Sustainability of local versus global bread supply chains: a literature review

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Summary

The sustainability of the food supply chain is a core issue in the research and policy debate and is one of the priorities in the EU Horizon 2020 Strategies (EU, 2014). As a result, increasing knowledge of the resource efficiency of the food supply chain can help to meet EU global challenges. The literature review on food chain performance reveals methodological differences when investigating multiple dimensions, i.e. economics, social, human health, environmental, ethics; thus, comparisons are arduous. The majority of studies focus on environmental, social and economic performance overlooking health and ethical aspects. The paper will investigate the scientific literature focusing on the contribution of supply chain on economic, social, health, environmental and ethical performance. Results could help in understanding the strengths and weaknesses of different approaches as well as their reliability in assessing how food chain sustainability is affected by its length.

Keywords: sustainability dimensions, food supply chain, local, global, bread
JEL Q18 – Agricultural Policy; Food Policy; Q10 General

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1. INTRODUCTION

In recent years, the sustainability of the entire food sector has sharply raised concerns. Social, environmental and economic issues, such as population growth, soil infertility, depletion of natural resource, waste management, market volatility and changes in consumer behaviour have rapidly focused public attention on the food supply chain (European Union, 2014). The sustainability of the food supply chain is a core issue in the research and policy debate and is one of the priorities in the EU Horizon 2020 Strategies ((European Union, 2014). As a result, increasing knowledge of the resource efficiency of the food supply chain can help to meet EU global challenges (European Commission, 2011). However, scholars do not share a common method to quantify the impact of the most representative food supply chains and to date an optimal food supply chain has not been identified. A number of research papers have been published which contrast (Wilhelmina et al., 2010) and compare (King et al., 2010) local versus global food chains, pointing out the challenges in meeting sustainability goals.

Our literature review on food chain performance highlights that researchers do not share common methodologies when investigating the dimensions of sustainability, i.e. economic, environmental, human health and social. Thus, contrasting and comparing the sustainability of food supply chains are arduous tasks. Most studies focus on environmental, social and economic performance overlooking health and ethical aspects.

The present study frames the state of the art on the assessment of sustainability in food supply chains and answers the following research question: "To what extent does the length of the supply chain affect its economic, environmental, health, social and ethical performance?". This systematic literature review will contribute to the scientific knowledge by classifying selected scientific articles on sustainability in the bread supply chain within five dimensions of sustainability, i.e. economic, environmental, human health, social and ethic. In addition we evidence which steps of the supply chain have received most attention and with respect to which dimension of sustainability.

Our paper aims to show which dimensions are investigated most, to point out the main results and limitations of the studies on sustainability in the bread chain and to highlight the gaps to bridge.

To the best of our knowledge, a comprehensive analysis of how the indicators of sustainability can help to contrast local and global food supply chains is missing. Moreover, scientific literature on localness and globalness of bread supply chains is weak. Our results could help to understand the strengths and the weaknesses of different approaches towards the assessment of sustainability in length-driven food supply as well as the reliability of those studies.

2. BACKGROUND

2.1. Sustainability of the food chain with relation to length

The current political and scientific debate on the sustainability of food supply chains is wide, covering the impact of food production, distribution and consumption on economy, environment, human health and society. On one side, the negative externalities of globalized food chains on the environment and society, especially in developing countries (Swinnen and Martens, 2007) made global players more sensitive to sustainability concerns. Corporate social responsibility incorporates the notion of sustainability into business decision making with the objective of implementing sustainable management practices, also in agri-food supply chains. The "triple bottom line" concept (Elkington, 1997) stresses the distinction between economic social and environmental dimensions is a good tool for developing a social responsibility evaluation framework for the sustainability of supply chain management (Nikolaou et al., 2013). On the other side, alternative food networks (AFN) are called into the debate as potentially able to overcome some of the limitations of global food chains. AFN are based on novel ways of interaction among producers and consumers, characterized by geographical (Pretty et al., 2005; Hogan and Thorpe, 2009) and social proximity (Renting, 2012). The actual contribution of AFN to more sustainable food systems, rural development and promotion of nutrition and health still needs a comprehensive and robust assessment.

The assessment of sustainability of food supply chains is complicated by three sets of issues: first, the absence of a shared definition of local and global supply chains; second, the identification of suitable criteria and indicators for the assessment and third, a common and robust methodology (the latter is discussed in the next paragraph). Regarding the first issue, researchers have debated on the definitions of local and global food chains, but the boundaries still remain blurred. Scientific literature explains the distinction between local and global based on geographical distance (Pretty et al., 2005), organization issues and governance (Gereffi, 2005; Marsden, 2000), resources and technologies used (Wiskerke, 2003) and territoriality (Barham and Sylvander, 2011). However the food supply chain is rarely completely local or global. In fact, the inputs to agricultural production (i.e. fuel or machinery) are generally sourced globally by necessity. Also at the consumption level, localness depends on how the product is distributed (e.g. online sales of typical and niche products) or the consumption behaviour (e.g. some basic standardized foods produced industrially, such as bread, may be present exclusively on the national market). The disposal phase (i.e. waste), if included into the analysis, further complicates the overall picture.

The task of identifying suitable criteria and indicators to evaluate food chain performance and to compare local with global food supply chains needs to comply with the multiple dimensions of sustainability. Shorter food chains can at contribute to the economic sustainability of the supply chain at different levels, i.e. farmers, consumers and communities. At the same time, the net balance between costs and benefits is closely related to scale related costs and trade-offs (e.g. the offsetting of imports by local productions). On a social level, the performance of food supply chains relies on a range of social issues, such as employment, working conditions and food security, which are interdependent. In scientific literature, the social performance of food supply chains lacks in practical assessments. To the best of our knowledge, most scientific papers on sustainability of food supply chains of different lengths focus on the environmental dimension. Several studies cover the chilling and freezing, the transport, the storage and the packaging of foodstuffs. In addition, some scientific literature contrasts local versus global supply chains with regard to public health and nutritional quality and ethics.

Compared to long supply chains, short food chains are more suitable for trading fresh produce (vegetables, fruits and animal products) and are less widely spread for staple crops (Hills et al., 2013; Galli and Brunori, 2013). Wheat is traded as a commodity, being a raw material in baking and in pasta production and an

ingredient in the processing of different foodstuffs. Thus, wheat is hardly traceable as an agricultural produce. In most European countries, bread is traditionally a staple food, the production and consumption of which are strongly affected by territoriality and cultural heritage. As a result, the last two decades have seen a reconnection between staple crop producers, processors and consumers in many places in the EU, as confirmed by the emergence of Protected Designations of Origin (PDO) and Protected Geographical Designations (PGI) for bread as well as the proliferation of unofficial initiatives promoting local baking. We can assert that for bread, global industrial chains co-exist alongside many local craft supply chains.

The present contribution, beyond reviewing the literature on sustainability assessment in food supply chains in general, provides a specific focus on how the sustainability issues related to the bread supply chain have been explored. The centrality of bread as a staple food and within almost any diet across the world together with the above mentioned global/local character makes the wheat/bread supply chain an interesting lens through which to look at sustainability assessment. The assessment of sustainability impact of bread supply chains needs to account for specific factors, in order to judge whether or not locally based food production promotes sustainability. In particular i) the use of locally produced wheat as opposed to imports from large scale distant producers, also in relation to external dependence; ii) energy use in processing and transportation and other environmental consequences; iii) economic and social implications in terms of price sustainability for consumers and consumption patterns (Sundkvist et al., 2001).

2.2. Methodology to assess sustainability in food chains

The assessment of sustainability in food chains relies either on monetary or non-monetary analyses. The monetary assessment involves the quantification of the social cost-benefit ratio of a supply chain. The non-monetary assessment entails the measure of the indicators which are able to track quantifiable changes within one of the dimensions of sustainability.

A monetary approach to AFN is the cost-benefit analysis (CBA) of all players in the food chain. To the best of our knowledge, no scientific study has assessed the monetary evaluation of the food chain from cradle to grave or has compared food chains of different length So far, literature on food chain assessment has dealt widely with a segment or a specific actor of the supply chain.

Within supply chains, the monetary impact can be measured basing either on the level of change in players' welfare (income) or on the distribution of value among food chain actors (see Porter et al. (2009) for a review on assessment methods). Broad literature focuses on consumers' willingness to pay in regard to their choice of purchasing food (e.g. Burton et al. (2001) or Van Wezemael et al. (2014)). The willingness to pay could arise from product features. Intrinsic features are search characteristics, e.g. colour and texture, experience characteristics, e.g. taste and freshness, credence characteristics, e.g. nutrition, and process characteristics; extrinsic features are packaging and labels providing information about origin, nutritional properties, etc. of the produce (Grunert, 2004). To date, papers analysing consumers' willingness to pay for food supplied by AFN have been growing. This trend could result from the raising consumers' concerns on the origin of their food as well as the increasing availability of information about AFN (Caputo et al., 2014). According to this literature, consumers' willingness to pay is higher for local than for non-local food, thus highlighting an economic return of the communication about the features of food chains (Caputo et al., 2014).

A wide literature quantifies the environmental impact of a food chain moving from the concept of the total economic value of all natural resources which are affected by the production processes. The total economic value is a monetary measure of the direct and indirect market value as well as the option value (see

Pearce and Turner (1993) for a discussion). The non-use value can be assessed through the evaluation of either stated or revealed preferences. Those preferences simulate the creation of a market for the natural resource (Pearce and Turner, 1993). A growing number of economic assessments rely on the benefit transfer of the natural resource from site to site (see Wilson and Hoehn, 2006). The social and ethical dimensions of sustainability are hardly evaluated by means of monetary methods, as disentangling the impact of food chains with different lengths and identifying causal mechanisms among social and ethical issues are complex tasks.

The non-monetary assessment of sustainability relies on the measure of stakeholders' utility using economic indicators (expressed in physical terms) and often involves a multi-criteria analysis (MCA). MCA can help to deal with multi-dimensional problems incorporating a wide set of economic, environmental and social impacts on different actors/stakeholders (French 1993). So far, a plethora of MCA Models have been developed to support the process of making, modelling and aggregating decisions. Operational researchers have proposed a huge number of algorithms intended to synthesise the preferences of Decision Makers.,For a review of the methods see Bartolini and Viaggi (2010).

A large number of papers compare CBA with MCA. Some authors see the CBA more fit than MCA to quantify a judgement. In fact, the CBA approach considers the preferences of the entire population, while MCA methods quantify the priorities for decision-makers and stakeholders using weighting procedures. As a result, these Authors refer to CBA as more "democratic" than MCA and to MCA as more "technocratic" than CBA. (Munda, 2009). According to other authors, the MCA can help the process of decision-making, explicitly involving different stakeholders within the process itself and involving either negotiations or compromises.

CBA and MCA evaluations in food chain length are affected by difficulties in quantifying benefits that are often intangible (e.g. physiological externalities by animal welfare Mann and Wüstemann 2005) and costs are not equally shared among the value chain. The attribution of cost and benefit represents a tricky issue due to the production of different goods along food chain as well as imputation of (often very low) WTP/benefit to the different products. Indicators used to measure food chain length impacts can be separated between area-based or product-based (Halberg et al., 2005). Within the second a growing application based on Life cycle analysis can be found in the literature. LCA is an approach that evaluates all stages of a product's life and several paper are applied to the environmental evaluation (see Roy et al., (2009) for a review of application to food chain) The growing interest of LCA concept at food chain follows the ability to assess impact from raw material products, processing, distribution, use, and disposal. This methodology allows to quantify both flow of materials/outputs and environmental impacts of these. Despite this literature, a harmonized assessment of the performance of length-driven food chains is still missing. Often, the emerging literature on the sustainability of local and mainstream supply chains focuses on the environmental, social and economic impact, failing to provide a comprehensive and systematic analysis of all relevant sustainability dimensions.

3. METHODOLOGY

The objective of the present paper is to systematically review empirical papers dealing with the sustainability in food supply chains. Our goal is two-fold. We aim both to assess the indicators which allow to compare local with global food chains and to apply our findings to the bread supply chain.

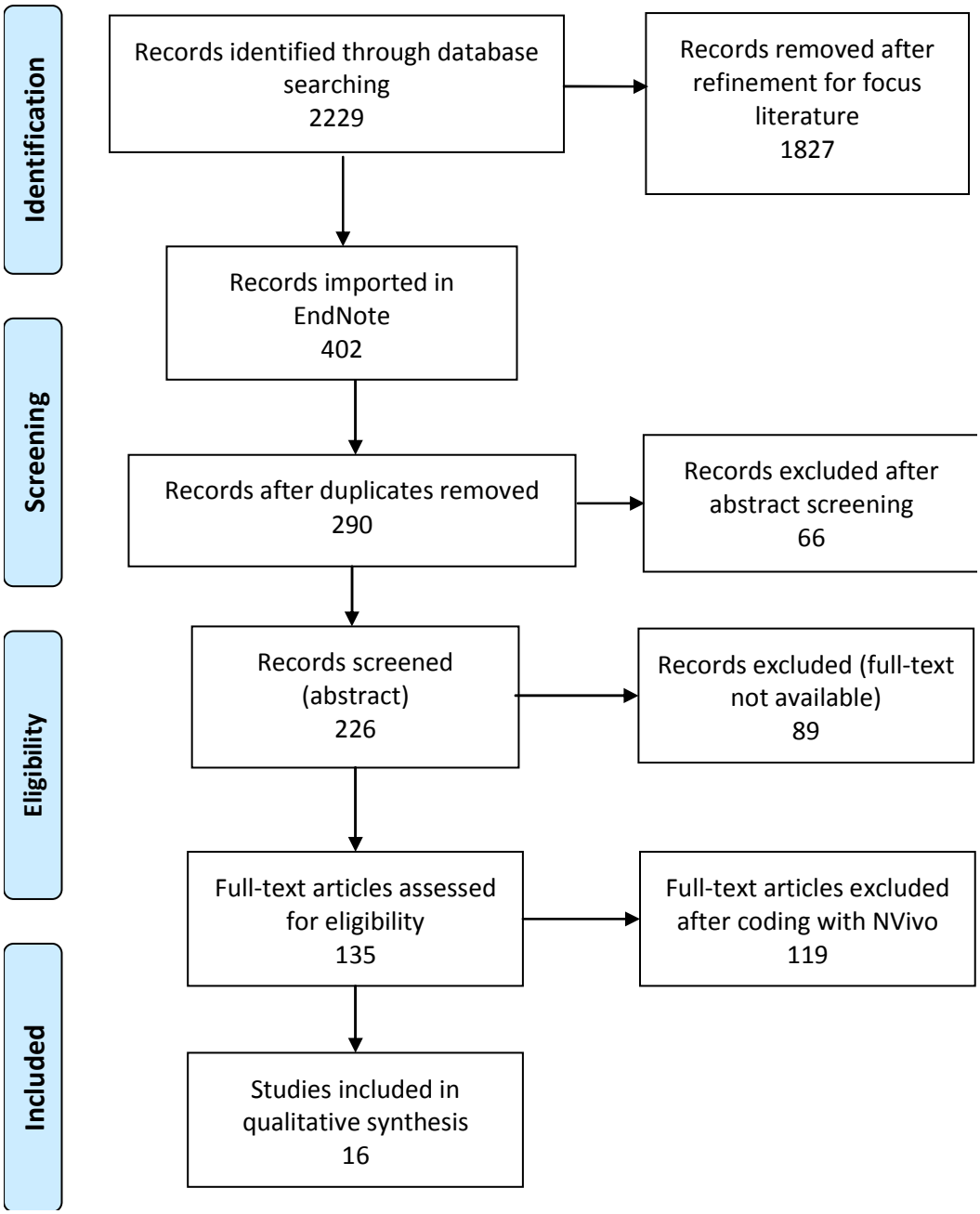
Systematic reviews are exhaustive literature searches (Cook et al., 1997), which attempt to collate all empirical evidence in order to answer specific research questions (Higgins et al., 2009), as well as to

highlight the critical gaps to bridge, while creating directions for future research (Webster & Watson, 2002). The methodology for the present systematic literature review moves from a consolidation of insights from Fink (2014), Pfau et al. (2014) and Stechemesser and Guenther (2012). The flow chart of the practical screening is shown in Figure 1.

We selected the search terms and defined the logic to combine such terms into strings which could cover all relevant reputable literature about our target domain (Levy and Ellis, 2006). The database search (carried out during April 2014) was restricted to papers written in English, but, for completeness of purposes, no boundaries for methodology, quality criteria and time span were set. The search string was run on Scopus and WoS[1] and we limited the outputs to articles and reviews in peer reviewed academic journals (including "in press"), scientific books (including book chapters) and conference proceedings. This search returned in 2229 papers (1300 from Scopus and 929 from WoS), which were reduced through a practical process of screening[2] and elimination of duplicates that returned 290 unique citations. We screened all 290 abstracts according to the following selection question: "Does the paper assess the sustainability of a food supply chain?". We rejected 66 papers. Institutional availability of full texts limited the number of papers to 135. For the last refinement we used the NVivo software for qualitative data analysis[3]. Ultimately, we selected 16 papers to review. These were integrated with ad hoc[4] searches on Google Scholar specifically aimed at identifying assessments of the bread supply chains, including both peer-reviewed and grey literature. We finally identified a total of 28 papers to review.

[1] The search fields were "TITLE-ABS-KEY" within Scopus® and "TOPIC" within Web of Science™, both including the title, the abstract and the author's keywords of the document.
[2] In a first refinement, the 2229 papers collected via Scopus and WoS were reduced to academic journals and books focused on sustainability issues, environmental issues, food industry, agriculture, supply chain studies, supply chain management, rural studies and agricultural economics.
[3] We imported all 135 papers, run a "text search" query using the term "indicator" and displayed the word tree, which we based on for the coding. We pointed out all papers mentioning the use of indicators for assessing the dimension of sustainability in food supply chains.
[4] From GS, reviewing papers were collected using a combination of the terms "bread", "grain", "wheat", "sustainab*","chain", "supply", "value", "local" and "global" in Boolean phrases. Papers assessing the sustainability in the bread sector were manually selected.

Figure 1. Flow diagram of the practical screening (Moher et al., 2009), modified.



4. RESULTS

Table 1 provides the result of the literature review process and contains the list of all papers dealing with sustainability assessment. Most papers assess the sustainability in food supply chains by means of quantitative analyses, while only few Authors rely on qualitative or mixed methods. Scientific literature is heterogeneous, disentangled by the sector and investigating the whole supply chain or specific phases of it.

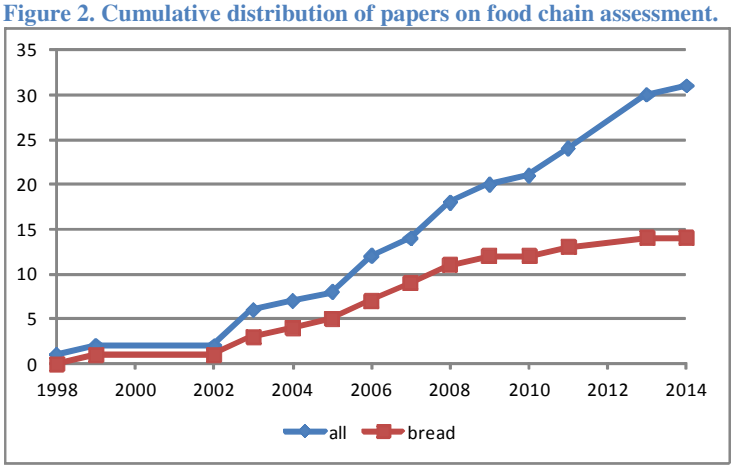
Applications deal with several sectors, including cereals, vegetables, dairy products, meat, coffee and wine. Among other sectors, bread and different types of meat are the most widely assessed. In terms of step of the chain, we distinguished among articles that consider the whole chain for the assessment ("yes" identifies production, processing - milling and baking for bread - and distribution), those that deal with a subset of phases but not all of them ("subset"). Then papers dealing with a single phase (namely "production", "baking", "packaging" and "retailing") and finally those that consider a wider set of phases in the assessment ("extra" identifies whole chain plus input supply and/or consumption and/or disposal). The largest share of articles deals with the whole chain, especially whereas standardized methodologies such as LCA are applied.

Table 1. Papers selected for review (alphabetical order).

Reference	**Approach (Empirical or methodological paper)**	**Sector of interest**	**Food chain phase(s)**
Andersson and Ohlsson, 1999	Quantitative	Bread	Extra
Bimpeh et al., 2006	Quantitative	Bread	Subset
Braschkat et al., 2003	Quantitative	Bread	Subset
Büsser and Niels 2009	Quantitative	Butter and coffe	Packaging
Caputo et al., 2014	Quantitative	Veal and chicken	Yes
Caritte et al., 2013	Quantitative	Yes (indirectly: meta-analysis)	Packaging
Carlsson-Kanyama, 1998	Quantitative	Vegetables	Yes
Coff et al., 2007	Qualitative	Bread	Yes
De Magistris and Garcia, 2008	Quantitative	Bread	Yes
Erol et al., 2011	Quantitative	No (methodological paper)	Yes
Espinoza Orias et al., 2011	Quantitative	Bread	Expanded
Fiscus, 2009	Qualitative/Quantitative	Human-beef supply network	Yes
Garnett, 2011	Qualitative	No (methodological paper)	Yes
Gerbens-Leenes et al., 2003	Quantitative	No (methodological paper)	Retailing
Gronroos et al., 2006	Quantitative	Rye bread	Expanded
Heller et al., 2013	Quantitative	Yes (indirectly: review): restaurants	Extra
Hills et al., 2013	Qualitative and Quantitative	Bread	Baking
Liedtke et al., 2010	Qualitative	Coffee and cream cheese	Yes
Murrey and Dey, 2007	Quantitative	Bread	Sector
Pelupessy and Diaz, 2008	Quantitative	Coffee	Yes
Penker, 2006	Quantitative	Bread	Yes
Pretty et al., 2008	Qualitative/Quantitative	Value chain	Yes
Qiang et al., 2013	Quantitative	China's food trade	Yes
Rugani et al., 2013	Quantitative	Wine	Yes
Sundkvist et al., 2001	Quantitative	Bread	Subset
Van Holderbeke et al., 2003	Quantitative	Bread	Yes
Vasileiou and Morris, 2006	Quantitative	Fresh potatoes	Yes
Vieux et al., 2013	Quantitative	Diet (based on food intake data from a representative sample)	Extra

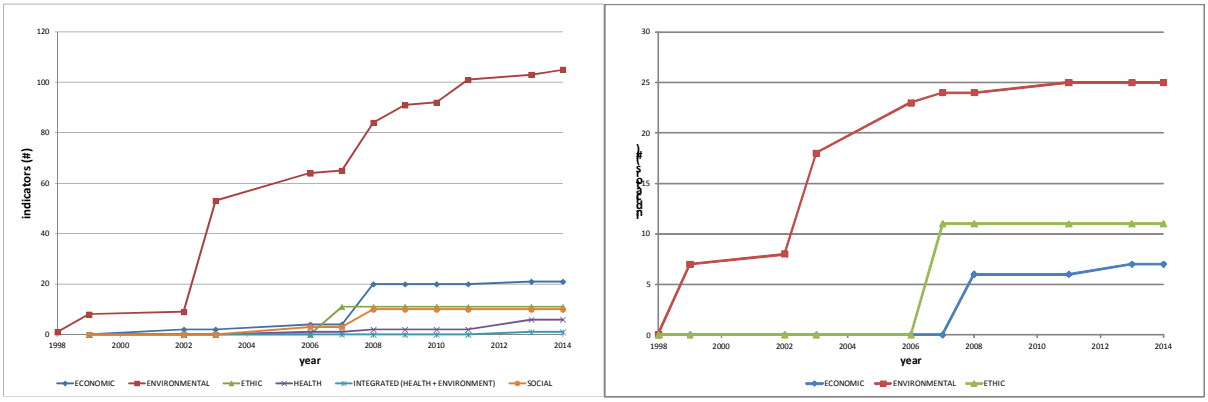
Figure 2 shows the cumulative distribution of the papers on food chain assessment. It indicates an increasing relevance of sustainability assessments over time as a consequence of the growing pressure of scientific and policy debates on sustainability matters. It also shows a growing number of articles dealing with assessment of the bread supply chain.

Figure 2. Cumulative distribution of papers on food chain assessment.



The following figures represent cumulative distributions over time of indicators used to assess specific dimensions of sustainability, respectively for foods chains (left) and bread chains (right). It clearly indicates a wider availability and application of indicators to catch the environmental implication of food chains. This goes in parallel with the spread of life cycle assessments and suitable databases built for this purpose. The bread sector is representative in this sense as several papers deal with life cycle analysis of bread at different scales, or compare different milling and baking methods (i.e. industrial vs home baking see Bimpeh et al, 2006) . Moving to the economic dimension, a limited availability of economic performance indicators is to be noted: although economic data is available at the firm level, it is often hard to obtain an economic performance measure at the supply chain level (for example, the construction of a value added measure implies obtaining details on prices and costs for all steps of the chain limitedly to the product considered). Unsurprisingly social, health and ethical dimensions are less straightforward to assess through qualitative or quantitative indicators, whereas these concern final beneficiaries of the supply chain, such as consumers and local communities. A notable exception to this is provided by Sharpe et al. (2007) who develop a qualitative assessment of the ethical dimension of different chains, including bread, in relation to traceability.

Figure 2: Cumulative distribution of indicator available to assess food chain



A all sectors

B Bread Sector

Tables 3 to 8 provide an overview of the number of indicators referred to more general attributes defined to catch each one of the dimensions of sustainability. An attribute is here defined in general terms as a specification of a dimension of sustainability. As defined by the EU project

Glamur attributes are "observable qualities relevant for the characterization of sustainability in relation to local/global features of a food chain" (e.g. contribution to climate change, distribution of value added, human health). Often attributes are relevant to more than one dimension of sustainability, but here we attempted to associate attributes to what we think is the most relevant dimension captured by the attribute at stake.

The most widely used attributes for the economic dimension are income and competitiveness. For the environmental dimension, biodiversity, emissions, quality of the urban environment and waste represent the most widely assessed characterizations. Nutritional quality is the attribute on which most studies focus in order to assess the impact on health of food supply chains. The social dimension encompasses labor relations and animal welfare as most relevant issues, although animal welfare is also assessed in relations to ethics.

Table 3. List of attributes developed for the economic dimension.

attributes	methodological paper	empirical analysis		Total
		bread sector	other sectors	
Competitiveness	0	5	0	5
Costs	0	0	2	2
Ecosystem services	0	0	1	1
Export	0	1	0	1
Financial risk	0	0	2	2
Import	0	1	0	1
Income	0	0	6	6
Information & communication	0	0	1	1
Local embeddedness	0	1	0	1
Potential for investment in innovation & technology	0	1	0	1
Relocalization	0	1	0	1
Technological innovation	0	0	1	1

Table 4. List of attributes developed for the environmental dimension.

attributes	methodological paper	empirical analysis		Total
		bread sector	Other sectors	
Agricultural inputs	0	0	2	2
Biodiversity	1	1	6	8
Climate change	0	3	0	3
Ecological embeddedness	0	0	1	1
Ecological network	1	0	0	1
Efficiency	0	0	2	2
Emissions	1	2	3	6
Energy	1	1	1	3
Forestry	2	0	1	3
Land use	1	0	0	1
Pollution	7	0	0	7
Quality of urban environment	6	3	5	14
Resource depletion	0	0	4	4

Risk	0	0	1	1
Soil biodiversity	7	0	1	8
Waste	4	2	0	6
Water	42	35	44	121

Table 5. List of attributes developed for the health dimension.

		empirical analysis		Total
attributes	methodological paper	bread sector	Other sectors	
Food safety	0	0	1	1
Nutritional quality	3	0	2	5

Table 6. List of attributes developed for the social dimension.

		empirical analysis		Total
attributes	methodological paper	bread sector	Other sectors	
Animal welfare	0	1	4	5
Employment	0	1	0	1
Family income	0	1	0	1
Labour relations	0	0	2	2
Labour relations/connection	0	0	3	3
Tax	0	1	0	1

Table 7. Indicators available for all dimensions against supply chain steps (all sectors).

Dimension	production	processing	retailing	full supply chain	Other (transportation)
Economic	1			18	2
Environmental	16	1	6	40	
Ethic				11	
Health				6	
Social	5			3	2

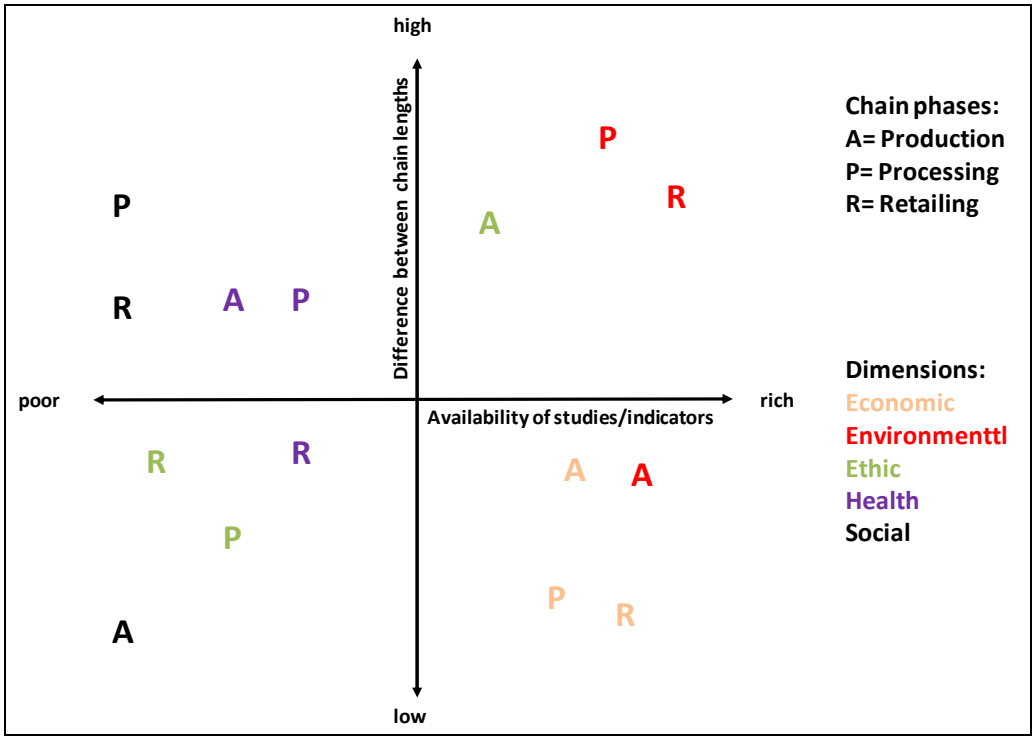
Table 8. Indicators available for all dimensions against supply chain steps. (bread sector).

Dimension	production	processing	full supply chain
Economic	1		6
Environmental	1	1	23
Ethic			11

In relation to the bread supply chain, the following figure provides a synthetic representation of the availability of studies per phase of the supply chain and dimension of sustainability in relation to the assessment of the performance of chains of different lengths. The horizontal axis expresses the increasing availability of studies (and indicators), while the vertical axis represents the difference between chains length (in terms of – one or more - the four dimensions indicated in paragraph 2.1). In particular the upper-right quadrant indicates that there is a relatively higher

availability of studies (and indicators) that are suitable to capture the different performance of local/global chains for what concerns processing, retailing and agricultural phases in environmental terms. The lower left quadrant indicates for the same phases, a lack of studies (and indicators) concentrating on the health, social and ethical dimensions able to discriminate between supply chains of different lengths. The economic dimension is widely assessed for all steps but few indicators are available to capture the difference between local and global food chains (lower right quadrant) while health and social dimensions are good at discriminating between local and global chains but there is a lack of studies and availability of indicators.(upper left quadrant).

Figure 3: Cumulative distribution of indicators available to assess the bread chain



5. CONCLUSION

The paper reviews the available literature on assessment of sustainability performance of food supply chain in relation to length. This topic represents a growing issue into academic and policy debates. The sustainability of the food supply chain is a core issue in the research and policy debate and is one of the priorities in the EU Horizon 2020 Strategies. As a result, increasing knowledge of the resource efficiency of the food supply chain can help to meet EU global challenges.

The paper focuses on the bread sector and highlights the differences and similarities among the other sectors. Results point out that despite its relevance for land use and for its weight on the international trade, the bread supply chain lacks a comprehensive assessment in terms of all sustainability dimensions and for all steps of the supply chain. In particular the health, social and ethic dimensions in relation to the processing and retailing phases are less investigated and would deserve more attention by the scientific community.

The paper highlights several directions for further work due to the potentially of increasing sustainability assessments for example by understanding the causal links between food supply chain and the impacts. Room for further developments can be found in the statistical comparison (meta-analysis) on alternative food supply chain lengths. Even if large literature deals with quantification of impacts on several sustainability dimensions, aggregated assessment taking into account all relevant dimensions is still missing. In this direction the monetary assessment of the impact across the food supply chain and/or use of weights of MCA can allow a comparison of utilities of the supply chain stakeholders and of society whose utility is affected by stakeholder's actions.

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