Environmental, social and economic aptitudes for sustainable viability of sheep farming systems in northern Spain

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Abstract: Overall assessment of farming systems is an issue necessary to take into account due to multiple interactions in agriculture sector. Several studies have appeared the latest years trying to measure sustainability in one of its dimensions (environmental, social, and economic), or all together in order to give an answer to society demands for one hand and farmer's needs for the other.

The main objective of this study is to find strengths and weaknesses of traditional milk sheep production in the Basque Country comparing with intensive farms that have emerged recent years, as well as trying to trace correlations between different indicators of sustainability.

Economic, social and environmental indicators have been studied, in different categories. These indicators have been combined into a single index of sustainability (numerical integration) to every dimension, to present together into three diagrams (visual integration).

This study shows preliminary results of an integrated study of environmental, social and economic aptitudes of sheep farms in the Basque County (Northern Spain) through a set of indicators and possible interactions between them. A holistic view of farms will improve viability options for survival of farms, as well as seeing correlations between social, economic and environmental aptitudes to adapt farms and farmers to new challenges.

Keywords: sheep farming, sustainability, indicators, multicriteria

Introduction

Livestock sector has been coping with different problems that have been put against it, especially with climate change issues. There is a need in livestock sector stakeholders (policy makers, scientists, farmers…) to bring economic, social and environmental consequences of livestock agriculture(Gill *et al.* 2010)

Sheep farming is a livestock sector predominating in the Mediterranean basin, and contributed, not only in the economic sector of the livestock sector, furthermore, they have influence, into the environment, and social activity especially in rural areas (de Rancourt, *et al*. 2006, Faye and Konuspayeva 2012) and it's important to evaluate and take into account not cattle dairy sector in the studies of sustainability. The importance of this kind of farms are not only in terms of production, also in terms of cultural, economic and ecological interest (Faye and Konuspayeva 2012).

The viability of farms towards a long term future is needed to tack in a wide point of view, especially for those kinds of farms which are weakness in economic terms, but they have a really important contribution to rural areas and to society in general.

Sustainability assessment has been a target in many research works latest years in order to identify the role of these production systems. The use of indicators has been a wide extend method to tackle the study. For environmental assessment life cycle assessment (LCA) hs become recently the method most extended, using different indicators categories (global warming, land use, energy use, and eutrophication and acidification potentials. It has been applied in sheep farming systems in Sweden (Wallman, *et al*. 2011),in Spain (Ripoll-Bosch, *et al.* 2013) and Wales (Edwards-Jones, *et al.* 2009). Nevertheless, this methodology doesn´t incorporate social or economic aspects in the assessment. Several approaches, with the use of indicators have been appeared in literature latest year, with a holistic point of view of systems: MESMIS (López-Ridaura, *et al.* 2002), MOTIFS (Meul, *et al.* 2008), IDEAS(Zahm, *et al.* 2008) , and other multicriteria studies (Bernués, *et al.* 2011). There are some studies in Spain, evaluating small ruminants systems using MEMIS approach (Nahed, *et al.* 2006, Ripoll-Bosch, *et al.* 2012).

The main objective of this study is to find strengths and weaknesses of traditional milk sheep production in the Basque Country comparing with intensive farms that have emerged recent years, as well as trying to trace correlations between different indicators of sustainability, and put in relevance the importance which those farms have for society, because they use public resources which bring better viability taking into account a multicriteria perspective.

Sheep farming in the Basque Country.

Primary sector in the Basque Country has no relevant economic importance, less than 1% of GDP (EUSTAT, 2011). Nonetheless, cheese production and sheep farming have a strong link between society construction and territorial identity (Mauleón, 2009). Sheep farming is one of the most relevant animal productions in this territory. Although its quantity importance is relative (22% of farms), it has an importance on quality, relative to production of cheese with PDO “Idiazabal”, and using of permanent grasslands with pasture activities and maintenance of rural and less favorable areas.

Approximately, 54% of cheese production, it is made in farms directly by farmers. A study relative to sustainability of cheese production in the Basque Country (Ruíz *et al*, 2011) showed the 18% decreased of local breeds flocks (Latxa and Carranzana) in the period 1999 – 2009, due to the emergence of flocks with foreign breeds, and the abandonment of the activity.

Material and Methods.

Indicator framework is based on a previous work made from dairy farm and a extended list of 127 indicators to sheep farming. (Arandia, *et al.* 2011); Batalla, *et al,* 2013). The set of indicators have been listed thought multidisciplinary discussion groups with experts in different contexts for sheep farming in Mediterranean basin. All the indicators agreed have been combined into a single index of sustainability (numerical integration) in several dimensions, to present together into three diagrams (visual integration).

Every dimension is a composite index, with a specific weight of a set of indicators selected by the discussion groups. Every indicator takes a value into scores between 0 (indicating a worst-case situation) and 10 (indicated assumed maximum sustainability), the range to give a mark for every indicator come from, average national ranges, historical data from the technical advisory center and for groups of experts, depending in each indicator. For each indicator, we converted the value into 0-10, by using the results of the lowest-performing and best-performing farm as benchmark values. This choice of benchmarks was made based on the validation results, using 10% best performing and 10% lowest performing farms as benchmarks. The dimensions of every sustainable aspect are an integrated index, with a weight of every indicator of that dimension, and also, take values with scores between 0 and 10.

$$\boldsymbol{DIMENSION\ (0-10)} = \sum_{i=0}^{n} \boldsymbol{Value\ of\ indicator \cdot Weight}$$

Once numerical integrations are done, and every dimension has its numerical value, results will be show through AMEBA graphics to get a visual integration of all of them.

Following tables (table 1, 2 and 3) display every dimension study with the indicators consensual.

Table 1. Economic indicator values for sheep farms

Dimension	Indicator	Dimension	Indicator
Profitability	Net Margin/ Family manpower unit Family Labor Income/Family man-power unit Labor Income/ Hour Net margin/liter of milk Gross margin(without sub-sides)/sales Gross margin/ Gross product Net Margin (without subsi-dies)/sales Net Margin/Gross Product	**Cost structure**	Structural cost/Total production Structural cost/LSU[1] Costs and volatility Costs and prize final product
Diversification of activity	Production variability Number of customers per type of production Importance of the production with the largest share Feed prizes (stability) Financial risk Production variability	**Stability**	Gross Margin stability Net Margin stability Final product price sta-bility
Self-sufficient	Autonomy without subsidies Financial autonomy Feed autonomy Manpower autonomy Surface area autonomy		

[1] LSU : Livestock unit.

Table 2. Environmental indicator values for sheep farms

Dimension	Indicator	Dimension	Indicator
Energy	Total energy consumption/ha Total energy consumption/manpower unit per year Total energy consumption/net margin Energy Efficiency (including feed energy) Energy efficiency Use of Renewable energy Total energy consumption/liter of milk	**GHG emissions**	Kg CO2 eq/ha Kg CO2 eq/manpower unit per year Kg CO2 eq/Net Margin Kg CO2 eq/liter of milk
		Natural elements and biodiversity	% natural habitats in the farm surface % natural habitats off the farm (use for pasture) Ecotones. Number of crop species Other elements in the farm with high ecological value Threatened or endangered species. Native species.
Nutrient balance	N "SURPLUS"/Ha N "SURPLUS"/1000 l milk N "SURPLUS"/100 Kg meat Efficiency N P_2O_5 "SURPLUS"/ha P_2O_5 SURPLUS/1000 L milk P_2O_5 SURPLUS/100 Kg meat P_2O_5 Efficiency	**UAA[2] uses and management**	%UAA of permanent pasture %UAA temporary meadow % UAA annually sown % UAA under irrigation % UAA treated with pesticides % UAA receiving organic matter Sustainable management of UAA
Waste analysis	Lung and slurry pit capacity (law indicators) Rainfall collection Recycling other waste in the farm. Wastewater collection after cleaning	**Livestock census and lane base**	LSU/ha UAA Kg organic N/UAA LSU/forage surface area % use of own forage. Feed autonomy Use of commons or other Natural Areas.

[2] UAA. Utilized Agriculture area. LSU: Livestock unit.

Table 3. Social indicator values for sheep farms

Dimension	Indicator	Dimension	Indicator
Job characteristics	Professionalism Sex (% women) Age % manpower< 40 years Social economy Continuity Family farming	**Work quality**	Independent decision-making Ergonomic and psycho-sociological quality Personal assessment Hours worked Level of work concentration
Job creation	Land occupation (UAA/manpower unit) Tangible assets/manpower unit (familiar) Dependency to subsidies Liters necessary per Reference Rent	**Animal welfare**	Frequency of visits to the farm Grazing Housing Livestock movement Animal health
Quality of life	Time availability Training and education Free days/ week Holidays (days/year) Personal assessment	**Landscape and tradition**	LIVESTOCK MOVEMENTS * Transhumance * Use of communal areas and Natural Parks. * Pasture practices. APPRECIATION OF SUR-ROUNDINGS * Crops chromaticism * Other uses of natural re-sources (popular knowledge) * General environmental keeping BREEDS * Endangered species breeds *Local breed.
Product quality and nearness to consumer	Microbiological requisites DO/PGI Other certifications Absence of GMOs in concentrates Complementary activities (agro tourism, visits…) Way of marketing		
Gender	Feminization index Employment status of women Continuing education gender gap Female participation decisions Grade satisfaction of women		

[2] UAA. Utilized Agriculture area

To tackle with the objective of this study, and focus on the strength and weaknesses of traditional sheep milk in Northern Spain, 12 sheep farms from the Basque Country have been analyzed. Main technical characteristics are showed in Table 4.

Table 4. Main technical characteristics of farms analyzed in this study.

Indicator	Average value FOREIGN BREED	Average values LOCAL BREED
Farms	3	9
Farm size (ha)	101.79	78.21
% grassland	71.05%	98.65%
Manpower	2.33	1.94
Herd size	628.34	247.5
kg concentrate year	103,681.6	59,855.71
kg fodder year	90,363.3	29,761
Kw h/year	13,818.86	6,220.92
Liters oil/year	4,521.6	4,588.31
Liters year/ewe	363.72	149.7
% time on pasture	0%	48.5%
% farms producing cheese	0%	55.5%
kg concentrate year/ewe	287.8	251.9
kg concentrates/liter milk produced	1.27	1.61
Lamb sold/ewe	0.56	0.77

Results

Primary results from the study case of 12 farms can be found in Table 5. Lowest, average and highest dimensions values obtained in the study can be found.

Table 5. Dimension values for sheep farms

Dimension	Lowest value	Average value	Highest value
ENVIRONMENTAL	4,4	6,0	6,9
Livestock census and lane base	0,6	2,2	4,1
UAA uses and management	4,7	6,4	8,0
Nutrient balance	5,0	6,3	8,4
Waste analysis	7,5	8,8	10,0
Natural elements and biodiversity	1,2	6,4	9,4
Energy	1,2	3,3	6,1
GHG emissions	7,8	8,7	9,6
ECONOMIC	3,1	6,1	7,5
Profitability	0,7	7,6	10,0
Self-sufficient	5,0	6,9	8,0
Diversification of activity	0,7	5,6	7,0
Cost structure	0,7	3,7	5,0
SOCIAL	4,6	5,9	7,3
Job characteristics	4,0	6,0	8,0
Job creation	0,5	2,3	4,8
Quality of life	3,5	7,1	8,8
Work quality	3,4	6,1	8,4
Animal welfare	5,5	8,8	10,0
Landscape and tradition	5,5	8,8	10,0
Product quality and nearness to consumer	1,0	5,2	8,0
Gender	0,0	3,3	6,0

We have divided farms into two groups, the former (n=3) correspond to more intensive farms of foreign breeds, latter (n=9) represents traditional farms (local breeds), some of them produce their own cheese, other ones sell milk to industry.

Figures 1 and 2 show the visual integration of the indicators through AMEBA graphics for these two types of farms. Lower values of the indicator are closer to the center of the graphics. In general, highest global values of sustainable indicators correspond to traditional farms. Biggest differences can be seen in social indicators. Also, at first sight, economic values for traditional farms are seen highest, due to these ones sell directly cheese to consumers and Net Margin/liter milk are higher. Intensive farms have highest indicators values for emissions per ha, emissions per liter of milk, yields, etc… Figure 2 present the values for social, economic and environmental indicator of the two types of system studied. It is possible to see differences between them, and how local breed production systems are more separated of the center of the graphic, which that means, are more closer to sustainability aptitudes than the other ones. Nevertheless further analyses are needed.

Figure 1. Visual integration of sustainable indicators thorough AMEBA graphics.

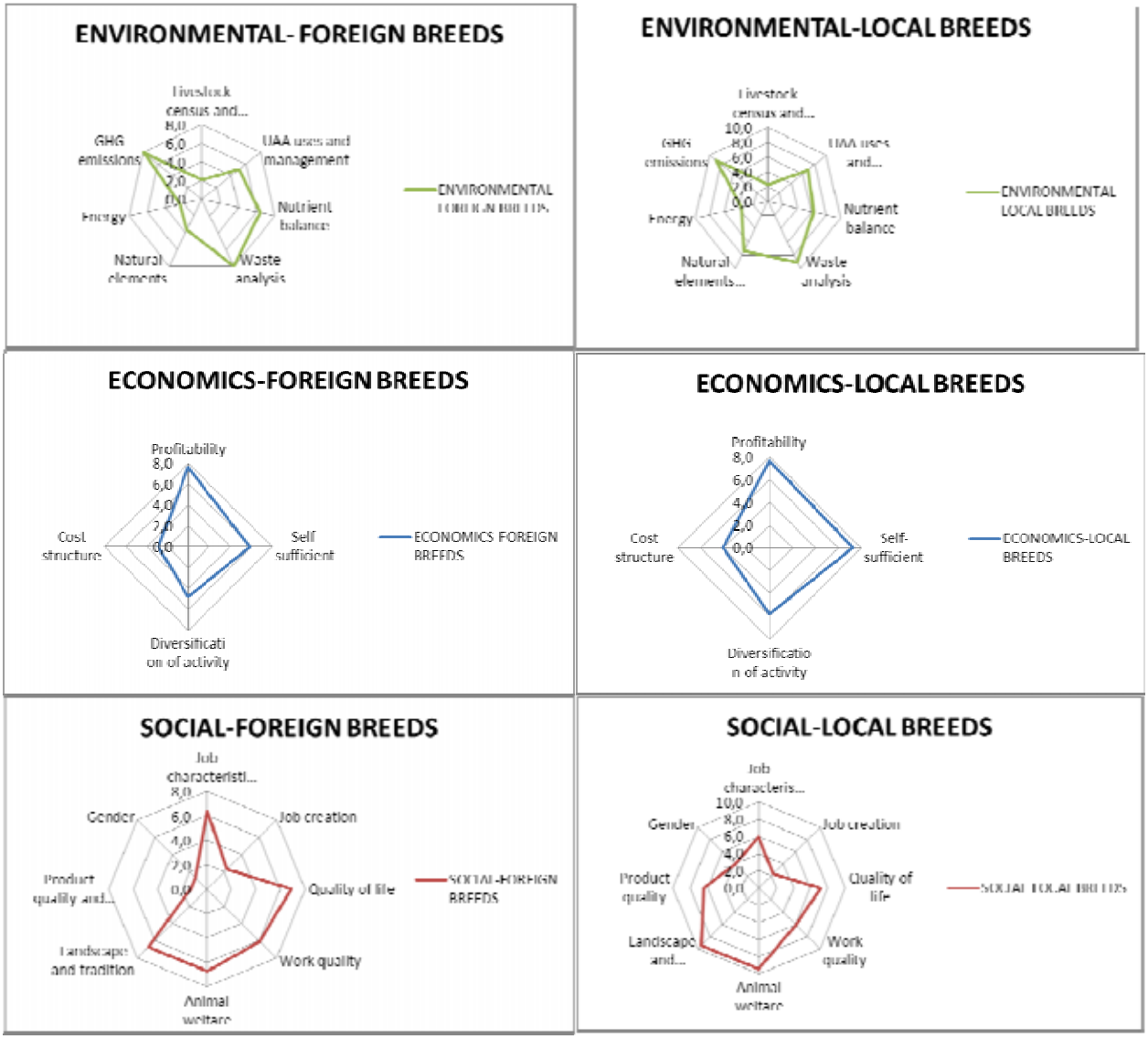
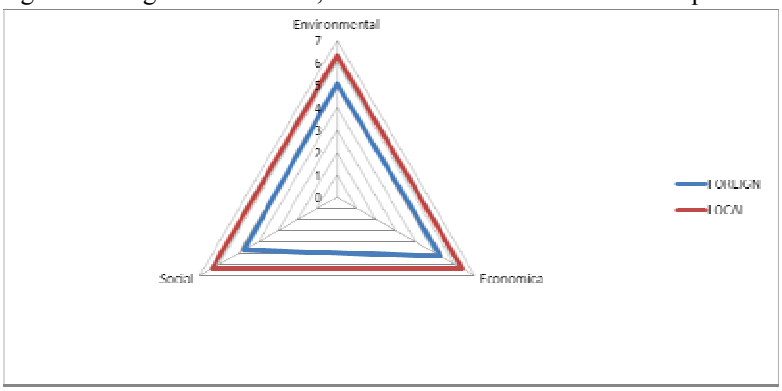


Figure 2. Integration of social, economic and environmental complex index.



These first results of this approach have been helpful to have a preliminary whole vision of milk sheep sector in the Basque Country. A SWOT matrix summarizes these results, and it will be first step to continue working on the sustainability assessment of the sector. SWOT matrix can be found in Table 6.

Table 6. SWOT analysis for traditional sheep sector in Northern Spain.

STRENGTHS (internal facts)	WEAKNESSES (internal facts)
- Quality products. (PDO "Idiazabal") - "How-know" - Family farms - Traditional cheese/ more profitably activity when farmer produces it in the farms (no to industry) - More value of quality of life this kind of farmers. - Women in these farms have an important role in making decisions.	- Low and seasonal productivity of local breeds. - High hour/Man Work Unit - Low generational relay. - No pasture practices for intensive farms. - Low profit.
OPPORTUNITIES (external facts)	THREATS (external facts)
- Environmental friendly practices. - Short food chains (local markets). - Prize of cheese in markers. - Greening of the CAP. (Supporting permanent grasslands) - Common grasslands(property right for common goods) - Enhance of familiar agriculture	- Abandonment of rural areas/activities. - Less favourable area. Mountains area. - Underestimate role of farmers in rural areas. - Finish public subsides. - Decreased number of farms last years.

Conclusions

The awareness from a development of a sustainable farming practices is one of the main objectives for stakeholders: consumers want environmental friendly products, farmers need to understand their weakness specially relative to economic viability of their farms, and policy marker are working to maintain rural areas in Europe with population, and need to justify public budget for that purpose. On that way it is important to define sustainability towards developing concrete tools for measuring and promoting achievements in sustainability. In fact, sustainability need to be defined in order to be measure easily to focus on look for a way to work on improve it. Indica-

tors are a good approach to integrate the three pillars, and make sustainability assessment more tangible and easy to monitoring year by year.

This study shows preliminary results of an integrated study (in course) of environmental, social and economic aptitudes of sheep farms in the Basque Country through a set of indicators and possible interaction between them. A holistic view of farms will improve viability options for survival of farms, as well as seeing correlations between aspects to adapt farms and farmers to new challenges, and support local productions with strong links to rural culture.

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