to local food and eating, such as food freshness, support for local producers, and the wish to bring production and consumption places closer together (Schnell, 2013; Bazzani & Canavari, 2017). Others emphasise that there is no single relationship between distance travelled and environmental sustainability (Edwards-Jones *et al.*, 2008; Lee *et al.*, 2015). Further, others argue that to express an overall judgment on the alleged lower environmental impact connected to local food systems, an assessment based on the entire food life cycle would be necessary, that is, from the production of the raw materials to the waste disposal generated by their consumption (Plassmann & Edwards-Jones, 2009). Thus, the focus is shifted to food chain sustainability (Van Passel, 2013).

In recent years, researchers and experts have increased their interest in studying local food supply systems and their effects in terms of social and environmental benefits (Marsden *et al.*, 2000; McIntyre & Rondeau, 2011; Cicatiello & Franco, 2012a; Marino & Cicatiello, 2012; Michel-Villarreal *et al.*, 2019). In these studies, FMs have been used increasingly frequently as an indicator of the environmental benefits of local food chains due to the lower CO_2 emissions (Pirog *et al.*, 2001; Jones, 2002; Smith *et al.*, 2005; Foster *et al.*, 2006; Weber and Matthews, 2008; Coley *et al.*, 2011; Garnett, 2000; Kemp *et al.*, 2010; Hiroki *et al.*, 2014; Torquati *et al.*, 2015; Galli *et al.*, 2015; ISFORT, 2013). Furthermore, numerous studies on FMs have estimated consumers' perception of the distances travelled by food and the value attributed to this information (Caputo *et al.*, 2013a, 2013b; Kemp *et al.*, 2010; Sirieix *et al.*, 2008; Akaichi *et al.*, 2016).

It is currently agreed that the validity of FMs as an indicator of the local food chains' sustainability depends on the following two elements of the sustainability assessment: (1) the simultaneous use of additional indicator sets that also include transport modes, rather than a single indicator based on the distance travelled, and (2) the possibility of including economic and social aspects associated with these systems. Furthermore, it is considered necessary to conduct additional empirical research to improve the logistical efficiency of local food networks, so as to avoid cancelling out the environmental benefits induced by the reduction of the distance between food production and consumption (Smith *et al.*, 2005; Van Passel, 2013).

1.2. *Value chain*

Vertical integration analysis incorporated Porter's value chain theory, which was designed for businesses to highlight the costs of elementary activities and to understand the nature of the competitive advantage in each of the activities that businesses perform (Porter, 1985). In fact, Porter considers a company as a system of interdependent activities aimed at creating value for the customer (Porter, 1985).

The extension of the value chain concept to the chain's relationships with the suppliers and customers leads to the value system of the supply chain, as well as to the strategic analysis of the various economic agents who collaborate for value creation (Antonelli, 2011). In this context, the value chain is made up of a series of actors (or stakeholders) – from input suppliers, producers, and processors, to exporters and buyers – engaged in the activities required to bring a product from its conception to its end-use (Kaplinsky & Morris, 2001). Therefore, the value chain represents a tool for analysing and decomposing the value generation process.

Often, the agri-food chain fragmentation and the farmers' low market power create the farmers' increasing difficulty in retaining a consistent value share, both in absolute and relative terms, compared to the final product value purchased by the consumer. This lack of a consistent value share works to the advantage of agents downstream and upstream of the supply chain (Italian Institute for Food and Agricultural Market Services [ISMEA in Italian], 2012; Munasinghe *et al.*, 2019; Jäckering *et al.*, 2019).

The analysis of the agri-food value chain is a very complex operation. The ISMEA has conducted this analysis for Italy by using the inter-sectoral tables of the Italian economy, which allow tracing all the economic activities that are involved in the creation of a product.

Following a macroeconomic and top-down approach, the ISMEA has developed a value chain to quantify the value subdivision of goods produced by the agricultural sector and the food industry, and purchased by final consumers. In other words, it includes the economic subjects that directly and indirectly become part of the production and distribution processes (ISMEA, 2012). The method used may be considered as a subdivision of the price paid by consumers among all economic agents who directly and indirectly contributed to the purchased good or performed service. It results in useful information for understanding the contribution of the various processes and products that are involved in supply chains to the value chain. The final sale price, therefore, is considered as the result of the AV provided by each sector that participates in the production cycle. The starting point of the analysis is precisely the price paid by the final consumer, which represents the value that the buyer attributes to that given food and which is also affected by the contribution of the different actors involved in the production, processing, and availability of food in the manner the consumer likes.

The results obtained highlight the constant downsizing of value in the primary phases of food production, compared to all the activities that occur from the moment the product leaves the 'gate' of the farm, until the moment of its sale to the final consumer (ISMEA, 2012). This downsizing process is also justified by the evolution of consumption styles, in which service and several material and nonmaterial aspects, more often generated and added in the phases closest to the consumer, are of increasing importance (ISMEA, 2012).

2. Materials and methods

2.1. *Purchasing models and identification of the supply chain*

The micro-economic approach was used to analyse the environmental and economic sustainability of the EVOO supply chain, starting with the analysis of the purchasing habits of eight families living in the Umbria region, whose members are customers of shops located in Perugia, the regional county seat.

The purchasing habits data were collected in 2013 using purchase booklets created ad hoc for the survey, where the 8 families recorded their purchases of EVOO and 13 other food products consumed weekly during the four seasons.

Specifically, for each product, the families were requested to report the following on the purchase booklet: purchase date, food description indicating whether the food was organic or not, quantity, brand, packaging type, price, company logo, and types of stores.

The collected data were first used to classify families based on eating habits[1] and, subsequently, to characterise them based on their prevailing

1. The classification criteria adopted to define the families' eating habits were purchase frequency of organic products, proportion of organic products purchases out of the total purchases (expressed as a percentage), number of organic products purchased, proportion of organic products consumed out of on total number of products consumed (expressed as a percentage). Families were classified as follows: 1) 'Conventional' if they did not buy organic products. 2) 'Organic-weak' (org-weak) if they met at least two of the following conditions: (a) they bought organic products less than once a week, (b) their organic products expenditure amount was less than 20% of their total expenditure amount, (c) they purchased no more than n. 3 different organic foods, and (d) less than 20% of food amount they consumed was organic. 3) 'Organic-strong' (org-strong) if they met at least two of the following conditions: (a) they bought organic products more than once a week, (b) their organic products expenditure amount was equal to or larger than 20% of their total expenditure amount (c) they bought more than n. 3 different organic foods, and (d) more than 20% of the food amount they consumed was organic.

purchasing habits at the different stores. The following seven purchasing models resulted from this analysis:

1. conventional family that mainly purchases from 'Emisfero' and 'Famila' supermarkets;
2. conventional family that mainly purchases from 'Todis' and 'Eurospin' discount stores and local markets;
3. conventional family that mainly purchases from 'Pam' supermarkets, 'Carrefour' hypermarkets, and traditional shops;
4. organic-weak family that mainly purchases from 'COOP' hypermarkets, 'CONAD' supermarkets, and supermarkets specialising in the distribution of organic products such as 'NaturaSì';
5. organic-weak family that mainly purchases from 'Auchan' and 'Carrefour' hypermarkets and small shops specialising in the distribution of organic products;
6. organic-strong family that mainly purchases from supermarkets specialising in the distribution of organic products such as 'NaturaSi';
7. organic-strong family that mainly purchases from organic solidarity purchasing groups (SPG).

Subsequently, to conduct both an environmental and economic analysis and compare the organic and conventional supply chains, the seven purchasing models above were analysed according to four key elements:

1. the purchased product and the origin of both the raw materials and semi-finished products expressed as the distance (in kilometres) the product travelled to reach the store;
2. the store where the purchase was made, representing the commercial organisation and distribution logistics;
3. the brand owner, representing the main element of the supply chain;
4. the price paid by the family, representing the economic value of the value chain.

Combining the four key elements with the seven purchasing models, five types of supply chains were identified, characterised by four aspects: (1) the product type, (2) the origin of the raw materials, (3) the main element of the supply chain (agricultural entrepreneur who owns the local brand, processing industry of the industrial brand, or distributor of the commercial brand or private label), and (4) the place of purchase by the consumer (SPG, specialised shop [SpShop], or MMR). The five types of supply chains identified are:

- Org_SPG_Ita: organic, local brand EVOO from Italian-origin raw materials, purchased from an SPG;
- Org_SpShop_Ita: organic, local brand EVOO from Italian-origin raw materials, purchased in a specialised organic products shop;
- Org_MMR_Ita: organic, commercial-brand EVOO from Italian-origin raw materials, purchased in an MMR shop;

- Conv_MMR_Ita: conventional local-brand EVOO from Italian-origin raw materials, purchased in an MMR shop;
- Conv_MMR_Int: conventional commercial-brand EVOO from international raw materials, purchased in an MMR shop.

2.2. *Value chain reconstruction*

The value chain reconstruction is based on the data collected on the purchase of a 1-litre bottle of EVOO, outlining the sequence of the elementary operations and distinguishing the following phases: agricultural, industrial or artisanal, packaging, marketing, distribution, and transport.

The survey was conducted in 2014 through direct interviews with 15 Umbrian economic agents, as summarised in Table 1. Beside the limited sample size, which could affect the accuracy of the analysis, the descriptive nature of the economic and environmental analysis implemented does not assume the adoption of an inferential statistical framework. To this regard, no mandatory characteristics in term of sample size and representativeness are required.

Thanks to the agents' collaboration, it was possible to reconstruct in detail the value chains of both local and national supply chains, as well as the kilometres travelled by the food, from where the raw materials were produced to where the food was sold. Concerning the reconstruction of international supply chains, the information collected, which in some cases was incomplete, was integrated with additional data from the literature, available through commodity exchanges records, and the Internet.

Table 1 - Interviewed economic agents for EVOO networks

Tipology	**Number**
Organic farm	2
Conventional farm	2
Oil mill	2
Agri-food industry	1
Handicraft packaging company	1
Mass market retail - headquarter	2
Mass market retail - point of sale	2
Traditional point of sale	1
Solidarity Purchasing Group	2
Total	15

Transport costs were estimated by using the unit costs for international transport of goods (Pastori *et al.*, 2014) imported from Italy by transport mode (euros per tons, weighted average of the volumes). These data are published by the Bank of Italy and the National Institute of Statistics (ISTAT in Italian), the Centre d'Études Prospectives et d'Informations Internationales, and on the Searates site[2]. Further, the road transport costs calculated by the Ministry of Transports and available on its website[3] were used.

Inspired by the methodology used by the ISMEA (2012), but using a bottom-up approach, we split the value of the goods purchased by families across all the supply chain actors. In particular, the price paid by the final consumer for a 1-litre bottle of EVOO was broken up as follows: 1) into the amount allocated to cover the value of the raw material (olives); 2) in the AV created by milling activity (using an oil conversion index of 17%); 3) in the AV created by bottling, packaging, and storage activities; 4) in the AV generated by transport across the entire supply chain; 5) in the AV generated by the organisational activities in some supply chain phases (conducted by farmers or by the first processing industry in the chain); 6) in the AV generated by distribution companies; 7) in the AV created by the stores; and 8) in the 4% share of the value added tax (VAT).

2.3. *Calculation of FMs and equivalent CO_2 emissions*

Consistent with the objectives of the analysis, after the reconstruction of each supply chain, the FMs were calculated in terms of the standard unit of measurement [t-km], defined as the transport of one tons of a product by a generic means of transport for a distance of 1 km.

Through the interviews, FMs were estimated by reconstructing the distances and the types and technical characteristics of the vehicles used in the transport. For the international supply chain, the data were adjusted based on the origin of the materials and the hub of international trade.

Subsequently, the environmental impact was calculated based on the 'cradle to gate' LCA approach, computing the emissions of GHGs, represented by equivalent CO_2 (CO_2eq) for the transport process of each supply chain.

To perform the aforementioned calculations, the SimaPro ver. 8.0.2 software and Ecoinvent database v2.0 were used (Frischknecht *et al.*, 2007), in accordance with the International Organization for Standardization (ISO) 14040 (ISO, 2006) and 14044 (ISO, 2006).

The GHGs emissions were expressed in terms of Global Warming Potential (GWP), with a return period of 100 years, considering the following

2. www.searates.com/reference/portdistance.
3. www.mit.gov.it/mit/site.php?p=cm&o=vd&id=3035.

emission factors in the CO_2eq calculation: 1 kg of CO_2eq for 1 kg of CO_2eq, 1 kg of CH_4 for 25 kg of CO_2eq, and 1 kg of N_2O for 298 kg of CO_2eq.

The functional unit was referred to 1 litre of EVOO. The data collection included primary data collected through direct farm surveys; if absent, these data were integrated with secondary data from the database Ecoinvent v2.0.

The system boundaries included all the logistics operations of movement and transport, from the production site of raw materials to the transformation and consequent packaging, until the final retail distribution of the product.

In particular, based on the diesel and lubricants consumption estimated at the primary level, the transport was modelled by adapting the related processes from the Ecoinvent v2.0 database, specifically: a) road transport with a van with a capacity less than 3.5 tons and average load of 1 ton; b) road transport with lorries with a capacity between 7.5 and 15 tons, with an average load of 6 tons; c) road transport with 16 and 32 tons lorries with an average load of 5.79 tons; d) road transport with lorries over 32 tons with an average load of 19.2 tons; e) sea transport on Roll-on/Roll-off (Ro-Ro)[4] ships and with bulk liquid storage. Given the absence of primary data, in maritime transport cases, a transoceanic ship was assumed to be the mode of transport, in accordance with the related process in the Ecoinvent database. In particular, following Spielmann *et al.* (2007), each transport process was modelled through the following three components: the transport operation, the vehicle use, and the infrastructure use.

The first component includes all the directly connected sub-processes, quantifying the emissions related to the fuel combustion, its production, and mineral oil production. The second component concerns the indirect impacts of the means of transport used, from the production of the vehicle itself, its maintenance, and the related disposal. The third component considers the impacts related to the use of the road infrastructure system.

The methodology described above allowed us to obtain the GHG emissions amount for each supply chain examined, expressed in terms of the CO_2eq kg for the transport of 1 litre of EVOO.

3. Results and Discussion

Figures 1 and 2 show graphic representations of the five supply chains examined, showing the system boundaries, the economic agents involved, and the kilometres travelled.

4. Roll-on/roll-off (Ro-Ro) ships are cargo ships designed to carry wheeled cargo, such as cars, trucks, semi-trailer trucks, trailers, and railroad cars, that are driven on and off the ship on their own wheels or using a platform vehicle, such as a self-propelled modular transporter.

Figure 1 - System boundaries, economic agents and kilometres travelled for organic EVOO purchased in Perugia shops

(Figure 1 - A) **(Figure 1 - B)** **(Figure 1 - C)**

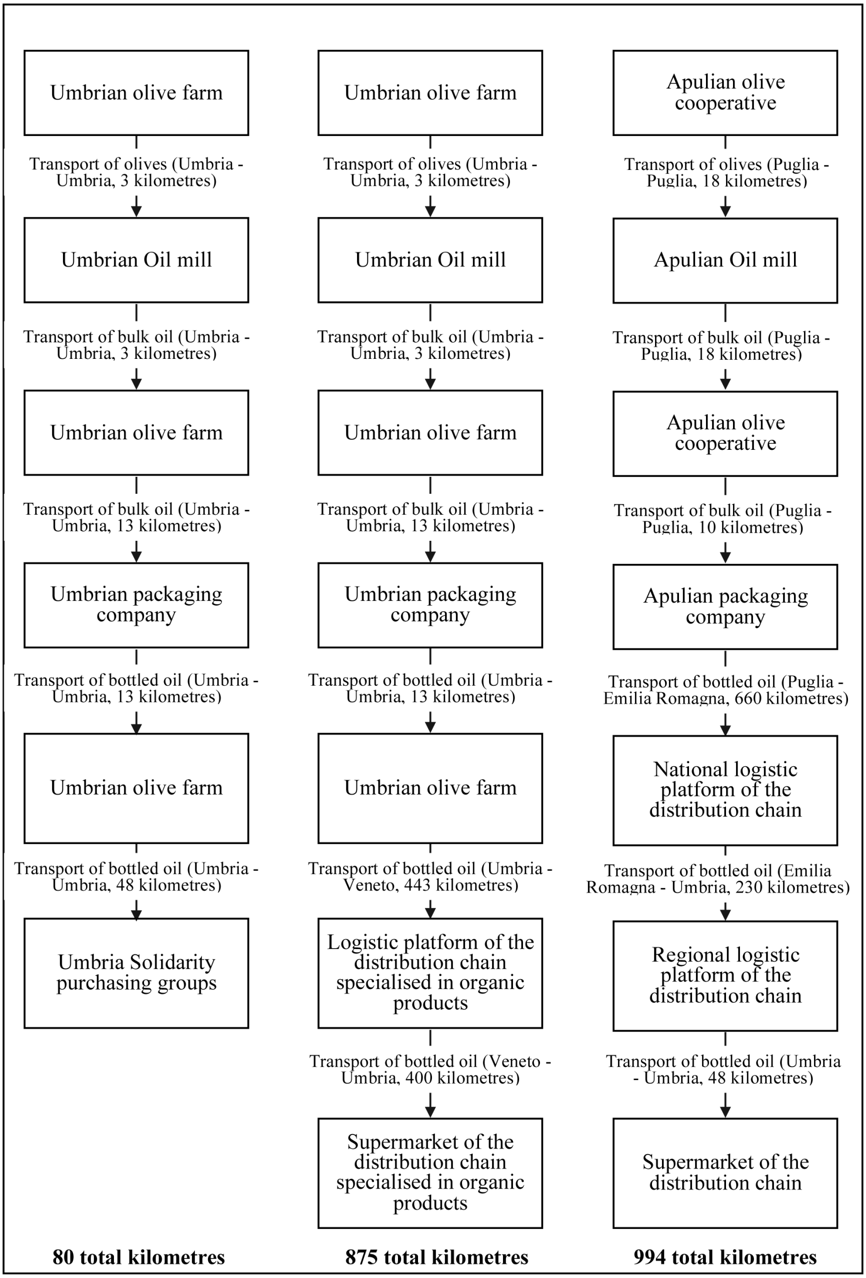
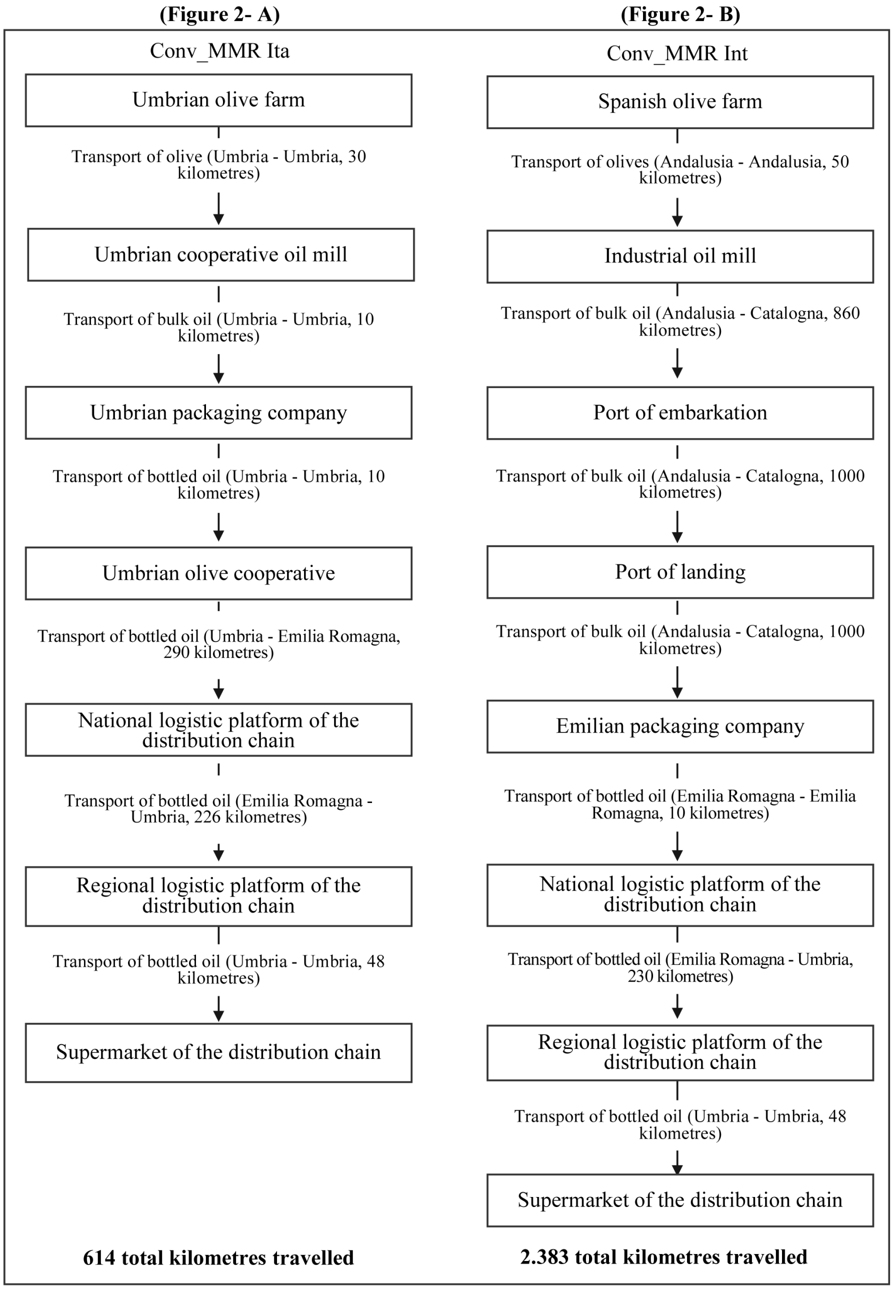


Figure 2 - System boundaries, economic agents and kilometres travelled for conventional EVOO purchased in Perugia shops



The Org_SPG_Ita supply chain (Figure 1-A) is a typical short organic supply chain managed entirely by a farmer, which deals with the production of olives and organises all the other phases of the supply chain using third-party services for the milling of the olives, the bottling, and the packaging. The farmer sells the product through the local SPG of which he is a member.

The value chain analysis highlights that the purchase price paid by the organic-product consumer is €15.00/1 litre bottle. Specifically, the olive production corresponds to 39% of the final price while the milling represents 7%, the bottling, packaging, and storage 14%, and the transport costs along the entire supply chain 1% of the final price. The farmer organisational activities correspond to 18%; the SPG distribution, which imposes a 21% mark-up on the purchase price it pays to the producer, represents 17% of the final price. Finally, VAT corresponds to 4% of the final price (Table 2).

The farmer values his/her work, both as an olive producer who is guaranteed a remuneration of €1,000/tons, which corresponds to the fine organic olives market price, and as a producer of EVOO, for which he/she obtains a mark-up of 30% on the total production costs (from the raw materials value to the transport costs). It should be noted that transport costs are limited (€ 0.14), given the shortness of the supply chain.

The AV that depends on the farmer through the organisational activities performed in the different phases of the supply chain is drastically reduced when the farmer sells his/her product through a specialised organic product distribution chain, such as the Org_SpShop_Ita supply chain (Figure 1-B). In fact, in this case, the farmer becomes a direct supplier of an organised distributor and the product follows the typical path of large-scale retailers: it starts from the farm and travels to the distribution chain logistics platform and then returns to the shops in Perugia. In this case, EVOO travels across 875 km and the commercial mark-ups are very different from those of an SPG.

From the value chain analysis, it appears that the purchase price paid by the organic-product consumer reaches € 20.00 for a 1 litre bottle, identical to the one commercialised in the SPG chain. Specifically, agricultural activities correspond to 29% of the final price and milling activities to 5% of that price, whereas bottling, packaging, and storage represent 10% of the final price. The transport costs along the entire supply chain correspond to 7% of the final price and the farmer organisational activities to 4% while the distribution and marketing activities at the distribution centre and shops represent 39% of that price (Table 2).

In this case, as in the Org_SPG_Ita supply chain, the farmer manages to enhance his/her work as an olive producer with a remuneration of €1,000/ton, but he/she values his work as a bottled oil-producer much less, applying a mark-up of only 8% on the total production costs (from the raw materials value to the transport costs). It should be noted that transport costs start from

Table 2 - Value chains in EVOO supply chains

	Organic EVOO (Euros/1 litre bottle)			Conventional EVOO (Euros/1 litre bottle)	
	Org_SPG Ita	**Org_SpShop Ita**	**Org_MMR Ita**	**Conv_MMR Ita**	**Conv_MMR Int**
Purchase price paid by final consumer	15,00	20,01	15,80	6,64	5,49
Value added tax	0,58	0,77	0,61	0,26	0,21
Added value generated by solidarity purchasing groups	2,49		–	–	–
Added value generated by distribution companies and stores	–	7,85	6,75	2,13	1,76
Added value generated by the organisational activities conducted by farmers	2,75	0,84	–	–	–
Added value generated by the organisational activities conducted by the first processing industry	–		0,77	0,20	0,17
Added value generated by transport	0,14	1,50	0,11	0,45	0,34
Added value generated by bottling, packaging, and storage activities	2,06	2,06	1,76	0,55	0,55
Added value generated by milling activity	1,10	1,10	1,10	0,70	0,70
Value of the raw material (olives)	5,88	5,88	4,70	2,35	1,76
Values in %					
Purchase price paid by final consumer	100%	100%	100%	100%	100%
Value added tax	4%	4%	4%	4%	4%
Added value generated by solidarity purchasing groups	17%				
Added value generated by distribution companies and stores		39%	43%	32%	32%
Added value generated by the organisational activities conducted by farmers	18%	4%			
Added value generated by the organisational activities conducted by the first processing industry			5%	3%	3%
Added value generated by transport	1%	7%	1%	7%	6%
Added value generated by bottling, packaging, and storage activities	14%	10%	11%	8%	10%
Added value generated by milling activity	7%	5%	7%	11%	13%
Value of the raw material (olives)	39%	29%	30%	35%	32%

€ 0.14/litre to € 1.50/litre, which is more than the AV derived from milling. These costs are also partly due to the low quantities transported, both in the first phases of the supply chain and in the transport to the logistics platform of large-scale retailers.

The third organic supply chain considered was Org_MMR_Ita (Figure 1-C) and it concerned the production and distribution of EVOO by a commercial brand that claims to use only Italian organic olives. In this case, the same society owns the private label and deals with all supply chain phases using third-party services, located in Italy. It sells the product at its own shops.

The value chain analysis highlights that the purchase price paid by the organic-product consumer is € 15.80 for 1 litre bottle of EVOO. Specifically, the cost of olives, produced in Southern Italy and standing at a market price of € 800/tons, corresponds to 30% of the final price while the milling to 7% of that price. The bottling, packaging, and storage represent 11% of the final price, whereas the transport cost along the entire supply chain corresponds to 1% of that price. The society that owns the trademark attributes 5% of the AV to the processing industry while the distribution activities, which result in a total mark-up of 80%, correspond to 43% of the final price of 1 litre bottle of organic EVOO (Table 2).

In this supply chain, the Southern Italian farmer is only a raw materials supplier while the transport cost is limited, despite the almost 1,000 kilometres travelled, due to both the transport means used and a better organisation of logistics.

The fourth supply chain considered was Conv_MMR_Ita (Figure 2-A) and it concerned the production and distribution of a conventional EVOO of a well-known national brand that claims to use only Italian olives. It is one of the typical supply chains of conventional EVOO, in which the agri-food industry deals with the production and the MMR addresses the distribution aspects.

The value chain analysis highlights that the purchase price paid by the conventional-product consumer is € 6.64/litre of EVOO. Specifically, the value of the olives, produced in Central Italy and reaching a value of € 400/tons, corresponds to 35% of the final price of 1 litre of EVOO. A share of 11% of the price paid by the conventional-product consumer represents the AV for the milling, while another 8% of AV corresponds to the bottling, packaging, and storage activities. The cost of transport constitutes 7% of the final price of 1 litre of EVOO, while the AV of the activities conducted by the processing industry is only 3% because its commercial policy is focused on the quantities it manages to sell thanks to MMR. Finally, the AV from the distribution centre and the shop represents 32% of the purchase price paid by the consumer (Table 2).

The fifth supply chain was Conv_MMR_Int (Figure 2-B) and it concerned the production and distribution of a conventional EVOO of a brand that is widespread on a national level and that does not claim to use only Italian olives. In this supply chain, the agri-food industry handles the production, also importing large quantities of olive oil (in this case, from Spain), and the MMR manages the distribution aspects. The value chain analysis highlights that the purchase price paid by the conventional-product consumer corresponds to 32% of cost of the raw materials from Spain, which stands at a market price of € 300/tons of olives. The milling represents 13% of the final price, while bottling, packaging, and storage constitute 10%, and the transport costs along the entire supply chain correspond to 6% of the final price. The AV of the organisational activities of the processing industry (3%) and that of distribution and marketing activities (32%) is similar to that of the previous supply chain, which implies similar commercial strategies are used (Table 2).

Among the different types of organic EVOO, the highest remuneration for raw materials occurs with sales through SPGs (€5.88/litre, corresponding to 39% of the selling price), while among conventional types, the raw materials remuneration is significantly lower (€2.35/litre), especially for imported EVOO (€1.78/litre). Generally, in longer supply chains, whether of organic or conventional EVOO, a significant AV share benefits the distribution and commercial chains.

To calculate the FMs and the corresponding CO_2eq emissions, the transport of olives, bulk oil, glass bottles, and bottled oil was taken into consideration, for a 1 litre bottle of EVOO ready to be purchased in a Perugia shop. The environmental transport impact, measured by the emission of CO_2eq, was calculated by adopting a LCA approach, which was applied to all five supply chains examined. The results of the FMs carbon emissions are reported in Table 3.

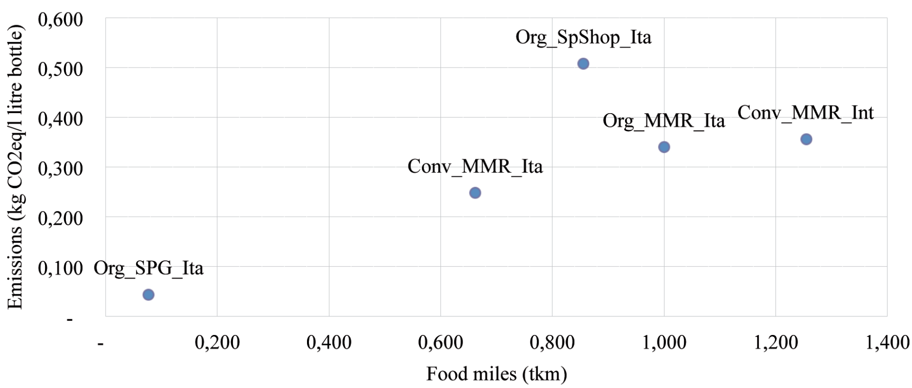
The supply chain with the highest volume of emissions is Org_SpShop_Ita, which emits 0.508 kg of CO_2eq for each bottle of the highest selling price (€ 20/litre). The supply chain with the lowest impact in terms of FMs is Org_SPG_Ita, for the estimated CO_2eq is 0.044 kg. This result underlines the advantages of a short, local supply chain (Org_SPG_Ita), despite the artisanal structures and less efficient means of transport. It should be noted that the Org_MMR_Ita and Conv_MMR_Int supply chains have the same level of emissions: this situation reflects the importance of handling the quantities to achieve greater efficiency from a logistical point of view, within the same organisation. The differences between the various purchasing models are highlighted in Table 3 and in Graphs 1-4. The largest distances travelled are obviously those for cases where the raw material is imported, which, however, do not correspond to the greatest environmental impact in terms of

Table 3 - Food Miles, CO_2eq emissions, selling prices and remuneration of the raw material in the EVOO supply chains

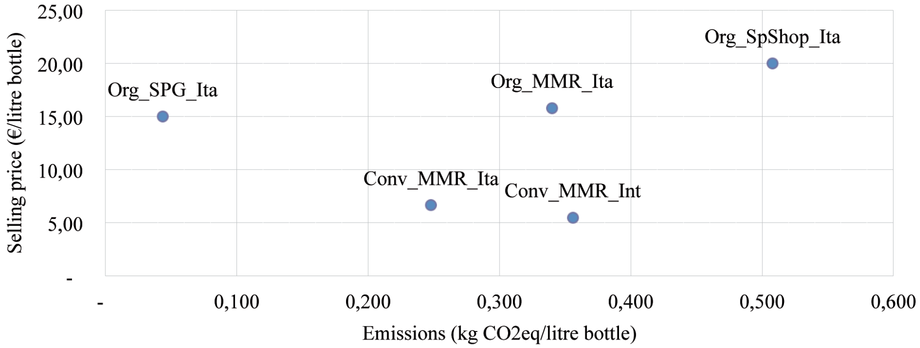
	Unit of measure	Org_SPG Ita	Org_SpShop Ita	Org_MMR Ita	Conv_MMR Ita	Conv_MMR Int
Selling prices	€/1 litre bottle	15.1	20.01	15.80	6.64	5.49
Total distance traveled by means of transport	km	80	875	994	614	2.382
Food miles	tkm	0.077	0.856	1.000	0.662	1.255
CO_2eq emissions	kg CO_2eq/1 litre bottle	0.044	0.508	0.340	0.248	0.356
Remuneration of the raw material	€/1 litre bottle	5,88	5,88	4,7	2,35	1,76

CO_2eq emissions (Graph 1): the rule that lower consumer prices correspond to greater impacts does not apply (Graph 2). The supply chain with the lowest market price for EVOO is Conv_MMR_Int and this chain also has a lower impact than the Org_SpShop_Ita supply chain. In the MMR supply chain, conventional EVOO is not only cheaper than organic olive oil but the chain also exhibits a lower impact. Further, in this case, the raw material with the highest value is obviously the organic olives (Graph 3). Based on FMs, only the Org_SPG_Ita supply chain exhibits a substantial difference from the other chains (Graph 4).

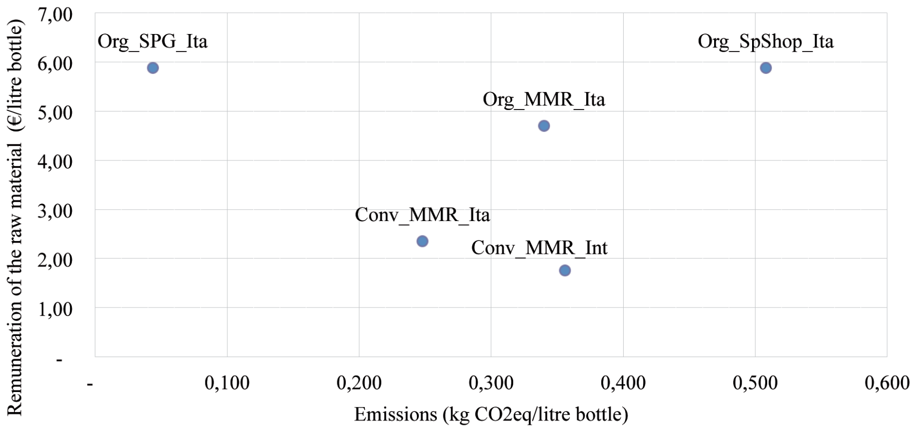
Graph 1 - EVOO supply chains: Comparison of CO_2eq emissions and Food miles



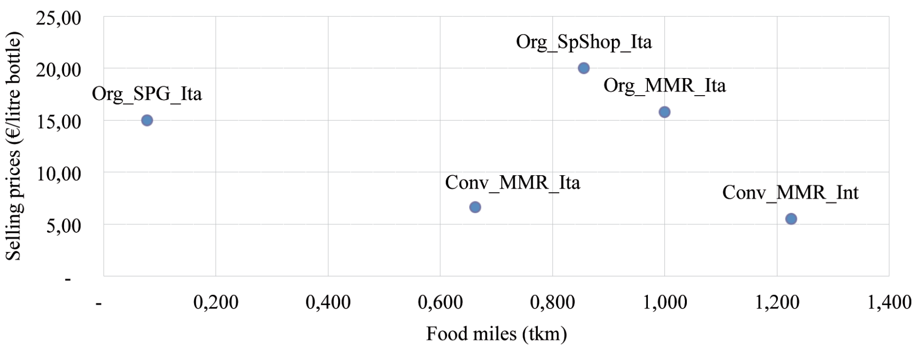
Graph 2 - EVOO supply chains: Comparison of CO_2eq emissions and selling prices



Graph 3 - EVOO supply chains: Comparison of CO_2eq emissions and remuneration for the raw material



Graph 4 - EVOO supply chains: Comparison of Food miles and selling prices



Analysing the environmental impact data, it emerges that the lowest CO_2eq emissions are produced by the short supply chains, despite the widespread use of light commercial vehicles, due to the market fragmentation (into small producers and small retailers). Second, in terms of CO_2eq emissions quantities, are the conventional supply chains with raw materials of Italian origin, whose protagonists are the large agri-food producers and MMR.

The environmental impacts in terms of transport emissions follows the rules of modern logistics, handling large quantities of products. In these supply chains, the impact of transport is lower than that of organic products in long supply chains. These results confirmed the environmental limitation of organic farming in terms of FMs (Franco, 2007).

Despite, the transport issue is only one of the aspects related to the sustainability of a supply chain. In fact, as consumption moves away from places of production, the modes of social and environmental values transmission, typical of organic culture and based on personal relationships and on the construction of local networks, are replaced by institutionalised standards and codification systems (Abitabile, 2015).

To this regard, an excessive proliferation of standards and labels that are not always clear and easily understood by the consumer has been observed (Abitabile, 2015). On the other side, however, empirical evidence underlines the benefits of a label that indicates the environmental effects of transport.

Among others, Akaichi *et al.* (2016) confirm the consumer's willingness to pay a premium price for products that have low GHGs emissions, a reduced number of FMs, and are locally produced. In particular, that study is among the few ones to consider these three attributes simultaneously and show that consumers are much more sensitive to low GHGs emissions than to a reduced number of FMs or local production. In addition, consumers do not seem to perceive the FMs and local production attributes as perfect substitutes.

4. Conclusions

The results of the analysis confirm some general-nature evidence already present in the literature, such as 1) the greater enhancement of agricultural products through short supply chains (Cicatiello *et al.*, 2012a); 2) the association between greater logistical efficiency in terms of impact per t-km and high transport intensity (ISFORT, 2013); 3) the prevalent use of road transport of agri-food products with heavy commercial vehicles for medium distances, and with light commercial vehicles for short distances (ISFORT, 2013); and 4) the existence of intermediate models between the short chain model and the MMR dominant chain model, which can be defined as hybrids (Sonnino, 2009).

The results of this study show that there are differences between the EVOO supply chains in value chains where consumer price plays an important role.

However, combining the value chain results with the environmental impact based on FMs, no real trade-offs, but rather trends, emerge. For example, in organic supply chains, the products with the lowest selling prices generally also have the least impact, while in conventional supply chains a lower selling price is associated with the greatest impact. Organic products, compared to conventional ones, always have higher prices, but exhibit a lower impact in terms of transport only if they are sold in short supply chains. When the sale of organic products occurs in specialised stores, the environmental impact can be even higher than in all other supply chains.

The aim to have accessible consumer prices for organic products has been fulfilled by MMR organic supply chains. They represent supply chains mainly oriented to the market segment in which customers choose organic EVOO for its health benefits but these chains do not pay attention to a fair distribution of AV or to the environmental impacts of transport. Therefore, the Italian organic sector has to counteract the commercial organisation of developed countries on the one hand and the low production costs of emerging countries on the other. The analysis clearly shows the difference between the local organic supply chains and MMR ones.

Several studies (Akaichi *et al.*, 2016; Cecchini *et al.*, 2018; Polenzani *et al.*, 2020) underlined the demand for locally produced food is increasing due to consumers' growing attention towards environmental and social sustainability: these results suggest that the use of environmental information labels could be a product differentiation mechanism and generate more support for sustainable companies.

The wide adoption of such environmental and social voluntary certification schemes turns out to be consistent with the European Green Deal strategy, which aims to create a healthier and more sustainable European Union food system. Further, toward this goal, the Commission intends to propose mandatory harmonised nutrition labelling to be placed on the front of packaging and to develop a framework for labelling sustainable food products that includes their nutritional, climatic, environmental, and social aspects. The environmental results of the empirical analysis demonstrate the possibility of obtaining reliable estimates of transport-related GHGs emissions by using the LCA method on the distribution chain. Moreover, the results show that is possible to link the distance question with that of transport type. The economic results, on the other hand, underline how the spatial proximity between the operators favours a higher producer remuneration, which can have a positive economic impact on the territory, and consequently, on its long-term sustainability. The study of the different organisational methods of the supply chains made it possible to compare the environmental impact of transport with the allocation of the economic benefits. Despite a few exceptions, it is unequivocal that short and local supply chains, both conventional and organic, can ensure a more equitable distribution of the AV produced among the various parties involved, and a lower environmental impact of the transport of the products.

Far from wanting to extend the results of this study to the entire olive oil sector in Italy, as it focused, in a case study perspective, on 8 families and 15 economic operators, the results achieved could contribute to providing useful indications.

This study has some limitations. Although the chosen bottom-up approach has the typical limits of the case studies method, at the same time, it can generate very detailed information and results.

Moreover, the calculation methodology presents some uncertainties regarding the hypotheses formulated and the recourse, in a few cases, to secondary data, which can generate distortions, and make a comparison with other studies' results difficult.

Finally, the impossibility of interpreting results in a frame of statistical significance limits their external validity and the possibility to extent them to other contexts. On the other side, the wide set of high detailed and accurate primary data collected contributes to increase the internal validity of the analysis with regard to the considered EVOO supply chains.

In this perspective, the obtained results allow us to outline well-defined trends between CO_2eq emissions due to transport and the economic value of the supply chains, which produce useful information for both consumers and policymakers. All of this attains greater importance in the Italian context, where only limited investigation has been conducted to date (Transport and Territory [TRT in Italian], 2006; Blengini & Busto, 2009; Mariani *et al.*, 2011; Cicatiello *et al.*, 2012b; ISFORT, 2013; Torquati *et al.*, 2015; Galli *et al.*, 2015).

As pointed out by Garnett (2011) provide scientific value to the intuitive concepts of FMs and local production, could allow consumers to make informed consumption choices and public decision-makers to develop policies capable of integrating agricultural, environmental, and nutritional objectives (Garnett, 2011). Furthermore, researchers are tasked with studying the local production system in an integrated way, to increase its sustainability from several perspectives (Duram & Obertholtzer, 2010) and to identify the best communication techniques to convey information on the sustainability of agri-food supply chains.

References

Abitabile, C. (a cura di) (2015). *L'internazionalizzazione del biologico italiano*. Roma: CREA.

Akaichi, F., Nayga, R.M. Jr. & Nalley, L.L. (2016). Are there trade-offs in valuation with respect to greenhouse gas emissions, origin and food miles attributes? *European Review of Agricultural Economics*, doi: 10.1093/erae/jbw008.

Antonelli, G. (2011). La prospettiva del valore nell'analisi delle filiere agroalimentari. *Economia Agro-Alimentare*, *13*(1-2), 9-35, doi: 10.3280/ECAG2011-001002.

Bazzani, C. & Canavari, M. (2017). Is local a matter of food miles or food traditions? *Italian Journal of Food Science*, *29*(3), doi: 10.14674/IJFS-733.

Blanke, M. & Burdick, B. (2005). Food (miles) for thought-energy balance for locally-grown versus imported apple fruit (3 pp). *Environmental Science and Pollution Research*, *12*(3), 125-127, doi: 10.1065/espr2005.05.252.

Blanquart, C., Gonçalves, A., Kebir, L., Petit, C. Traversac, J.B. & Vandenbossche, L. (2010). *The Logistic Leverages of Short Food Supply Chains Performance in Terms of Sustainability*. Proceedings of the 12th WCTR, Lisbon, Portugal, 11-15 July 2010.

Blengini, G.A. & Busto, M. (2009). The Life Cycle of Rice: LCA of Alternative Agri-Food Chain Management System on Vercelli (Italy). *Journal of Environmental Management*, *90*(3), 1512-1522, doi: 10.1016/j.jenvman.2008.10.006.

Cairns, S. (2005). Delivering supermarket shopping: more or less traffic? *Transport Reviews*, *25*(1), 51-84, doi: 10.1080/0144164042000218391.

Caputo, V., Vassilopoulos, A., Nayga, R.M. Jr. & Canavari, M. (2013a). Welfare Effects of Food Miles Labels. *The Journal of Consumer Affairs*, *47*(2), 311-327, doi: 10.1111/joca.12009.

Caputo, V., Nayga, R.M. Jr. & Scarpa, R. (2013b). Food Miles or Carbon Emissions? Exploring Labelling Reference for Food Transport Footprint with a Stated Choice Study. *The Australian Journal of Agricultural and Resource Economics*, *57*, 465-482, doi: 10.1111/1467-8489.12014.

Cecchini, L., Torquati, B. & Chiorri, M. (2018). Sustainable agri-food products: A review of consumer preference studies through experimental economics. *Agricultural Economics*, *64*(12), 554-565, doi: 10.17221/272/2017-AGRICECON.

Cholette, S. & Venkat, K. (2009). The energy and carbon intensity of wine distribution: A study of logistical options for delivering wine to consumers. *Journal of Cleaner Production*, *17*(16), 1401-1413, doi: 10.1016/j.jclepro.2009.05.011.

Cicatiello, C. & Franco, S. (2012a). Filiere corte e sostenibilità: una rassegna degli impatti ambientali, sociali ed economici. *QA Rivista dell'Associazione Rossi-Doria*, *3*, 47-65, doi: 10.3280/QU2012-003003.

Cicatiello, C., Pancino, B. & Franco, S. (2012b). Un modello per la valutazione della sostenibilità territoriale delle filiere agroalimentari: struttura e applicazione alla sfera ambientale. In 2012 First Congress, *Verso una bio-economia sostenibile: aspetti economici e sfide di politica economica*, June 4-5, 2012, Trento, Italy (No. 124383). Italian Association of Agricultural and Applied Economics (AIEAA).

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

Coley, D.A., Howard, M. & Winter, M. (2011). Food Miles: Time for a Re-Think? *British Food Journal*, *113*(7): 919-934, doi: 10.1108/00070701111148432.

Duram, L. & Oberholtzer, L. (2010). A geographic approach to place and natural resource use in local food systems. *Renewable Agriculture and Food Systems*, *25*(2), 99-108, doi: 10.1017/S1742170510000104.

Edwards-Jones, G., i Canals, L. M., Hounsome, N., Truninger, M., Koerber, G., Hounsome, B., … & Harris, I. M. (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, doi: 10.1016/j.tifs.2008.01.008.

Foster, C., Green, K., Bleda, M., Dewick, P., Evans, B., Flynn, A. & Mylan, J. (2006). *Environmental Impacts of Food Production and Consumption: A Report to the Department for Environment, Food and Rural Affairs*. Manchester Business School. London: DEFRA.

Franco, S. (2007). Agricoltura biologica e 'food miles': la crisi di un matrimonio di interesse. *AgriRegioniEuropa*, *3*(10), 45-48.

Frischknecht, R., Jungbluth, N., Althaus, H. J., Hischier, R., Doka, G., Bauer, C., … & Margni, M. (2007). *Implementation of life cycle impact assessment methods. Data v2. 0 (2007). Ecoinvent report No. 3* (No. INIS-CH--10091). Ecoinvent Centre.

Galli, F., Bartolini, F., Brunori, G,. Colombo, L., Gava, O., Grando, S. & Marescotti, A. (2015). Sustainability Assessment of Food Supply Chains: An Application to Local and Global Bread in Italy. *Agricultural and Food Economics*, *3*, 21, doi: 10.1186/s40100-015-0039-0.

Garnett, T. (2000). *Exploring the Relationship Between Food, Transport and* CO_2. London, UK: Transport 2000 Trust.

Garnett, T. (2011). Where Are the Best Opportunities for Reducing Greenhouse Gas Emissions in the Food System (Including the Food Chain)? *Food Policy*, *36*, S23-S32, doi: 10.1016/j.foodpol.2010.10.010.

Hendrickson, J. (1996). *Energy Use in the US Food System: A Summary of Existing Research and Analysis*. Madison, WI, USA: Center for Integreted Agriculture Systems, University of Wisconsin-Madison.

Hiroki, S., McLaren, S.J. & Garnevska, E.V. (2014). "What is 'Local'? Consumer Perception of Local Food in New Zealand", pp. 137-141, in Conference Proceedings *Life Cycle Thinking and Policy: Towards a Sustainable Society*, Massey University, Palmerston North: 3rd LCANZ and NZLCM Centre Conference.

ISFORT (2013). *La sostenibilità delle filiere agroalimentari. Valutazione degli impatti e inquadramento delle politiche*. Rapporti periodici, 18, Roma.

ISMEA (2012). Check up agroalimentare. -- Available at www.ismea.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/7430 (Accessed: 15 September 2020).

Jäckering, L., Fischer, S. & Kehlenbeck, K. (2019). A value chain analysis of baobab (Adansonia digitata L.) products in Eastern and Coastal Kenya. *Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS)*, *120*(1), 91-104, doi: 10.17170/kobra-20191030732.

Jones, A. (2002). An Environmental Assessment of Food Supply Chains: A Case Study on Dessert Apples. *Environmental Management*, *30*(4), 560-576, doi: 10.1007/s00267-002-2383-6.

Kaplinsky, R. & Morris, M. (2001). *A handbook for value chain research* (Vol. 113). Ottawa: Idrc.

Kemp, K., Insch, A., Holdsworth, D.K., Knight, J.G. (2010). Food Miles: Do UK Consumers Actually Care? *Food Policy*, 35, 504-513, doi: 10.1016/j.foodpol.2010.05.011.

Kissinger, M. (2012). International Trade Related Food Miles – The Case Of Canada. *Food Policy*, *37*, 171-178, doi: 10.1016/j.foodpol.2012.01.002.

Lang, T., Barling, D. & Caraher, M. (2001). Food, social policy and the environment: towards a new model. *Social policy & administration*, *35*(5), 538-558, doi: 10.1111/1467-9515.t01-1-00252.

Lee, G.G., Lee, H.W. & Lee, J.H. (2015). Greenhouse gas emission reduction effect in the transportation sector by urban agriculture in Sreoul, Korea. *Landscape and Urbn Planning*, *140*, 1-7, doi: 10.1016/j.landurbplan.2015.03.012.

López, L.A., Cadraso, M.A., Gómez, N. & Tobarra, M.A. (2015). Food Miles, Carbon Footprint and Global Value Chains for Spanish Agriculture: Assessing the Impact of a Carbon Border Tax. *Journal of Cleaner Production*, *103*, 423-436, doi: 10.1016/j.jclepro.2015.01.039.

Malak-Rawlikowska, A., Majewski, E., Wąs, A., Borgen, S.O., Csillag, P., Donati, M., … & Nguyen, A. (2019). Measuring the economic, environmental, and social sustainability of short food supply chains. *Sustainability*, *11*(15), 4004, doi: 10.3390/su11154004.

Mariani, A., Taglioni, C., Torquati, B. & Viganò, E. (2011). Alternative Food Networks e Sviluppo Locale Sostenibile: Riflessione sui Gruppi Organizzati di Domanda e Offerta. *Economia & Diritto Agroalimentare*, *16*(2), 263-281, doi: 10.1400/184767.

Marino, D. & Cicatiello, C. (a cura di) (2012). *I farmers' market: la mano visibile del mercato*. Milano: FrancoAngeli.

Mariola, M. J. (2008). The local industrial complex? Questioning the link between local foods and energy use. *Agriculture and Human Values*, *25*(2), 193-196, doi: 10.1007/s10460-008-9115-3.

Marsden, T., Banks, J. & Bristow, G. (2000). Food supply chain approaches: exploring their role in rural development. *Sociologia ruralis*, *40*(4), 424-438, doi: 10.1111/1467-9523.00158.

McIntyre, L. & Rondeau, K. (2011). Food Security and Global Health. In Benatar, S.R. & Brock, G. (Eds.), *Global Health and Global Health Ethics* (pp. 261-273). Cambridge, UK: Cambridge University Press.

Michel-Villarreal, R., Hingley, M., Canavari, M. & Bregoli, I. (2019). Sustainability in alternative food networks: A systematic literature review. *Sustainability*, *11*(3), 859, doi: 10.3390/su11030859.

Munasinghe, M., Jayasinghe, P., Deraniyagala, Y., Matlaba, V.J., dos Santos, J.F., Maneschy, M.C. & Mota, J.A. (2019). Value-Supply Chain Analysis (VSCA) of crude palm oil production in Brazil, focusing on economic, environmental and social sustainability. *Sustainable Production and Consumption*, *17*, 161-175, doi: 10.1016/j.spc.2018.10.001.

Mundler, P. & Rumpus, L. (2012). The Energy Efficiency of Local Food Systems: Comparison between Modes of Distribution. *Food Policy*, *37*(6), 609-615, doi: 10.1016/j.foodpol.2012.07.006.

Pastori, E., Tagliavia, M., Tosti, E. & Zappa, S. (2014). L'indagine sui costi del trasporto internazionale delle merci in Italia: metodi e risultati. *Occasional papers*, *223*. Banca d'Italia, Eurosistema.

Pirog, R., Van Pelt, T., Enshayan, K. & Cook, E. (2001). *Food, Fuel and Freeways: An Iowa Perspective on How Far Food Travels, Fuel Usage, and Greenhouse Gas Emissions*. Ames, IA, USA: Leopold Center for Sustainable Agriculture, Iowa State University.

Plassmann, K. & Edwards-Jones, G. (2009). *Where Does the Carbon Footprint Fall? Developing a Carbon Map of Food Production*. London: IIED.

Polenzani, B., Riganelli, C. & Marchini, A. (2020). Sustainability Perception of Local Extra Virgin Olive Oil and Consumers' Attitude: A New Italian Perspective. *Sustainability*, *12*(3), 920, doi: 10.3390/su12030920.

Porter, M.E. (1985). *Competitive Advantage*. New York: The Free Press.

Pretty, N., Ball, A.S., Lang, T. & Morison, J.I.L. (2005). Farm Costs and Food Miles: An Assessment of the Full Cost of the UK Weekly Food Basket. *Food Policy*, 30, 1-19, doi: 10.1016/j.foodpol.2005.02.001.

Rizet, C., Cornélis, E., Browne, M. & Léonardi, J. (2010). GHG emissions of supply chains from different retail systems in Europe. *Procedia-Social and Behavioral Sciences*, *2*(3), 6154-6164, doi: 10.1016/j.sbspro.2010.04.027.

Schilich, E., Biegler, I., Hardtert, B., Luz, M., Schröder, S., Schroeber, J. & Winnebeck, S. (2006). La consommation d'énergie finale de différents produits alimentaires: un essai de comparaison. *Courrier de l'environnement de l'INRA*, *53*, 111-120.

Schnell, S.M. (2013). Food miles, local eating, and community supported agriculture: putting local food in its place. *Agriculture and Human Values*, *30*(4), 615-628, dOI: 10.1007/s10460-013-9436-8.

Sirieix, L., Grolleau, G. & Schaer, B. (2008). Do Consumers Care about Food Miles? An Empirical Analysis in France. *International Journal of Consumer Studies*, *32*: 508-515, doi: 10.1111/j.1470-6431.2008.00711.x.

Smith, A., Watkiss, P., Tweddle, G., McKinnon, A., Browne, M., Hunt A., Treleven, C., Nash, C. & Cross, S. (2005). *The Validity of Food Miles as an Indicator of Sustainable Development*. AEA Technology Environment. Final report DEFRA, ED50254 Issue 7, London, UK.

Sonnino, R. (2009). Quality Food, Public Procurement, and Sustainable Development: The School Meal Revolution in Rome. *Environment and Planning A*, *41*(2), 425-440, doi: 10.1068/a40112.

Spielmann, M., Bauer, C., Dones, R. & Tuchschmid, M. (2007). *Transport Services: Ecoinvent Report no. 14*. Dübendorf, Switzerland: Swiss Center for Life Cycle Inventories.

Torquati, B., Taglioni, C. & Cavicchi, A. (2015). Evaluating the CO_2 Emission of the Milk Supply Chain in Italy: An Exploratory Study. *Sustainability*, *7*, 7245-7260, doi: 10.3390/su7067245.

TRT (2006). *ECOTRA: Energy use and cost in freight transport chains*. Final Report for Institute for Prospective Technological Studies (IPTS), EC DG-JRC, TRT Trasporti e Territorio srl: Milano.

Van Passel, S. (2013). Food Miles to Assess Sustainability: A Revision. *Sustainable Development*, *21*, 1-17, doi: 10.1002/sd.485.

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, doi: 10.1021/es702969f.

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