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Sustainability Assessment of PDO value chains: the cases of L' Etivaz and Le Gruyere in Switzerland

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1. Introduction

There is an increasing consumers' awareness about the impact of food products on the natural resources (rainforest, biodiversity, climate change are key issues), on their health (for ex. the residues of pesticides and antibiotics in food and water are very sensitive issues) and on social aspects (gender, fair prices and child labor are particularly addressed). 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 farms¹. For this reason, more accurate scientific evidences are welcome to understand those impacts.

The European research project GLAMUR² (Global and Local food assessment: a multidimensional performance-based approach) adopts a multi-criteria perspective that takes 'measurement' and 'evaluation' and combines qualitative and quantitative approaches. Sustainability represents an important challenge for all food chains as several forces push to improve the sustainability impact: not only consumers' preferences but also other stakeholders such as governments, environmental organizations, and value chain actors which are nowadays asking for less negative performance on natural resources and better social performance. 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 plans³." In the GLAMUR project, five dimensions of performance were considered: economic, social, environmental, health and ethical. The health and ethical dimensions were added to the three more usual dimensions of sustainability, in order to rely more closely 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 Third foresight exercise on consumption behavior⁴.

The objective of this paper thus are (1) to present a method of constructing indicators of sustainability, adapted from the SAFA guidelines developed at FAO, (2) to present the results for two PDO cheeses that have existed for many decades in the Swiss Alps but have been legally registered as PDO for about 10 years only and (3) to propose responses in terms of policies' adaptation or changes for improving the impact on sustainability of the concerned products.

2. Study cases

In Switzerland, two specific cheese value chains have been studied: the *Le Gruyère* and *L'Etivaz* chains. The value chain of the *Le Gruyère* cheese starts with the milk production, which is delivered twice a day to the creamery that must be no further than 20 km. Creameries process the un-pasteurized milk once a day to transform it into cheese. The ripening phase can begin in the creamery's cellars for the four first months, then the cheeses are transferred in the cellars of bigger companies such as *Emmi* or *Migros*. The cheeses are sold after at least 5 months of aging.

The *Le Gruyère* was the second Swiss cheese to obtain the *Appellation d'Origine Contrôlée* (AOC) status in 2001 and was registered in 2011 at the European level such as *Protected designation of origin* (PDO). The code of practice lists strict rules regarding cows

¹ RENTING, H., MARSDEN, T. K., & BANKS, J., 2003, *Understanding alternative food networks: exploring the role of short food supply chains in rural development*. Environment and Planning A, 35(3), 393–411. doi:10.1068/a3510

² GLAMUR is a FP7 European Research Project, Grant agreement no: 311778, 01.02.2013-30.01.2016. Coordinator: Rudolf van Broekhuizen, University of Wageningen. Scientific coordinator: Prof. Gianluca Brunori, FIRAB and University of Pisa.

³ OECD, 2010, *Supply chains and the OECD guidelines for multinational enterprises bsr discussion paper on responsible supply chain management*, Paris: s.n.

⁴ EU COMMISSION, 2011, Standing Committee on Agricultural Research (SCAR) (2011) - *The 3rd SCAR Foresight Exercise: Sustainable food consumption and production in a resource-constrained world*. Retrieved January 13, 2013 from http://ec.europa.eu/research/agriculture/scar/pdf/scar_feg3_final_report_01_02_2011.pdf

feed, milk treatment, area of production and the final product characteristics such as size, aspect, taste and nutritional values. Figure 1 shows the structure of the *Le Gruyère* value chain with the number of actors at the respective stages:

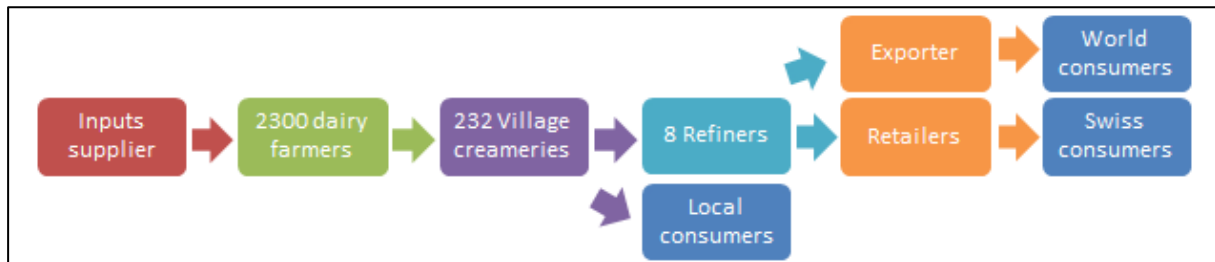


Figure 1 - Chart of the global cheese chain “Le Gruyère” in 2014. Source: own survey made by the authors with the support of L. Gratteau, in 2014.

The geographical area of production of the milk and cheese includes several cantons of South-West French speaking Switzerland like the cantons of Fribourg, Vaud, Neuchâtel and Jura as well as several townships in Berne. Different sale channels exist: the *Le Gruyère* can be produced and consumed within a locality as directly sold by the creamery, but more than 95% is sold to industries, such as *Mifroma* owned by the major Swiss retailer *Migros*, which can add value to the final product extending the ripening period until 18 months using specialized cellars.

The whole chain is regulated by the Interprofessional organization of Gruyère (IPG), created in 1997. Its aim is to manage agreement and communication between producers, cheese makers and retailers, as well as the PDO code of practice, quantity and quality, commercialization and promotion (publicities, sponsors, website, etc.). It encloses 13 representatives in the committee between milk producers, cheese makers and cellar men. There are also small milk and cheese associations linking milk producers and their cheese-makers at a smaller scale, enabling communication between actors of the same area. The *Le Gruyère* is considered as a traditional cheese made with modern and automated technologies: each processing phase is done automatically and is controlled by both machines and qualified staff.

Named after the Swiss region where it was originated more than 800 years ago, it has a strong link with its territory of production. Sold as a traditional high quality product, this link to the territory is particularly used as a marketing strategy. Around 29,000 tons of *Le Gruyère* are produced a year, which is the highest cheese production in Switzerland. The *Le Gruyère* value chain is composed by 2,500 small-scale enterprises: 2,300 milk producers, 223 creameries and around 50 alpine creameries.

The second chain is the one of *L’Etivaz*, another Swiss ripened cheese. *L’Etivaz* value chain (Figure 2) is composed of farmers producing milk and processing it themselves into cheese, of the refiner and cooperative, of exporters and of retailers. Farmers move their cows to high pastures in the Alps (between 1.000-2.000 meters high) from May to October and process the milk into cheese every day directly in their alpine chalets by heating milk over a wood fire inside copper cauldrons. The cheese is delivered several times per week to *L’Etivaz* cooperative where it is ripened a minimum of 135 days until a maximum of 24 months.

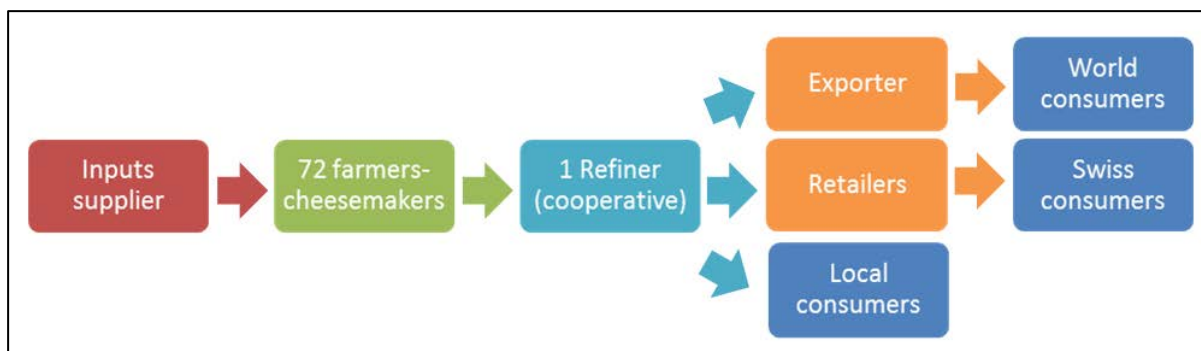


Figure 2 - Chart of the local cheese chain L'Etivaz. Source: own survey made by the authors with the support of L. Gratteau, in 2014.

L'Etivaz was the first Swiss non-wine product obtaining the Swiss PDO status, in 1999 recognized by the European Union from 2013. It is produced in the Canton of Vaud, in specific municipalities located between 1,000 and 2,000 meters of altitude: *Château-d'Oex, Rougemont, Rossinière, Ormont-Dessous, Ormont-Dessus, Leysin, Cobeyer, Villeneuve and Ollon and Bex*. The ripening phase is located in the *Pays d'En-haut* region.

Thus, production is limited to a small zone whereas retail and consumption surpass the national borders. Producers can retail at their chalets 10% of their own production. The 90% left are taken up by "La Maison de L'Etivaz" and then repined 135 days min., before being sold to exporters or retailers such as *Migros, Emmi, Intercheese* and *Huguenin* among others. Around 70% of the total volume is sold in Switzerland, 40% in the French speaking part. The 30% is sold mostly in France, Belgium and Germany. 20% is sold locally.

Upstream from the chain, the cattle are mostly fed on alpine meadows. However, concentrated feedstuff such as cereals and soy coming from Europe, Argentina and Brazil are authorized, to a maximum of 1 kilogram per cow per day. The production and first sale steps are regulated by the *L'Etivaz* cooperative, owned by the producers. Seven members form the Committee and are in charge of the cooperative's administration, being assisted in the daily management by Quality and Promotion employees.

The aim of the cooperative is to support and guide producers regarding decision making on quality control, traceability, the book of specifications, but also marketing researches, promotions, sale management, establishment of prices and negotiation with wholesalers. The sale management is thus centralized to a single enterprise to avoid parallel markets by direct sales. Hence, governance is managed by an effective structure characterized by a strong cohesion between different actors⁵.

The knowledge and know-how employed in the production process is part of an ancient tradition passed from generation to generation. Indeed, farmers work with their families teaching to the next generation how to transform the milk and guide the cattle. Technologies used are traditional: the un-pasteurized milk is compulsorily heated in copper boilers on wood fire in accordance with *L'Etivaz* practices. The copper boilers are more than one century old. Moreover, the PDO specifications forbid any kind of mechanical alteration of the milk such as centrifugation before transformation or pasteurization. Also this cheese has a strong link to its territory of production. This link is strengthened by the highly traditional production processes and the code of practice stipulating that the typical wood of the region (spruce) has to be used for the ripening shelves. Sold as a very traditional and high quality product, this link to the territory is also in this case used as a marketing strategy. 72 families working in 130 traditional alpine chalets carry out the production. The annual production is around 420 tons (equivalent to 16,000 rounds of *L'Etivaz*).

⁵ BARJOLLE, D., & CHAPPUIS, J.-M., 2000, L'Etivaz (Appellation d'Origine Contrôlée): Atouts et contraintes pour l'exploitation agricole en montagne. In Quality and Valorization of Animal Products in Mountain. FAO-CIHEAM Annual scientific seminar in Luz-Saint-Sauveur, France.

2. Method

A few methods of sustainability assessment already exist, such as life cycle assessment (LCA)⁶ 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 FAO⁷ or the Response-inducing sustainability evaluation (RISE)⁸, 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 these methods, the method developed in the GLAMUR project⁹ allows evaluating 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 were defined as “areas of possible impacts on sustainability exerted by the features of a food chain”, e.g. Animal welfare is an attribute¹⁰. 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 how the attribute can be evaluated through a mix of carefully chosen indicators. Actually, there are for each attribute not an only way to make this evaluation. The choice of indicators may have big influence on the final score. Other parameters may have a big influence, such as the benchmarks chosen for comparing the value calculated in a certain case to a value that is considered to “acceptable” regarding the impact (“normative value of the indicator”).

The list of attributes chosen for these two case studies comes from a systematic literature and media review (scientific and grey literature), completed with interviews with key respondents. Most frequent items in literature and interviews were grouped in ‘themes’, each of them being thoroughly described and justified. These themes were later revised according to their relevance for sustainability assessment and actors’ opinions and elaborated into attributes in a participatory way. The selection of indicators is thus specifically adapted to a Swiss context and relates only to 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 key issues of the supply chains and be sufficient to compare *L’Etivaz* and *Le Gruyère* food chains. The interviews also allow identifying what are the crucial elements of performance within an attribute and thus start elaborating indicators that can be calculated. The division of attributes into indicators was made with a practical sense according to data that were realistically made available through a survey, according constraints like available time and staff, and with the possibility to create a pertinent benchmark. Moreover, indicators with a plausible difference between the *L’Etivaz* and *Le Gruyère* 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

⁶ UNEP/SETAC, 2011. *Towards a Life Cycle Sustainability Assessment*. Making informed choices on products, s.l.: s.n.

⁷ FOOD AND AGRICULTURE ORGANIZATION (FAO), 2013, *Sustainability Assessment of Food and Agriculture systems (SAFA)*. Draft guidelines.

⁸ HÄNI, F. ET AL., 2003, *RISE, a Tool for Holistic Sustainability Assessment at the Farm Level*. International Food and Agribusiness Management Review, 6(4).

⁹ SCHMITT, E., CRAVERO, V., TANQUEREY-CADO, A., BARJOLLE, D., 2014, *GLAMUR WP3 Guidelines for case studies*, Research Institute of Organic Agriculture, Frick.

¹⁰ KIRWAN, J., MAYE, D., BUNDHOO, D., KEECH, D. AND BRUNORI, G., 2014, *GLAMUR WP2 - Scoping / framing general comparative report on food chain performance (deliverable 2.3)*. Countryside and Community Research Institute, University of Gloucestershire, UK.

usually applied to them. 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 3 shows:

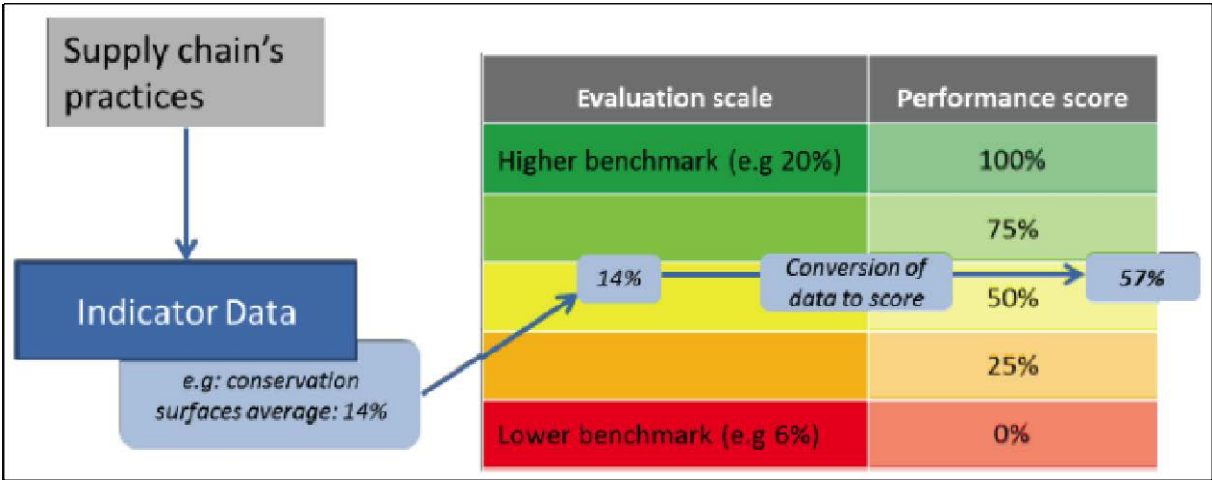


Figure 3 - Methodology of measurement of indicators' scores.

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. 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 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 both chains 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. 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. The set of attributes, indicators and benchmarks used is presented in Table 1 below:

Table 1 – Dimensions, attributes, indicators and benchmarks used to assess the performance of *Le Gruyère* and *L’Etivaz* value chains.

Dimension	Attributes	Indicators	Unit	Benchmarks: Low-High
Economic	Affordability	Ability to provide food at acceptable prices	CHF/kg cheese	7.75- 23.36
		Price perception of consumers	Rate by consumers	Scale from 0 to 4. Price perceived to be: 0=very expensive; 1=expensive; 2=neither expensive nor good value; 3=good value. 4=very affordable.
Economic and social	Creation and distribution of added value	Net business profit	CHF/year	40 000 – 100 000
		Distribution of price between actors	Ratio GINI	1 - 0
		Contribution to the economy of the region	FullTimeEquivalent/t cheese	1.47 - 18
Social	Information and communication	Communication along the chain	qualitative	0 – 3 (<i>L’Etivaz</i>) or 4 (<i>Le Gruyère</i>) Number of steps in which the actors are satisfied with the communication along the chain.
		Availability of Information	qualitative	6 Categories (each one scoring 1 if fulfilled): •website available •personal contact with producers possible •possibility to taste cheese •newsletter •information at point of sale • Communication via social media
		Product Labelling	qualitative	5 Categories (each one scoring 1 if fulfilled): •nutrition •ingredients •provenance •ethical info •production practices
	Consumer Behaviour	Consumers use	qualitative	These indicators remained purely qualitative and are described textually.
		Taste preference	qualitative	
		Convenience	qualitative	
		Willingness to pay	qualitative	
Environment	Resource Use	Soil improvement practices	qualitative	5 Categories (each one scoring 1 if fulfilled) : • absence/presence of mineral fertilization (no mineral fertilizer = 1) • frequency of soil sampling (every 10 years=0; every year=1) •absence/presence of pH regulation • eco-friendly tillage practices (no till = 1; “alternative” till= 0.5; conventional till = 0) • application of chemical products such as pesticides (no chemicals =1; plant by plant = 0.5; surface application = 0)
		Material consumption practices	qualitative	3 Categories (each one scoring 1 if fulfilled): • Quantity of concentrate feed in cows’ ration (0,5=avg 800kg/cow/year; 1=no concentrate feed) • Recyclable material used (everybody = 1; two actors out of three = 2/3; one actor out of three = 1/3; no one =0) • Recycled material used (everybody = 1; two actors out of three = 2/3; one actor out of three = 1/3; no one =0)
		Waste reduction and disposal	qualitative	4 Categories (each one scoring 1 if fulfilled) : • Management of waste (sorting/burning in biogas installation/recycling...) • Presence of a policy of waste reduction (everybody = 1; two actors out of three = 2/3; one actor out of three = 1/3; no one =0)• Reusing material (everybody = 1; two actors out of three = 2/3; one actor out of three = 1/3; no one =0)• Percentage of whey reused (calf/pig feeding; cream/butter; etc. If everything is thrown in fields = 0)

		Processing efficiency	kg cheese/100 kg milk	8.4 – 10.3
	Biodiversity	Landscape management practices	qualitative	7 Categories (each one scoring 1 if fulfilled) : • Ecological compensation areas (relevant in CH) (7% of total farm area=0; 100% of total area=1) • protection of wild habitat connections • maintaining of wildflower strips, nesting aids or ecological structures such as stone heaps or dry masonry walls; wood heaps; hedgerows; nest boxes; beehives; field trees • maintaining multi species tree populations • maintaining wildlife habitats or edge of a forest • practice of delayed or adapted mowing • ecological management of pests and weeds
		Diversity of Production	qualitative	4 Categories (each one scoring 1 if fulfilled) : • Several productions (1 production=0; 5 productions =1). Other dairy products, and beef meat due to dairy farm do not count. • Practice of mixed cropping / intercropping • several breeds in the cattle (1breed=0; 3 breeds=1) • Crops, Breeds or trees locally adapted, rare or traditional.
	Pollution	GHG mitigation at farm level	qualitative	8 Categories (each one scoring 1 if fulfilled) : •Type of organic fertilizer application : Spray, classic or spread deflector=0; alternative practices=1; both alternative and classic=0,5 •Manure composting: Absence or presence •Cows : 0,5 if dual purpose breeds: 0,5 if slaughter age>6 years •Energy : Presence or absence of alternative sources of energy •Trees: 1=more than 4 trees •Machines: 0,33 if Machines shared; 0,33 if machines optimisation; 0,33 if transport optimization •Mineral application: no lime and no mineral fertilizer=1; no lime or no mineral fertilizer=0,5; lime and mineral fertilizer=0 •Diesel/essence consumption
		GHG mitigation from processing	qualitative	7 Categories (each one scoring 1 if fulfilled) : •Energy source for heating milk: wood or alternative source=1; electricity=0,5; diesel=0. •Informing employees about energy saving (creamery) •Improving thermal insulation (creamery) •Reduce useless expenses (creamery)•Energy source in ripening cellars: alternative energy source=1 (biogas, solar energy...)•Thermal insulation of ripening cellars : Natural site=1. Improving insulation=0,5 •Optimisation of machines and procedures in ripening cellars.
	Health	Salt content	g/100 g	2.6 – 0.4
		Fat content	g/100 g	49.1 – 17.5
		Fat types	g/100 g	41.66 - 5
		Calcium content	mg/100g	675 - 1200
Ethics	Animal Welfare	Animals density	cows/ha	3 – 0.5
		Lifetime of dairy cows	years	3 – 10.5
		Time spent on pasture or housed	%of hours in a year	0 – 50

3. Results

This section illustrates the scores of performance obtained by the *L'Etivaz* and *Le Gruyère* chains for the indicators measuring the selected attributes.

3.1 Affordability

Both cheeses are part of the most expensive Swiss cheeses. *L'Etivaz* is more expensive than *Le Gruyère* when taking into account the average price on the market between different ripening-stage cheeses (20.95 CHF/kg in the end of 2014 for *L'Etivaz* and 17.85 CHF/kg for *Le Gruyère*^{11;12;13}), thus the *Le Gruyère* performs better for the indicator “Ability to Provide Food at Acceptable Prices”. Yet, according to the consumer focus group, consumers perceive both cheeses’ prices reasonable. Thus, both chains perform a medium value for “Price Perception of Consumers”. However, for this attribute *Le Gruyère* performs better than *L'Etivaz* (figure 4).

3.2 Creation and Distribution of Added Value

The indicator “Net Business Profit” was calculated for both milk producers and cheese makers in both chains. Within *Le Gruyère* chain, those two steps are physically separated, whereas within *L'Etivaz* chain, the milk producers are also cheese makers. *Le Gruyère* chain performs slightly better: the chain provides more revenue to the farmers and the cheese makers. For the indicator “Distribution of Price between Actors”, the Gini ratio, usually used to estimate wage inequalities within countries, has been adapted. The Gini ratio is a number between 0 and 1 where 0 represents perfect equality. Instead of the wages, the prices per kilogram of cheese earned by each stage of the supply chain have been compared. Both chains perform very well for this indicator. The price is thus distributed rather equally between the actors taken into account (milk producers, cheesemakers, refiners, retailers). In food chains, a very small part of the final price often goes to producers. Thus, it is interesting to note that the price of milk at production stage for *Le Gruyère* cheese is the highest in Switzerland. Note that for *L'Etivaz* cheese, there is no direct price of milk at production stage because the milk is processed on the farm.

For indicator “Contribution to the Economy of the Region”, *L'Etivaz* chain performs well (11.36 Full Time Equivalent (FTE)/t of cheese) whereas *Le Gruyère* chain performs rather less well (5.8 FTE/t of cheese). For this indicator, it has been possible to calculate an average number of FTE per ton of cheese, at the farms’ and cheese makers’ levels (as the number of FTE per ton at the refiners’ level is very small and negligible, and it is impossible to estimate such a number at the retailers’ level). This result can easily be explained by the higher degree of standardization and mechanization in *Le Gruyère* chain. Nevertheless, being annual quantities much higher for *Le Gruyère* chain, the total number of FTE concerned by the whole chain are far more important within this chain. *L'Etivaz* chain performs better for attribute “Creation and Distribution of Added Value”. Each chain has its strength: *L'Etivaz* chain contributes significantly to the economy of its small region, and *Le Gruyère* contributes strongly to the annual net business profit of farmers and cheese makers (figure 4).

¹¹ COOP, 2015, *Le supermarché en ligne de Coop* - coop@home. Retrieved February 17, 2015, from <http://www.coopathome.ch/home-page-d-accueil/C/fr>

¹² FEDERAL OFFICE FOR AGRICULTURE (FOAG), 2014, *Bulletin du marché du lait*, Novembre 2014 - Le prix à la consommation reflète celui de la matière première.

¹³ MIGROS, 2015, *LeShop.ch - Le premier supermarché en ligne de Suisse*. Retrieved February 17, 2015, from https://www.leshop.ch/leshop/Main.do?currentMenu=SHOP_MAIN

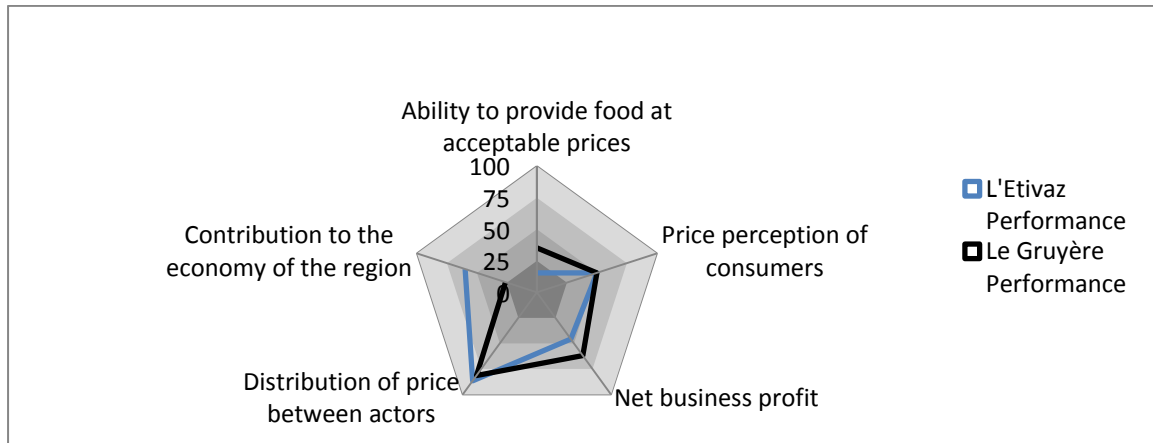


Figure 4 - Performance scores for Affordability and Creation and Distribution of Added Value.

3.3 Information and Communication

L'Etivaz chain performs better for indicator “Communication along the Chain”. Indeed, actors of each step are generally more satisfied with the communication within the chain (figure 5).

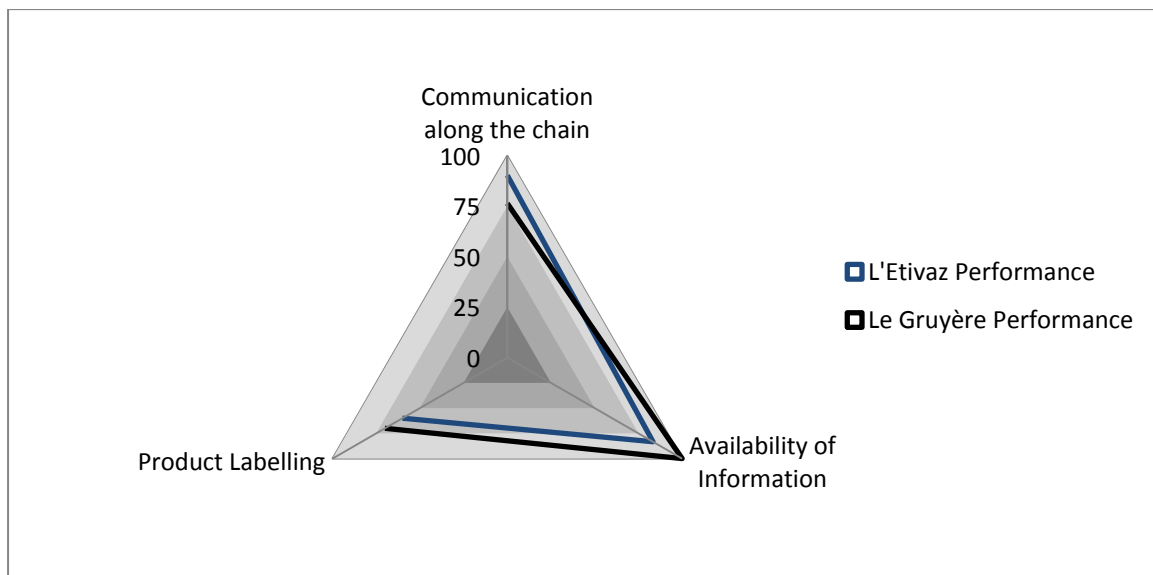


Figure 5 - Performance scores for Information and Communication.

Retailers, involved in both chains, are the ones making the difference for this indicator: Within *L'Etivaz* chain they are in personal contacts with the place of cheese repining (“La Maison de L’Etivaz”), and they have access to information about the producer who made the cheese they buy. On the contrary, for *Le Gruyère* chain, some retailers have difficulties to get more information than the basic information (age of the cheese, place of maturation), and they are not always very satisfied with the quality of communication they have with actors such as refiners or the Inter-profession (IPG). The PDO organisations (IPG, *La Coopérative de L’Etivaz*) help create a basis for communication; however not all steps are included: only farmers, cheesemakers and refiners. Within *Le Gruyère* chain, even communication between farmers and refiners is almost inexistent. Nevertheless, both chains still perform very well for this indicator: milk producers, cheesemakers and refiners are mostly satisfied with the communication within their chains. Both chains perform also very well for indicator “Availability of Information”, though *Le Gruyère* chain is better than *L'Etivaz* chain. This indicator

addresses information available by different means to consumers. *Le Gruyère* chain makes the difference by using social media to communicate to consumers (Twitter, Facebook...). Other criteria used for this indicator are equivalent in both chains: website available; personal contact with cheese maker possible; tasting possible; newsletter available; information at point of sale available. Once again, *Le Gruyère* chain performs better for indicator “Product Labelling”. Indeed, the sticker used for *Le Gruyère* contains more information about the product than the one used for *L’Etivaz*. In summary, *Le Gruyère* chain performs slightly better than *L’Etivaz* chain for this attribute.

3.4 Consumer Behaviour

This attribute was analysed only in a qualitative way: no benchmarks were applied to its indicators and no scores calculated. The analysis concerns “hard cheese” and therefore, it was not always possible to distinguish *L’Etivaz* from *Le Gruyère*, and thus not always possible to compare them. *Le Gruyère* was often given as an example by consumers when talking about cheese. Concerning the indicator “Consumers Use”, consumers have many different habits: hard cheese can be eaten as a full dish accompanied with bread, in fondue, as a cheesecake, as a raclette dish. But it can also accompany the dish, grated or not. Regarding the indicator “Taste Preference”, all consumers agreed that taste is much more important than price, within a reasonable limit. Several underlined that one can find some very good *Le Gruyère* in small cheese dairies for a normal price. For the indicator “Convenience”, a convenient cheese can be preserved for a long time. According to others, convenience is referred to the shape and size of the portion. Other also highlight that the smell of a convenient cheese should not be so strong and unpleasant. A convenient cheese can also be a multi-purpose cheese (melted, cut, grated...), or easy to find. Concerning the last indicator “Willingness to Pay”, all consumers met are enthusiastically willing to pay for good cheese such as *Le Gruyère* or *L’Etivaz*.

3.5 Resource Use

For the indicator “Soil Improvement Practices”, *L’Etivaz* chain performs better than *Le Gruyère* chain (figure 6). The criterion making the higher difference between the chains is the pH regulation (by the amendment of lime for example), considering that absence of pH regulation reveals an appropriate soil management. Concerning the indicator “Material Consumption Practices”, both chains perform well: all actors in both chains use recyclable material, however regarding the criterion recycled material used *Le Gruyère* chain performs worst. *L’Etivaz* chain is graded higher for the criterion of concentrate feed due to the high limitation set by the book of specifications. Concerning the indicator “Waste Reduction and Disposal”, both chains perform well: all actors from both chains have a management of waste. *L’Etivaz* chain has a higher grade for the criterion of material reused due to the fact that it is in the interest of *L’Etivaz* chain’s farmers to reuse everything that can be reused as a consequence of their isolation during the summer period. Nevertheless, *Le Gruyère* chain achieved higher grades for the percentage of whey reused and for the existence of a policy of waste reduction: indeed, all the whey is reused whereas in *L’Etivaz* chain some whey can be thrown away in fields. For the indicator “Processing Efficiency”, benchmarks were set by calculating the highest and the lowest theoretical yields possible for *Le Gruyère* cheese. As the production process of *L’Etivaz* cheese is the same as *Le Gruyère* one, those benchmarks can apply for both chains. Maybe there is a physical limit making the highest theoretical yield impossible to reach, which would explain the low performance of both chains. For

this attribute, *L'Etivaz* chain performs generally better, with the exception of indicator “Waste Reduction and Disposal” for which *Le Gruyère* chain performs better.

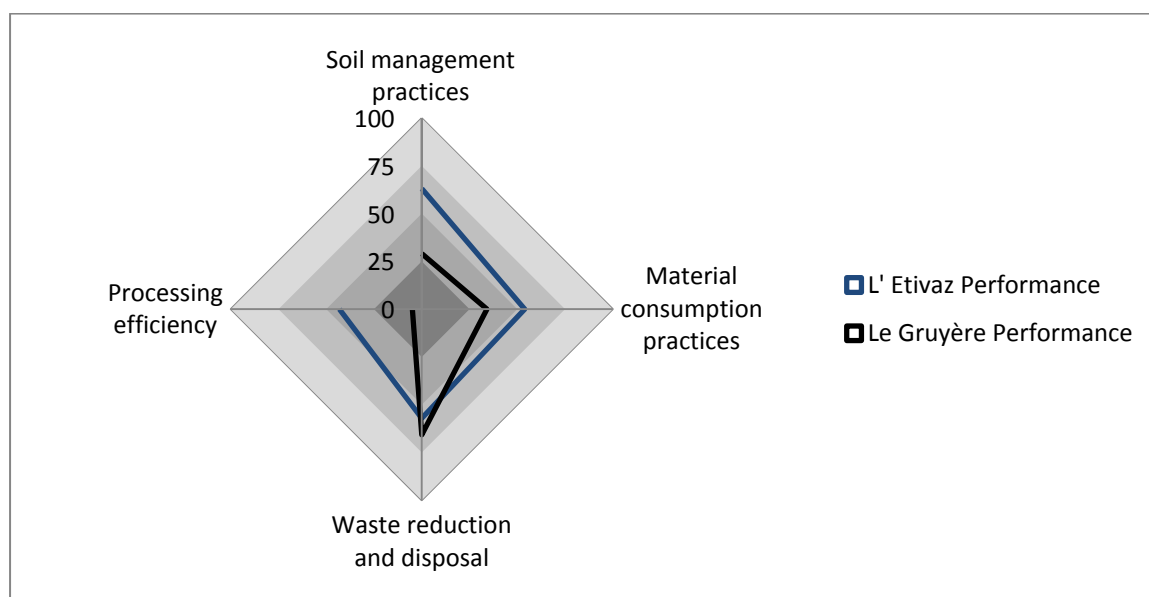


Figure 6 - Performance scores for the Resource Use.

3.6 Biodiversity

Concerning the indicator “Landscape Management Practices”, this was made of several criteria applied at the farm level. *L'Etivaz* chain gets a higher grade than *Le Gruyère* chain concerning the percentage of ecological compensation areas on farm, the presence of ecological structures on farm (such as wildflower strips, nesting aids, stone heaps, wood heaps, hedgerows, nest boxes, beehives, etc.), and an ecological management of pests and weeds. *Le Gruyère* chain gets a higher grade than *L'Etivaz* chain for the criteria concerning the protection of wildlife habitat connections, the existence of wildlife habitats on farm, the practice of delayed or adapted mowing, and the existence of multi-species tree populations on farm. The indicator “Diversity of Production”, was made of several criteria applied at the farm level: regarding the number of different productions on farm, *Le Gruyère* chain is graded slightly higher than *L'Etivaz* chain. The latter is graded higher than *Le Gruyère* chain concerning the number of cow breeds in the cattle and the presence of mixed cropping or intercropping (figure 7).

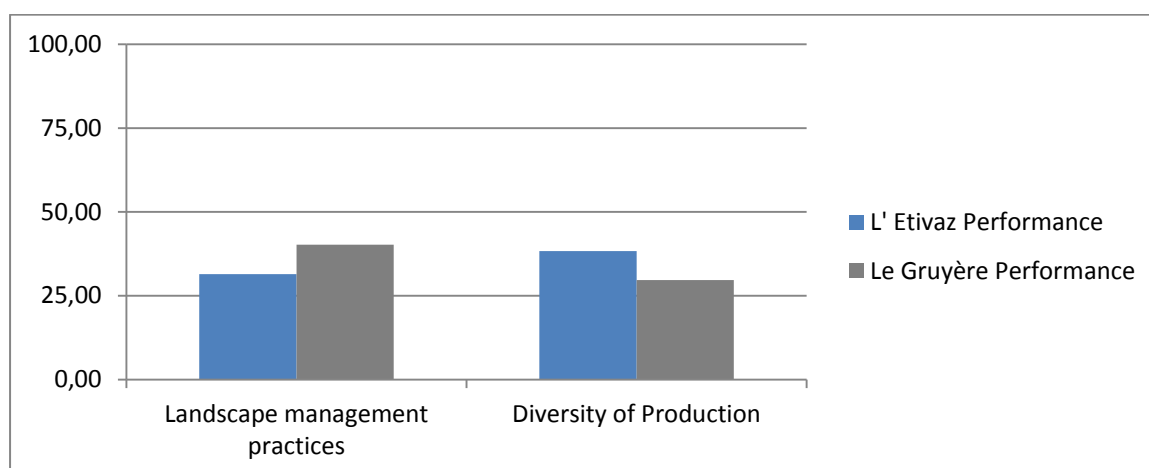


Figure 7 - Performance scores for the Biodiversity.

3.7 Nutrition

Concerning the indicators “Salt Content, Fat Content and Fat Types”, both chains perform almost the same and moderately well (figure 8). These moderate performances are quite expected: indeed, cheese in general is known to be fat and salty, thus it is not a health product. In both cheeses the same type of fats are found and similar production process are used. Regarding the indicator “Calcium Content”, the *L’Etivaz* chain performs better than the *Le Gruyère* chain although the quantity of calcium can vary significantly.

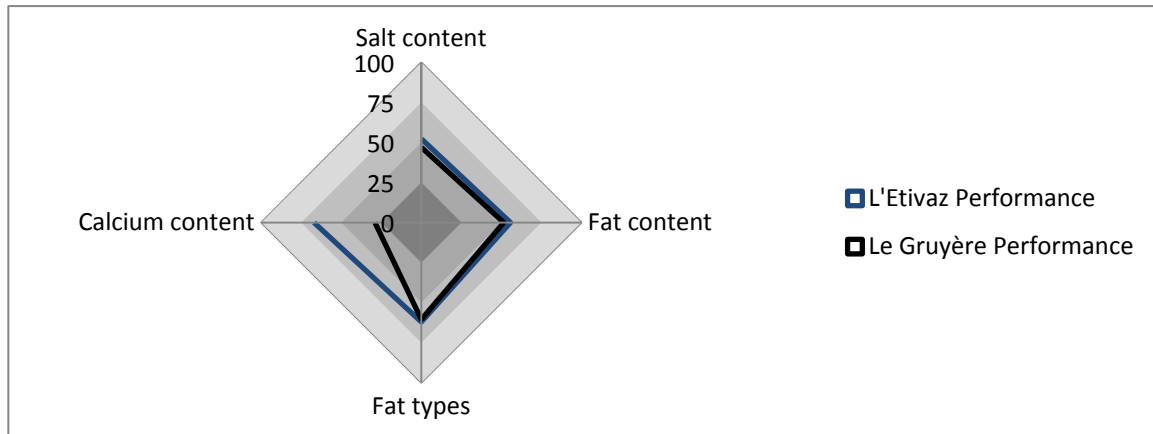


Figure 8 - Performance scores for the Nutrition.

3.8 Animal Welfare

Concerning the indicator “Animal Density”, for the *L’Etivaz* chain the summer pasture land was taken into account, and permanent pasture land was taken into account for *Le Gruyère* chain. Concerning the indicator “Lifetime of Dairy Cows”, *L’Etivaz* chain performs better than the *Le Gruyère* chain: cows producing milk for *L’Etivaz* live in average 7 years and 9 months, whereas cows producing milk for *Le Gruyère* live in average 6 years and 10 months. Both chains perform well for indicator “Time Spent on Pasture”, however, the *L’Etivaz* chain clearly performs better for this attribute (figure 9).

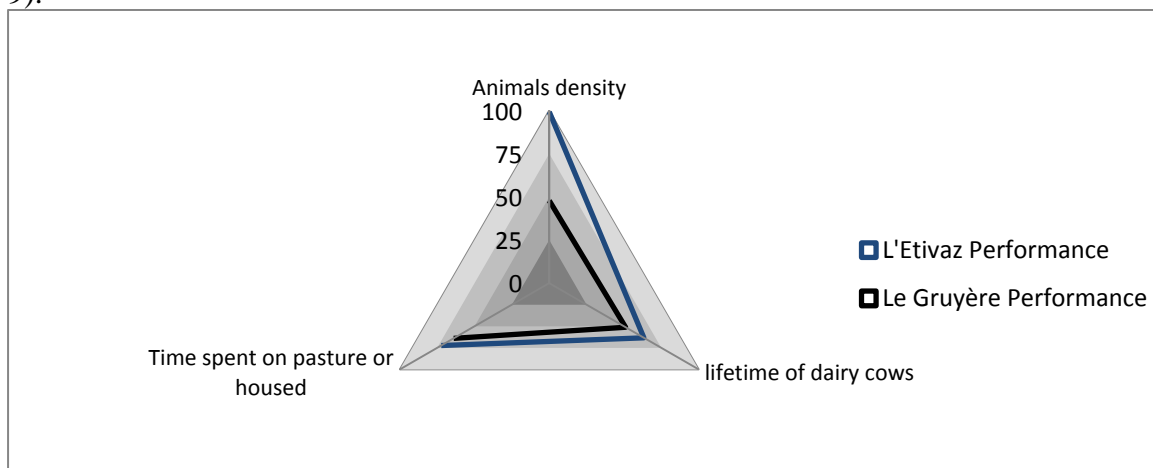
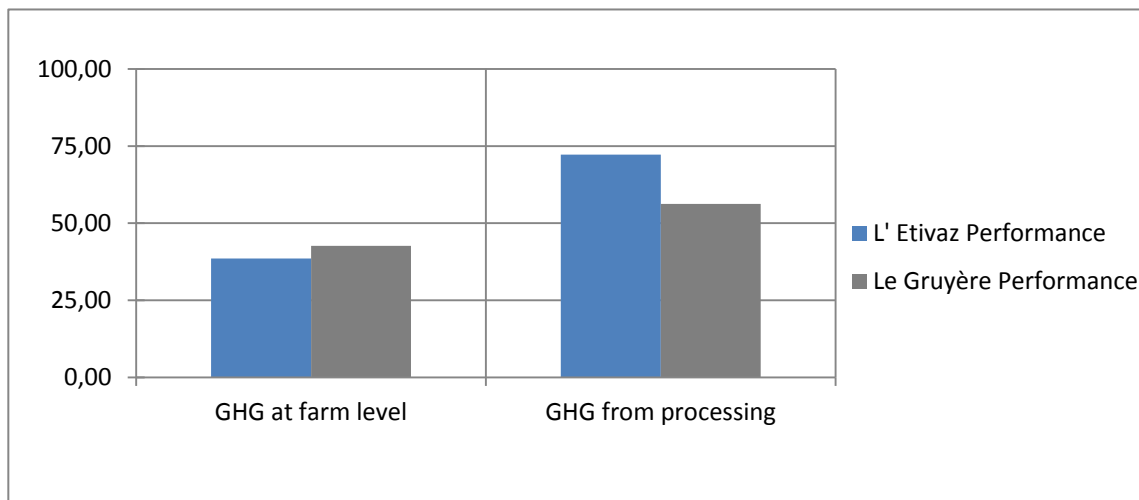


Figure 9 - Performance scores for the Animal Welfare.

3.9 Pollution

The indicator “GHG Mitigation at farm level” was made of several criteria applied at farms. The *L’Etivaz* chain is graded significantly higher for the criterion regarding the application of lime and mineral fertilizer. The *Le Gruyère* chain is graded significantly higher for the criteria of energy sources, the way organic fertilizer is spread, share and optimization of machines and transport, and whether there are trees on the farm. This could be explained by the fact that *L’Etivaz* farms are on a mountainous area where it may not be easy to grow trees, whereas *Le Gruyère* farms are more on areas where trees can grow more easily. The indicator “GHG mitigation from processing” was made of several criteria applied at the processing level. The *Le Gruyère* chain is graded higher for the criteria of the reduction of useless expenses on the creamery (light, heat...), and of informing employees about how to save energy on the cheese dairies. The *L’Etivaz* chain is graded significantly higher for the criteria of the optimization of machines and procedures during the cheese maturation, the type of energy used on the cheese dairies, and the type of energy used during the cheese maturation. Concerning the types of energy used in the creamery, this result is easily explained by the fact that *L’Etivaz* cheese has to be heated over wood fire. The wood often comes from farmers’ own forests. For the types of energy used in the cellars, this result is explained by the fact that the cooperative of *L’Etivaz* uses renewable energy for its cellars, unlike refiners from the *Le Gruyère* chain. In summary, regarding this attribute, each chain has its own strengths (figure 10).



In summary, *L’Etivaz* chain performs better within fourteen indicators against nine indicators for the *Le Gruyère* chain. One indicator reveals the same performance between the two chains (Price perception of consumers) (figure 11).

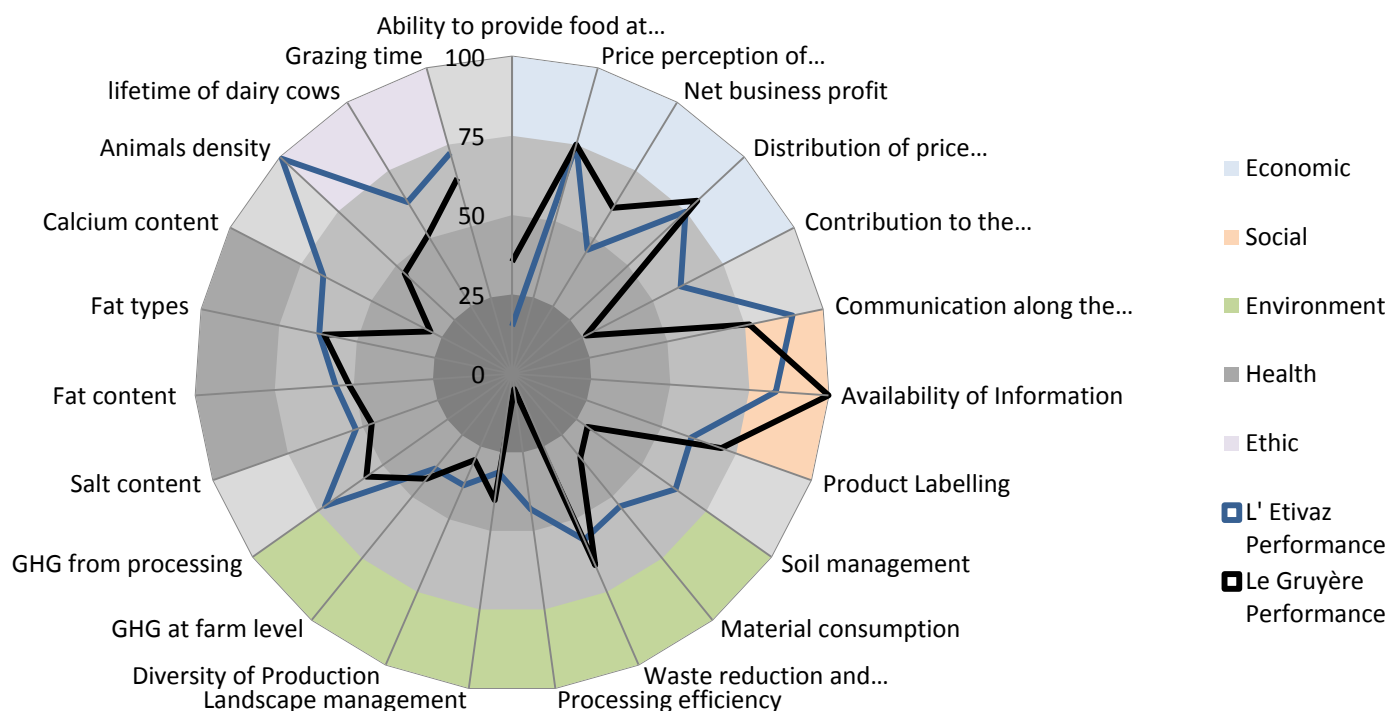


Figure 11 - The *Le Gruyère* and *L'Etivaz* performance around the five dimensions.

4. Discussion

The average scoring for both products is the following:

	L'Etivaz	Le Gruyère
Ethics	78	53
Social	77	81
Health	59	46
Economy	48	49
Environment	49	37

Le Gruyère performs better only in the social dimension, whereas *L'Etivaz* is particularly strong in ethical and social aspects.

Although the two products are PDO and demonstrate a good link to their *terroir*, five main indicators are quite different between the two products:

- Ratio between employment and quantity of cheese produced (economic dimension).
- Soil management practices (environmental dimension)
- Material consumption practices (environmental dimension)
- Milk and cheese processing efficiency (environmental dimension).
- Calcium content of cheese (health dimension).
- Animal density (ethical dimension)

In the economic dimension, the creation of added value is a highly important contribution to the welfare of all actors along their respective chains. Both chains have high costs of production that cannot be fully covered by the actual prices of milk.

Hence, important subsidies reaching 18cts/kg of transformed milk are given to farmers in both chains, constituting up to 21% and 17% of the price gotten by respectively *Le Gruyère* and *L'Etivaz* milk producers, contributing thus to incomes. These subsidies better allow *Le Gruyère* chain reaching a net business profit, delivering to consumers less expensive cheese compare to *L'Etivaz* chain. The higher *L'Etivaz* cheese price is also a consequence of the presence of a significantly human workforce rather than mechanization production processes such as in *Le Gruyère* chain, entailing a higher contribution to the region's economy in terms of jobs maintenance. According to the focus group, Swiss consumers perceive both prices of *Le Gruyère* and *L'Etivaz* justified according to their intrinsic quality. But it would be harsh to assume that if the final product would be sold for a higher price, producers would obtain higher revenue. A higher income and fairer distribution were expected for *L'Etivaz* producers as the chain is shorter and governed by a cooperative organization. However, it seems not to be the case for the moment, especially for the revenues that are still lower. The lower score in the distribution of price between actors is actually probably due to the lower number of actors in the calculation of the GINI ratio. The production stage of the chain thus seems to get the whole price and the result is biased. This indicator would need more research in its application to food value chains as it is the first time it was used in this context.

In the social dimension, *Le Gruyère* chain shows better capacity to address information to customers using efficient tools including stickers providing elaborated information. This result may be due to higher financial resources available for publicity purposes. However, a certain lack of internal communication between stakeholders still exists describing the difficulty for a big group to keep close contact among its members. Indeed, the high number of actors makes the organisation of the IPG much more complex: for example, it has been often mentioned that communication between milk producers and refiners hardly exists. In addition, a few farmers from *Le Gruyère* chain expressed that they do not feel integrated in the discussions within the IPG: decisions are discussed and taken by their representatives within the committee of the IPG and then presented to the other farmers, but a large majority of the interviewees feel that their opinion is not taken into account or even asked. On the contrary, *L'Etivaz* chain is structured in a smaller group (only 70 farmers and the cooperative, who is also the refiner) enabling better communication within the chain. However, in both chains information concerning steps downstream of the ripening step do not take place: there is apparently no communication or information transiting between milk and cheese producers and the retailers. Usually, refiners only meet the wholesalers they are selling to, but they do not have information about the final clients, or the final destination of their products. Consequently, producers neither have information about where their products end up. Concerning *Le Gruyère* production, it has been reported that some distributors expressed their dissatisfaction with the lack of information. Distributors are more satisfied with the communication with *L'Etivaz* chain as they are in direct contact with the cooperative and the *Maison de L'Etivaz*.

In the environmental dimension, *L'Etivaz* chain shows less mitigation efforts than the *Le Gruyère* chain on waste, wild biodiversity and air quality through GHG emissions on farms. One critical point is the use of whey. All cheese makers from *Le Gruyère* chain reuse it, while some farmers from *L'Etivaz* chain throw a part of it in the fields, mostly because they can't find a use for the whole quantity of whey they produce. This issue impacts the quality of soils and water in the concerned ecosystem: when reused, the whey can be given to feed pigs or calves, composted, centrifuged to extract cream (that can be used as such, transformed again into serac for

example or sold to dairy industries), or sold as such to industries that will process it (dried for livestock feeding, used to produce biogas...)¹⁴. Even if a small part of the whey is thrown away in *L'Etivaz* chain, this is still a weakness for the chain. Currently there is an initiative being developed with “La Maison de L'Etivaz” for using whey to grow reeds. The Gruyère has greater impacts than L'Etivaz on air quality through GHG emissions during processing, soil balance and quality, material consumption, quantity of primary resource used, and agro-biodiversity. Concerning agricultural inputs, farmers from Le Gruyère chain use in average more concentrated feed per cow per year (Le Gruyère: 938kg \pm 366 ; L'Etivaz: 755kg \pm 311). It is thus possible to argue that Le Gruyère chain has greater impacts than L'Etivaz chain on biodiversity abroad, water use, and possible climate (through deforestation in the producing countries of concentrate feed). However, in both chains high variability on concentrates use has been found. Thus, a general conclusion that L'Etivaz farmers use less inputs than Le Gruyère cannot be categorically made. Within the interviews conducted, a major difficulty was to find some information about the agricultural inputs such as the composition of concentrate feed, the provenance of its ingredients, the transformation processes, the route followed by the primary ingredients from their production to the farms, etc. Farmers and cheese makers from both chains could not answer precisely, either because they do not have the information, or because they are not interested in it. Information online or on labels and catalogues did neither cover our interrogations

Concerning the energy and GHG emissions, this issue has been treated due to the important role that agriculture has in mitigating GHG emissions . The analysis conducted has been merely qualitative, and focus on the farming and cheese processing practices. It has been found that farmers from L'Etivaz chain optimize more their machines and procedures used when producing cheese than cheese makers from Le Gruyère chain. On the contrary, the same farmers from L'Etivaz chain optimize less their machines and transport concerning milk production, although their production relies highly on grazing. Also, farmers from L'Etivaz chain use more renewable energy emitting less GHG. This is due to the fact that L'Etivaz cheese has to be heated over wood fire. Also, the ripening of L'Etivaz chain uses renewable energy in the cellars (solar and biogas energy), whereas not all refiners from Le Gruyère chain do so. Nonetheless, some refiners from Le Gruyère chain use very little energy in the cellars because they are in natural caves that offer the proper moisture and temperature conditions. Only in some Le Gruyère factories, with a special support of Fromarte (the association of Swiss cheese makers), renewable energies are used.

Concerning the processing efficiency, a real challenge is associated with choosing the right cow breed and feeding according to the processing properties of the milk. Nowadays, many farmers still use high-producing breeds, such as Holstein cows, which were selected mainly due to the high yield per year and not for other parameters such as fat or protein content . A Jersey cow for example, will give less milk per day but produces milk that is more suitable for cheese production. Montbéliarde and Brown Swiss breeds are other high milk solids–yielding breeds that have been shown to have a positive effect on cheese making meaning that the milk produced is more resource efficient allowing a higher cheese yield per litre of milk. This could as well benefit farmers financially as some cheese dairies give incentives on the milk price according to an appropriate fat and protein content. Moreover, the total carbon footprint for cheese produced from Jersey cows has also been shown to be lower in comparison with

¹⁴ PRAZERES, ANA R; CARVALHO, FÁTIMA; RIVAS, J; PATANITA, MANUEL; DÔRES, JOSÉ, 2014, *Reuse of pretreated cheese whey wastewater for industrial tomato production (Lycopersicon esculentum Mill.)*, 40, 87-95. doi:10.1016/j.agwat.2014.04.002

Holstein cows . However, neither Le Gruyère IPG nor L'Etivaz cooperative have addressed this question yet nor the currently used breeds vary a lot. Nevertheless, it has been noticed that farmers in L'Etivaz have a higher proportion of high milk solids-yielding cows than in Le Gruyère chain. This could explain the higher performance in “processing efficiency” and “fat types” of L'Etivaz cheese makers. Regarding the health dimension, the two cheeses are very similar nutritionally, except for calcium content where L'Etivaz cheese contains more calcium in average. However, the variability of the amount of calcium in these cheeses is high, especially in L'Etivaz cheese, and the difference is not significant. Cheese is known to contain high amounts of fat, and especially unhealthy saturated fat of animal origin that have been linked to different types of cancers, excess cholesterol, inflammations, cardio-vascular diseases and obesity . The salt content is also a trigger of high pressure and all related diseases. However, as for all potentially unhealthy food, the effects depend on the quantities consumed, the overall diets, the personal metabolism and the environment and lifestyle. It is thus extremely hard to qualify a single food as healthy or unhealthy and that is why the different recommended daily intakes depicted by several nations or organizations differ and research is still ongoing. The consumer behaviour thus plays an important role, both regarding quantities and the association with other food in the total diet. Swiss people consume a substantial amount of cheese (27.9 kg of hard cheese per capita in 2012) as it is an important part of the culture. Fondue and Raclette are national dishes exclusively composed of melted cheese. However, cheeses also contain positive health nutrients such as vitamins. Related to this issue, it has been shown that pasture systems can have a positive effect on the fatty acids types found in the milk and thus the local chain might produce cheese with healthier amounts of the different components.

During the focus group, consumers seem to be aware of the potentially unhealthy levels of salt and fat in cheese, but they nevertheless consider the taste of the cheese more important and would not stop consuming cheese for these reasons. Some consumers however pay attention to not consume too much of it. Moreover, consumers usually do not pay too much attention to the nutritional labelling on cheese.

Regarding the ethical dimension, big differences have been found concerning the indicator “Animal Density”. Animals in L'Etivaz chain live longer in average and have greater access, in time and space, to pasture land. These differences in the results can easily be explained by the general breeding conditions in L'Etivaz, where producers are constrained by specifications on the product as well as by the non-arable steep alpine environment. The length of time animals live can be due to strategies of farmers and/or health conditions of the animals: breeds used for L'Etivaz are often hardy, thus produce less milk but have better health conditions⁹. Some highly productive breeds used for Le Gruyère like Holstein may more likely show health problems at a rather young age⁸. They are moreover less fit for pasture in colder climates (spring or autumn), when they could suffer from cold and not find enough feed to maximize their production. Spacious and comfortable buildings hosting animals also play an important role on animal welfare: during winter time or hot summer days, the animals' health is improved when kept in buildings to protect them from cold or heat respectively . In general, it seems that animal welfare for these chains is seasonal: more grazing for L'Etivaz in the spring and summer time but better living conditions in buildings for Le Gruyère in the winter time. The integration of the health and stress levels of animals would also be relevant for the animal welfare attribute. However, neither direct observations nor secondary sources linked to the case study has been found. Farmers in both chains encounter problems with mastitis and lung problems in their herds but we failed in collecting more precise indications on the frequency or magnitude of the sicknesses.

5. Limitations of the research

The method used to conduct this assessment has limitations. The first is that 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.

A second limitation is that the final performances calculations and graphical representations don't take into account interactions between indicators as this would require much more complex modeling.

A third limitation was the availability of data: 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.

A fourth limitation is that more specific in-depth analysis would have been necessary for assessing some indicators more precisely. Such 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.

Another limitation is that this study does not integrate much the stage of agricultural inputs, though the input stage is very important in most value chains. It was extremely hard to know where the inputs come from and how they are produced and processed. The inputs level is the least transparent stage of the chains. The absence of agricultural inputs in the study induces a bias in the results for the environmental dimension. Indeed, the use of imported inputs can pressure the natural resources abroad: it can cause for example a loss of biodiversity, water pollution, deforestation and soil erosion in developing countries producing soy . However, the amount of concentrate feed was taken into account within indicator "Landscape Management Practices".

Still, in comparison with other multi-dimensional methods, the indicators are context specific. Moreover, the range of 0 to 100 for the performance leaves high level of precision for the results. For instance, SAFA indicators are rated into two to five categories of performance. The GLAMUR approach thus enables a multi-dimensional sustainability assessment.

An additional weakness of this study is that it is not balanced between the five dimensions. The environmental 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 . 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 regulated and the food is therefore at high level of safety. The indicators' selection thus reflects what seems important to a panel of different stakeholders in order to evaluating the food chain performance in a specific context (Swiss dairy sector) and cannot be used in another context. The selection of the relevant attributes requires an important preliminary and participatory work but renders the analysis more relevant than using generic indicators.

6. Conclusion

The methodology of performance evaluation through indicators is overall relevant. However, there are still a lot of on-going research and questions in society about what is sustainable. Setting the benchmarks is particularly a difficult task. The goal of this research was to be holistic and multi-dimensional. To be more multi-dimensional, more indicators could have been used, in combination with more time for preparation and data collection. More precise methods could have been used such as LCA for the environmental indicators as it is done in some of the other GLAMUR case studies, however these methods require more resources. To be more holistic, it would have been interesting include all stages of the chain more deeply (e.g. retailers). Nevertheless, due to the difficulty to secure interviews with big companies, this paper mostly focuses on the core stages of the value chains.

The sustainability performance of both chains is quite good and above average (50%) expect for Le Gruyère in the environmental dimension. Concerning the sustainability of both chains, both chains could actually increase their performances and could adopt better practices: L'Etivaz should consider to invest more in renewable energy, although some programs have been initiated for cheese-makers to increase energy use efficiency; whereas Le Gruyère could improve the efficiency of information exchange and communication within its actors, including distributors and retailers in the discussions.