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A SUSTAINABILITY ASSESSMENT OF ORGANIC DAIRY SHEEP SYSTEMS IN CASTILLA LA MANCHA (SPAIN)

Sustentabilidad del sistema ovino ecológico lechero en Castilla La Mancha (España)

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ABSTRACT

Sustainability of the organic farming dairy sheep systems in the central region of Spain (Castilla-La Mancha) has been assessed using an adaptation of the Framework for the Evaluation of Management Systems Incorporating Sustainability Indicators (MESMIS). The critical points and indicators that determine the organic dairy sheep systems were identified. These indicators were classified according to attributes and sustainability dimension to their aggregated indexes. The sustainability was evaluated in each of the 31 sampled farms, which were then grouped into three production systems (Family Subsistence, Commercial Semi-Intensive and Family Commercial). The Family Commercial system presented the best global sustainability index, highlighting the sustainability attributes of productivity and adaptability, as well as the environmental conservation dimension. The Family Subsistence system was located in an intermediate situation, presenting some resemblance to the Family Commercial System, but it was still considerably less productive. The Commercial Semi-Intensive system had shortcoming attributable to its degree of intensification and technical mismanagement. Self-weaknesses were identified for each system and recommendations have been proposed for increasing their level of sustainability.

Key words: MESMIS, organic farm, Castilla La Mancha.

RESUMEN

En este trabajo se ha evaluado la sustentabilidad del sistema ovino ecológico lechero en Castilla La Mancha mediante el marco para la evaluación de sistemas de manejo de recursos naturales incorporando indicadores de sustentabilidad (MESMIS). Se identificaron puntos críticos de evaluación e indicadores, que fueron clasificados de acuerdo a atributos y a dimensiones para construir índices de agregación. La evaluación se ha desarrollado en 31 granjas correspondientes a tres subsistemas de producción (Familiar de subsistencia, Comercial semi–intensivo y Familiar comercial). El sistema Familiar comercial presentó el mejor índice de sustentabilidad global, destacando los atributos de productividad y adaptabilidad, así como la dimensión ambiental. El sistema Familiar de subsistencia presentó una situación similar al sistema Familiar comercial, aunque considerablemente menos productivo. El sistema Comercial semi–intensivo presentó defectos atribuibles a su grado de intensificación y a una gestión técnica deficiente. Se identificaron debilidades en cada sistema y se han propuesto recomendaciones para aumentar su nivel de sostenibilidad.

Palabras clave: MESMIS, ganadería ecológica, Castilla La Mancha

INTRODUCTION

Livestock production is considered sustainable if productivity and profitability of production are maintained in the long term and the resources are conserved. Therefore, incomes are guaranteed and meet the basic human needs, apart from social and cultural demands, such as security, fairness, freedom, education, employment and recreation [30, 35].

Organic farming in Castilla-La Mancha has experienced a tremendous growth over the period 2001-2009, having increased the number of organic producers from 387 to 4,751 and the surface howing gone from 14,790 to 246,076 ha. The organic dairy sheep (*Ovis aries*) sector has maintained a rising trend during the period 2001-2009, with annual growth of about 40% [16]. Conversion to organic farming milk production is made from traditional farms, which meet many of the techni-

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cal requirements. However, in the conversion process to organic production, a need to change its structure and reorganize the production system was required [1], generating a wide variety that allows a typology of systems [12]. Organic production does not guarantee but allows obtaining an adequate level of global sustainability that includes economic, ecological and social dimensions [26].

For the implementation of sustainable agriculture, the basic condition is the design of methodologies to assess, in addition to the environmental impact, changes that will occur in the economic and social environments, consequences of the changes to the system. The initial assessment, being the basis of comparison for future assessments, is an essential tool for the analysis of system changes. Various methods have been developed, with implementation in the livestock systems of the proposals by Meul *et al*. [17, 18], Van Calker *et al*. [32], Van der Werf and Petit [33], Rigby *et al*. [23], Masera *et al*. [16], amongst others. Although they are focused on particular scenarios, they have common indicators. The indicators according to Gras [13] are "variables that provide information on other variables difficult to measure or access, which can be used as a benchmark to make a decision." The indicators emerge as the basis for sustainability assessment methodologies, and aim to measure the distance and direction of change from the initial state of a system, to a transition state, and then to a sustainable scenario [34]. The MESMIS methodology [14] is very flexible and can be adjusted to different livestock systems [10, 11, 16, 21], but its application is unknown in organic farming systems. This methodology is based on a systemic approach that defines seven basic attributes for sustainability: productivity, stability, reliability, resilience, adaptability, equity and self-reliance [9, 14]. Its application ranges from knowledge of the general attributes to obtain indicators and it is developed in six stages: description of the management system, determination of critical points, selection of strategic indicators, measurement and monitoring of indicators, presentation and integration of results as well as conclusions and recommendations.

Thus, the aim of this study was to evaluate the degree of sustainability of the organic dairy sheep systems in the region of Castilla La Mancha (Central Spain) using an adaptation of MESMIS methodology.

MATERIAL AND METHODS

Data were collected through a survey of 31 dairy sheep farms: the 10 organic ones existing (100%) in the region of Castilla-La Mancha (Spain) and other 21 (84% of existing ones) that had begun the certification process and met more than 80% of the necessary requirements to access the organic certification [6, 15]. The farms in conversion were selected through stratified random sampling with proportional allocation by province, according to the farm size and geographic location, according to Milan *et al*. [19]. The survey included questions on technical, economic and social data and was performed in 2008. The technical data include management, size and level of intensification variables. The economic data covered the main expenses (feed, labor), depreciation (of facilities, machinery and animals), and revenue from the sale of animals, milk and subsidies. Among the social data, the prospect of continued activity and family workforce were highlighted.

Adaptation of the MESMIS methodology to organic dairy sheep system

The organic dairy sheep system in Castilla La Mancha is based on family labor force, Manchega breed, use of external feeding resources and local agricultural byproducts. The following three sub–systems were characterized by Toro–Mujica et al. [28] (TABLE I).

- Group I: Family Subsistence System (29% of farms). Where workforce is formed by workers from the owner family, with an average of 56 years old and 36 years working with sheep. The combination of this profile with a low level of education limits their job opportunities outside the sector. Flocks are smaller and stocking rates are the lowest (0.12 livestock units (LU)/ha). The feeding is based on complementing grazing with supplementation on pen (3.6kg /L milk). The average milk productivity is 76 L/sheep year. This group obtains a negative economic result with average outcomes of -49.8 € *per* ewe and year.
- Group II: Semi-Intensive Commercial System (29% of farms). It is characterized for having high levels of investment and driving the sheep indoors most of the year (0.7LU/ha). The feeding base is composed by conserved forages supplemented with concentrates (4.1kg/L milk). Workforce tends to be external (49%), and productivity is medium (0.5WU/100 sheep). All this coupled with high levels of investment and mismanagement of feeding, causes adverse economic results (-38.3 € per ewe and year).
- Group III: Family Commercial System (42% of farms). Corresponds to family farms profile with skilled workforce. Flocks are medium size and their management is semi-extensive. Supplementation feed is lower than in the other two groups (2.2 kg/L) due to the importance of herds' grazing in large areas. It presents positive results from the technical and economic points of view with average outcomes of 43.8 € per ewe and year.

TABLE II shows the critical points, diagnostic criteria and indicators for each attribute, according to Nahed *et al*. [20] and the strategic aspects of organic dairy sheep production [6]. For each indicator, the dimensions of sustainability (economic, social and ecological) to perform its evaluation according to this categorization [27] have been considered in addition to the attributes. The attributes of stability, reliability and resilience were considered as one, as indicated by Lopez-Ridaura

TABLE I
DIMENSION VARIABLES OF ORGANIC DAIRY SHEEP SYSTEMS

Technical variables	Average	Group I	Group II	Group III	P
Flock size (LU)[1]	77.9	24.9^{a*}	138.7^{c}	72.6^{b}	0.00
Stocking rate (LU/ha)[1]	0.4	0.1^{c}	0.7^{a}	0.4^{b}	0.00
Farm surface area (ha)	359.2	280.2	371.9	404.9	0.55
Agricultural area (ha)	109.2	12.4	203.8	110.5	0.11
Grassland area (ha)	227.4	267	165.8	242.1	0.59
Supplementary feed consumption (kg/L)	3.1	3.6^{ab}	4.1^{a}	2.2^{b}	0.03
Milk production (L/ewe *per* year)	97.4	75.5^{b}	103.5^{a}	108.3^{a}	0.03
Total production of lambs (lambs sold/year)	528.0	202.5^{a}	801.6^{c}	565.5^{b}	0.00
Economic variables					
Lamb sales income (€/ewe/year)	47.2	50,2	39,5	50,4	0,17
Milk sales income (€/ewe/year)	97.4	75.5^{b}	103.5^{a}	108.3^{a}	0.03
Gross margin (€/ewe/year)	-7.2	$-49,8^{b}$	$-38,3^{b}$	$43,8^{a}$	0,00
Family unit gross income (€/ewe *per* year)	53.6	$41,8^{b}$	$34,6^{c}$	$74,9^{a}$	0,00
Family unit gross income (€/L)	0.53	$0,56^{a}$	$0,26^{b}$	$0,71^{a}$	0,00
Social variables					
Responsible age (years)	46.8	56.1^{a}	45.0^{b}	40.9^{b}	0.00
Experience of activity (years)	25.0	36.1^{a}	22.0^{b}	18.6^{b}	0.01
Family labour (%)	83.3	100.0^{a}	51.9^{b}	93.4^{a}	0.00

[1] Livestock Unit. *Values with different letters on the same row are different (P<0.05).

et al. [14]. Through a linkage between attributes, critical points and diagnostic criteria indicators to use were defined. Thus, thirty-five indicators were selected, which represented the attributes of sustainability and its three dimensions together.

Obtained management and sustainability indicators

The measurement of indicators relating to the farm as an unit of measurement was performed by literature review and surveys [16]. Thresholds or benchmarks were determined for each indicator, identifying the maximum possible values and optimal values relating to the sustainability. To obtain the optimum value of each indicator, previously reported data were used, apart from expert opinion and information obtained through surveys. For example, for indicators of economic dependence of subsidies or lamb mortality, the first quartile as optimal level [10] was considered. Additionally, for expenditure of external or supplementary feeding, 0 values were considered optimal, since what is sought is self-sufficiency in food [21].

For the evaluation of the indicators, criteria of the AMOEBA (a general method of ecosystem description and assessment) method were used [2], which transforms the original values of the variables to sustainability indicators of percentage basis. The AMOEBA approach is a model used to visually assess a system's condition relative to an optimal condition. The model is circular with the various indicators positioned around the outside. Lines radiate from the center to the indicators, on a continuum from unsustainable (in the center) to sustainable (the outer ring) [10]. TABLE III shows the transformation methodology of sustainability indicators in variables whose values can range from 0 to 100, where values closer to 100 are indicative of the best or highest sustainability. Next, the indicators were added by two complementary approaches: sustainability attributes and dimensions [21].

The differences between groups were determined by ANOVA or Kruskal-Wallis contrast, according to applicability given by the contrast variance. When the Kruskal-Wallis test was used, in a second step we applied the Mann-Whitney test to check for differences between groups for each variable. Spearman correlations were used to analyze the relationships amongst the original variables inside each group. For the development of statistical analysis SPSS 11.5 was used [25].

RESULTS AND DISCUSSION

Grouping of sheep farms by typology allowed to appreciate 22 statistically significant differences (P<0.05) for the original variables and 21 for the indicators (TABLES IV and V).

The breed was eliminated as a variable because it did not show variability (all the flocks showed the same breed). The lack of statistical significance of variables such as education level, stocking rate, equipment and level of supplementation feed per litre, arises from the use of optimal related levels; which giveS rise to the standardization of variables that have higher or superior values to the optimal. In the opposite case, the significant differences in investment indicators per animal and meat productivity come from the selection of an optimum value above the average for all groups, increasing the differences between them.

TABLE II
ATTRIBUTES, CRITICAL POINTS AND INDICATORS SELECTED IN THE CASE STUDIED

Attributes	Critical points	Diagnostic criterion	Indicators	Unit	Dimension[10]
Self-reliance	No organized marketing channels	Liquidity or cash-flow	Participation of intermediates	Nº	E
	Reduced association level	Membership	Workers unions	Nº	S
	Few land owned	Risk	Level of own land	OA/TA[1]	S
Adaptability	High dependence of subsidies	Risk	Subsidies per hectare	€/ha	E
			Subsidies per ewe	€/ewe	E
			Dependency of subsidies	IS/TI[2]	E
	Low income resources	Risk	Activities	Nº	E
	Inadequate technical management	Improving capacity	Females/male ratio		M
			Equipment	Nº	E
	Educational level	Education	Education and training		S
Equity	Generation of fix labor	Employment generation	Percentage of fix labor	FL/TL[3]	S
			Percentage of fix labor from the owner family	FFL/TL[4]	S
	Abandon of farms	Continuity	Perception of continuity	-	S
	High dependency of the activity	Dependency of the exploitation	People depending on the activity	Nº	S
	Low labor productivity	Intensification per animal	Labor productivity per animal	AWU/ 100 sheep[5]	S
		Intensification per area	Labor productivity per area	AWU/100 ha[5]	S
Stability, reliability and resilience	High dependency of external resources	Purchase of inputs	Cost pen feeding	CPF/TEF[6]	M
		Grassland area	Grassland area	GA/TA[7]	M
		Intensification	Stocking rate	LU/ha[8]	M
	Low investment on capital goods	Investment	Investment per area	€/ha	E
			Investment per animal	€/ewe	E
	Low biological diversity	Breeds	Sheep breeds exploited	Nº	M
		Species	Shannon index	-	M
		Cultivated species	Number of species	Nº	M
Productivity	High economic vulnerability of the activity	Profitability	Net margin/liter milk produced	€/L	E
			Net margin/Annual work units	€/AWU[5]	E
			Net margin/ hectare	€/ha	E
	Inadequate management of resources use	Intensification	Milk production per area	L/ha	M
			Milk production per animal	L/ewe	E
			Supplementary feed per liter milk produced	Kg/L	M
			Supplementary feed per ewe	Kg/ewe	M
		Efficiency	Technical efficiency	%	E
			Meat productivity	Kg of lamb/ewe	E
	Inadequate technical management	Lamb mortality	Lamb mortality	DL/BL[9]	E
		Goat replacement	Goat replacement rate		E

[1] Own area/Total area, [2] Inputs from subsidies/Total inputs, [3]Fix labor/Total labor, [4]Fix familiar labor/Fix labor, [5]Annual Work Unit, [6]Cost pen feeding /Total feed cost, [7]Grasssland area/Total area, [8]Livestock Unit, [9]Dead lambs/Born lambs, [10]Dimension: E: Economic, M: Environmental, S: Social.

TABLE III
ADAPTATION OF AMOEBA METHODOLOGY

Optimal value chosen	Expression
Maximum	VI[1]/VO[2] * 100
Minimum	VO/VI*100
Percentile or mean value with indicator value lower than optimum	VI/VO * 100
Percentile or mean value with indicator value higher than optimum	VO/VI*100

[1]VI: Indicator value, [2]VO: Optimal value.

Self-reliance

Gaspar *et al*. [10] found that self-reliance for pasture systems in Extremadura (Spain) exceeded 70%. However, the values below 40% of the self-reliance index show a common weakness in the three studied systems (TABLE V). Therefore, they should increase participation in the commercial channel and improve the organization of the productive processes.

Farms in groups I and III are more actively involved in the process of organic production, despite having more difficult access to land (1.7% and 20.2% in groups I and III, respectively) when compared to 50.5% in group II (P<0.05) (TABLE V).

Adaptability

The Family Subsistence System (Group I) presents the highest level of adaptability attribute, while the lowest value (P <0.05) corresponds to the Semi-Intensive Commercial System (Group II). The Family Commercial System is located in an intermediate position between groups I and II. The variables that affected the adaptability to a greater extent were the subsidies per sheep and per ha (TABLE V). Group I receives lower subsidies (16.4 €/ha) mainly for its lower stocking rate (0.1 LU/ha) and flock size (24.9 LU). Group II shows less adaptability (57.5%) due to their larger flock size (138.7 LU) and stocking rate (0.7 LU/ha). This determines a higher level of subsidies (up to 15.3% of total revenues). Finally, group III reaches 61.9% of adaptability; corresponding to intermediate flock size and stocking rate, 72.6 LU and 0.4 LU/ha, respectively. The farmers of group I should carry on producing organic dairy sheep without subsidies because they do not have any other job alternative. The last agrees with García *et al*. [8], who found that the opportunity cost of family labor is zero for this production system. Adaptability values are similar to those described by Nahed *et al*. [20] in dairy goat *(Capra hircus)* systems in the south of Spain.

Equity

Equity analyzes the system capacity to allocate resources among the involved individuals, both at intra and intergenerational [11, 17]. In this sense, there is a proper relationship between family labor, productivity and continuity, exceeding the attribute of 72% in the three systems (TABLE V). The three groups did not show differences in the attribute, but in some of the indexes that compose it. Group I is a pure family system (100% of the workforce), with the prospect of continuity in the activity (85.2%), although with a lower productivity (50.9%) of labor per animal, compared to 73.8 in Group II and 76.5% in III (P<0.05). The low labor productivity of Group I is related with the replacement of the deficit technology for labor, as it is showed in the positive correlation between productivity per area and level of investment per hectare (r: 0.49, P =0.0081). In the same way, there is a positive correlation between investment and stocking rate (r: 0.94, P =0.0005), a relation that has also been pointed out by Castel *et al*. [5] in dairy goat systems in poor areas of southern Spain.

Group II presents a smaller percentage of fixed family labor, according to the commercial profile of the farms, although this variable is not correlated within the group, with labor productivity (r: 0.40, P =0. 1235). Thus, contrary to the expectations, the productivity of external labor is similar to the productivity of family labor. A similar situation was observed by Gaspar *et al*. [10].

Stability

Analyzing the sustainability from the stability system perspective, values lower than 42% are obtained in each of the groups (TABLE V), similar to that described by Nahed *et al*. [20] in dairy goats. According to Masera *et al*. [16], the low stability reflects the inability of the system to maintain productivity under normal conditions. This deficiency is due in part to the high dependence of external supplementary feeding, which is 55 to 70% of the feeding cost. Castel *et al*. [4] found the same when studied dairy goats in Southern Spain.

At a structural level it is observed that the average area of Group I is 280.2 ha with 88.9% for livestock use, while in Group II farms are of a larger size (371.9 ha) and use 39% as grazing area (TABLES I and IV). There are also significant differences (P<0.05) between Groups I and II for the pasture indicator area, with values of 66.7 and 32.6%, respectively (TABLE V). Meanwhile, Group III maintains an intermediate situation. The low stocking rate of Group I reveals its pastoral character compared to Groups II and III. Group I seeks the balance between pasture production and livestock nutritional requirements [3, 24]; while Group II combines the sheep activity with cereal and grapevine (indicator of crops is 38.9 vs. 20.3%) using crop residues in feeding sheep [3]. Group II, with more investment per hectare (P<0.05) than group I increases intensification and labor productivity (TABLE IV), This strategy seeks applying economies of scale [7] to increase production and reduce fixed unit costs, but fails to generate profits (net margin of -0.7 € / l). Group III has an intermediate investment level and gets the greatest value on Investment per area indicator (TABLE V).

TABLE IV
MEAN VALUES OF ORIGINAL VARIABLES, OPTIMAL VALUES AND CRITERION USED

Attributes	Variable	T[1]	Group I	Group II	Group III	Optimal value	Criterion
Adaptability	Subsidies per ewe (€/ewe/year)	A	22.2^{a}	23.9^{ab}	26.0^{b}	23.2	C25
	Subsidies per ha (€/ha/year)	A	16.4^{a}	108.2^{b}	56.6^{ab}	17.6	C25
	Dependence on subsidies (% of total incomes)	A	13.5	15.3	13.3	11.5	C25
	Activities (Nº)	A	1.3	1.2	1.2	3.0	Max
	Equipments (Nº)	A	7.7^{a}	6.7^{b}	6.5^{a}	7.0	C50
	Ratio females/male	A	52.5	55.0	47.4	25	Rec[3]
	Education	A	2.3^{b}	1.4^{a}	2.2^{b}	2.0	C75
Self -management	Participating intermediates (Nº)	A	0.7	0.9	0.9	0.0	Min
	Worker unions (Nº)	A	0.8^{b}	0.2^{a}	0.8^{b}	2.0	Max
	Own land (%)	K	1.7^{a}	50.5^{b}	20.2^{b}	100	Max
Equity	Fix labor (%)	A	100.0^{b}	86.7^{ab}	74.0^{a}	100	Max
	Fix family labor (%)	A	100.0^{b}	64.8^{a}	81.5^{ab}	100	Max
	Perception of continuity	A	2.6	2.9	2.6	3.0	Max
	Dependent people (Nº)	A	3.4	4.8	4.5	4.0	C50
	Labor productivity (AWU/100 sheep)[2]	A	0.7^{b}	0.5^{ab}	0.3^{a}	0.3	C50
	Labor productivity (AWU/100 ha)[2]	A	0.7^{ab}	2.6^{b}	0.6^{a}	0.5	C50
Stability	Cost pen feeding (%)	A	55.8	66.7	69.4	0.0	Min
	Grassland area (%)	A	88.9^{b}	39.1^{a}	63.9^{ab}	75.0	Rec
	Stocking rate (LU/ha)	A	0.1^{a}	0.7^{c}	0.7^{b}	0.2	C50
	Investment per area (€/ha)	A	186.8^{a}	1623.6^{b}	782.9^{ab}	695.7	P75
	Investment per animal (€/sheep)	A	241.6	305.7	282.9	320.1	P75
	Sheep breeds (Nº)	-	1.0	1.0	1.0	2.0	Rec
	Shannon index	A	0.0	0.1	0.1	1.5	Max
	Species cultivated (Nº)	K	1.2^{a}	2.3^{b}	2.5^{b}	6.0	Max
Productivity	Net margin/liter milk produced	A	-1.2^{a}	-0.7^{a}	0.2^{b}	0.6	C75
	Net margin/ AWU (€/AWU)[2]	A	-8115^{a}	-16836^{a}	8268^{b}	5831	C75
	Net margin/ hectare (€/ha)	A	-42.2^{ab}	-446.4^{a}	114.5^{b}	41.7	C75
	Milk productivity (l/ha)	A	49.6^{a}	437.2^{b}	271.0^{ab}	94.6	C50
	Milk productivity (l/ewe)	A	75.5^{a}	103.4^{b}	108.3^{b}	120.7	C75
	Supplementary feed level (kg/L)	A	3.6^{ab}	4.1^{b}	2.2^{a}	2.15	c25
	Supplementary feed level (kg/ewe/year)	A	226.0^{a}	386.5^{b}	229.4^{a}	185.9	C25
	Technical efficiency (%)	A	55.5^{a}	71.7^{b}	69.8^{b}	100.0	Max
	Meat productivity (kg of lamb/ewe)	A	14.9	11.9	14.7	16.6	P75
	Lamb mortality (%)	A	11.8	16.9	10.8	5.5	C25
	Replacement rate (%)	A	21.6	19.0	22.1	20.0	Rec

Values with different letters (a, b, c) on the same row are different (P<0.05). [1] A: ANOVA, K: Kruskal-Wallis and Mann-Whitney for independent samples. [3] Annual work unit. [3] Recommended values.

Productivity

The productivity index fluctuates between 62.2 and 73.7%, and is dependent on indicators that are grouped into four diagnostic criteria: profitability, resource use, production level and animal management. The variability found for this attribute among the groups analyzed, is less than that reported by Gaspar *et al*. [10], and similar to that described by Nahed *et al*. [20].

Group I shows a milk productivity of 75.5 l / sheep year, much lower (P<0.05) than those of 103.4 and 108.3 l / sheep a year for groups II and III, respectively (TABLE IV). This results in the indicator values for milk productivity per animal of 62.5% (TABLE V). Moreover, the indicator of meat productions shows differences between groups I, II, and III with values of 80.9, 65.9, and 80.5%, respectively (P<0.05). The productive performance of Group II is lower and is accentuated

TABLE V
INDICATORS OF SUSTAINABILITY (%) PER TYPOLOGY GROUPS

Indicator, attribute or dimension (%)	Groups		
	I	II	III
Adaptability	66.1[b]	57.5[a]	61.9[ab]
Subsidies per ewe	44.8[b]	35.6[ab]	29.8[a]
Subsidies per ha	69.8[b]	27.7[a]	58.8[b]
Dependence on subsidies	86.0	74.8	83.2
Activities	44.4	40.7	41.0
Equipments	91.6	89.2	87.2
Ratio female/male	53.7	51.3	58.2
Education level	72.2	83.3	75.6
Self -management	35.7	39.1	37.5
Participating intermediates	66.7	55.6	53.8
Workers unions	38.9[b]	11.1[a]	38.5[b]
Own land	1.7[a]	50.5[b]	20.2[b]
Equity	79.9	73.1	72.4
Fix labor	100.0[b]	86.7[ab]	74.0[a]
Fix family labor	100[b]	64.8[a]	81.5[ab]
Perception of continuity	85.2	92.3	87.2
Dependent people	73.0	71.9	60.9
Labor productivity per animals	50.9[a]	73.8[b]	76.5[b]
Labor productivity per area	70.1[b]	45.0[a]	54.6[ab]
Stability	40.9	41.5	38.9
Cost pen feeding	44.3	33.3	30.6
Grassland area	66.7[b]	32.6[a]	53.7[ab]
Sheep stocking rate	56.5	42.6	60.7
Investment per area	26.8[a]	28.1[a]	59.8[b]
Investment per ewe	72.0[b]	79.3[b]	54.9[a]
Shannon index	0.0	4.4	3.6
Species cultivated	20.3[a]	38.9[b]	41.0[b]
Productivity	65.6[a]	62.2[a]	73.7[b]
Net margin per liter milk produced	46.5[a]	61.3[a]	85.6[b]
Net margin per AWU[1]	58.4[a]	51.4[a]	71.0[b]
Net margin per hectare	65.9	49.2	57.3
Milk productivity per area	52.5[ab]	33.7[a]	61.4[b]
Milk productivity per ewe	62.5[a]	81.8[b]	79.6[b]
Supplementation level per liter	57.1	60.5	69.3
Supplementary feed level per ewe	74.4[b]	51.2[a]	67.7[b]
Technical efficiency	55.5[a]	71.7[b]	69.8[b]
Meat productivity	80.9[b]	65.9[a]	80.5[b]
Lamb mortality	88.1	83.1	89.3
Replacement rate	79.6	73.9	78.8
Global sustainability	59.3[ab]	55.4[a]	59.5[b]
Economic sustainability	64.9	62.5	65.6
Social sustainability	65.7	64.8	63.2
Environmental sustainability	47.3[ab]	38.7[a]	49.6[b]

Values with different letters (a, b, c) are different (P<0.05). 1. Annual Work Unit.

by a high mortality rate, reaching 16.9% (TABLE V). Group II corresponds to a semi-intensive system with a high level of feed supplementation (4.1 kg / L) compared to 2.2 kg / L in Group III, which represent values for the indicator being 60.5 and 69.3%, respectively.

The technical efficiency indicator [29] shows that Group I has the lowest technical efficiency (55.5%), compared to Groups II and III, having values close to 69.8% (P<0 05). Both Gaspar *et al*. [11] and Pérez *et al*. [22] found greater heterogeneity in the technical efficiency of meat sheep production systems in Extremadura and Aragon as a result of greater diversity in specificity and structure.

The Net Margin indicator per liter of Group III presents (P<0.05) higher values (85.6%) compared with those in groups I and II (46.5 and 61.3%, respectively). Group I responds to a maintenance or subsistence and self-employment model, which charges neither the family salary nor depreciation in its accounting; the strategic objective of this group is to generate a living wage for a family unit, as indicated by Giorgis *et al*. [12] in grazing dairy systems of the Pampas and Valerio *et al*. [31] in small ruminants systems of subsistence in the Dominican Republic.

Group II increases its productivity due to a higher technological level. However, given the heavy reliance on external inputs (food, labor, etc.), these improvements do not allow to reach a positive net margin, and farms register losses. Farms in this group have an uncertain future and their continuity in the activity are at the expense of losing capital (by not accounting depreciation), a finding that is similar to Garcia *et al*. [8] in the agroforestry systems of Andalucía.

Global sustainability

When comparing the Sustainability in the three systems, TABLE V shows that the differences are explained mainly by the Productivity (P<0.05) and Adaptability attributes (P<0.05). Gaspar *et al*. [10] reported significant differences for these two attributes, in addition to the Stability attribute. The three systems show low values of the Stability and Self-reliance attributes, while for the Equity attributes values are more elevated, although there were no significant differences among the systems.

The organic dairy sheep systems have a global sustainability level of 58%, by aggregation of the economic, social and environmental (TABLE IV) values similar to those found by Gaspar *et al*. [10], in systems with predominance of sheep. There are differences (P<0.1) between Group II (55.4%) and Group III (59.5%), indicating the viability of the latter in terms of global sustainability.

TABLE V shows the dimensions of the sustainability according to the typology established. The social and economic dimensions have values around 64% with no differences among the systems. The environmental dimension is low (<50%), revealing a critical situation, since the evaluated systems are formed by organic and conversion process farms. This problem stems out from an inadequate enforcement of the organic production rules and own deficiencies of standards do not guarantee the sustainability of the system (e.g. 40% of the diet can be concentrate-based, and stocking rate until 2 LU/ha is unable to maintain the systems stability). The differences between Groups II and III show that the Family Commercial system is environmentally sustainable, the Semi-Intensive Commercial system does not respond to the principles of sustainability, going into conflict with the concepts of sustainability and organic production. Family Subsistence system presents a level of sustainability similar to the Family Commercial system, as a result of similar behavior at the economic and environmental sustainability level. Differences between Groups I and III are not significant, although Family Subsistence system (Group I) is important to conserve the agro eco-systems.

CONCLUSIONS AND RECOMMENDATIONS

The main weakness of organic dairy sheep systems is that they are highly dependent on subsidies, the degree of diversification is low, they have high feeding requirements and biodiversity is low. It is necessary to enhance multi-functionality and complementarity of activities in order to reduce the dependence on farms from a single source of revenue and facilitate self-sufficiency in production inputs.

In organic dairy sheep systems, the family nature of the workforce avoids the abandonment of rural areas and enhances activity continuity. It highlights the effectiveness in managing of resources in Family Commercial systems (Group III) which means less economic vulnerability.

In Family Subsistence (Group I) and Family Commercial systems (Group III), the low percentage of land owned limits the investment, higher production and the development of other agricultural activities. These systems must promote the access of producers to pasture, either publicly or privately ownership, by creating specific rules (use of crop residues for livestock, etc.) or modification of regulations use of natural and protected areas.

The Family Commercial system is the most sustainable globally in both the adaptability and productivity attributes, such as the environmental dimension. This system should improve certain productivity indicators. In the short and medium term indicators related to marketing channels (by increasing active participation in the channel and vertical integration in the production chain), the stability of the workforce and the development of complementary activities should be improved. In the long term, it requires an increased access to land, either owned or for long periods through contractual arrangements.

The lower sustainability of Family Subsistence (Group I) and Semi-Intensive Commercial (Group II) systems is due to mismanagement of resources, which determines less productivity and lower margin in relation to the Family Commercial system (Group III).

Family Subsistence system presents low profitability resulting from low investments in both infrastructures and improving grasslands, which do not allow adequate stocking rates and generate low technical efficiency. Sustainability would improve by increasing the productivity of labor and optimization of supplementary feeding especially in the last third of gestation and lactation. In addition, producers must join to racial improvement programs within the Scheme Selection of the Manchego Sheep Breed, and other improvement programs.

The Semi-Intensive Commercial system (Group II) presents an inefficient management of resources, as its high productivity per hectare is derived from a high stocking rate and an excessive level of supplementation per animal. Structural changes are required to reduce both, plus an increasing degree of specialization of labor.

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