Sustainability of the Lebanese small ruminant dairy products supply chain

Rodrigue El Balaa, Michel Marie

INPL – ENSAIA-INRA, URAFPA, Vandœuvre lès Nancy, France – michel.marie@ensaia.inpl-nancy.fr

***Abstract**: Small ruminant production systems in the Middle Eastern region in general and specifically in Lebanon are facing a wide array of problems such as feed shortage, grazing and labour expenses, low productivity and poor management of the organic matter. In order to understand these problems and propose adequate solutions, it is important to consider the farming systems as a part of a larger supply chain, including other interrelated components. The aim of this study is to analyse the three levels of sustainability (economical, environmental and social levels) for each component of the small ruminants dairy supply chain (producers, processors, distributors and consumers), provide a better understanding of this chain strengths and weaknesses, and present recommendations for improvement.*

To reach this objective, a series of surveys covering specific sustainability parameters have been carried over different Lebanese regions, for every component. The surveys, which included over 129 producers, 15 processors, and 83 distributors, led to the calculation of 12 sustainability indicators. Using principal component analysis and analysis of variance provided a profiling of the individuals distribution according to their sustainability situation. The survey also covered 250 consumers, and a multiple component analysis showed the effect of the determinants of their purchasing behaviour and their conception of small ruminant farming sustainability.

The results showed a need for further investments to improve the products diversification and technological advances. Most of the electrical power is generated by thermal conversion technology and all used packaging material are non recyclable, which poses an important threat to the supply chain on the environmental level. Convenience plays an important role in the consumers' purchasing behaviour. A sustainability-based labelling scheme would provide the consumers with a guarantee for the development of the supply chain sustainability.

***Keywords**: small ruminants, dairy, supply chain, sustainability*

Introduction

Small ruminants account for 30-40% of the value of agriculture output in near eastern countries (Bahhady, 1986) and play an important role in the Lebanese agriculture (FAO, 1980). The small ruminant production in the Middle Eastern region has been recently experiencing difficulties and facing many obstacles, especially feed shortage (Nordbolm and Shomo, 1995). In Lebanon, it is also suffering from a low productivity, (Hamadeh et al., 1996), high feed, grazing and labour costs (Hamadeh et al., 2001), a limited variety of annual and temporary cultures in specialized farming systems and a poor management of organic matter (Srour, 2006, Srour et al., 2007). According to the Lebanese Ministry of Agriculture, in 2002, there was 297 892 sheep and 408 933 goats heads in Lebanon. Milk production was around 22 128 Tons for the ovine and 29 365 Tons for the goat sector with a mean productivity of 124 Kg/year and 144 Kg/year respectively. The seasonality of dairy production is very acute, due to the scarcity of intensive production systems. The largest part of small ruminant milk production (sheep: 92.4%, goat: 87.6%) is sold by the producers as whole milk to manufacturers or directly to consumers, the remaining part is either consumed by the producers or processed by them into dairy products (mainly Kesheck and Chanklish) to be sold afterwards directly to distributors or consumers.

Only over 135 dairy processing plants are officially declared, mainly being based in central Bekaa and near the capital Beirut (Institut de l'élevage, 2003). Local dairy products can be distributed into three categories; the first one includes milk and fermented milk products such as yoghurt (Laban) and fresh cheese (Labneh) which is similar to yoghurt with lower water content; these products have a short shelf life of around 10 days. Fresh cheese can also be preserved in olive oil for a long period. The second family includes Halloumi and Akkaoui cheese and their serum produced by-product Double Cream, which can be preserved for a few months in brine, in a refrigerated environment; Karisheh,

which is also a serum by-product however, cannot be preserved for a long period of time. The third family includes products which can be preserved for a long period: Chanklish is a highly fermented cheese and Kesheck is a powdery mixture of dehydrated milk and mashed wheat which can be preserved for several months and consumed in the form of soup or as a spreading on small pizzas (Manakish). Processors provide the refrigerated transportation to the distributors which include small scale grocers and large supermarkets, mainly based in the major cities, since most of the Lebanese population lives in urban regions.

According to Khalifat (2003), over 35% of the Lebanese distribution market is being controlled by 9 supermarkets chains which are spreading all over the country, the remaining part of the food distribution market being controlled by over 25 000 traditional and modern sales centres. Dairy products currently represent between 12 and 20% of food products total sales, and are sold as readily packaged units or as on the spot cut and packaged units.

Dairy products are a major part of the Lebanese diet with an estimated 189 Kg (Institut de l'élevage, 2003) per capita yearly consumption, which is close to other Mediterranean countries' consumption (190 Kg per capita in Spain and 207 Kg per capita in Greece). The sources of purchase are mainly grocers and supermarkets, the remaining source being the producers during week-ends and holidays. According to a previous study (El Balaa et al., 2004), small ruminant products are appraised by Lebanese consumers, the preferred products being Kesheck and Halloumi cheese, followed by Double Cream cheese, Akkaoui cheese and Chanklish. The Kesheck's frequency of consumption is at least once a week, as for Halloumi, Akkaoui and Double Cream cheese, they are consumed mostly once or more per week. The local milk production covered in 2005 more than one third of Lebanon consumption needs (in fresh milk equivalent) (Ministry of Agriculture, 2005). The total quantity of locally produced milk increased up to 252 thousands tons in 2005 with a 3% increase from 2004. Lebanese dairy exports reached 420 Tons in 2002, especially for Halloumi and Akkawi cheese as well as a transit or re-export activities for foreign dairy products to different Arab countries, and cheese imports equalled 32 000 tons in 2002.

The above presentation of the Lebanese small ruminants supply chain is in accordance with Tansey and Worsley's (1995) definition of the food system which consists of four major processes for food production and consumption: agriculture, processing, distribution and consumption. Stevens (1989) adds that these actors are linked together via a feed-forward flow of materials and feedback of information. The objective of our study is to analyse the sustainability of Lebanese small ruminant dairy supply chain and identify its assets and weaknesses before providing the recommendations for improving its performance. The first pillar of the sustainability is the economical level which indicates the current financial status and the future viability of every unit; the second pillar is the environmental level which indicates the input of natural resources and the output of wastes; finally, the social level, reflects the workers socio-economic profile and quality of life. On the basis of a series of surveys, we will consider each component of the supply chain and analyse its sustainability.

Material and Methods

Surveys

The producers' survey was conducted over 129 small ruminant breeders (Srour, 2006) distributed over the four rural regions in Lebanon; Northern Lebanon (NL, 33), Mount Lebanon (ML, 35), the Bekaa Valley (BEK, 30) and Southern Lebanon (SL, 31); Beirut was not considered since it contains no farms. The breeding types were also taken into consideration zero grazing (ZR, 7), sedentary (SE, 35), semi nomadic (SN, 17), horizontal transhumance (HT, 17) and vertical transhumance (VT, 53). The questionnaire included three types of variables: the economical level covered by number of animals, number of workers, electric and fuel consumption, nitrogen stock, feed consumption, employees' fees, rent cost, and milk, animal and vegetable sales, the environmental level including electricity and fuel consumption and animals' effluents and the social level including efficiency, number of employees and employees' fees.

The processors' survey was conducted over 15 dairy processing units, eleven of which being located in the Middle Bekaa region, Lebanon's dairy centre, three in the Mount Lebanon region and one in Northern Lebanon. The variables of the economical aspect are needs for total investment, sales evolution, small ruminant products' sales, mean salary, total salary, electricity expense, water expenses, small ruminants' milk cost, total milk cost, number of kilometres and cost of carburant. The

environmental aspect is represented by the need for packaging material, electricity consumption, water consumption and carburant consumption. The social aspect is covered by the number of employees, weekly working hours, percentage of men, percentage of married employees, number of adherent to the National Social Security Fund (NSSF), percentage of locals and mean salary.

The distributors' survey covered 83 units of which 71 small scale groceries and 12 supermarkets. In each of the four regions (Northern Lebanon, Mount Lebanon, Southern Lebanon and the Bekaa Valley), seven groceries were chosen in the rural areas and seven in their respective major cities. In Beirut, 15 mini-markets and 12 supermarkets were covered. The economical variables include sales monetary value, electricity costs, rent costs, percentage of small ruminants' dairy products sales from total dairy sales and the income evolution. The environmental variables include packaging material needs (plastics and Nylon), refrigerated volume, the ratio of the volume occupied by small ruminants' dairy products in the refrigerated space, the refrigerator's capacity and electrical needs. Finally, the social variables include number of employees engaged in small ruminants related activities, number of working hours, salary, percentage of male employees, percentage of married employees, percentage of Lebanese employees and percentage of employees adhering to the NSSF.

The consumers' survey covered a sample of 250 individuals from all five districts of Lebanon. Fifty individuals were selected from Beirut, the capital; for each of the other districts (Northern Lebanon, Mount Lebanon, Southern Lebanon and the Bekaa Valley), 30 individuals were chosen from their respective major cities (Tripoli, Jounieh, Saida and Zahle) representing the urban environment and 20 individuals from three different villages representing the rural environment. The questionnaire included three main parts to understand the factors governing the purchasing behaviour of small ruminant dairy products. The first part includes the socio-economical status with income, educational level, profession and ratio of food expenses. The second part concerns the consumers' residence such as geographical position and frequency of contact with small ruminants' production systems, and the third part covers the consumers' conception of sustainability such as the economical and social situation of small ruminant farmers and the environmental impact of small ruminant farms. The considered products were sheep and goat milk, yoghurt, Labneh, Labneh preserved in olive oil; fresh and preserved Baladi (local) cheese, Halloumi, Akkaoui and Double Cream cheese, Chanklish, Kesheck and Karisheh.

Indicators

These variables allowed the calculation of 12 sustainability indicators covering the three levels of sustainability for the producers, processors and distributors:

The economical level is represented by three indicators: the first one is the added value (AV) which calculation is based on the difference between total costs (working force, electricity, water, fuel, and milk price) and small ruminants dairy products sales value, divided by the volume of produced, processed or sold milk or milk equivalent. The second indicator is the productivity (PROD), calculated by dividing the total volume of small ruminants milk or milk equivalent by the workforce units (WFU) number. The third one is the yearly profit growth (GRW) over the last five years, provided by the interviewee.

The environmental level is represented by five indicators: Energy consumption (NRG) including electricity and transportation and milk treatment and processing, divided by the volume of milk or milk equivalent. Green House Gaz emissions (GHG) include Carbon dioxide, Methane, and Nitrogen monoxide emissions for the production, processing, or sale of one litre of small ruminant milk or milk equivalent, calculated in CO2 equivalent and coming from electricity, transportation, processing and even animal activity. Water consumption (WAT) is calculated by dividing the water consumption by the volume of produced or processed small ruminant milk, Nitrogen effluents (N) from the animal faeces or unprocessed serum, divided by the total small ruminant milk production or processing, finally, the packaging material (PACK) is calculated by dividing the volume of packaging material used for small ruminants' dairy products by the volume of small ruminants processed or sold milk or milk equivalent.

The social level is represented by the monthly salary of employees (SAL), the employees gender equity (EQU), based on the percentage of female employees, the percentage of employees registered at the NSSF (SS) and finally, the yearly turn over rate (TO).

A score, ranging from 0 to 10, has been assigned to indicators' values according their distribution as reported in Table 1.

Statistical analyses

For the producers, processors and distributors, a principal component analysis has been performed followed by an ascending hierarchical classification in order to distribute the individuals into classes according to their sustainability performance.

For the **producers**, the active quantitative variables were AV, PROD, NRG, GHG, WAT, N and SAL, the illustrative quantitative variables are total Small Ruminant Milk (SR-M) production, Small Ruminant products Turnover (SR-T) or sales value, the Total Working Force (TWF) and the small ruminant Animals' Total (AN-T) number; the illustrative qualitative variables are the region (REG) and the types of farming systems (TYPO).

For the **processors**, the active quantitative data were AV, PROD, GRW, NRG, GHG, WAT, N, PACK, SAL, EQU, SS and TO, the illustrative quantitative data total milk production (SR-M), product's turn over (SR-T) and total working force (TWF), and illustrative qualitative variable the region (REG).

For the **distributors**, the active quantitative data were AV, PROD, GRW, NRG, GHG, PACK, SAL, EQU and SS, the illustrative quantitative data total milk production (SR-M), products' turn over (SR-T) and total working force (TWF), and the illustrative qualitative variables the region (REG) and the rural/urban environment (ENV).

The **consumers**' data were analysed using a Multiple Correspondence Analysis (MCA). For the socio-economical level, the six active nominal variables used were the husband's and the wife's educational level and profession, monthly remuneration and percentage of food spending. For the regional level, the active nominal variables were the region, lifestyle (urban/rural), the contact frequency with urban and rural environments and finally the contact frequency with small ruminants farming systems. In both cases, the nominal illustrative variables were the consumption frequency for each of the 15 small ruminants dairy products (daily, weekly, monthly, seasonally, never).

Table 1. Indicators scores according to variables ranges

Indicator	score / Abr.	0	1	2	3	4	5	6	7	8	9	10
Added Value (€/l)	AV	< -1	-1/-0.75	-0.75/ -0.5	-0.5/-0.25	-0.25/0	0/0.2	0.2/0.4	0.4/0.6	0.6/0.8	0.8/1	>1
Growth (%)	GRW	< -10	-10/-5	-5/-1	-1/-0.5	-0.5/0	0/0.1	0.1/0.5	0.5/1	1/5	5/10	>10
Productivity (T/WFU)	PROD	<1	1/2.5	2.5/5	5/10	10/20	20/50	50/100	100/150	150/200	200/250	>250
Energy (Mj/l)	NRG	>40	40/20	20/10	10/5	5/3	3/2.5	2.5/2	2/1.5	1.5/1	1/0.5	<0.5
Green House Gas (g/l)	GHG	>10	10/5	5/1	1/0.5	0.5/0.3	0.3/0.25	0.25/0.2	0.2/0.15	0.15/0.1	0.1/0.05	< 0.05
Water (l/l)	WAT	>80	80/50	50/20	20/10	10/7	7/5	5/4	4/3	3/2	2/0.8	<0.8
Packaging (g/l)	PACK	>50	50/30	30/20	20/15	15/10	10/8	8/6	6/4	4/2	2/1	<1
Effluents (g/l)	N	>400	400/200	200/100	100/50	50/25	25/20	20/15	15/10	10/5	5/1	<1
Equity (% female)	EQU	0/10 100/90	10/15 90/85	15/20 85/80	20/25 80/75	25/30 75/70	30/32.5 67.5/70	32.5/35 67.5/65	35/37.5 65/62.5	37.5/40 60/62.5	40/45 60/55	45/55
Salary (€/month)	SAL	<50	50/100	100/150	150/200	200/225	225/ 300	300/ 400	400/ 500	500/ 1000	1000/ 2500	>2500
Social Security (%)	SS	<40	40/50	50/60	60/70	65/70	70/75	75/80	80/85	85/90	90/95	95/100
Turn Over (%)	TO	100/80	80/60	60/50	50/40	40/30	30/25	25/20	20/15	15/10	10/5	<5

Data analysis was conducted using SPAD Version 5.0 (SPAD Coheris, France) for principal component analysis (PCA) and multiple correspondence analysis (MCA), and Genstat 9th Edition (VSN International, UK) for summary statistics and analysis of variance.

Results

Classification according to sustainability performances

Producers

As shown in Figure 1, axis 1 (31.84% of the variation) represents good performances of nitrogen effluents (N), green house gas emissions (GHG), water use (WAT) and productivity (PROD). Axis 2 (22.53% of the variation) represents in its negative values the added value (AV), energy performance (NRG) and salaries (SAL). Two types of farming systems are opposed along this factor, with ZG (Zero Grazing) on the positive side and VT (Vertical Transhumance) on the negative side.

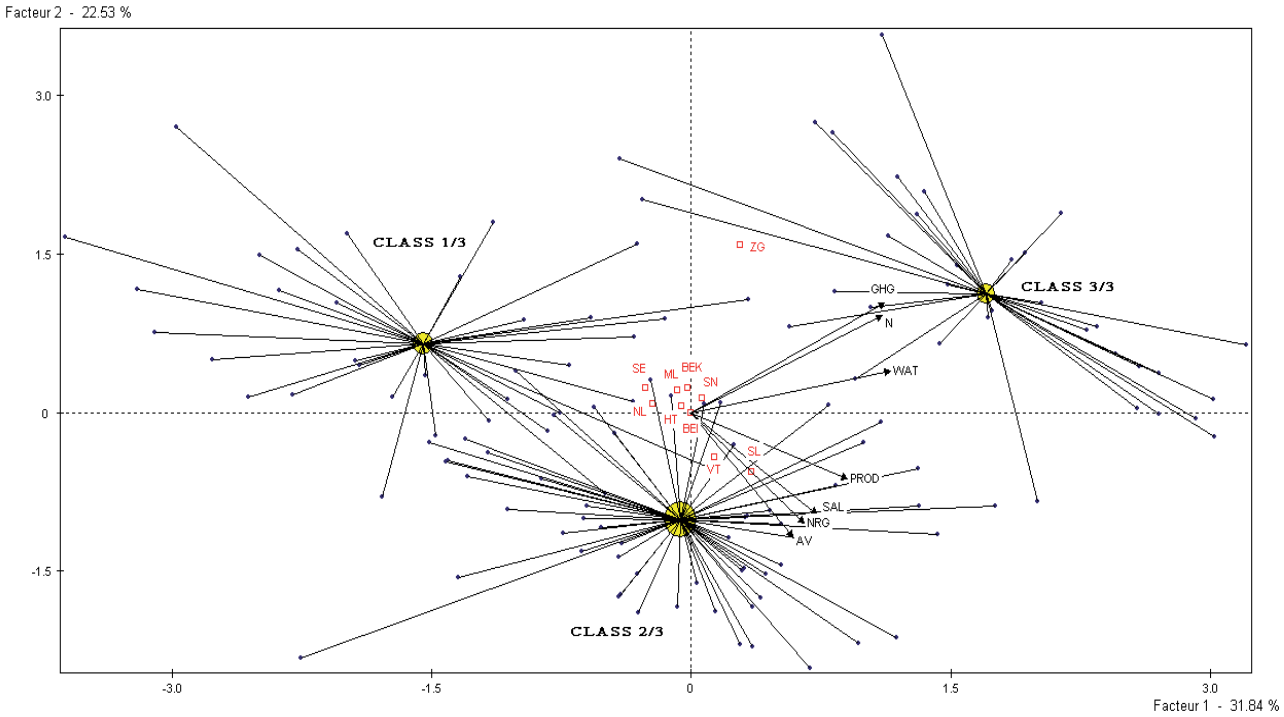

Figure 1. Producers' distribution according to their sustainability scores with the representation of the principal components governing their classification.

According to the above mentioned factors, the producers are distributed into three classes:

Class 1 (35 producers) contains producers characterized by low scores for all measured indicators, be it the environmental factors, GHG (1.0), NRG (4.77), and WAT (0.84) or the economical added value AV (4.2) and productivity PROD (2.0) and the social salaries SAL (4.21). These individuals are mainly small producers with an average small ruminant milk turnover (SR-T) of 3715 €/year. Horizontal transhumance producers' percentage (26%) is higher than the average score (13%).

In **Class 2** (60 producers), vertical transhumant producers farming systems are the best represented (62% compared to 41% average score). The sustainability situation is good for some variables, AV (4.21), NRG (8.85) and SAL (5.65), but bad for others, GHG (1) and N (1.16)

Class 3 (34 producers) farming systems are the best environmentally performing with the highest GHG (2), WAT (2.03) and N (1.9) scores. They are also the most selling small ruminant farming systems with an average 7057 €/year added value.

Processors

Figure 2 shows that axis 1 (33.39%) represents mostly the decreasing performance of energy (NRG), green house gas (GHG), packaging material (PACK) and productivity (PROD); at the same time, it represents good social conditions such as low staff turn-over (TO) and high percentage of social

security membership (SS). The second axis (18.98%) represents good male/female equity (EQU), and high added values (AV). It is also important to note that axis 2 represents the processors' activity concerning small ruminant milk processed milk (SR-M) and small ruminant products turn over (SR-T).

The individuals are distributed into three main classes:

Class 1 (6 processors) includes processors with the lowest environmental performances for GHG (6.33), N (4.66) and NRG (4.5). The economical performance is characterized with the lowest productivity average score of 5.5. The good social conditions are characterized by the best turn over score (10) which mean less than 5% per year. In fact, these low performance and high social conditions are not surprising, as this class includes one Non Governmental Organisation (T12), one research centre (T2), and one attached to a social institution (T1), which aim is to provide social support for the locals without real emphasis on productivity.

Class 2 (5 processors) contains, among others, the two largest processors (T3 and T13), with the highest average small ruminant milk turnover of 944677 €/year and an average processed volume of 944 Tons/year. Environmental performances are high for GHG (8.6), N (7.8) and NRG (7.2), water performance (WAT) is the highest with an 8.2 score; socially, the gender equity (EQU) presents the highest score of 6.2.

Class 3 (4 processors) contains individuals with high environmental performances for NRG (7.75), GHG (8.6) and N (7.8); productivity performance is also high (7.25), but the equity score is the lowest (0.25), which means a percentage of female employees lower than 10%.

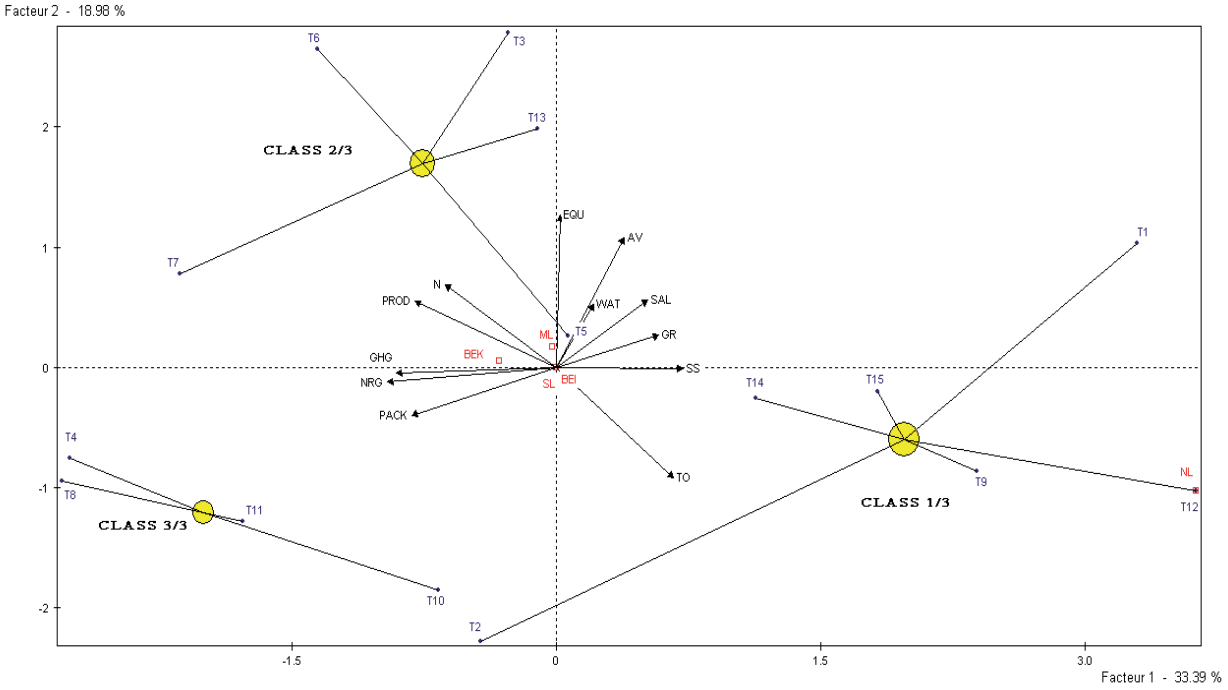

Figure 2. Processors' (T1 to T15) distribution according to their sustainability scores with the representation of the principal components governing their classification.

Distributors

Axis 1 (33.67%, Figure 3) represents the decreasing performance for productivity (PROD) and for the environmental parameters of energy (NRG), green house gas emissions (GHG) and packaging material (PACK). The lifestyle situation is distributed along this axis with the rural distributors in the positive side and the urban distributors in the negative side; the regional positions are also distributed along this axis with the four regions in the positive side, and the capital Beirut in the negative side.

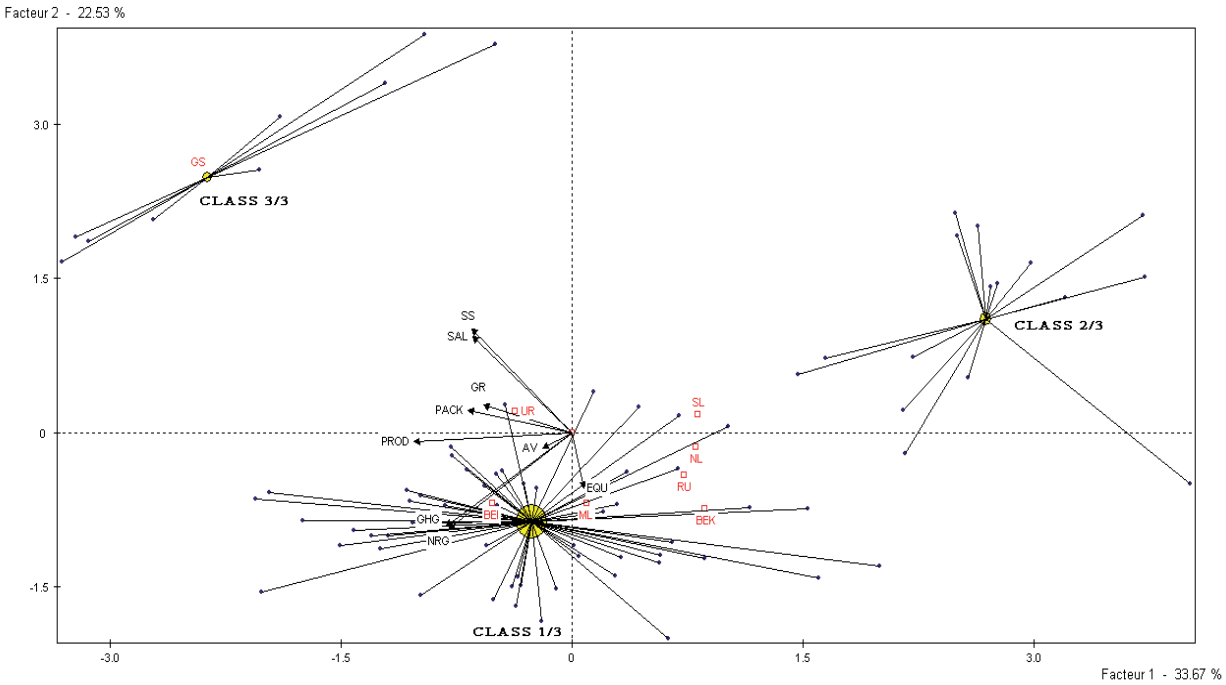

Figure 3. Distributors' distribution according to their sustainability scores with the representation of the principal components governing their classification.

The second axis (22.53%) represents the environmental performances of green house gas emissions (GHG) and energy consumption (NRG) in the negative values and the social performance of monthly salary (SAL) and social security (SS), in the positive values. The distributors can be therefore distributed into three major classes:

Class 1 (57 distributors) contains distributors with the best GHG (9.3) and NRG (8.9) performances. The social conditions are quite low for SAL (3.14) and SS (0.54). Productivity score is high (7.2).

Class 2 (14 distributors) individuals have the lowest small ruminant dairy products both on the volume (3298 l/year) and turnover (2635 €/year) levels. They are characterized by the lowest environmental performances for GHG (4.2), NRG (3.6) and PACK (4.1) and are also the least productive individuals with an average score of 4.3.

Class 3 (12 distributors) contains strictly hypermarkets, their large size is mainly reflected by their small ruminant average milk equivalent volume of sales (29109 l/year) and working force of 3.6 WFU specific for the dairy sales section. They are the most economically performing individuals for GRW (7.08) and PROD (9.08). The employees' social conditions are also the best for SAL (5) and SS (10). The packaging material performance is also the best with a score of 8.9.

Overall comparison of sustainability scores

The average of sustainability variables scores have been calculated for producers, processors and distributors and the results are presented in Figure 4 in order to compare the performance of each actor.

Economical level

There is no large difference between the AV scores of producers and processors, which range between 5.3 and 5.8 which means a range of 0 to 0.2 €/l. For the distributors, AV average score is worth 4.4, which means a negative value between 0 and -0.2 €/l; this can be traced to the fact that the distributors purchasing prices were estimated based on the processors sales prices, since it was not possible to get them directly from the distributors due to confidentiality factors. The producers' productivity performance is the lowest with 2.5, which means a range between 2.5 and 5 T/WFU, as for the processors and the distributors; the averages are close (6.6 and 6.9) and thus range between

50 and 100 T/WFU. Processors show a negative growth performance (score: 3.4) as for the distributors (score: 4.0)

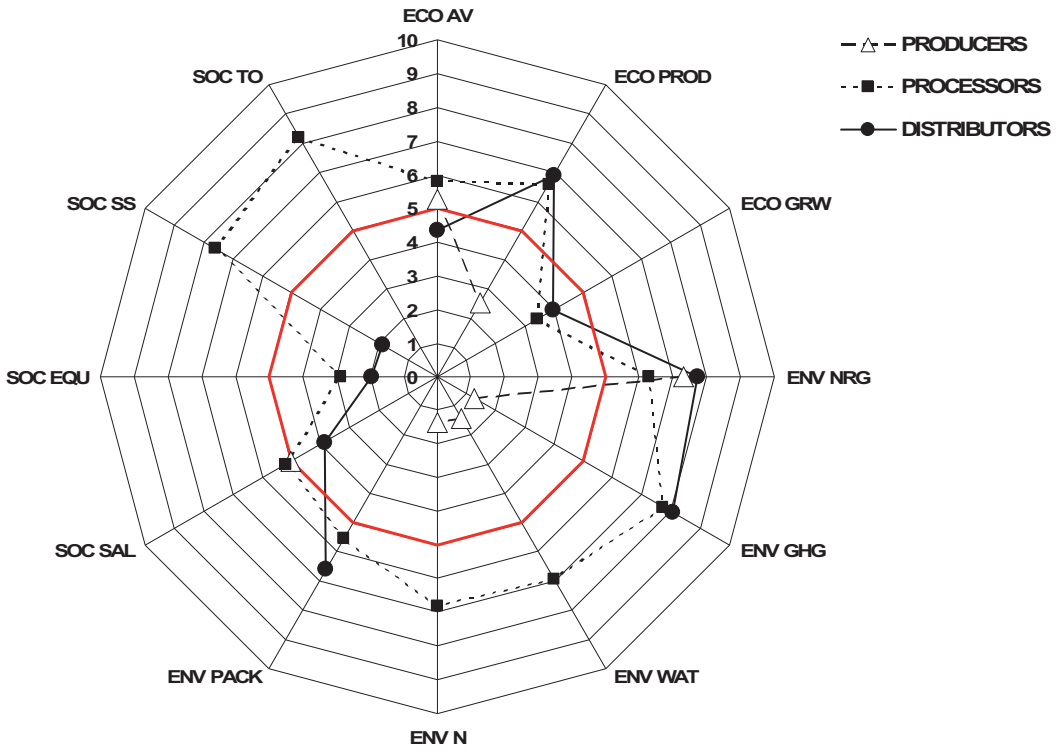

Figure 4. Sustainability indicators overall scores by actor (Producers, Processors and Distributors)

Environmental level

The producers' overall values are high for GHG (20-40 g/l), WAT (50-80 l/l) and N (200-400 g/l). As for energy consumption (NRG), there isn't a large difference between the three actors with values ranging between 1.5 and 2.5 MJ/l. Packaging material production ranges between 6 and 10 g/l.

Social Level

Salaries of producers (5) and processors (5.2) are slightly higher than the minimal wage. The processors' and distributors' employees dominating gender is male (80-85%), since it is a physically demanding job. The social security is one of the major indicators of social status and job stability; for the processors, the percentage of NSSF affiliates ranges between 80 and 85%, which means that this industry provides a large number of long term work opportunities for the local community. As for the distributors' employees the ratio is only between 40-50%, mainly for the large distributors' employees. As for the processors employees' turnover rate, it ranges between 10-15%, which is another indicator of the positive social conditions provided by the dairy processing work opportunities.

Consumers

The role played by consumers in the supply chain is crucial since the purchasing behaviour is the basis for setting and updating production and marketing strategies; therefore, it is important to study the behaviour's determinants, and the consumers' conception of small ruminant farms sustainability.

Purchasing behaviour determinants

In this section the consumers' frequency of consumption for 15 small ruminants dairy products are analysed according to the above mentioned socio-economical and regional parameters. The analysis showed that sheep and goat milk, yoghurt, Labneh, olive oil preserved Labneh and preserved Baladi cheese are frequently consumed in poor areas. Traditional sheep cheese (Baladi) is evenly consumed in almost all regions but is more frequently consumed in poor areas; traditional goat cheese, on the other hand, is less consumed. Halloumi, Double Cream and Akkaoui cheeses are consumed in middle

class and comfortable areas on a weekly basis. Widely distributed products across the different classes are Kesheck and Chanklich, probably due to their long periods of storage. Considering the regional distribution, the products consumed mostly in the Bekaa, considered as the country's dairy centre, are sheep milk (54%), goat milk (59%), sheep yoghurt (48%), goat yoghurt (40%), sheep Labneh (43%), goat labneh (53%). The cheeses mostly consumed in urban areas are Halloumi (72%), Double Cream (72%), Akkaoui (70%), and Chanklish (74%).

Sustainability conception

It is important to note that over 43% of the interviewees have a frequent contact with small ruminants' farms and 17% have a rare contact, while over 40% have never had any sort of contact with these farms. On the economic level, over 73% think that the farmers' economical situation is good, 4% that it is acceptable and 19% that these farms suffer from economic problems. On the sociological level, over 45% think that the farmers are not well established in the society, 21% think that their situation is acceptable and 32% think that their social situation is good. At the environmental level, the survey showed that consumers' knowledge over the influence of small ruminants farms is very limited; most of them think they have now influence over erosion, biodiversity, atmospheric pollution and global warming, and a large part think that they have a positive effect over vegetation. Finally, over 86% of the interviewed consumers didn't have any conception of the sustainability concept, but, when explained to them, they expressed their will to pay extra for products from sustainable production farms.

Discussion

Environmental impact of producers is high because the animals have an effect on water consumption, gas emissions and nitrogen effluents all year long, whereas their milk production is only a seasonal activity. The producers' low productivity performance, which ranges between 2.5 and 5 T/WFU, is mainly due to the fact that milk production systems are mainly extensive systems, and thus requiring a large number of working hours from breeders. Size has definitely a positive influence on the overall processors performance; however, they mostly show a negative growth performance, ranging between -0.5 and -0.1 %, which is due to the illegal competition from smaller undeclared processors and the unfair competition due to the open market strategy. Processors also show a high productivity performance since they are businesses specialized in dairy production. There is a striking difference between the hypermarkets and the grocers' performances, which is probably due to the relatively recent expansion of hypermarkets and their influence on small businesses.

Overall, energy consumption isn't very different between the three actors with values ranging between 1.5 and 2.5 MJ/l, however, its environmental impact, especially for electricity is very high, due to the fact that over 96% of electricity production in Lebanon is based on the thermal conversion. The solution would be to replace the current energy sources with more sustainable ones, but since it is a long term project, it might be interesting to focus on low energy consuming technologies. Packaging material production ranges between 6 and 10 g/l, but what is really dangerous is that most of the packaging material is part of the polypropylene or polyethylene family, with a complete absence of recycling activities for these two materials.

The socio-economical distribution of small ruminants' dairy consumption shows a clear relation between the consumption of short shelf life products such as milk, yoghurt and Labneh and the poor regions, which are at the same time the regions of their production, probably due to their short expiry date. On the other hand, products such as Halloumi, Double Crème and Akkaoui cheeses are consumed in urban middle class and comfortable areas on a weekly basis, mainly because of their convenience and the possibility of fairly long storage both for distributors and consumers. Moreover, the consumption of Kesheck and Chanklich which can withstand even longer storage periods is distributed along all socio-economical and regional classes. Therefore, convenience is clearly a major issue, and it is important to make small ruminant dairy products available for the urban market for the longest period possible by increasing their shelf life, considering that this market represents 85% of Lebanon's population and holds the highest purchasing power. Using preservatives would certainly enhance the availability of these products in urban areas; however, it is important to use them without affecting their traditional aspect. This study also showed that the consumers' conception of sustainability is weak especially for farming systems, and that they are not aware of the problems these farms are facing; therefore it is important to improve the consumers' conception of sustainability

and make them aware of the problems the farms are facing to increase their feelings of social responsibilities.

Several methodologies have been used in environmental studies of hard systems, including life cycle assessment (LCA), material flow accounting (MFA), and substance flow analysis (SFA), (Sonesson and Berlin, 2002), whereas our method adopts a more global approach to cover the economical and social levels as well. Life cycle assessment (LCA) is a method to identify and quantify the environmental performance of a process, it provides a quantitative basis for assessing potential improvements in environmental performance of a system throughout the life cycle. It is based on setting boundaries for each level and following the input and output evolution at each level. In our case the environmental level is only one of the analysed facets, and we adopted a more global approach including two more facets, the economical and social sustainability levels.

Yakovleva and Flynn (2004) aimed to establish linkages between innovation and sustainability of the food system by mapping of chicken supply chains and exploring inputs and outputs of the systems which have important implications for the sustainability. In their approach, relying on statistical information provided by official data sources; they showed that the whole supply chain is subject to a huge pressure from the retailers, which is reflected on every level of the supply chain. In the Lebanese case, the hypermarkets only entered the market a few years ago and though they are gaining a larger market share and negatively affecting the status of smaller distributors, they still don't have the same extent of influence. Both our findings agree on the importance of convenience of products in an increasingly industrialised and global world. Yakovleva's findings concerning the societal concerns are completely the opposites of ours, where the western concerns over animal welfare and quality of life and even environmental impact are limited. Their approach insists on the importance of innovation in increasing the variety and qualitative aspects of the products in order to cater for the retailers' requests; in our case, the quantitative facet of production is still an important issue and such innovations might alter the traditional aspect of the small ruminants' dairy products. However, it is important to work on finding solutions for increasing the expiry date of products, since the availability of these products is a major drawback. The innovations in our case must also target the farms where the productions' seasonality is also a major drawback.

Conclusions

According to this study, the small and medium sized processors need further investments which would carry the local dairy industry to higher level of diversification and technological advances. The introduction of recyclable packaging material would bring a major improvement to this sector where almost all packaging material used on the processors' and distributors' levels are non recyclable.

It is clear that convenience is of major importance to the distributors and consumers, which presents the fermented Chanklich cheese and the dehydrated Kesheck as important products and potential candidates for further development. The inclusion of preservatives to the other products will certainly increase the expiry date but it might also harm their traditional image.

Finally, it is recommended for the above results to be used in setting a new labelling scheme based on the sustainability criteria and that simulation of potential changes are tested before they are applied to the local small ruminants dairy supply chains. The application of such labelling schemes would provide a guarantee for consumers and a framework for developing the sustainability of the whole supply chain.

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