PERFORMANCE ASSESSMENT OF FOOD VALUE CHAINS: A WAY TO IDENTIFYING THE RESPONSES IN TERMS OF POLICY INTERVENTIONS

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Abstract

In the context of growing consumers' awareness about the impact of food products on the environment, their health or on social aspects, a careful analysis needs to be conducted to compare the sustainability performance of local and global food value chains. Indeed, a critical analysis of local food chains' performance in comparison with more global ones will help to objectively assess the real benefits and drawbacks of local and global food chains.

In this paper, a comparison of a local and a global milk supply chain is presented. The assessment of their sustainability was realized with a set of attributes and indicators around five sustainability dimensions (economic, social, environmental, health and ethical). Scores of performance are measured for each chain in each of the indicators and results show that the local chain performs better in 40% of the indicators and performs equivalently to the global chain in 40% of the indicators. The higher performance of the local chain is especially striking in the health and social dimensions. It was possible to identify that inputs procurement and the capability of chain's actors to create and share added value are two main factors of performance and very important regarding policy interventions targeting value chains sustainability.

Keywords: Local, global, value chains, sustainability, indicators

1. Introduction and context

Currently, there is an increasing consumers' awareness about the impact of food products on the environment, on their health or on social aspects. Indeed, consumers' demand for food produced locally has increased significantly as a consequence of their willingness to purchase quality products and to support local economy and local farms (King et al., 2010). For this reason, more accurate scientific answers are needed to understand those impacts. The EU GLAMUR project (Global and local food assessment: a multidimensional performance-based approach) thus adopts a multi-criteria perspective that takes 'measurement' and 'evaluation' in ways that combine qualitative and quantitative approaches. Assessing the sustainability of food chains will be useful to determine which chains (global or local) perform better around five dimensions (environment, economy, social, health and ethics).

Beretta et al. (2013) define a food value chain as "the system of organizations, people, and activities involved in moving food from its producer (usually the farmer) to the consumer" (Beretta et al., 2013:765). It is still difficult to make a distinction between local and global food value chains as the boundary remains very fuzzy (Edwards-Jones, 2010). In addition to the geographical distance separating the production site and the consumer, there are other elements that are important to define a value chain as more local or global. The GLAMUR project uses the following variables to make a distinction between local and global: (i) the physical and geographical distance between production and consumption; (ii) the type of governance and organization of the supply chain (degree of control of "local actors" and "global actors"); (iii) the kind of resources, knowledge and technologies employed; (iv) the way supply chain actors shape product identity with regard to the reference to the territory of production. Notwithstanding that the value chains in the real

world are more often on a continuum between global and local aspects, these four criteria can help identify ideal-typical cases of local and global food value chains to be examined.

Sustainability represents an important challenge for all food value chains on that continuum as several forces push to increase it: not only consumers' purchasing preferences but also other stakeholders such as governments, environmental organizations, and value chain actors which are nowadays aware of the need to improve sustainability. Performance is here understood as "The degree to which a […] value chain operates according to specific criteria/standards/ guidelines or achieves results in accordance with stated goals or plans." (OECD glossary, 2010). The five dimensions of performance (economic, social, environmental, health and ethical) rely to the consumers' concerns, which are a balance between economic determinants (for consumers, as reflected in the prices) and other "attributes of performance" they consider relevant, such as health, or ethical considerations as described by the SCAR 3rd foresight exercise on consumption behavior (EU Commission, 2011).

In Switzerland, two specific milk supply chains have been respectively identified as "global" and "local". The reasons why the two chains are considered global and local respectively are presented according to the four GLAMUR criteria. The global supply chain is represented by *Valflora,* which is a generic milk distributed all over the country. In terms of geographical distance (i): the chain's inputs come from several continents as dairy farmers feed cows with concentrated feed, constituted of Brazilian soy and European cereals for example. The milk is produced in three main dairy regions of west, noth-west and north-east Switzerland and collected by milk collecting centers before being transported to South Switzerland, where it is pasteurized and packaged. The milk cartons are then sold all over the country in the biggest supermarket chain of the country via ten distribution centers. The governance of the chain (ii) is mainly in the hands of the retailer, who has bought the processing factory and has a very strong position on the prices due to a monopole situation of two main retailers in the country. Milk producers are organized into associations and federations defending their interests but the milk prices have still been decreasing in the last few years (SMP-PSL, 2014). The resources, knowledge and technologies (iii) present at the production or processing stage of this supply chain do not show any sign of a particularly local process but are rather highly industrialized and rationalized techniques targeting hygiene and economy of scale. The product identity (iv) also does not show any reference or link to a territory or even a place of production. It is not possible to know from which region the raw milk comes from as all is mixed at the processing stage.

The local supply chain is represented by the *Wiesenmilch* (Pasture milk) characterized by a shorter distance travelled (i) as soy inputs are proscribed from inputs use and later in the chain, the milk is produced transported, processed, sold and consumed only in a delimited region of central Switzerland. The governance of the chain (ii) is thus also within this region as the processing and branding are managed by one of the same retailer's regional branch. The farmers' organization IP Suisse also participated in a significant way in the starting of the brand and its conditions and guarantees a higher milk price by apposing its ecological label "Terrasuisse" on the product. However, the local product is pasteurized and packaged in a similar way than the global milk as no special process (iii) was found in this case but the whole processing happens in the same region as production and consumption, thus relying on local resources. The identity of the product (iv) highlight its regional origin as it shows the

label “from the region, for the region”. Thus, the product chosen as a local chain shows indices of a higher localness in all the criteria of distinction presented before. An important factor of selection of these two chains as local and global examples is also that the local chain comprises fewer steps, five instead of six between inputs and consumption.

2. Method

Methods of sustainability assessment already exist, such as life cycle assessment (LCA) that focuses on the environmental impacts of a defined product all along the production chain, or such as the Sustainability Assessment of Food and Agriculture systems (SAFA) Guidelines from the FAO or the Response-inducing sustainability evaluation (RISE), focusing at a farm or firm level assessment. However, these methods still do not include a multidimensional assessment operated at the scale of the entire food value chain (from input suppliers to consumers).

In comparison with previous methods, the method used here allows to evaluate the performance of a food value chain in its whole. For this case study, a set of attributes and indicators of performance was selected to compare the multi-dimensional performance of both chains. Attributes are defined as “areas of possible impacts on sustainability exerted by the local/global features of a food chain”, e.g. Animal welfare is an attribute (GLAMUR Project, 2014). More practically, an attribute of performance, as used in this approach, is the “category of assessment” that is under the overall sustainability performance dimension and above the direct measure done by indicators. Attributes are a sub-level of dimensions, regrouping indicators into sustainability themes. In this sense, indicators are practical tools for the assessment of supply chains’ performance. Their score give information on the condition of an attribute.

The list of attributes chosen for this case study comes from a systematic literature and media review (scientific and grey literature), completed with interviews with key-respondents. The high number of sources found was analyzed through software of qualitative data analysis. Most frequent items in literature and interviews were grouped in ‘themes’, each of them being thoroughly described and justified. These themes are later revised according to their relevance for sustainability assessment and actors’ opinions and made into attributes in a participatory way. The selection of indicators is thus specifically adapted to a Swiss context and concerns the dairy sector. The goal of this process is to sort out a smaller selection of attributes, that should in the end cover the major issues of the supply chains and be sufficient to compare a local and a global food chain in a precise sector. The interviews also allow identifying what are the crucial elements of performance within an attribute and thus start creating indicators. The division of attributes into indicators was made with a practical sense according to data that was realistically available in the existing time frame, and with the possibility to create a pertinent benchmark. Moreover, indicators with a plausible difference between the local and global chains were firstly chosen. Existing lists of indicators (SAFA, RISE, etc) have been used as they also give insights about how such indicators have been measured before and what are the benchmarks usually applied to them, but can be adapted to each case. Further indicators have been created according to the case and consulted stakeholders (final list table 1). The benchmarks are reference values from the same context setting a frame for the evaluation of the performance. The result obtained by each “indicator of performance” has been thus converted into a score on a percentage scale as figure 1 shows.

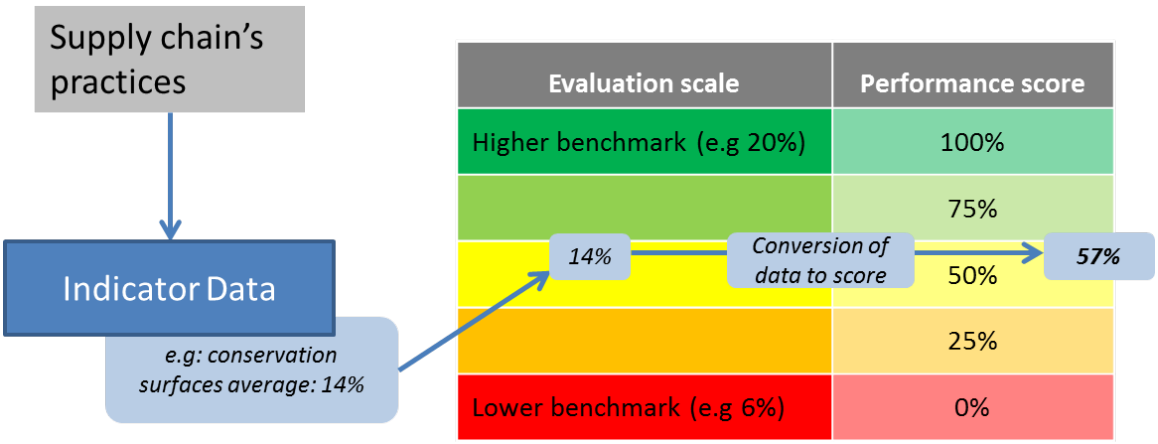

Figure 1: Methodology of measurement of indicators' scores

Indicators require either qualitative, mostly categorical, or quantitative data. Data have been collected through semi-structured interviews and secondary sources towards each stage of the supply chains. Producers represent the stage with the most actors. Farmers in the local chain were sent an online anonymous questionnaire to collect data about indicators concerning the farming stage and the response rate was of 24% on a total of 75 farms. Data for farms in the global chain were mostly secondary data as the number of farms is above 2000 and the national statistics for "industry milk producers in the plane region" is considered representative. They were completed by five interviews in the region of production (Graas, 2013). To calculate the score of indicators for the stage "farm production" for the whole chain, averages of farms' answers are used to represent all producers. In some cases, the percentage of farmers applying a certain sustainable practice is used as the score. The other stages of the chain were surveyed via seven semi-structured direct interviews and e-mail or telephone interviews to collect the remaining data. After entry of the data into a database, the performance based on the indicators is calculated for the local chain and the global chain and can afterwards be compared. For the calculation of performance, each indicator must contain a scale of performance represented with benchmarks of minimum and maximum performance (figure 1). These benchmarks are either available from standardized indicators (theoretical sustainability reference values) or can be adjusted according to context justification and strong integration of stakeholders. For some indicators, especially in the socio-economic dimensions, sustainability reference values are not available and thus, expert opinions was sought and in some cases, averages and ranges of existing values are used to create benchmarks.

3. Results

Table 1 shows the questions used to collect the data and the scores obtained for each indicator by the local and the global chains. For seven indicators (19% of indicators), there is no difference in the scores obtained by both chains. It is mostly the case when both chains have either a very good performance (100%) and are both above the maximum benchmark or that both perform very badly (0%). In the attribute "Social capital" for example, both chains perform at the maximum as they fulfill fully the maximum target for the two indicators concerned. Indeed, both chains contain farmers' organization and are both parts of exchange

platforms where negotiations are possible. For one indicator (packaging material), both chains perform at 40% because the exact same kind of package is used (FSC certified but not recyclable nor reusable). For 55% of indicators however, the local chain shows a higher performance than the global chain, which performs better in 27% of the indicators.

Table 1: List of indicators by attributes, questions and scores for the local and the global chains

ATTRIBUTE	INDICATOR	QUESTIONS	GLOBAL SCORE (%)	LOCAL SCORE (%)
Value Creation and Distribution	Differentiation of the product	Is the product clearly differentiated in order to increase its value?	**0.00**	**100.0**
	Producers' income	What is the price obtained by primary producers?	**9.35**	**12.15**
	Distribution of profit	What is the share of producers' price on sale price?	**13.56**	**0.00**
Social Capital	Association of farmers	Do Producers form cooperatives or associations to defend their interest ?	**100.00**	**100.0**
	Platform for decision making	Is there an inter-professional association or a platform for actors of the chain to meet and negotiate?	**100.00**	**100.0**
Working conditions	Wage of farm employees	What is the salary paid to employees on farm?	**1.02**	**2.71**
	Farmers' living standard	What is the average annual income? (CHF/year Agricultural familial net income incl. directs payments, average 2012-2013)	**45.36**	**29.92**
Eco-efficiency	Cows productivity	What is the average age of the cattle herd? (Years) // What is the average milk production per cow per year? (Kg per cow per year)	**8.96**	**37.81**
	Optimization of N mineral fertilization	How many mineral fertilizer N is used per ha of grassland?	**62.60**	**65.63**
	Packaging material	What kind of packaging is used for the product? Is it in a recyclable, ecologically produced or recycled material?	**40.00**	**40.00**
	Land productivity	Milk produced on average per hectare of land?	**56.82**	**22.38**
Climate change potential	GHG emissions from transport	What transport means do you use to deliver your product? // What is the distance of delivery?	**0.00**	**59.06**
	GHG emissions from agricultural production	How much GHG is emitted on the farm-production stage?	**69.00**	**52.50**
Biodiversity	Conservation surfaces	What is the percentage of the ecological compensation surfaces in relation to the total agricultural area?	**41.34**	**51.83**
	Crop rotations	How many crop rotations do you undertake on average per field?	**0.00**	**67.50**
	Locally adapted varieties	Do you use locally adapted/resistant/endangered crop varieties? (According to *Pro Specie Rara*)	**0.00**	**0.00**
	Pesticide use	On what percentage of your total cropland area do not you apply pesticides?	**27.91**	**33.53**
	Use of GMO	Is the animal feed GMO free (labelled/certified) and do you renounce on the plantation of GMO crops?	**0.00**	**87.50**
	Breeding degree of the livestock	What breeds do you have in your herd? Are they traditional or highly bred varieties?	**50.00**	**21.57**
Soil preservation	Growing of legumes	On what percentage of your cropland do you regularly grow legumes?	**0.00**	**100.0**
	Organic fertilizer	What is the percentage of organic fertilizers compared in the total fertilizer application? (Mineral and organic)	**71.40**	**69.71**
Food quality & safety	Fat quality	What is the proportion of concentrates in the feed?	**25.09**	**51.78**
	Percentage of roughage in animal feed	What is the percentage of roughage in the daily feed ration in winter/ summer?	**33.33**	**57.72**
	Application of food safety standards	Does the food chain actor have food safety insurance from the participants preceding them in the chain?	**100.00**	**100.0**
Transparency	Information shared between actors	Question to farmers on interview or survey: which information is available to you (from final price, type of product, place)?	**0.00**	**42.42**
	Information available to consumers	Which kinds of information are available to consumers at the place of sale?	**40.00**	**80.00**
	Information publicly available	Which kinds of information are freely available online or elsewhere?	**66.67**	**100.0**
Food Wastage	Use of biogas plants	Is the home yard manure and organic waste further processed in biogas plants?	**0.00**	**0.00**
	Food waste used as animal feed	Are by-products from the food industry used as animal feed?	**20.00**	**17.65**
	Food loss on farm	What percentage of milk produced is lost (not incl. Converted as by-product) at production?	**90.00**	**85.29**
	Food loss at processing	What percentage of milk produced is lost at processing stage?	**0.00**	**60.00**
Traceability of Origin	Upstream traceability system	Is it possible to retrace the whole supply chain of the purchased products?	**20.00**	**67.65**
	Downstream traceability system	Are the produced food products clearly marked so that they are completely retraceable to their source?	**100.00**	**66.67**
Animal welfare	Summer grazing	Do you take part of the project Regular Outings?	**92.00**	**100.0**
	Cows' lifespan	What is the average age of the herd?	**0.00**	**0.00**
	Tying of animals	Are the animals tied in the stable? (BTS program)?	**76.67**	**100.0**
	Use of Antibiotics	What proportion of dairy cows is treated with antibiotics on average per year?	**100.00**	**90.29**
	Transportation duration to the slaughter	What's the average transportation time to the slaughterhouse?	**81.94**	**85.71**

Figure 2 shows the proportion of indicators where the local chain or the global chain performs better between the dimensions of sustainability (Environment, social, economic, health ethics) and in total. Some indicators are present in two dimensions but are counted only once in the total.

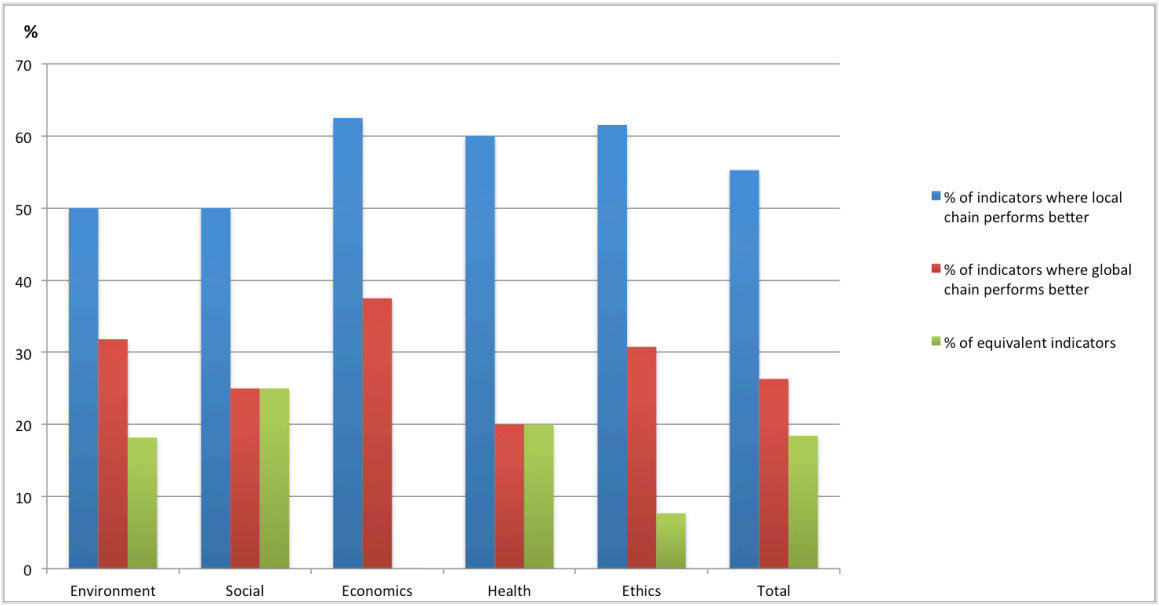

Figure 2: Proportions of indicators performing better in the local or the global chain

The biggest difference of performance appears in the health dimension where many local performances are better whereas in the ethics dimension a majority of indicators give equivalent performances between the two chains. In the other dimensions, there are about as many indicators where local chain is performing better as indicators where both chains are equivalent. Generally, few indicators show a better performance in the global chain. Health seems the most differentiating dimension between global and local chains, followed by the social dimension. In the dimensions environment and economics, the local chain has a slight advantage.

Figure 3 shows the scores averaged by attributes. The average scores by attribute are not precise indications of each chain's performance, due to the great differences of performance between indicators within the same attribute. Such a loss of information thus leads to biased analysis; for that, figure 3 only highlights the fact that global and local supply chains for the Swiss milk sector perform differently according to the attribute analyzed. The bigger differences appear in the attributes "value creation and distribution", "transparency", "soil preservation", "climate change potential" and "food quality and safety".

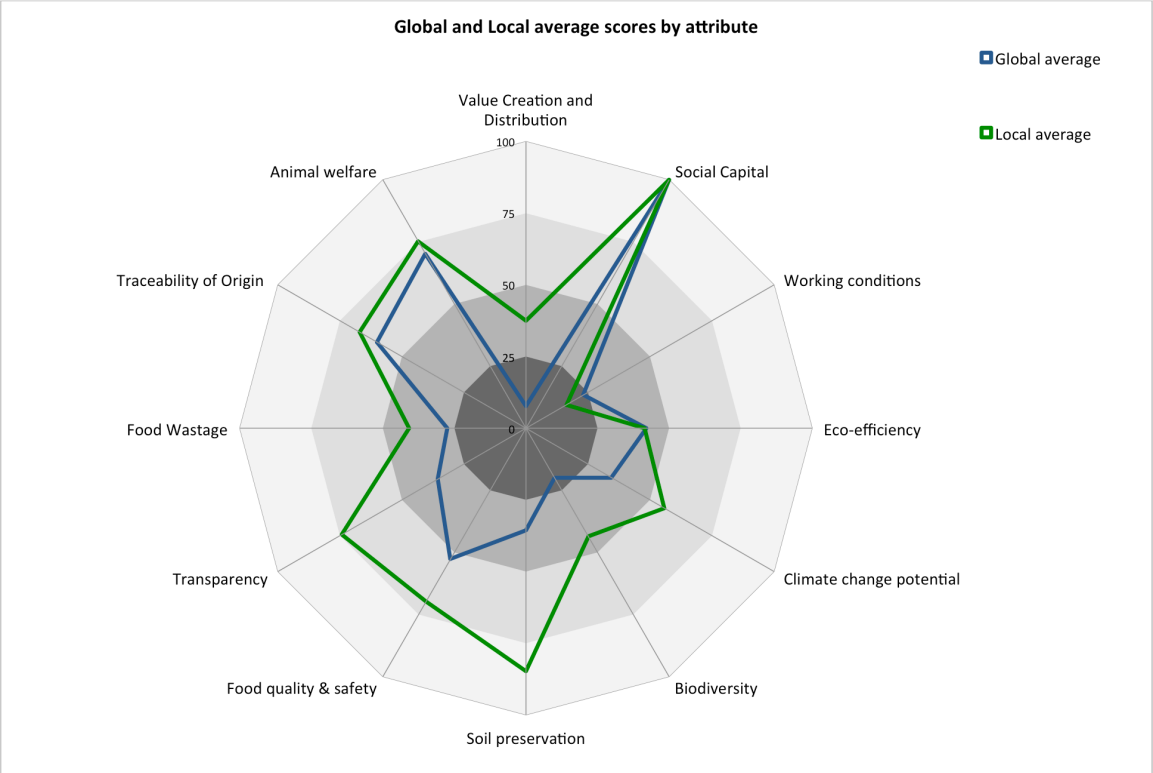

Figure 3: Performances of the local and the global chain by attributes

In terms of scores' differences between local and global supply chains, the largest difference appears for the indicator "Differentiation of the product" within the attribute "Value Creation and Distribution". Indeed the local chain performs the best (100%) whereas the global chain performs the lowest score (0%). This qualitative indicator highlights the fact that the packaging as well as the marketing strategy of the local milk allow to differentiate it from the standard products permitting increasing the visibility of the added value. As this indicator is measured on a bimodal scale (yes or no), the difference between the two chains is very large.

Concerning the three indicators in the attribute "transparency" (see table 1), they all score better in the local chain, as farmers get more information regarding the final product and reversely, consumers can read more information about the production of the product on the package and online.

Regarding the "soil preservation" attribute, the global performance for the indicator "Growing of Legumes" is zero as legumes were not present in their rotation (within our dataset) and local performance is 100%. Note that this indicator is influenced positively by the indicator "Crop Rotations" (Attribute Biodiversity) as more crops in the rotation could mean more possibilities for legumes, but is not necessarily the case. Global and local performances are both good for the indicator "Organic Fertilizer", and they are very similar: 71.40% for the global chain and 69.71% for the local one.

Other significant differences are shown by the attribute "Climate Change Potential" for the indicator "GHG Emissions from Transport". Indeed, the global performance is zero (0%)

while local performance is moderately good (59.06%). This is mainly due to the much shorter distance traveled in the local chain. Nevertheless, the global chain performs better than the local chain in the indicator "GHG Emissions from Agricultural Production": the global chain performs quite well (69%) whereas the local chain shows a medium performance (52.50%). As the local system produces less milk on the same area because of grass-based feed, more cows are needed to produce the same amount of milk. And this is why the local system produces more GHG at the production stage: more cows for a liter of milk means higher methane emissions from cows' digestive systems (Sutter et al., 2013) for the same amount of milk produced.

The difference between the two chains in the attribute "food quality and safety" is also explained by the different diet for the cows in the two chains. Indeed, the much lower amount of concentrate feed and extended pasture in the local chain favors a better ratio of omega3/omega6 in the fatty acids of the milk (Thomet et al., 2012). The safety systems of the two chains, which guarantee a low risk of contamination by pathogens or antibiotic residues, are however both very strict and similar between the two chains, where both perform at 100%.

For other attributes with smaller differences, it can still be noted for example, for attribute "biodiversity", the local chain performs slightly better than the global chain for the indicator "Conservation Surfaces". Nevertheless, both chains perform moderately well. The global performance for the indicator "Crop Rotations" is zero (0%) because of low diversity of cultivated crops whereas the local chain performs quite well (67.50%) because more diversified crops are adopted. Concerning the attribute "Food wastage" the indicator "Food loss at processing" shows significant differences between the local and global supply chains. Indeed, the global chain's score is 0 % whereas the local chain's score is 60%, as processors reported fewer losses but this is to be taken with some precautions as this information was not verified.

4. Discussion

The general result of the comparison between global and local in the milk sector is that although the local chain has a better general performance of sustainability, it also has weaknesses that could be improved. In parallel, the global chain has strengths that the local one hasn't. This is in line with the paper of Born and Purcell (2006) in which the authors warn about what they call the "local trap", defined as "the assumption that local is inherently good" (Born and Purcell, 2006).

In the social dimension for example, it could be assumed that as the final product is sold for a higher price in the local chain, producers would get more. In absolute terms, farmers indeed get a little more per liter of milk produced, however when calculating the share of producers on the final price, they get a smaller percentage of the total value as in the global chain. The local chain can position its product with a higher price by promoting a better quality (pasture milk with two labels) but the retailer still retains most part of the price increase. Thus, both chains show a power imbalance towards the end of the chain. Thus the economic situation of producers in the local chain is probably not much better off as the barely higher milk price probably does not compensate for the lower quantity produced due to the withdrawal of protein concentrates in the cows diets but more precise economic

calculations would be needed. Farmers also reported lower annual revenues in the local chain, which confirms that the local milk is not able to offer them better economic conditions, or not yet. The local milk chosen is indeed a new product and an interviewee confirmed that they are willing to increase the price once the product is well placed on the market.

In the environmental dimension, it is hard to determine which chain performs better. The main negative impact of the local chain is on climate, with the GHG emissions due to the production of methane during cows' digestion. Those emissions are known to be the most important in the production stage (FAO 2006; FAO 2007). The greatest impact of the local chain is on the greenhouse effect and thus the climate. This is due to the fact that more cows are needed to produce the same amount of milk and thus produce more GHG per litre milk. At the same time, this chain does not use soy feedstuff for animal feed, thus no GHG emissions are producing by their transportation towards the farms. However, the effect of concentrate use or roughage use on GHG emissions is controversial. Methane emissions from digestion depend on the feed ration and several models calculating them (Schader et al., 2014) give different results with regard to their impact on the climate (Flysjö et al., 2012). Other sources of GHG emissions on farm are manure management, fodder production, and to a lesser extent imported concentrated feed (Schader et al., 2014). Regarding transportation, the global chain emits much more GHG than the local chain having thus a higher impact on climate. Indeed, this chain makes use of soy feedstuff which increase the amount of GHG product as the soy produced comes from far countries such as Brazil and Argentina. This could be lowered by either reducing distances within the chain, either reducing the number of geographical steps in the supply chain, or using less polluting means of transport. Recently, FAO published a report presenting some GHG mitigation practices for animal breeding around the world (Gerber et al., 2013).

The local chain also needs a greater surface of land for producing the same amount of milk, so its impact on the quantity of land used is also important. A way to lower both these impacts could be to grow more efficient fodder cultures on pasture land. Land use, the second important environmental negative impact of the local chain, is thus another critical issue for agriculture and especially for livestock, correlated with land degradation (FAO 2007). Indeed, livestock grazing land and cultivated land for animal feed represented 70% of the world's agricultural area in 2007 (FAO 2007). The environmental negative impacts of the global chain on biodiversity and soil quality neither are surprising, as the global chain's practices on farm are in some ways close to intensive agriculture practices: less crop rotation, fewer legumes grown. Those practices are indeed known to degrade the soil balance and reduce agro- and wild biodiversity (MA 2005; FAO 2006; UNEP 2010). Farmers from the global chain include fewer rotations in their crop rotations: this means their rotations doesn't last as long as for farmers from the local chain, and that they include less cultures in their rotations.

Farmers from the global chain also cultivate slightly fewer conservation surfaces such as wildflower strips or extensively used pastures. The main impact of the global chain is thus on agro and wild biodiversity, and on soil balance. These impacts could be quite easily lowered by encouraging farmers to adopt environmentally friendly practices.

In the health dimension however, the direct benefits of the local chain are undoubtable higher thanks to roughage feed that gives a higher nutritional quality of milk than concentrate feed. Many studies confirmed this in the past (Goldberg et al., 1992; Wyss and Collomb,

2008). This higher performance of the local chain is thus once again linked to the type of inputs used to feed the dairy cows.

The proportion of pastured feed in the cows diet also influences the performance of the chain in the ethical dimension as it contributes to a better animal welfare (animals spend more time freely grazing outside). The difference between the two chains in this dimension was however not large.

As can be seen, the major impacts and differences come from the feeding strategy for cows (inputs provision) that impacts the climate, land use, animal welfare and health. It is moreover a part of the definition of the supply chain as local as the overall distance is shorter without concentrated feed. This has an important policy implication as regulations or taxations on the inputs provision could have a strong impact on the performance of supply chains in multiple dimensions. However, relocalizing the feed production or having only pasture-based production would lead to more land used for dairy production or reduced production.

Concerning the method used to conduct this assessment, is has limitations, as the calculations worked out don't weight indicators or attributes according to their importance. Indeed, determining different weights to indicators is a delicate process because very subjective: two different researchers would probably not give the same weights to an identical set of indicators or attributes because of each one's expertise and values. In this case study, it was thus decided that each indicator has the same mathematical weight to calculate averages of performance by attribute.

The final performances calculations and graphical representations don't either take into account interactions between indicators as this would require much more complex modeling. Besides, more numerical data would be necessary to perform more extended calculations on the inputs' GHG emissions or economic calculations for example. This would be possible only with the full collaboration of the actors and their willingness to share data, as secondary data are good for analysis at country level but not for a specific supply chain. However, more specific in-depth analysis are part of more specific methodologies like LCAs that focus on one specific aspect as the method used here allowed to get a multi-dimensional evaluation of two supply chains. The multi-dimensionality however leads to a certain loss of precise information.

More research on benchmarking and how to evaluate the performance of indicators is needed as their definitions are for now sometimes missing objectivity. They depend partly on the reference chosen in priority and on the researcher's background, expertise and values, as setting benchmarks strictly means deciding from which point the performance is considered bad, or good. The notion of bad and good is indeed different from one research team to another. Nonetheless, to be as objective as possible, benchmarking needs review of precise sources adapted to a Swiss context. In this study, benchmarks are often based on only one and rarely more sources as scientific references on the sustainability of practices are still rare. However, when the benchmark is based on regional or national statistics, it is well contextualised and quite objective. When it is based on official bodies' recommendations, the benchmark is also making sense, but when it is based on one or two scientific studies made in specific contexts that can vary a lot from the context of this study, then a better benchmark should be found, which is not always possible. In the worst cases, expert's opinions enabled to

set some benchmarks, and one limitation of this study is that too few experts could be consulted for those benchmarks.

Still, in comparison with other multi-dimensional methods, the contextualized indicators are more precise and relevant than the SAFA default indicators. Moreover, the range of 0 to 100 for the performance leaves more possibility of precision for the results than the SAFA performances, as SAFA indicators are rated into two to five categories of performance. The indicator and evaluation method used here thus enable a multi-dimensional sustainability assessment, although the study is not balanced between the five dimensions. The Environment dimension indeed takes a bigger place in this study than the other dimensions, probably because of the Swiss context: environmental issues are particularly discussed and important in Switzerland (Schmitt et al. 2014). The study could have included more indicators especially in the Social and Health dimensions. However, health is not a critical issue in the food sector in Switzerland, as all the food chains are strictly regulated and the laws followed. The indicators selection thus reflects what is important to evaluate in a precise context (swiss dairy sector) and cannot be used in another context. This requires an important preliminary and participatory work but renders the analysis more applicable and relevant than using pre-defined indicators from SAFA for example.

5. Conclusion

As seen in this example of developing a set of attributes of performance for food value chains comparison, the process of selecting the appropriate data to measure is particularly challenging. There is often a trade-off between the precision of data that researchers can collect and the multi-dimensionality of an evaluation. We try here to overcome this challenge by downsizing the amount of attributes according to their relevance in the specific context of the dairy sector, while keeping some precise indicators. An in-depth exploration of the context and the participation of stakeholders in an iterative process were used to define the attributes of performance. In the case of the Swiss milk sector, it has been possible to define several attributes declined in indicators after an accurate analysis. The local and global milk supply chains perform differently and thus have different impacts on natural resources and socio-economic conditions and trade-offs could be found between the local and global settings. Through this study, it was found that the local milk supply chain performs generally better but still through many aspects, the local and the global chains are equivalent. The greater impacts of the local chain on natural resources are the quantity of land used and the GHG emissions whereas the greater impacts of the global chain on natural resources are on agro and wild biodiversity, soil balance, soil quality and on GHG emissions during transport. Concerning the milk nutritional quality (health), the local chain performs better because cows have more grazing time and eat less concentrate, therefore the fatty acids in their milk is of higher quality. Finally, the value distribution is unequal in both chains, at the expenses of farmers, even if social structures defending farmers' interests are present in both chains.

The methodology of performance evaluation through indicators is generally useful to get an overall assessment, but for some indicators, benchmarking lead to subjective judgments as more research is needed to define them. Indeed their setting depends on the reference used in priority, the expertise and the values of the researcher. Besides, there are still on-going research and questions about what is sustainable and what is not: this is especially tricky for

selecting indicators and setting benchmarks. However, with more indicators and benchmarks defined as research advances, the more this tool will be appropriate to help policy-makers to analyze food supply chains on their whole and in a multi-dimensional way. This allows identifying trade-offs and critical issues, as well as interactions between dimensions, as it is not possible with methods focusing on one aspect.

6. Reference

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