Sustainability evaluation of sheep farming systems in the Sierra y Cañones de Guara Natural Park (Spain)

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Sustainability evaluation of sheep farming systems in the "Sierra y Cañones de Guara Natural Park" (Spain)

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Abstract. The sustainability of agriculture is considered essential for its implications with the biosphere and human food. To assess the sustainability of agricultural systems various methodologies have been developed. Usually, the three functions; environmental, economic and social developed for agro-ecosystems are considered. The aim of this paper was to analyse the sustainability of sheep farming systems using the "Sierra y Cañones de Guara Natural Park". Based on a typology of these sheep farming systems, a direct survey on eleven sheep farms representing the four types of sheep farming system established was carried out. For each farm several indicators of sustainability were designed, according to the SAFE framework. The sheep farms that were large in size, had big flocks and widely available grazing areas were economically and socially very sustainable, whilst the smaller sheep farms, with relatively important cereal production, and smaller flocks, were also very socially sustainable.

Keywords. Sustainability – Mediterranean mountain areas – Sheep farming systems – SAFE.

Évaluation de la durabilité des systèmes d'élevage ovin du "Parc Naturel de la Sierra y Cañones de Guara " (Espagne)

Résumé. *La durabilité de l'agriculture est considérée comme essentielle pour ses implications avec la biosphère et l'alimentation humaine. Pour évaluer la durabilité des systèmes agricoles, diverses méthodes ont été développées. Habituellement, les trois fonctions, environnementale, économique et sociale, développées pour les agro-écosystèmes, sont considérées. Le but de cet article est d'analyser la durabilité des systèmes ovins qui utilisent le Parc Naturel "Sierra y Cañones de Guara". Sur la base d'une typologie de ces systèmes d'élevage, une enquête directe sur onze exploitations représentant quatre types de systèmes d'élevage a été effectuée. Pour chaque exploitation, plusieurs indicateurs de la durabilité ont été élaborés, selon le cadre SAFE. Les exploitations ovines ayant une grande taille, de grands troupeaux et une disponibilité élevée de zones de pâturage, ont une plus grande durabilité économique et sociale. Alors que les exploitations ovines avec une taille plus petite et une certaine importance des céréales, ont également une durabilité sociale élevée.*

Mots-clés. *Durabilité – Montagne méditerrannéenne – Systèmes ovins – SAFE.*

I – Introduction

The sustainability of agriculture is considered essential for its implications with the biosphere and their role in the human food. Their sustainability is linked to the development of a quality environment and quality natural resources on which it depends, provides food for human consumption, economically viable while improving the quality of the farmer´s life and society as a whole. These features should be long term and using appropriate technology and practices which result in an equitable distribution of costs and benefits.

To evaluate the sustainability of farming systems several methods have been proposed. The SAFE is a method to assess the sustainability of agricultural systems proposed by Van

Cauwenbergh *et al.* (2007). This method proposes a framework of principles, criteria and indicators classified into three pillars: economic, social and environmental, related to the agro-ecosystems functions. The economic function is concerned essentially to the economic viability of these systems, and in many cases a necessary condition for other issues addressed in the social function. The social function of agro-ecosystems may concern both at farm level (quality of life of the farmer and his family) as a social level (demands or social concerns). The environmental function is related to the management and conservation of natural resources and fluxes within and between these resources.

The aim of this paper was to analyse the sustainability of sheep farming systems using the "Sierra y Cañones de Guara Natural Park" (SCGNP).

II – Material and methods

The sheep farms that used the grazing areas inside the "Sierra y Cañones de Guara Natural Park (SCGNP)", located in the central area of the province of Huesca (Spain) were studied. From a direct survey conducted among the holders of all sheep farms (54) using the SCGNP, a typology based on structural variables, location in the SCGNP and availability of grazing resources was established for the characterization of sheep farming systems by means of the multivariate statistical methods (Bernués *et al*., 2004). We obtained four groups of farms or types of sheep farming systems. Subsequently, we conducted a survey, in 2002, in depth to the owners of 11 sheep farms representative (case studies) of the four types of sheep systems. Likewise, we used information from 2007-2008 survey which collected information about the changes in the farms since 2000 and farmers' opinions, attitudes and goals. For each representative farm of the types of SCGNP sheep farming systems various indicators of the sustainability of these systems were developed, using the SAFE method. Indicators related to the three pillars were calculated for each representative farm. To select economic indicators finally used, we calculated the correlations between some of them, eliminating those that had a high degree of correlation and had a similar meaning. All the indicators calculated, qualitative and quantitative, were expressed on a scale of 1 to 5, lowest to highest contribution to the sustainability of the systems, so that 1 is the least favorable value for farm sustainability and 5 is the most favorable value. For some of them a score of 5 would coincide with the lowest value, as the case of those related to external dependency (Livestock Variable Costs/Ewe and %Subsidies/Farm Net Value). Finally, considering that the contribution of the indicators to the sustainability of the farm is not the same, they were weighted in relation to their importance, based in the opinion of experts consulted.

III – Results and discussion

Groups 2 and 1 presented the highest degree of economic sustainability (Table 1). When individual farms were analyzed, there was some diversity of situations within the farm groups. The farm 4 of the Group 2 showed the highest economic sustainability, but, in the same group the farm 6 showed a low average value (2.57), in relation to the farms of other groups (Fig. 1). Both farms were large scale of herd size, but farm 6 had more labour availability, 3 Annual Work Unit (AWU), and the area under cereals was important. Also the Utilized Agricultural Area (UAA) of the farm 4 was located almost entirely within the Park; however the farm 6 had all the UAA in the Peripheral Protection Zone (PPZ).

Table 1. Weighted average values of the economic sustainability of SCGNP sheep farming systems

	Agricultural Output (TAO)/Ewe	Livestock Variable Costs/Ewe	Total A. Output/ Total Costs	Farm Net Value (FNV)/AWU	%Subsidies/ Farm Net Value	Agricultural activities diversity	Age and number of folds	Quality productions	Marketing relations	Economic sustainability indicator
Weighting (%)	7	11	7	22	18	7	7	14	7	100%
Group 1										
1	0.07	0.54	0.21	0.21	0.54	0.21	0.21	0.14	0.21	2.36
2	0.21	0.43	0.14	0.64	0.54	0.14	0.36	0.71	0.36	3.54
3	0.29	0.32	0.21	0.86	0.71	0.29	0.29	0.14	0.36	3.46
Group average										3.12
Group 2										
4	0.36	0.43	0.29	1.07	0.71	0.07	0.14	0.57	0.36	4.00
5	0.21	0.32	0.14	0.86	0.36	0.14	0.21	0.57	0.36	3.18
6	0.07	0.21	0.14	0.43	0.36	0.29	0.29	0.43	0.36	2.57
Group average										3.25
Group 3										
7	0.14	0.21	0.07	0.64	0.18	0.21	0.07	0.43	0.36	2.32
8	0.14	0.11	0.14	0.43	0.54	0.29	0.36	0.14	0.14	2.29
9	0.14	0.43	0.21	0.21	0.71	0.36	0.29	0.43	0.07	2.86
Group average										2.49
Group 4										
10	0.29	0.43	0.36	1.07	0.89	0.36	0.07	0.14	0.14	3.75
11	0.21	0.32	0.07	0.21	0.18	0.29	0.14	0.14	0.36	1.93
Group average										2.84

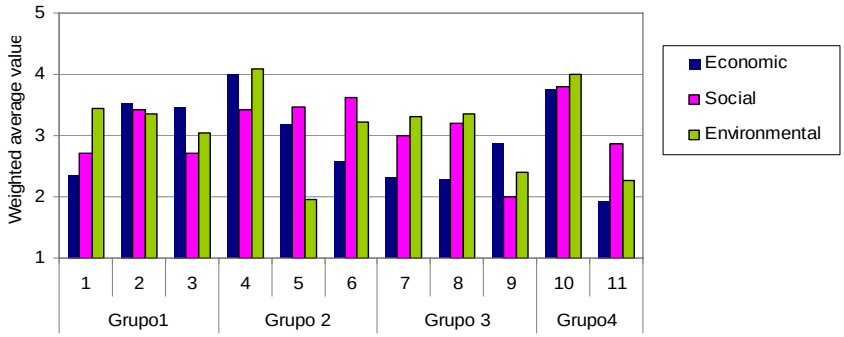

Fig.1. Weighted average values of sheep farms sustainability.

In the Group 3, that was the least sustainable from an economic perspective, the farms also had low average values of economic sustainability. However, in the Group 4, farms presented very different values. Thus the farm 11 was the least sustainable, mainly due to the low productivity

of labour (FNV/AWU), economic efficiency (TAO/ Total Costs) and their high dependence on subsidies. This farm had a small flock (420 ewes); the area under cereals was important and only 15% of their UAA was located in the PPZ. Instead, the farm 10 had a high average value of economic sustainability, as a result of higher productivity of labour, higher economic efficiency and reduced economic dependence on subsidies (%Subsidies / FNV). This farm had also a small flock, but the physical size and dry grasslands availability were higher.

Sheep farms in Group 2 also had a high weighted average value of social sustainability (Table 2). Mainly because they had a high family income, a high degree of family contribution to the farm work and the farm continuity was assured.

Table 2. Weighted average values of the social sustainability of SCGNP sheep farming systems

	Farm continuity	Education level	Family contribution to farm work	Holidays	Distance to service centre	Associations	Family income per capita	Animal welfare	Social sustainability indicator
Weighting %	17	17	17	4	16	8	17	4	100%
Group 1									
1	0.33	0.83	0.17	0.08	0.16	0.33	0.67	0.13	2.70
2	0.33	0.83	0.83	0.13	0.32	0.33	0.50	0.13	3.41
3	0.50	0.67	0.33	0.08	0.32	0.33	0.33	0.13	2.70
Group average									2.93
Group 2									
4	0.33	0.50	0.67	0.21	0.48	0.25	0.83	0.13	3.41
5	0.67	0.17	0.67	0.13	0.66	0.25	0.83	0.08	3.45
6	0.50	0.67	0.50	0.21	0.48	0.42	0.67	0.17	3.62
Group average									3.49
Grupo 3									
7	0.50	0.50	0.17	0.21	0.82	0.42	0.33	0.04	3.00
8	0.50	0.50	0.50	0.21	0.82	0.17	0.33	0.17	3.20
9	0.17	0.33	0.33	0.21	0.16	0.25	0.33	0.21	2.00
Group average									2.73
Grupo 4									
10	0.50	0.83	0.67	0.17	0.66	0.25	0.50	0.21	3.78
11	0.14	0.21	0.29	1.07	0.70	0.21	0.07	0.14	2.85
Group average									3.31

The analysis of the social sustainability into the farm groups also showed some variability among the farms. The farm 10 (Group 4) presented the greatest average value of the social sustainability. However, the farms more sustainable from a social perspective were included in Group 2. The farm 9, belonging to Group 3, was the least sustainable. This farm had not ensured the continuity; the farmer's education level was low and the farm was located far from the service centre. Besides, this farm had a small flock size and a low labour availability.

The Group 1 was the most sustainable from a environmental perspective, however the average values of environmental sustainability were very similar among the groups (Table 3). With regard to individual farms, the farms 4 and 10, showed the highest average value of environmental sustainability indicator. However, the farm 5, belonging to Group 2 was the least

sustainable from an environmental perspective. This farm had a large flock size (1,700 head), and had not surface into the park or in the PPZ.

Table 3. Weighted average values of the environmental sustainability of SCGNP sheep farming systems

	Grazing Length	Eco-legal farm situation	Availability of grazing areas	Agrochemical costs/ ha	Fuel costs / ha	Diversity of crops	Environmental Sustainability Indicator
Weighing %	23	9	18	18	18	14	100%
Group 1							
1	0.68	0.45	0.55	0.55	0.55	0.68	3.45
2	0.23	0.09	0.91	0.73	0.73	0.68	3.36
3	0.45	0.09	0.73	0.55	0.55	0.68	3.05
Group average							3.29
Group 2							
4	1.14	0.45	0.55	0.91	0.91	0.14	4.09
5	0.45	0.36	0.18	0.36	0.18	0.41	1.95
6	0.91	0.36	0.18	0.55	0.55	0.68	3.23
Group average							3.09
Grupo 3							
7	1.14	0.45	0.36	0.55	0.55	0.27	3.32
8	1.14	0.45	0.55	0.36	0.18	0.68	3.36
9	0.45	0.09	0.36	0.55	0.55	0.41	2.41
Group average							3.03
Group 4							
10	1.14	0.09	0.91	0.73	0.73	0.41	4.00
11	0.91	0.09	0.36	0.18	0.18	0.55	2,27
Group average							3.14

IV – Conclusions

(i) The choice of sustainability indicators and their weightings are the key in the study of the systems sustainability.

(ii) It would be necessary to have reference values of the indicators of sustainability, so that we could compare with other sheep and to determine threshold levels of indicators of sustainability of the systems.

(iii) However, it must consider the impasse in many cases to proceed in this way, especially with regard to social and environmental indicators taking into account that sustainability must be measured not forgetting the context and in particular territory or agro-ecosystem in which they settle.

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Acronyms and abbreviations

Annual Work Unit (AWU) corresponds to the work performed by one person who is occupied on an agricultural holding on a full-time basis.

Utilized Agricultural Area (UAA) describes the area used for farming.

Farm Net Value is the total value of crop and livestock production (sales and on-farm consumption), less the variable costs of production for the average household.

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