



## CANNED TOMATOES: A COMPARATIVE ANALYSIS OF ITALIAN REGIONAL AND NATIONAL SUPPLY CHAINS<sup>1</sup>

*Cécile Sillig<sup>2</sup>, Gerardo Marletto<sup>3</sup>*

**Keywords:** food miles, logistics, environmental impact, canned tomatoes

### 1. Introduction

Globalization has brought to an exponential increase of food transportation. A first cause of such a growth is the evolution of consumption practices, characterised by increasing demands for highly processed and packed products, and for exotic or out of season products. Another reason is the evolution of supply patterns, with the advent of global firms and modern retailers.

<sup>1</sup> Il presente testo riproduce l'intervento svolto in occasione della XII Riunione Scientifica Annuale della Società Italiana degli Economisti dei Trasporti. Una sintesi dello stesso è stata pubblicata nel volume: "Sostenibilità, qualità e sicurezza nei sistemi di trasporto e logistica", Marcucci E.(Cur.), Musso E.(Cur.). Roma, 17-18 Giugno 2010, MILANO: Franco Angeli, ISBN/ISSN: 978-88-568-3797-1.

<sup>2</sup> DEIR – Università di Sassari, via Torre Tonda 34, 07100 Sassari, cecilesillig@uniss.it.

<sup>3</sup> DEIR/CRENoS – Università di Sassari, via Torre Tonda 34, 07100 Sassari, marletto@uniss.it.

Since the mid-1990's several studies have extended the research on the environmental impact of agribusiness to the specific issue of "food miles", i.e. the distance covered by food products (Safe Alliance, 1994). Quantitative research confirms the relevant impact of food transportation on global warming but also points out that there is no direct connection between short supply chains and sustainability. In fact, because of trade-offs involved in supply chains organization, longer supply chains can result, in some contexts, less polluting than shorter ones. A first trade-off discussed in literature (Jones, 2001) opposes the impact of transport to the one of production. The second significant trade-off involves the efficiency of logistics (AEA Technology, 2005). First, modal choice must be considered. In fact long distance supply chains can have a minor impact than shorter ones, if the last ones are based on vehicles with high impacts per ton-km. Secondly, the load factor must be considered. The higher the load factor, the lower the environmental impact per unit of good transported. The actual strategy of stock minimization can be associated to low load factors, except if the carrier can organize multi-pick and multi-drop trips, return journeys, etc. Big manufacturers and modern distribution (MD) succeed in conciliating just-in-time and high load factors thanks to their scale economies and an organization centered on few regional range distribution centers (DCs), where goods are grouped and then sorted. This higher logistic efficiency per ton-km is usually the corollary of a transport intensive system, though.

Probably the more relevant result of all these studies is the place-specific and market-specific nature of environmental impacts of food supply chains. This is why the analysis of new contexts and products is needed. Here we consider the Italian market, that until today has been seldom analysed, and we choose a processed product while food miles research has until now been almost oriented toward fresh products.

## **2. Case study**

### ***2.1. Scenarios and supply chains***

The research presented here compares eight scenarios of canned tomatoes supply chains. The city of Sassari, in the North of Sardinia, has been chosen as final market. The scenarios differ:

- for production location, with a Sardinian regional brand and an Italian continental brand;
- for distribution channel, with MD and independent retail (IR);

- for shopping transport mode, where only shopping on foot has been considered for IR (because it's the most representative way of shopping for this kind of stores) while both shopping on foot and by car have been considered for MD.

In the analysis, only the most important inputs and transport stages have been considered. The number of transport stages differs from scenario to scenario as the continental brand and some Cash and Carry (C&Cs) linked to IR organize their distribution through the centralization of loads in DCs. In addition to distances, segments differ in the type of vehicle used, load factor, presence of return cargo and driving style.

The figures below represents the regional and national supply chains and the distribution stages in the area of Sassari, that are the same for the two brands.

Fig. 1 - Regional brand routes

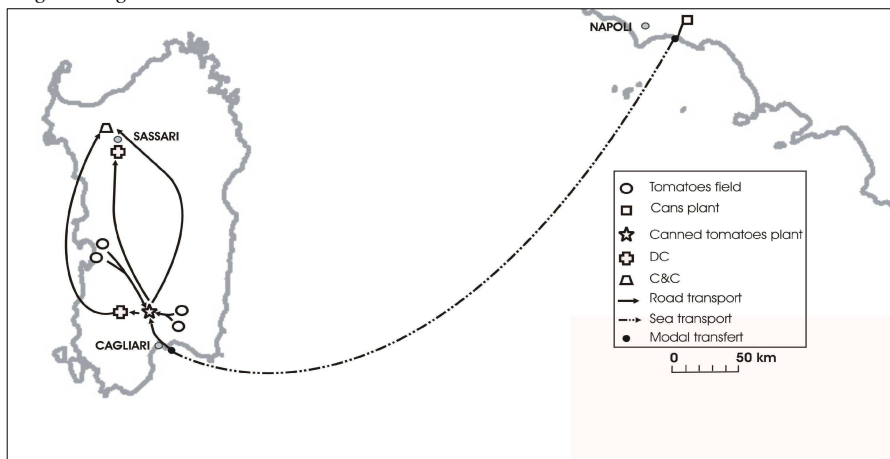


Fig. 2 - Continental brand routes

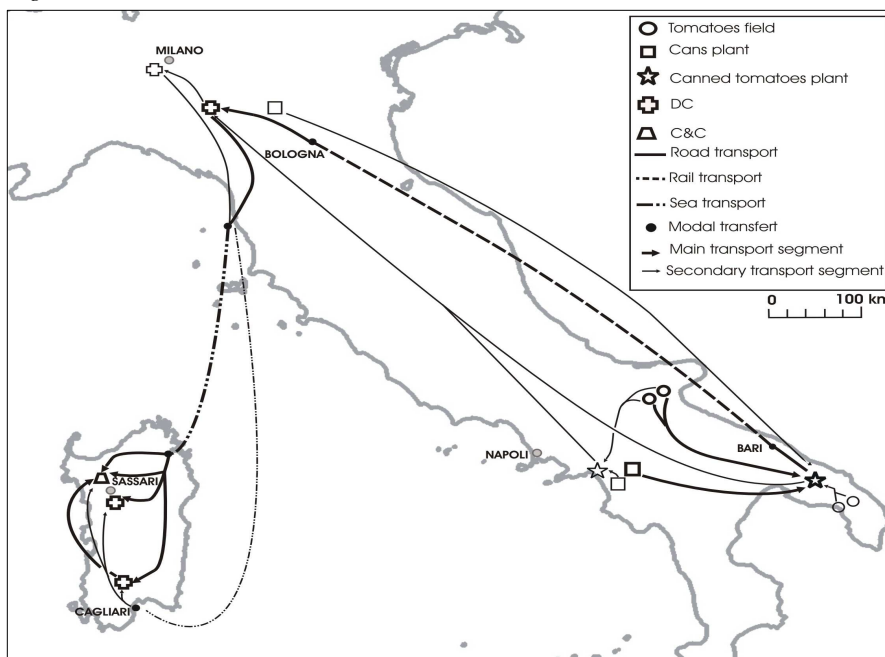
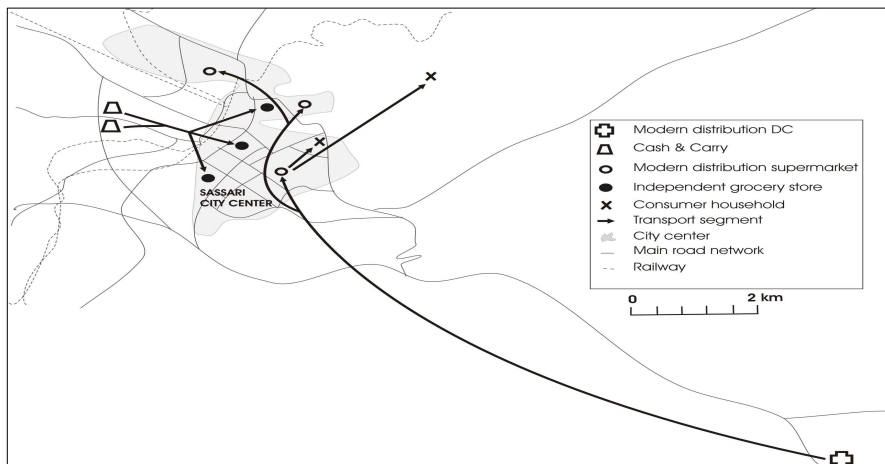


Fig. 2: Continental brand routes

Fig. 3 - Transport stages in the area of Sassari



## 2.2. Impacts and mains features of the assessment methodology

The effects of canned tomatoes transport on environment and traffic have been assessed through some quantitative indicators.

CO<sub>2</sub> has been chosen as global impact indicator as, with regard to the transport sector, this is the key factor of global warming. It has been assessed for all stages.

PM<sub>10</sub> emissions have been assessed only in urban and suburban areas of Sassari because it causes mostly health damages and is therefore particularly harmful in densely populated areas.

The effects of supply chains on traffic congestion have been assessed only where additional vehicles can bring an important contribution to traffic slowing down, that is, during peak-hours in the Sassari urban centre.

The assessment methodology has been based on real-life data from face to face and phone interviews to operators of the supply chains analyzed. The interview results have been integrated with data from cartographic software and statistics.

Given the system boundary, for every stage and scenario, the impact assessment methodology has been developed as follow:

- assessment of the distance related to the transport stage, inclusive of empty backward journey or detour;
- assessment of the number of vehicles that are necessary for transporting one net ton of peeled tomatoes equivalent;
- definition, for pollution indicators, of the emissions factors per vehicle-km (v-km), given the reference vehicle fleet;
- assessment of CO<sub>2</sub> and PM<sub>10</sub> emissions and urban km driven during peak-hours related to the transport of one net ton of peeled tomatoes.

### 3. Results and discussion

The quantification of the impacts revealed large differences between scenarios and between segments. The most significant differences between scenarios derived from product origin and shopping transport mode.

Fig. 4 - Scenarios comparison: CO<sub>2</sub> emissions per stage

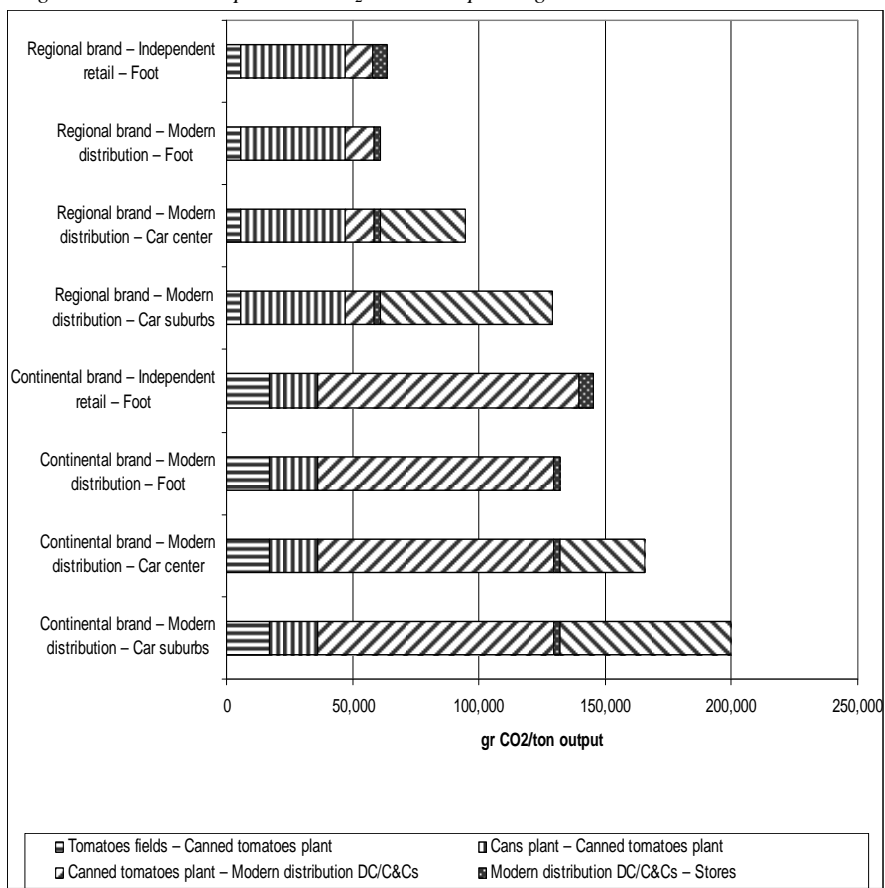


Fig. 5 - Scenarios comparison:  $PM_{10}$  emissions per stage

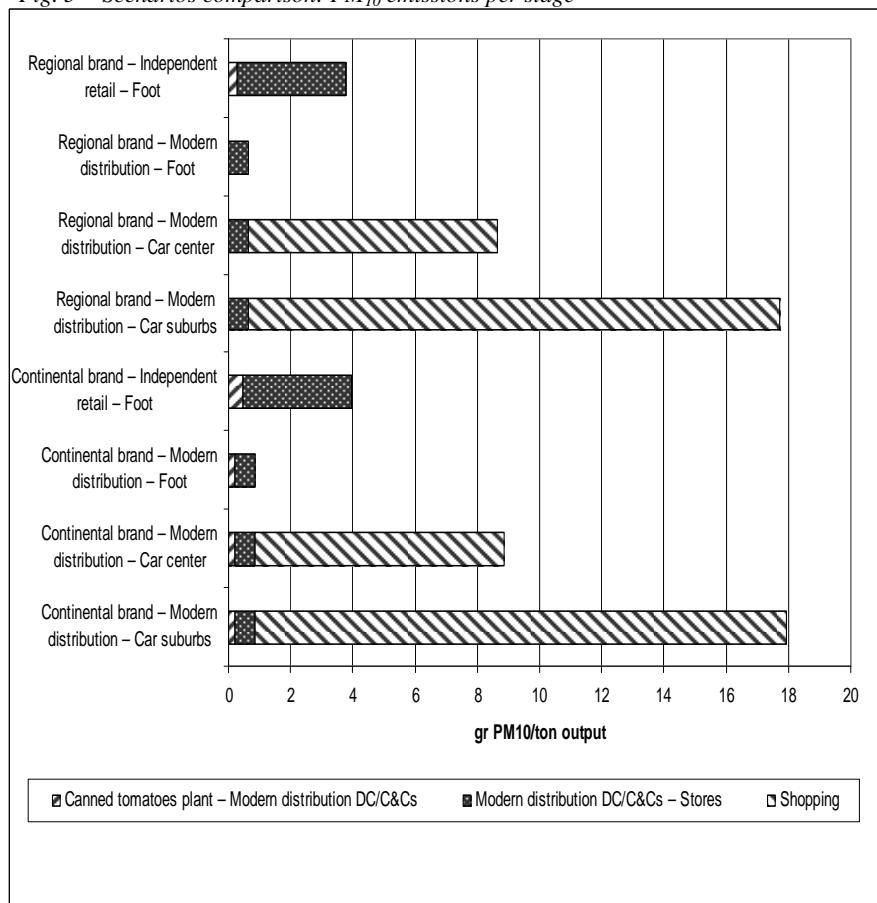
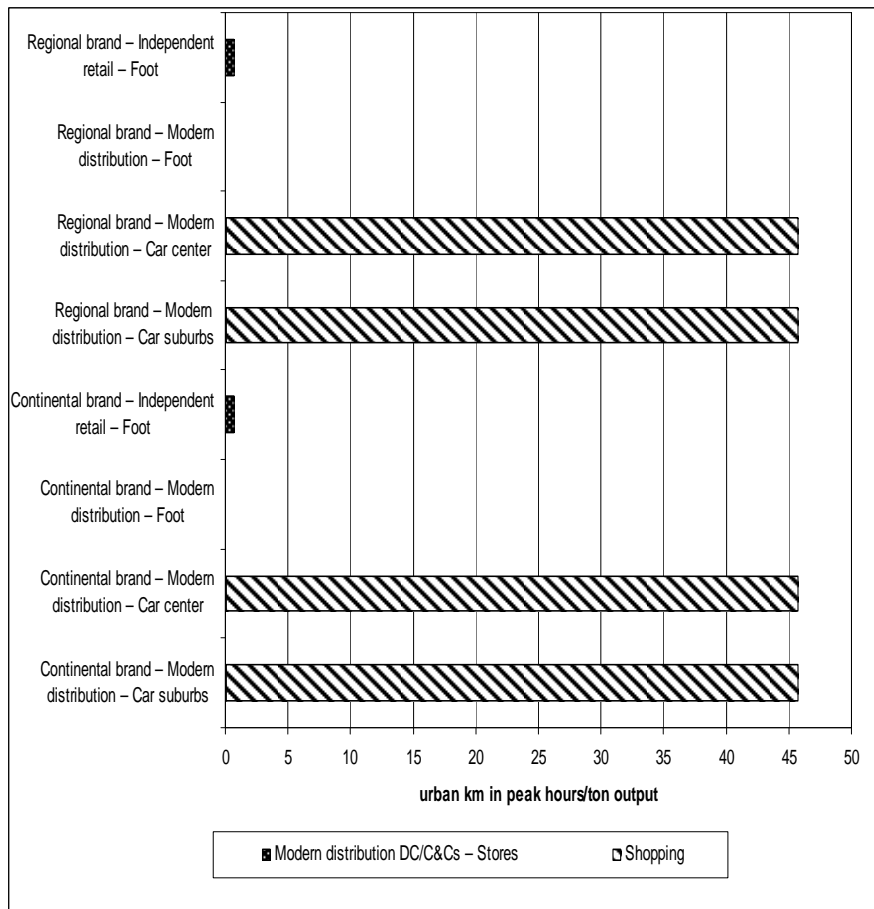


Fig. 6 - Scenarios comparison: congestion per stage



The research confirms some trends identified by other studies but at the same time emphasizes the place-specific nature of the results, that appear to be strongly influenced by specific elements of the supply chains examined, and by the Italian context.

Our study confirms the the huge weight of shopping by car. Congestion and local pollution are almost exclusively related to shopping and, with respect to global impacts, shopping by car generates a share of CO<sub>2</sub> emissions that varies, depending on the scenario (with shopping by car), from 20% to 53%.

With regards to the weight of the other stages, the final distribution has obviously a high impact per v-km because of the use of small and medium tonnage vehicles. It came out that MD is less polluting than IR, especially for local pollution (at least in the Sassari context). Anyway, considering the lower tendency to shop by car by IR, this option remains quite interesting.

The weight of the other stages, upstream and downstream of the canned tomato plant, differs for the two brands. Anyway, while this phenomenon has been seldom studied in food miles research, the high impact of primary packaging transport must be underlined. Solid packaging has a low weight/volume ratio and therefore the lorries carrying it have a low load factor. In spite of its low input/output ratio, primary packaging contributes highly to the impact of the upstream part of the supply chain and it suggests that the transport of processed food can be much more polluting than the one of unprocessed food.

Our study supports the view that, in terms of global impacts, local supply chains are a better option. The superiority of the regional industry is partly due to the specificities of the product and the final market examined, especially because the geographical demarcation of Sardinia greatly influences the organization of supply chains.

With reference to the continental brand, maritime transport (both brands have a sea leg with a similar impact) and the low concentration of urban centers in Sardinia, that requires long round deliveries, contribute greatly to the impact. We estimated that the global impact of the stage that goes from plant to MD DC/C&C could be, for destinations in northern Italy, almost 50% lower than for the Sardinian market.

Moreover the continental brand we analyse is particularly inefficient in its service to the Sardinian market. In fact the continental brand own a DC



in southern Italy and, at low organization costs, it could rely on it (instead of its North Italy DC) for its distribution in Sardinia. We estimated that such a scenario could reduce by about 50% the impact of the segment that goes from plants to MD DC/C&C.

The superiority of regional supply chains is a controversial topic in food miles literature. However, according to the quantitative assessment, the specificities of the supply chains analysed seem not sufficient to explain the superiority of the regional scenarios, so that, when comparing local and national industry, our research is definitely in favor of local supply chains.

While the literature emphasizes that longer supply chains may be better if they present economies of scale and inventory centralisation strategies (Garnett, 2003), the transit to a DC appears in our study as a factor that increases the impact. Apart for final distribution, we have similar results in terms of vehicle size and load factors irrespective of the size of the company and the strategies of centralization.

Shipping is a third element that highly contributes to our case study global impact. While literature emphasizes the low impact of this mode of transportation, this is true only for certain types of vessels. In the case of RO-RO cargo vessels, the impact is much higher. According to our assessment, the impact per v-km in the sea leg is about twice the one of HGV.

Another interesting issue is the weight of transportation impact with respect to the overall supply chain. In terms of energy consumption, Miyao *et al.* (1997) report a value of 0.94 GJ/ton canned tomatoes for tomato production while Carlsson-Kanyama and Faist (2000) report a value of 2.1-3.8 GJ/ton canned tomatoes for processing. For transportation, we obtain energy consumption values that goes from 0.76 to 2.81 GJ/ton output. It must be said that, because of different definition of boundaries and other assumptions, it is very difficult to compare studies from different backgrounds. Anyway, from these data, transportation appears to contribute between 37 and 48% of the supply chain overall impact and therefore it can never be considered as marginal.

#### **4. Conclusions**

It clearly emerges from our study that the magnitude of impacts and the comparison between alternative supply chains are highly influenced by geographical and productive specificities of the contexts analyzed. Anyway, the very clear results we obtain permit to make general conclusions.

First, in accordance with the prevailing result of literature it came out that shopping by car is a major responsible of food transportation impact.

Other results we obtain are, contrariwise, more controversial issues. Especially, with regards to the trade-off between a reduction in distance and centralization of loads strategy, our case study supports the view that short supply chains can be much more efficient. Secondly, we claim that with regards to the global impact, the superiority of MD compared to IR is not so significant.

At last our study highlight, as a new outcome, that the transport of packaging can cover a significant part of the food transportation overall impact.

### **Bibliographical references**

- AEA Technology (2005), *The validity of food miles as an indicator of sustainable development*, DEFRA, London.
- Carlsson-Kanyama A., Faist M. (2000), *Energy use in food sector: a data survey*, Stockholm, Zurich.
- Garnett T. (2003), *Wise moves. Exploring the relationship between food, transport and CO<sub>2</sub>*, Transport 2000, London.
- Jones A. (2001), *Eating Oil. Food Supply in a Changing Climate*, Sustain and Elm Farm Research Center, London.
- Miyao G., Klonsky K. and Livingstone P. (1997), *Sample costs to produce processing tomatoes in Yolo county 1997*, University of California Cooperative Extension, USA.
- SAFE Alliance (1994), *The food miles report: the dangers of long distance food transport*, London.