Food Policy 37 (2012) 609–615

Contents lists available at SciVerse ScienceDirect

Food Policy

journal homepage: www.elsevier.com/locate/foodpol

Review

The energy efficiency of local food systems: A comparison between different modes of distribution

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ARTICLE INFO

Article history:
Received 31 October 2011
Received in revised form 29 March 2012
Accepted 9 July 2012
Available online 23 August 2012

Keywords:
Energy efficiency
Local food systems
Food miles
Short sales chains
Food distribution
Sustainable food system

ABSTRACT

The possible contribution of local sales chains to the reduction of energy consumption has been hotly debated in recent years. Some authors establish a link between the reduction of distances traveled by food and lower energy consumption due to transportation, while others hold that local supply chains have a poor energy performance. This article engages this debate by comparing the rates of energy consumption attributable to different modes of distribution of fruits and vegetables in a region of France.

By studying actors' actual practices, we show that the establishment of local food systems leads to organizational efforts at the local level or in the form of geographically centralized networks which allow energy expenditures linked to distribution to be minimized. The studied chains' performances are variable, from 13.5 to 44.8 GOE/€ (Gram of Oil Equivalent per euro) of product, bringing them close to long chains in the best examples. Comparison with other research underscores the diversity of methods which are put in place. They also show that energy performance remains very dependent on where the study was conducted. Ultimately this study invites us to better analyze the ways in which actors collaborate to optimize energy expenditures relative to the distribution of food products in local sales chains.

Introduction

The social and environmental costs of our globalized food system, as well as its dependence on non-renewable resources, increasingly raise questions about its sustainability, and many possible alternatives – technical, social, or economic – are being explored (Pretty, 1998; La Trobe and Acott, 2000; Feenstra, 2002; Hendrickson and Hefferman, 2002; Defra, 2006; Gliessman, 2007; Schönhart et al., 2008; Wezel et al., 2009).

In this context, the many initiatives to both reduce the number of intermediaries in the food system and geographically relocalize production and consumption seem increasingly worthy of serious consideration (O'Hara and Stagl, 2001; Renting et al., 2003; Wiswerke and Van Der Ploeg, 2004; Goodman, 2004; Lyson, 2004; Maye et al., 2007). These initiatives share the ambition of meeting the various criteria of a sustainable food system. From the economic perspective, emphasis is placed on the redistribution of increased value for farmers, the relocalization of economic flows, and a reduced reliance on non-renewable resources (Maye et al., 2007; Ziesemer, 2007). In social terms, the development of local food chains seems more just and fair, allowing a renewal of the meaning of farm work and of the social links between city and country (Hinrichs, 2000; Lyson, 2004; Dufour et al., 2011). Lastly, from an environmental perspective, research explores their ability to better preserve natural resources (Gilg and Battershill, 2000; Duram and Oberholtzer, 2010; Deverre and Lamine, 2010).

Of course, the reality of this presumed greater sustainability of local food systems is up for debate (Ilbery and Maye, 2005; DeLind, 2011). Among the contested issues, the contribution of local food distribution chains to the reduction of energy consumption and greenhouse gas emissions has been particularly debated in recent years (Pirog et al., 2001; Watkiss, 2005; DuPuis and Goodman, 2005; Redlingshöfer, 2008; Mariola, 2008; Blanquart et al., 2010).

The increasing distances food travels has been underlined in different geographical contexts (Hendrickson, 1996; Pretty et al., 2005). In France, the transport sector represents nearly 27% of greenhouse gas emissions, which makes it the primary emitting sector and that which has seen the highest increase in the period 1990–2005. The share of food transport in the ensemble of transports is 21% of transported tonnage (CAS, 2007).

This increase in the distance foods travel between their place of production and their place of consumption has sparked much questioning of the energy performance of food distribution. In France, local authorities frequently use its reduction to justify their support for developing local sales chains. Indeed, these authorities, under impetus from the state, have appropriated the energy question in developing "Territorial Energy-Climate Plans".[1] These plans

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[1] According to ADEME (the Environment and Energy Management Agency), over 215 French local authorities had launched such a plan by the start of 2012 (http://www.pcet-ademe.fr).

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http://dx.doi.org/10.1016/j.foodpol.2012.07.006

concern food policy since a relocation of economic activities is advocated to help reduce the flow of transportation of goods and people (RAC, 2011). Many food chain relocalization policies are made under the auspices of these plans.

Yet this presupposition is not so straightforward. Several authors think that this indicator is insufficient for confirming a superior energy efficiency attributed to local sales chains (Saunders et al., 2006; Milà i Canals et al., 2007; Mariola, 2008). These chains may, in fact, put many small vehicles transporting low volumes on the roads, for which the balance between fuel used/volume transported is not favorable. Their performance varies in function with the distance, volumes transported, the degree to which vehicles are filled, or even whether the return leg of the trip is driven with a full or partial load (Redlingshöfer, 2008). Moreover, these sales chains need transportation infrastructure as much as long-distance distribution does, and their construction and upkeep are highly energy-consuming (Mariola, 2008).

Advancing our understanding of the energy efficiency of various forms of food distribution thus represents genuine stakes, and this article aims to shed new light on the subject.[2] The measurement of energy use of food distribution chains presents a great many methodological challenges: What perimeter of observation? What units of measurement? Which energy expenditures should be included? How to compare differing situations? According to the choices made, the results would appear very different, either in favor of local chains, or to their detriment.

Unlike most work on the subject, our research protocol was based on a close observation of the actual behaviors of actors – producers, intermediaries, and consumers – to be able to test the hypothesis that the establishment of localized food systems takes place through local organizational efforts or at the scale of small territorial networks which minimize energy consumption, a possibility that research based on moderate impacts that ignores actors' real spatial practices could not take into account. Basing ourselves on a methodology developed by Rizet et al. (2008), we show that the actors of the observed local chains endeavor to optimize the energy efficiency of their food provisioning. We also show the importance of accounting for particular geographical and social contexts when aiming to measure the respective energy performances of a range of modes of food distribution.

In the first section, we will review the state of knowledge on the energy efficiency of food distribution (i). We next present the methodology (ii) as well as the results for three types of fruit and vegetable distribution in local sales chains: food basket systems, direct sales from the farm, and sales at stores owned by groups of producers (iii). Lastly, we will discuss these results in comparison with pre-existing research (iv).

Local food systems: Controversial energy efficiency

Review of the existing literature shows two types of coexisting work concerning the energy efficiency of food distribution networks. The first establishes a theoretical link between the reduction of distance traveled by foods and a decrease in energy consumption due to transportation (Gilg and Battershill, 2000; Pirog et al., 2001; Jarosz, 2008; Pimentel et al., 2008). Defenders of this approach often rely on the notion of food miles, proposed by Pirog (2001). But if he defends the potential of this notion to illustrate diverse product qualities to consumers (product freshness, flavor), he does not intend it to be an indicator for lower energy use in local food chains.

The second approach is based on case studies. Some rely on scenario-types, others on real measurements; some study the impact of the product's provenance without distinguishing modes of sales, others focus on how products are put on the market. This work arrives at contrasting results manifesting the effects of methodological choices concerning the selection of measures (Edwards-Jones et al., 2008). Thus some authors affirm that the reduction of transportation distance and the number of intermediaries permits the reduction of energy consumption and its associated costs (Jungbluth and Demmeler, 2005; Pretty et al., 2005; Blanke and Burdick, 2005; Pimentel et al., 2008), particularly due to the importance of transport activities, packaging, and stocking on environmental impacts in the case of international provisioning chains (Sim et al., 2007). Others think that, to the contrary, local food chains' energy scores are strongly penalized by a weak structural optimization of logistics (Schlich et al., 2006; Coley et al., 2009; Rizet et al., 2008).

Even if most authors agree on the nature of the progress that local food distribution systems might make (Wallgren, 2006; Van Hauwermeiren et al., 2007), comparisons unfortunately remain difficult. Each study has its own protocol. Some are based on scenario-types, using data present in the literature (Blanke and Burdick, 2005; Milà i Canals et al., 2007). Others rely on actual measures from studies on the impact of the product's provenance (Schlich et al., 2006) or products' sales outlets (Wallgren, 2006).

Among work based on real measures we find the work of Schlich et al. (2006) on the energy consumption of three products (fruit juice, wine, and lamb). The authors compare the regional and global provisioning chains of each product type. This research reveals the positive influence of concentration (of production, transportation...) on a lower final energy consumption per product unit transported. An analogy is thus made with the rules of economy of scale to put forward the principle of "ecology of scale," a principle confirmed in certain Life Cycle Assessments (Poritosh et al., 2009). This work provoked numerous commentaries (Jungbluth and Demmeler, 2005). Their main limitation concerns their failure to account for the consumer's trip, although the heavy influence of these trips on energy efficiency is proven (Van Hauwermeiren et al., 2007; Davis and Sonesson, 2008). The other limitation concerns the adoption of standards for each mode of transportation which do not account for actors' actual practices (from producers through consumers, via all who intervene in logistical chains).

Research by Walgren (2006), Van Hauwermeiren et al. (2007), Coley et al. (2009), and Rizet et al. (2008) enrich these results by showing the conditions under which mass distribution systems could be less energy consuming than more localized distribution systems. These four studies compare local distribution systems (farmers' markets, on-farm sales, and basket systems) basing themselves either on measures that emerged from their study, or on Life Cycle Assessments available in the literature. All arrive at the conclusion that it is necessary to reexamine the supposed energy advantages of "localism" in the food sector, local food chains being penalized by the small quantities sold despite the short distances traveled.

Although all this research converges to challenge the presumed advantages of geographical proximity in terms of food distribution energy efficiency, several limits of this work should be underlined. Except for Rizet et al. (2008), they do not account for the actual reasons for individuals' travel, be they producers or consumers, and they neglect the concrete spatial practices of their travel. The work of Coley et al. (2009) is, from this perspective, very interesting. It compares a mass distribution system of food baskets (Riverford Organics) to the maximal trip that consumers would have to make to provision themselves directly from a producer, so that their trip would be more economical in terms of energy than the mass distribution system. Thus in this study, in addition to the fact that con-

[2] This article presents the results of a study aiming to compare energy consumption caused by different modes of fruit and vegetable distribution, financed by the Rhône-Alpes Regional government.