Measuring and comparing the carbon footprints of different procurement models for primary school meals

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PUBLIC FOOD PROCUREMENT FOR SUSTAINABLE FOOD SYSTEMS AND HEALTHY DIETS

VOLUME 1

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Edited by:

Luana F.J. Swensson
Food and Agriculture Organization of the United Nations

Danny Hunter
Alliance of Bioversity International and the International Center for Tropical Agriculture

Sergio Schneider
Federal University of Rio Grande do Sul

Florence Tartanac
Food and Agriculture Organization of the United Nations

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13 MEASURING AND COMPARING THE CARBON FOOTPRINTS OF DIFFERENT PROCUREMENT MODELS FOR PRIMARY SCHOOL MEALS: ANALYSIS OF CASES ACROSS FIVE EUROPEAN COUNTRIES

Angela Tregear, Maysara Sayed, Mary Brennan – University of Edinburgh Business School, United Kingdom of Great Britain and Northern Ireland

Ružica Brečić, Irena Colić Barić, Andrea Lučić, Martina Bituh, Ana Ilić, Dubravka Sinčić Ćorić – University of Zagreb, Croatia

Efthimia Tsakiridou, Konstadinos Mattas, Ioannis Papadopoulos – Aristotle University of Thessaloníki, Greece

Filippo Arfini, Beatrice Biasini, Daniele Del Rio, Michele Donati, Francesca Giopp, Gianluca Lanza, Alice Rosi, Francesca Scazzina – University of Parma, Italy

Jelena Filipović, Zorica Aničić – University of Belgrade, Serbia

Steve Quarrie, Ratko Bojović – European Training Academy, Belgrade, Serbia

ABSTRACT

The study presented in this chapter sought to assess the sustainability outcomes of different procurement models for primary school meals services in five European countries. Based on environmental impact analysis, this chapter reports on the size and composition of the carbon footprints of the procurement models and analyses the contributions to overall carbon emissions of the various activities in the supply chains for meals services. It was found that while the transportation of food by suppliers to schools contributed somewhat to overall carbon footprints, other variables have a more significant impact, in particular the amount of meat on the menu and the choice of waste disposal method. The chapter concludes by discussing which actions stakeholders should prioritize to improve the environmental impacts of public food procurement. The research for this chapter was funded under European Union H2020 grant agreement 678024.

13.1 Introduction

In the growing body of scholarship that investigates sustainability in public sector food procurement, debates have focused on the different forms, or models, that procurement systems can take, and what the consequences of these are for sustainability outcomes (Morgan, 2008; Goggins and Rau, 2016; Smith *et al*., 2016; Grivens *et al*., 2018). In particular, procurement models oriented towards lowest cost are often criticized for being unsustainable (Morgan and Sonnino, 2007; Morgan, 2008) due to their perpetuation of industrial-scale, fossil fuel-reliant production systems, their geographically extended distribution channels and the low quality of food on the plate. Alternative procurement models advocated as more sustainable include those featuring greater localization and/or sourcing of organic food (Walker and Preuss, 2008; Nielsen *et al*., 2009; Sonnino, 2010; Jones *et al*., 2012; Lehtinen, 2012; Tikkanen, 2014). Such models are associated with less ecologically harmful production processes, lower food miles, more equitable supply chain relations and more nutritious food. In Europe, specific policy instruments have been developed in accordance with these principles. For example, Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement makes provisions to facilitate the procurement of more local and organic food, and thereby pursue enhanced sustainability outcomes.

Although the arguments in favour of alternative models are compelling, to date few studies have systematically examined and compared the sustainability outcomes of different models of public food procurement. The aim of this chapter is to address this gap. A three-year study conducted under the Strength2Food project, funded by the European Union,[1] examined the environmental, economic, social and nutritional outcomes of different models of food procurement across a set of primary school meals services in five European countries. This chapter focuses specifically on the investigation of the environmental impacts of the meals services. The research questions that guided the study were:

- Which activities contribute most to the carbon footprint of a school meals supply chain? and

[1] For more information on the Strength2Food project, see **www.strength2food.eu**. The research was funded under grant agreement H2020 678024.

- Do alternative procurement models, which emphasize sourcing of local or organic food, have lower emissions than low-cost models?

The sections that follow provide an overview of the meal services that were used as case studies and describe the methods used to measure their carbon footprints. The chapter then presents the results of the analysis and discusses the environmental sustainability implications for public food procurement policies and practices.

13.2 School meals services: case studies

In each of the five countries included in the study (Croatia, Greece, Italy, Serbia and the United Kingdom of Great Britain and Northern Ireland), a pair of school meals services was selected (see Figure 1). Each case meals service comprised the supply chain and catering activities through which meals were provided to a sample of five schools (or four schools, for the Serbian cases). For all of the countries except Italy, one of the two case studies concerned a local service model (LOC), whereby the contract award criteria referred explicitly to local sourcing and/or local suppliers accounted for a proportion of food purchased in practice.

The other case study for each country concerned a low-cost service model (LOW), whereby contract award criteria emphasized lowest price, with little to no mention of local sourcing. In Italy, where regional laws require a minimum of 70 percent of food procured for school meals to come from organic or integrated production systems, or to be typical and traditional products, one study case concerned a LOC-ORG model (a model operating according to these regional laws), while the other concerned an ORG model (a model in which the contract primarily referred to organic sourcing). See Chapter 7 and Chapter 27 for additional analysis of the Italian experiences, and Chapter 1 and Chapter 25 for experiences in the United Kingdom of Great Britain and Northern Ireland.

Of the many national and regional differences in procurement practices that existed across the cases, the following are helpful to contextualize the study. In Italy, public procurement policies have embraced the sustainability agenda. Combined with a well-elaborated regime to support high-quality food and nutritional standards in school meals, they provide a policy context that is highly conducive to localized

Figure 1 **Map of case studies of school meals services**

Source: map from UN Geospatial Information Section, adapted from Tregear *et al.*, 2019.

and organic procurement. The provision of school meals in Italy is organized at the municipal level. In the United Kingdom of Great Britain and Northern Ireland, there are frameworks setting nutritional standards for school meals and at least some encouragement of local and organic sourcing, notably through the Food for Life programme.[2] In Scotland, all school meals services are organized at the municipal level; the spatial scales of organization vary in other parts of the country.

In Croatia and Serbia, public procurement policies have to date focused less on sustainability. In Croatia, and specifically in the city of Zagreb, a mix of collective and individually organized contracts are used for high and low-quality goods, respectively, while in Serbia, individual schools are normally responsible for contracting their own

[2] For more information on the Food for Life project, see **www.foodforlife.org.uk**.

meals services. Croatia established national nutritional standards for school meals in 2013, while Serbia introduced such standards in 2018. Greece presents yet another, very different context. Until 2016, there was no public provision of school meals in the country. Their introduction in 2016 stemmed from a national social welfare programme targeting lower-income municipalities. Contracts are awarded according to the most economically advantageous tender (MEAT) framework. As schools in Greece are without kitchens or canteens, all meals are prepared off-site in central kitchens and transported in sealed containers for service in classrooms.

13.3 Calculation of carbon footprints

The core measure for the environmental impact of the meals services that were used as case studies was carbon footprint, expressed as the kilograms of CO_2e emitted annually from the production, processing, transportation and waste handling of food items procured by the selected schools in each case. The following paragraphs describe the approach that was developed, adapted from the method of Lancaster and Durie (2008), to calculate these emissions.

First, to calculate the emissions relating to the agricultural production, processing and upstream transportation of the procured food items, the delivery invoices sent by all suppliers to the schools in the case studies were collected for a minimum period of six weeks in 2017/18.[3] Based on these invoices, the total annual quantities (in kilogram) of food items procured in each case were estimated. These annual quantities were then multiplied by the relevant per kilogram emissions factors.[4] These calculations captured all emissions up to and including the transport to first-tier suppliers (i.e. wholesalers).

[3] The exception to this was Italy, where it was not possible to obtain invoices. Instead, food quantities were estimated based on documents supplied by the municipalities and catering firms regarding menu composition and food quantities for the school year.

[4] For all cases except the ones in Italy, the emissions factors proposed by Audsley *et al.* (2009) were used for fresh food items, those of Slater, Chalmers and Craig (2019) for processed items, and those proposed by Williams *et al.* (2006) for organic items. For the Italian cases, well-established and reliable databases providing emissions factors that are more specific to the Italian context were used, including the Double Pyramid database of the Barilla Center for Food and Nutrition (BCFN, 2016), the Environmental Product Declaration (EPD) database (EPD International AB, 2019), the LCA food database and the ecoinvent database (ecoinvent, 2019).

Next, the emissions relating to the downstream transportation of the food items were calculated, from first-tier suppliers to the schools included in the case studies, over a school year. Information was gathered through interviews with suppliers on their vehicle types, loads, delivery round distances and frequencies; then, the estimation formula of the Department of Environment, Food and Rural Affairs (Defra) was applied (United Kingdom of Great Britain and Northern Ireland, Defra, 2013).[5]

Finally, the emissions relating to the handling of waste were calculated. Over a period of two weeks (or one week, for the Greek case studies), all types of daily plate waste were collected and weighed in two schools for each case study. Based on these data, average annual plate waste was estimated for all schools in each case study. These estimates were multiplied with the waste handling emissions factors elaborated by Moult *et al*. (2018), which not only make a distinction between different categories of waste, but also between different waste destinations (emissions from landfill, for example, are much higher than those from anaerobic digestion, composting or the transformation of waste into animal feed).

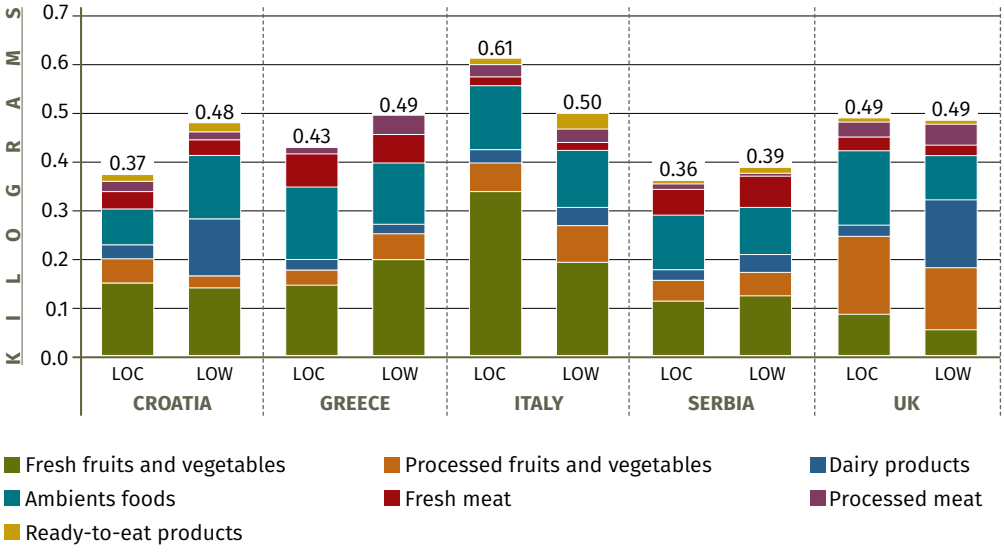
13.4 Results

Which foods were procured by the meals services that were used as study cases?

It is well-established that upstream production and processing activities make important contributions to the total carbon footprints of food supply chains; the magnitude of these contributions varies by type or category of food. Therefore, this study explored which foods were procured by the schools in the case studies, and in what relative amounts. Figure 2 summarizes the results, showing the types of foods and their relative weights per average meal. Note that the weights reported refer to the raw quantities of foods procured, before preparation and cooking, for the average meal, and not to the weight of the served meal.

[5] The formula used was the following (incorporating the assumption that 89 percent of the weighted average was allocated to the distance of the delivery round and 11 percent to the vehicle load) (Kellner and Otto, 2011):

Figure 2 **Weights and proportions of foods procured for the average meal in the meals services (kilograms per meal)**



Note: ambient foods include bread, pasta, rice and oils.

Source: Tregear *et al.*, 2019.

As Figure 2 shows, there was considerable variation between the paired cases, and across countries, in the total weights of foods procured for the average meal, from 0.61 kg and 0.50 kg (Italian cases) to 0.36 kg and 0.39 kg (Serbian cases).[6] Considerable variations were also found in the proportions of different food types making up these weights. In most cases, fruits and vegetables (fresh and processed combined) represented the largest category. However, their share in total meal weight varied from almost two thirds in the Italian LOC-ORG case to around one third in the Croatian LOW case. Notably, the cases in the United Kingdom of Great Britain and Northern Ireland showed the smallest proportions of fresh fruit and vegetables procured for the average meal, and the highest proportions of processed fruits and vegetables. Dairy products represented only a small proportion of total meal weight in all the cases, except for the Croatian LOW case and the LOW case in the United Kingdom of Great Britain and Northern Ireland. The higher proportions in those cases were due

[6] In some Italian schools, a proportion of the recorded fruit weight was served as a mid-morning snack instead of, or in addition to, the fruit served at lunch.

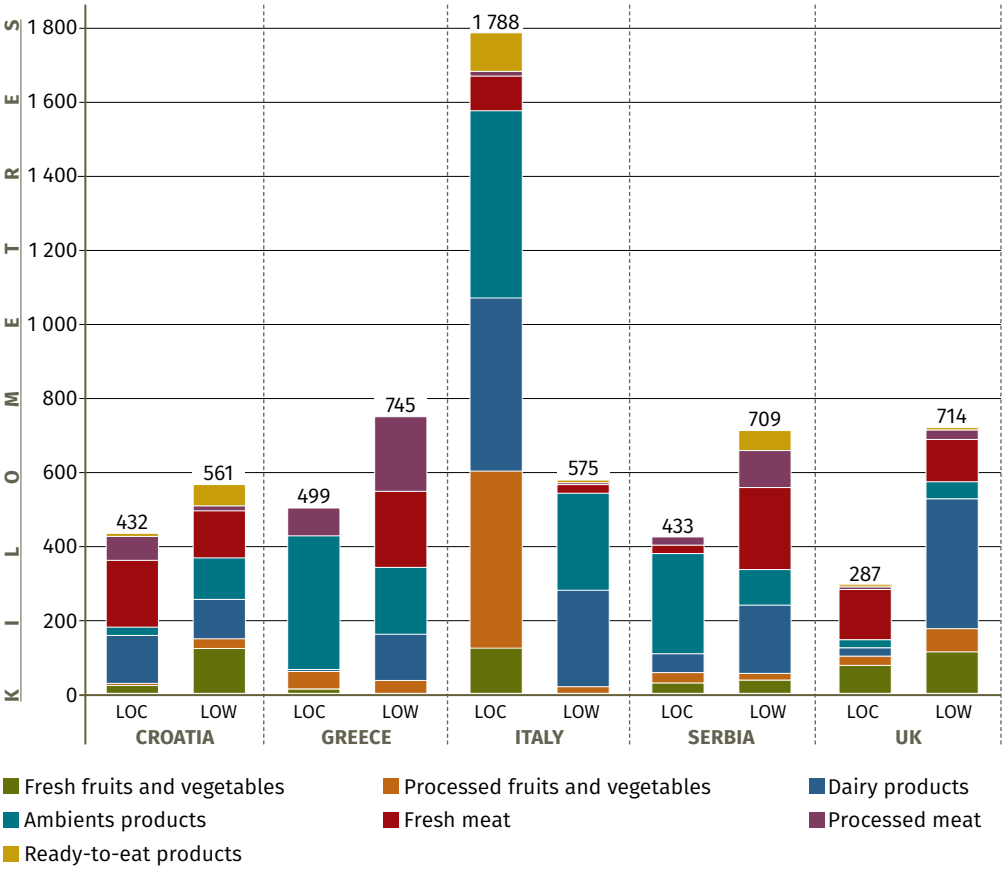
to the practice of procuring milk to drink with meals. Finally, variations are seen in the proportions of fresh meat across the cases, with the Greece and Serbian cases procuring noticeably more meat (including ruminant meat) than the other cases.

What were the transportation distances from first-tier suppliers to schools?

Food miles have long been a focus of attention in policies to improve the sustainability of public procurement. Hence, the study sought to estimate the transportation distances travelled by food suppliers for the case studies. Figure 3 shows the average weekly distances travelled by first-tier suppliers (i.e. wholesalers or equivalent end-chain suppliers) to the five schools in each case (or four schools, in the Serbian cases), based on their locations and the delivery frequencies. In order to make comparisons across cases, the total number of kilometres was divided by the number of weeks of delivery operations in a school year, as well as by the number of featured schools in the case, to obtain the average number of kilometres travelled per school per week. The estimates shown in Figure 3 depict the raw distances travelled, to provide a visual illustration and comparison. To estimate the emissions associated with these distances, factors such as the number of other customers in the rounds, shared loads and backhauling were taken into account.

As Figure 3 shows, in four out of the five case pairs, the kilometres travelled were smaller in the LOC case than in the other case. The Italian LOC-ORG case was an exception to this, due to the location of one or two key suppliers at a considerable distance from the central kitchen (e.g. canned tomatoes were transported from the Campania region, in southern Italy, to Parma). The distances between the locations of suppliers and of the central kitchen also explained the high number of kilometres travelled weekly in the Greek LOW case, where meat was transported from Germany. Other factors that influenced the number of kilometres travelled were the number of suppliers (e.g. the relatively high average number of kilometres in the Serbian LOW case were due to the relatively high numbers of individual suppliers making trips to the schools in an uncoordinated way) and the frequency of deliveries (the LOW case in the United Kingdom of Great Britain and Northern Ireland had the third highest average number of kilometres travelled due to the daily delivery to the schools of fresh milk for drinking).

Figure 3 **Average number of kilometres travelled by suppliers in the case studies of meal services (per school, per week)**



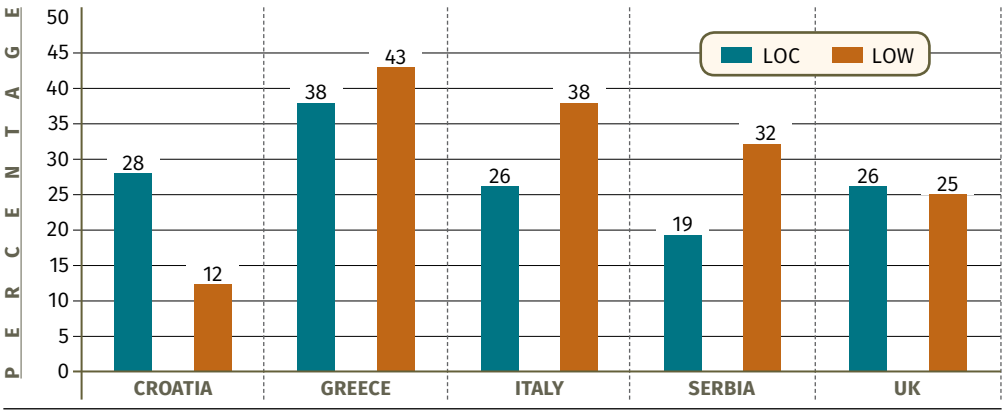
Note: ambient foods include bread, pasta, rice and oils.

Source: Tregear *et al.*, 2019.

What were the waste levels in the case study meals services?

Food waste is increasingly recognized as a significant environmental problem in public procurement (Sonnino and McWilliam, 2011), in addition to its implications for nutritional and financial losses. Hence, the study gathered data on the quantities and types of plate waste generated in the schools. Based on these data, the average plate waste generated in the schools, expressed as a proportion of the total food served, was estimated (Figure 4).

Figure 4 **Plate waste in the case study meal services, as a proportion of total food served**



Source: Tregear *et al.*, 2019.

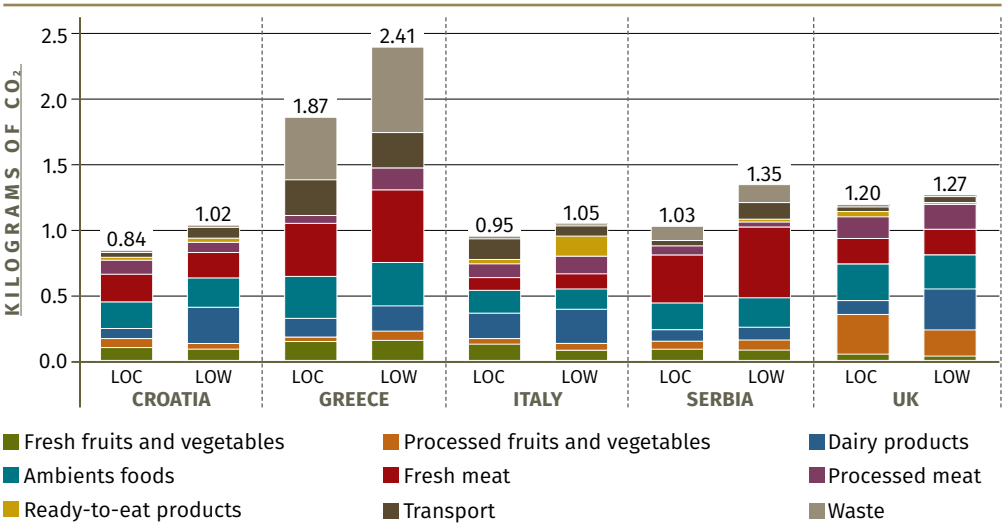
As Figure 4 shows, there was considerable variation within case pairs, and across countries, in terms of the percentages of served food that were wasted. The highest rates of waste were in the Greek LOW case (43 percent), the Greek LOC case (38 percent) and the Italian ORG case (38 percent). Meanwhile, the lowest rates were in the Croatian LOW and Serbian LOC cases (12 and 19 percent, respectively). In addition, data on the typical destination of the food waste were gathered. It was found that all cases relied exclusively on carbon-reducing waste disposal methods, except for the Greek (100 percent reliance on landfill) and Serbian cases (where a mix of landfill and composting/transformation into animal feed was used).

Carbon footprint of the case study school meals services

Having estimated the quantities and types of food procured by the meals services that were used as case studies, the related kilometres of transportation and the amounts and destinations of plate waste, the carbon footprints of the services were estimated. Figure 5 shows the total carbon emissions of the average meal in each meals service case study, along with the contribution of the different activities (production and processing per type of food, total transportation and total waste). Figure 6 shows the carbon intensity of the average meal in each case, that is, the kilograms of CO_2e per kilogram of food in the average meal. This latter measure is important for comparison

purposes within and across the case pairs, because it eliminates the variations in the total weights of average meals across the cases.

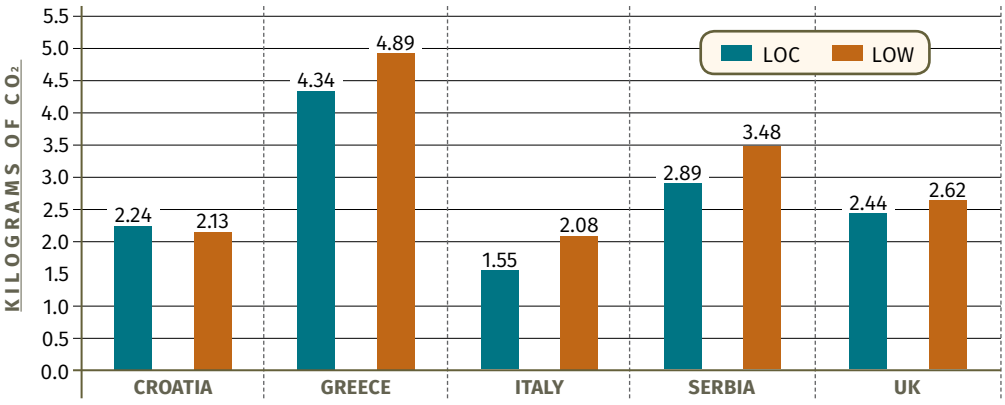
Figure 5 **Carbon emissions of the meals services case studies, per average meal (kilograms of CO_2e)**



Note: ambient foods include bread, pasta, rice and oils.

Source: Tregear *et al.*, 2019.

Figure 6 **Carbon intensity of the average meal in the meals services case studies (kilograms of CO_2e per kg of meal)**



Source: Tregear *et al.*, 2019.

Figure 5 and Figure 6 show that the two Greek cases had the highest carbon footprints per average meal, and per kilogram of meal. Indeed, according to the carbon intensity measure, the emissions of the Greek cases were more than double those of the case with the lowest emissions (Italy LOC-ORG). Figure 5 shows that the main contributors to emissions in the Greek cases were waste handling (due to the high waste levels and the exclusive reliance on landfill) and the use of fresh meat (which represented a relatively high proportion of the weight of the average meal). Waste disposal and meat consumption were also high contributors to emissions in the Serbian cases, which had the second-highest carbon intensities. Meanwhile, the Italian and Croatian cases showed the smallest carbon footprints. Per-meal emissions (see Figure 5) were lower in the Croatian cases; however, it should be recalled that in Italy, a much higher quantity of food was procured per average meal. When this variation is eliminated (see Figure 6), the Italian cases were found to have the lowest emissions per kilogram. Even on a per-meal basis, the low emissions of the Italian meals are striking. This demonstrates how the selection of the types of foods comprising the meals (in the Italian cases, a high proportion of fresh fruits and vegetables, and small amounts of meat) can have a strong carbon-reducing effect. The other key finding in Figure 5 that is worth highlighting is the relatively small contribution of transport emissions to the total carbon footprint in all cases, even those with a high number of kilometres travelled by first-tier suppliers. In particular, the Italian LOC-ORG case – where geographically distant suppliers were used – had the lowest carbon intensity of all cases.

13.5 Discussion

There is relatively little systematic evidence available as to the environmental impacts of public food procurement. Hence, this paper sought to explore: which activities contribute most to the carbon footprint of supply chains for school meals, and whether alternative procurement models, emphasizing localization or the use of organic food, have lower emissions than low-cost models.

Overall, the analysis found that across all cases, the greatest contributor to total carbon footprint was the **production, processing and upstream transportation** of the food items themselves, with emissions from those activities for meat (and in particular ruminant meat) being much higher than those for fruits and vegetables. By contrast,

downstream transportation, from first-tier suppliers to caterers/schools, contributed only a modest proportion of total emissions. Hence, the results indicate that the carbon footprints of public food procurement depend more on the composition of the meals than on the location of the suppliers. A further important finding is the **importance of the food waste disposal method for total carbon footprint**. In countries where methods with low carbon emissions such as anaerobic digestion, composting and transformation into animal feed are practiced (Croatia, Italy, the United Kingdom of Great Britain and Northern Ireland), waste disposal accounted for only a very small part of total emissions in all case studies – even in those cases with high rates of plate waste, such as in Italy. Meanwhile, in Greece and Serbia, where landfill is a common disposal method, waste accounted for much higher proportions of total emissions.

To answer the question of whether procurement models that feature local or organic sourcing have lower carbon emissions than low-cost models, a simple within-pair comparison of the case studies was carried out. This comparison revealed that for four out of the five pairs (Greece, Italy, Serbia and the United Kingdom of Great Britain and Northern Ireland), the LOC model had a lower carbon footprint than the LOW model. Furthermore, the Italian cases, both of which incorporated organic procurement, had the lowest carbon intensities of all cases. However, the analysis indicates that these differences were due to factors other than the specific localization and organic features of the models. As highlighted above, downstream transportation accounted for a relatively modest proportion of total emissions in all of the case studies, including LOW cases. Hence, any effect on emissions of localization is far outweighed by the effects of the types of foods procured and the waste disposal method chosen.

Similarly, the low emissions found in the Italian cases were due to their procurement of high proportions of fruits and vegetables and low proportions of meat, rather than to the organic status of these foods. In other words, even small increases in the amount of meat procured would greatly increase the emissions in both Italian cases, whether or not that meat was organic. Therefore, while localized and organic procurement models may be associated with – or could even promote – decision-making that makes environmentally friendly procurement and waste management choices more likely, the analysis points to the need for caution in attributing direct

causality between these specific procurement model features and beneficial environmental outcomes.

This is not to say that farm management practices, such as those associated with organic or low input farming, have no impact at all on the carbon emissions of meals services. On the contrary, according to measures used in other studies (e.g. the EX-ACT tool of the Food and Agriculture Organization of the United Nations [FAO]),[7] environmentally friendly agricultural practices could indeed lower the greenhouse gas emissions of school meals services, if those services have the same menu composition as their counterparts using conventionally farmed foods. However, the results of this study highlight that a greater impact on emissions can be had by adjusting the composition of menus, rather than farming practices.

13.6 Conclusion

From the results of this study, three recommendations can be drawn for policymakers and supply chain stakeholders that allow them to enhance the environmental sustainability of public food procurement.

First, it is recommended to focus on food waste disposal methods, and specifically to switch from landfill to a more environmentally friendly alternative (e.g. anaerobic digestion, composting or transformation into animal feed). The results of the case studies indicate that landfill disposal may account for up to one third of total carbon emissions in food procurement chains. Avoiding landfill can thus result in a dramatic reduction of emissions. To ease the switching between waste disposal methods, policymakers should improve the availability of anaerobic digestion/composting facilities. Meanwhile, procurement contracting authorities are encouraged to incorporate the use of such facilities in contract award criteria. Actions targeted towards the reduction of food waste should also be pursued, for example awareness raising about food waste among associations of supply chain actors and user groups. Awareness raising efforts could take the form of study tours or discussion forums to exchange experiences about minimizing waste in school canteens.

7 For more information on the FAO EX-ACT tool, see **www.fao.org/tc/exact/ex-act-home/en**

Second, it is recommended to make menu adjustments, and specifically to explore ways to reduce the use of ruminant meat, for example by substituting it with more white meat or fish or by introducing meat-free days in menu cycles. Increasing the proportions of fruits and vegetables, as well as of animal proteins that are less carbon-intensive (such as milk and eggs) would also result in a reduction of emissions. Such menu adjustments must be balanced against nutritional requirements and "plate appeal," which are particular concerns for school meals. Policymakers are encouraged to invest in more research on nutritionally sound low-carbon diets and menus; they should also implement programmes for the exchange of information and knowledge among nutritionists, menu designers, catering staff and pupils and parents, to ensure that the adjusted menus with a lower carbon profile are safe and appealing. For menus that have already been adjusted to include ingredients with a lower carbon profile, the attention can be shifted to procuring items from environmentally friendly farming practices; policymakers are encouraged to support and fund research into such practices.

Third, it is recommended to focus on transportation arrangements. Adjustments to those arrangements could involve sourcing items more locally (the transport emissions in the Italian and Greek cases, with their distant first-tier suppliers, were indeed higher than in other cases). However, in making such changes, authorities need to ensure that supply chains do not create a multiplication of short, local journeys as a consequence. Equal, or even greater, reductions in transport emissions may be obtained by switching to electric or more fuel-efficient vehicles, encouraging suppliers to share or backhaul deliveries, creating better coordinated local/regional transportation hubs or warehouses, and/or reducing the number of individual suppliers in the contract. Contracting authorities could promote these actions by allocating points to them in contract awards. Increasing storage capacities within schools (especially chilled and frozen storage) can also have the effect of reducing carbon emissions, as it allows for a reduced frequency of deliveries. However, such investments should be complemented with information and training efforts to ensure that kitchen staff understand the food safety implications of such storage methods.

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