CAPRINE FARMS IN NORTHWEST REGION OF DOMINICAN REPUBLIC: TYPOLOGIES ACCORDING TO LIVESTOCK MANAGEMENT AND ECONOMIC VARIABLES

Unidades de producción caprinas en la región Noroeste de la República Dominicana: Tipología de acuerdo al manejo del ganado y a las variables económicas

Elena Angón [1], José Manuel Perea [1], Daniel Valerio [2], Antón García [1], Raquel Acero [1] y Paula Toro-Mújica [1]*

*[1]Departamento de Producción Animal, Facultad de Veterinaria, Universidad de Córdoba, Campus de Rabanales, 14071 Córdoba, España. [2]Instituto Dominicano de Investigaciones Agropecuarias y Forestales, República Dominicana. *z82anpee@uco.es*

RESUMEN

El objetivo de este trabajo fue identificar y caracterizar las tipologías de los sistemas caprinos en la República Dominicana, que determinen el rendimiento técnico y económico. Los datos de 33 unidades de producción caprinas (UP) fueron recogidos mediante un muestreo aleatorio, 51 variables técnicas y socio-económicas fueron analizadas mediante un análisis multivariante. Este análisis permitió la selección de cuatro componentes principales relacionados con la intensificación, la productividad, la diversificación, el nivel tecnológico y el tamaño de la finca. Un análisis de cluster posterior clasificó las UP en tres grupos. Grupo 1, llamado Tradicional de subsistencia, incluye UP de tamaño medio, con un manejo tradicional con bajos niveles de productividad, tecnología y carga animal. El grupo 2, desarrolla un sistema semi-extensivo con mejores niveles tecnológicos y uso de alimentación externa, alta producción ovina y una mayor proporción de terrenos en propiedad a pesar de que logra bajos rendimientos productivos y económicos. Por último, el grupo 3, llamado Tradicional comercial, que consta de UP de gran tamaño, con bajos niveles tecnológicos y mano de obra externa más eficiente, logrando resultados económicos aceptables. Teniendo en cuenta las características de los sistemas identificados, las mejoras de las estrategias en el sector deben destinarse principalmente a las UP pertenecientes a los grupos 1 y 2 centrándose en la mejora de la productividad y los niveles de rentabilidad.

Palabras clave: Sistemas caprinos, República Dominicana, análisis multivariante.

Recibido: 06 / 09 / 2012. Aceptado: 25 / 01 / 2013.

ABSTRACT

The aim of this work was to identify and characterize the typologies of caprine systems in the Dominican Republic, which would determine their technical and economic performance. Data from 33 goat farms were collected by random sampling, where 51 technical and socio-economic variables were analyzed by multivariate analysis. This analysis allowed the selection of four principal components related to intensification, productivity, diversification, technological level and farm size. The subsequent cluster analysis classified the farms into three groups. Group 1, called Traditional subsistence, includes medium sized extensive farms with traditional management and low levels of productivity, technology and stocking rate. Group 2 develops a semi-extensive system with increased levels of technology and use of external feed, higher ovine production and larger proportion of land in ownership even though it achieves low productive and economic performance. Finally, Group 3, called Traditional commercial, comprises large size farms with low levels of technology, applying external labour more efficiently and achieves acceptable economic results. Taking into account the characteristics of the systems identified, enhancing strategies to the caprine sector should be primarily aimed at group 1 and 2 farms, focusing on the improvement of low productivity and profitability levels.

Key words: Goat systems, Dominican Republic, multivariate analysis.

INTRODUCTION

In the Dominican Republic, caprine production (*Capra hircus*) is mainly found in the Northwest region of the Country.

It directly generates 20,000 jobs and is a key element in the economic development of these very depressed areas, which have critical poverty levels [26, 39]. The caprine sector is made out of subsistence family farming that is small in size, taking advantage of marginal land that is not suitable for agriculture and is limited mainly by sociological, technological and commercial factors [47]. This activity has just helped the poor and especially women to successfully raise their income, social status and even the local environment [15].

Vries [48] gave some keys to understand the economic and social importance of the livestock caprine among developing countries and the need to spread the knowledge currently existing. 94% of the world populations of goats are found in developing countries. Thus worldwide goats and other small ruminants are among the most popular and beneficial livestock for those with very limited resources. Besides most of the production is consumed by the own producer so that goats play an important livelihood in countries where animal protein intake *per capita* does not high [7]. By other hand, Alexandre et al. [3] showed that goats are usually associated with traditional low technology production systems. However, traditional and extensive do not signify an absence of management since nomadism and transhumance are adaptive responses to the shortage of resources. The high diversity and exceptional qualities of goats (adaptability to a broad range of environments, ability to graze on a wide variety of poor quality forage and browse, ability to walk long distances, high turnover rates on investment and hence low investment risk, etc.) have made of goat production an important feature in marginal rural regions.

Peacock et al. [35] indicated the multi-dimensional nature of the sustainability of goat production has been explored in very broad terms. In most places goat keepers faces various threats to the continuity of their goat enterprises and their ability to respond and adapt to change. Finally, the caprine activity in developing countries has characterized being extensive and grassing systems than traditionally has used production methods friendly to the environment (land utilization, farm structure, livestock practices, etc.). Given the current situation, the analysis of technical and economic performance is useful for distinguishing groups and to discriminating while establishing typologies [31, 44]. The establishment of these typologies is of great interest for productive improvements and productive strategies in order to increase competitiveness [5]. In Spain and Sardinia multivariate techniques have been used to establish groups in small ruminant production systems (specifically organic dairy sheep), mainly cluster analysis with principal components analysis [12, 44, 46].

Therefore, given the lack of knowledge about the goat systems in Dominican Republic, the aim of this study was to characterize and establish a typology of the farms in Northwest region (the region where these are more abundant) according to livestock management and economic variables.

MATERIALS AND METHODS

Study area and data collection

The study was conducted in the provinces of Monte Cristi and Dajabón, located in the Northwest region of the Dominican Republic where dry forest and subtropical humidity prevails. The average annual rainfall is between 600 and 1200 mm, average annual temperature is 27°C and the average annual relative humidity is around 75% [32]. This region is considered one of the main areas for the breeding of small ruminants, reaching 21.5% of the national census [16]. The study population consists of 63 goat farms, with over 50 animals [13].

The design applied was a random sampling, stratified by geographic area in accordance with the methodology proposed by Food and Agriculture Organization of the United Nations (FAO) [18] and used by Perea et al. [37]. The study covered 33 farms, which amounts to 52% of the population. The information was obtained through collection of primary data from direct interviews with the farmers. The survey included 126 questions (65% of open answers), relative to the following aspects: sociology, facilities, reproduction, feeding, farm structure, animal health, market and economy, according to the methodology proposed by FAO [18] and used to study organic farming by Toro–Mujica et al. [44]. The data used relates to the 2007-2008 period and was obtained during 2008.

Statistical analysis

The development of the typology is based on the methodology proposed by Escobar and Berdegué [17], used by Giorgis et al. [23] and Toro–Mujica et al. [44], which consists of three stages: review and selection of variables, principal component analysis and cluster analysis. One hundred and twenty eight variables were analysed. Fifty variables were obtained directly from the information collected through the survey. All other variables come from a combination of original variables or estimated from data collected in the survey, according to the work of Gaspar et al. [21] and Ruiz et al. [40].

In the first stage, the fifty one variables with a coefficient of variation higher than 60% were selected (TABLE I). Then the correlation matrix was analysed to eliminate uncorrelated variables and the one with the lowest coefficient of variation of each pair with linear dependence [42, 45]. The following 14 variables were obtained through the selection process: flock size (LU), sheep LU (%), farm surface area (ha), land in ownership (%), total cost ($/ha), stocking rate (LU/ha), amortization cost ($/ha), labour productivity (AWU/100ha), total investment ($/ha), kids sold (kid/ha), total income ($/ha), supplementary feed (kg/goat), gross margin ($/LU), net margin ($/ha).

In the second stage, principal component analysis was used in order to reduce the number of variables and summarise the higher variability [45]. The variables were standardised to avoid influence by the use of different scales [25, 38]. Once

TABLE I
VARIABLES USED IN THE CHARACTERIZATION (*N*=33)

Variables	Description	Units	Mean
Surf	Total farm surface area	ha	220
Flock	Total livestock units (LU)[1]	LU	16.2
Own	Percentage of land owned by the farmer	%	22.3
Past_a	Pasture area per livestock unit	ha/LU	0.12
Past_p	Percentage of pasture over the total surface	%	1.41
Wood_a	Wooded area per livestock unit	ha/LU	8.6
Wood_p	Percentage of wooded area over the total surface	%	98.2
Goat_t	Number of goats	heads	243
Goat_p	Percentage of goats over total livestock units	%	92.9
Sheep_p	Percentage of sheep over total livestock units	%	7.1
Stock	Livestock units per ha of surface	LU/ha	0.20
L_sup	Days per year with use of supplementary feed	day/year	41
S_feed	Amount of supplementary feed used per goat	kg/goat/year	2.3
Graz	Hours of daily grazing	hours/day	10.5
Kid_g	Kids sold per female goat	kid/goat	1.14
Kid_s	Kids sold per ha of surface	kid/ha	0.54
Fem_m	Number of female goats per male goat	females/male	45.4
Replace	Percentage of replacement goats over total goats	%	18.1
Mort	Percentage of dead kids over total birth kids	%	9.2
Build	Total squared meters built	m^2	401
Build_l	Squared meters built per livestock unit	m^2/LU	26.6
Weight	Weight of kids sale	kg	22.0
Age	Age of kids sale	day	240
Invest	Total investment in the farm	$	30,624
Invest_l	Total investment per livestock unit	$/LU	1,302
Invest_s	Total investment per ha of surface	$/ha	226
I_B	Percentage of investment in buildings over total investment	%	2.9
I_M	Percentage of investment in machinery over total investment	%	7.6
Income	Total income of farm	$	5,316
Income_s	Income per ha of surface	$/ha	29.2
Income_l	Income per livestock unit	$/LU	169.6
Income_p	Percentage of incomes by activity goat over total income	%	97.4
Cost	Total cost of farm	$	4,418
Cost_s	Cost per ha of surface	$/ha	22.6
Cost_l	Cost per livestock unit	$/LU	202.1
Amor_s	Depreciation cost per ha of surface	$/ha	4.43
Amort	Percentage of depreciation cost over total cost	%	41.2
Feed	Cost of supplementary feed per livestock unit	$/LU	1,9
Feed_p	Percentage of supplementary feed cost over total cost	%	2.04
C_Lab_s	Cost of labour per ha of surface, including family labour	$/ha	6.11
C_Lab_p	Percentage of labour cost over total cost	%	49.0
C_Lab	Total annual work (AWU) units used in the farm	AWU	0.65
Lab_f	Percentage of family labour over total labour	%	94.0
Lab_l	Labour per 100 livestock units	AWU/100LU	4.71

TABLE I
VARIABLES USED IN THE CHARACTERIZATION (*N*=33) *(CONTINUATION)*

Variables	Description	Units	Mean
Lab_ s	Labour per 100 ha of surface	AWU/100ha	0.48
Age_f	Age of the farmer	years	52.8
GM	Gross margin (Total income – Total cost + Familiar labour cost)	$	2,294
GM_l	Gross margin per livestock unit	$/LU	71.1
NM	Net margin (Gross margin – Familiar labour cost)	$	-894
NM_s	Net margin per ha of surface	$/ha	-5.14
Prof	Percentage of net margin over total investment (excluding the land value)	%	-6.34

[1] *1 Adult goat/sheep = 0.15 LU*.

the components were selected, the orthogonal varimax rotation was applied to more easily relate the selected variables to the extracted factors. The Bartlett sphericity test and the Kaiser-Meyer-Olkin (KMO) index were applied to verify sample adequacy [29].

In the third stage, the farms were classified into groups using sequential cluster analysis [36]. Firstly hierarchical groupings were developed based on Ward's method, using the Euclidean, squared Euclidean and Manhattan distances [4]. The following non-hierarchical groupings were developed using as centroids and the number of groups obtained in each of the hierarchical groupings with each distance.

Seven solution groups were tested using discriminant analysis and analysis of variance. As a result of these tests, the non-hierarchical clustering was chosen because the discriminant function classified correctly the highest percentage of farms and generated significant differences in the largest number of original variables. This procedure maximises the homogeneity within groups and heterogeneity between groups [45]. To conduct statistical analysis SPSS 15 [43] was used.

RESULTS AND DISCUSSION

Characteristics of goat farms

The main variables used to characterize goat systems are described in TABLE I. The goat production in Northwest region of Dominican Republic had an average size of 220 ± 56 hectares (ha) and 243 ± 109 goats, being 93 ± 3.0% caprine and the remainder ovine (*Ovis Orientales*). The surface area of farm (ha), was positively correlated with the flock size (LU) (r=0.82; P<0.01), total investment ($) (r=0.63; P<0.05), total income ($) (r=0.78; P<0.05) and total costs ($) (r=0.74; P<0.05); surface area of farm was slighted negatively correlated with the productivity of labour (AWU/100LU) (r=-0.48; P<0.05) and the family labour (%) (r=-0.41; P<0.05). Considering the above, an increase in size leads to an increase in efficiency due to the highest level of qualification and expertise of the external labour.

Eighty four percent of the producers was not land owners and the use of public land (98.2 ± 5.7% being forests) that can be used directly by livestock prevails. These percentages are higher than those reported by Hamadeh et al. [24] and Usai et al. [46]. The availability of pastures (ha/LU) was positively correlated with the investment in buildings ($/ha) (r=0.74; P<0.05), labour cost ($/ha) (r=0.79; P<0.05) and total income ($/ha) (r=0.73; P<0.05). In this way, the farms with larger pastures showed greater investment mainly in fencing, livestock handling systems and accommodations. Also, the demand for labour to maintain the pasture increased and this was balanced by a rise in income by ha. In line with performance in other extensive systems [22], high investment ($/ha) was associated with higher extension of land in ownership (r=0.76; P<0.05).

The average daily grazing time was 10.5 ± 1.6 hours, and it was weakly positively related to the productivity (kid/ha) (r=0.50; P<0.05) and was reflected in an increase in the net margin ($) (r=0.58; P<0.05). As grazing rose so did the use of public land (%; r=0.72; P<0.01), and there was a decrease in stocking rate (LU/ha; r=-0.62; P<0.05) and in supplementary feeding (kg/goat/year; r=-0.78; P<0.01). Likewise the labour cost fell (r=-0.47; P<0.05), due to lower labour required in the free and continuous grazing of the region (r=-0.47; P<0.05).

According to Secretary of State for Agriculture (SEA) [41], low stock densities favour the sustainable use of the dry forest. In this way, stocking rate and supplementation reached values of 0.20 ± 0.05 LU/ha and 2.3 ± 1.3 kg/goat, respectively, although without evident correlations between the two variables. Stocking rate was higher than those obtained by Frías Mora [20] and Acero et al. [2] in extensive caprine systems in the south of Spain. As the stocking rate grew so did the amortization cost ($/ha) (r=0.84; P<0.05) and the total costs ($/ha) (r=0.89; P<0.05), as an indicator of a higher level intensification of the system. In the same way, the use of feed supplement was related to the technological level; there was a positive correlation between the supplementary feed (kg/goat/year), investment in buildings ($/LU) (r=0.50; P<0.05) and machinery ($/ha) (r=0.53; P<0.05).

Productivity was 1.14 ± 0.08 kid/goat, the mortality rate was 9.2 ± 1.7% and the sales *per* ha reached 0.54 ± 0.09 kid, with an average weight of 22 ± 0.08 kg and 240 ± 13 days of

age. The traditional management of these farms was related to low productivity and inadequate management of reproduction; using natural covering, without separating males from goats throughout the year, and the ratio of goat *per* male was 45.4 ± 8.9: 1. Paz et al. [33] found similar values for the kid sales *per* goat and mortality rate in traditional caprine systems in Argentina. On the other hand, the ratio of goat *per* male exceeds those recommended by Frías Mora [20] and Carné et al. [11].

The total investment was 1,302 ± 329 $/LU and 226 ± 68 $/ha. These values were higher than those obtained by Paz et al. [34] in caprine farms in Argentina. There was a positive correlation between investment in buildings and machinery ($/ha) and total income ($/ha) (r=0.69; P<0.05; r= 0.41; P<0.05). In spite of this, the rate of investment in infrastructure (handling pens, accommodation and others), machinery and equipment were only 10% of the total investment which highlights the low technological level found in the analysed farms. Labour force, mainly family, reached 0.65 ± 0.07 AWU/farm which is equivalent to 4.71 ± 0.68 AWU/100LU. It had a slight negative correlation with the total income ($) (r=-0.48; P<0.05), showing an inefficient relationship between labour and sales. Total income was 29.2 ± 6.3 $/ha, and 95% of it was due to caprine activity; likewise the expenses go up 22.6 ± 7.1 $/ha and labour accounts for 49 ± 5.8%. Net margin was -5.14 ± 6.03 $/ha, including the cost of family labour applied in the productive system. The profitability rate was negative, with an average of -6.34 ± 3.68%, having a negative correlation with the labour productivity (AWU/100LU) (r=-0.63; P<0.05) and a positive correlation with total investment ($) (r=0.45; P<0.05), which reflects the situation of crisis that is undergoing in the sector.

Principal components characterizing the farms

The KMO test of sampling adequacy showed a value of 0.73 while the Bartlett's sphericity test showed a satisfactory probability value (P<0.01), indicating the suitability of the analysis [29]. The results of the principal components analysis suggest that four factors justify 79.12% of the total variance accumulated (TABLE II).

The first principal component explains 36.77% of the variance and holds a positive correlation with the amortization cost ($/ha), kids sold (kid/ha), total income ($/ha), stocking rate (LU/ha) and gross margin ($/LU). This factor defines the intensification and productivity level of the system.

The second principal component justifies 16.85% of the variance and relates to the productive orientation of the farm. The factor has a positive correlation with the proportion of ovine LU (%), land in ownership (%) and supplementary feed (kg/goat) and negative correlation with net margin ($/ha). Farms with highest land in ownership ratio show a greater degree of diversification, combining caprine and ovine production, and make greater use of supplementary feed, decreasing the economic performance of the farm.

The third principal component validates 14.80% of the variability and shows a positive correlation between total investment ($/ha) and total cost ($/ha), and negative correlation with labour productivity (UTH/100ha). This factor reflects the technological level of the farm.

The fourth principal component explains 10.70% of the variance and relates to the size of the farm. This is a positive correlated factor with flock size (LU) and the farm surface area (ha).

TABLE II
PRINCIPAL COMPONENTS (PC) SELECTED, EIGENVALUE, EXPLAINED AND ACCUMULATED VARIANCE, AND CORRELATION COEFFICIENTS OF THE VARIABLES WITH EACH PC

PC	Eigenvalue	% variance explained (% variance accumulated)	Variables and correlation with the PC	
1	6.36	36.77	Amor_s ($/ha)	0.966
		(36.77)	Kid_s (kid/ha)	0.938
			Income_s ($/ha)	0.891
			Stock (LU/ha)	0.851
			GM_l ($/LU)	0.732
2	2.85	16.85	Own (%)	0.964
		(53.62)	S_feed (kg/goat)	0.885
			NM_s ($/ha)	-0.765
			Sheep_p (%)	0.723
3	2.52	14.80	Invest_s ($/ha)	0.819
		(68.42)	Cost_s ($/ha)	0.737
			Lab_l (AWU/100ha)	-0.723
4	1.87	10.70	Flock (LU)	0.953
		(79.12)	Surf (ha)	0.900

Establishment of the typology

A solution containing seven groups is achieved: a group consisting of fifteen farms (cluster 1), a group with nine farms (cluster 3), a further group with five farms (cluster 2) and a further four groups with one farm each (clusters 4, 5, 6 and 7). According to Usai et al. [46] clusters 1, 2 and 3 will be taken into consideration and clusters 4, 5, 6 and 7 would be disregarded due to limited representation (TABLES III and IV). The main differences between systems are shown in FIGS. 1 and 2.

Group 1: Traditional extensive system of subsistence

This group contains 45% of the farms and showed the most usual caprine farm in the Northwest region of the country. The flocks had an average size of 67 ± 12 goats, and there was a caprine activity (96.8 ± 3.2%) prevalence over the sheep which accounts for only 3.2 ± 3.2% of the livestock.

This group applies a system of subsistence economy which generates 0.51 ± 0.08 AWU, with low technological level, minimum used of external inputs and the family being the only workforce. The average investment by ha reached $57.2 ± 15.2 while amortization cost stayed at 3.8 ± 0.8 $/ha. Farms average 38.9 ± 14.1 m^2 of corrals *per* LU with 20.7 ± 9.3% of it being covered areas.

The system combines the direct exploitation of the scarce natural pasturages with continuous grazing resources of the dry forest, which is of public domain. Only 2.2 ± 1.55% of the land was ownership, consequently the stocking rate was very low, around 0.07 ± 0.01 LU/ha.

Most of the production was sold and 10 ± 3.2% was aimed at the family subsistence. The income *per* ha rises to $11.3 ± 1.5 and 97.8 ± 5.3% of this is due to kids sales and the remaining to the sale of lambs. Technical indicators show deficiencies in the management and productivity (0.24 ± 0.03 kid *per* ha), holding high relation of goats *per* male (39 ± 7:1) and high mortality rate (11.8 ± 3.7%).

The cost *per* ha was lower than in any other group (14.8 ± 2.8 $/ha) due to limited technology and traditional management. External food cost was null therefore labour cost was the

TABLE III
MEAN VALUES ± STANDARD ERROR AND SIGNIFICANCE LEVEL OF PRINCIPAL TECHNICAL VARIABLES FOR GROUPS IDENTIFIED

Variable	Group 1	Group 2	Group 3	*p*
n	15	5	9	-
Surf	158 ± 25^{b}	95 ± 17^{a}	288 ± 72^{c}	P<0.000
Flock	10.6 ± 1.9^{a}	10.4 ± 1.3^{a}	51.2 ± 16.6^{b}	P<0.000
Own	2.19 ± 1.55^{a}	33.33 ± 3.33^{b}	6.12 ± 4.51^{a}	P<0.01
Past_a	0.11 ± 0.08	0.11 ± 0.07	0.14 ± 0.04	NS
Past_p	1.47 ± 1.47	1.36 ± 1.33	1.57 ± 1.26	NS
Wood_a	15.78 ± 1.53^{b}	8.99 ± 1.14^{a}	8.39 ± 2.84^{a}	P<0.01
Wood_p	98.5 ± 1.5	98.6 ± 1.3	98.4 ± 1.2	NS
Goat_t	66.9 ± 12.6^{a}	58.3 ± 6.0^{a}	333.3 ± 111.7^{b}	P<0.000
Goat_p	96.8 ± 3.2^{b}	90.2 ± 3.7^{a}	96.6 ± 3.3^{b}	P<0.05
Sheep_p	3.2 ± 3.2^{a}	9.7 ± 3.7^{b}	3.4 ± 3.3^{a}	P<0.05
Stock	0.07 ± 0.01^{a}	0.11 ± 0.01^{ab}	0.20 ± 0.05^{b}	P<0.001
L_sup	0 ± 0^{a}	304 ± 61^{b}	0 ± 0^{a}	P<0.000
S_feed	0.0 ± 0.0^{a}	17.0 ± 3.2^{b}	0.4 ± 0.1^{a}	P<0.000
Graz	8.8 ± 0.1	9.2 ± 0.4	10.5 ± 1.6	NS
Kid_g	1.13 ± 0.13	1.03 ± 0.14	1.27 ± 0.24	NS
Kid_s	0.24 ± 0.03^{a}	0.31 ± 0.08^{a}	0.72 ± 0.15^{b}	P<0.001
Fem_m	39 ± 7^{a}	21 ± 2^{a}	79 ± 16^{b}	P<0.01
Replace	17.3 ± 5.4	16.1 ± 2.9	21.5 ± 5.8	NS
Mort	11.8 ± 3.7	8.5 ± 2.1	5.8 ± 1.0	NS
Build	307 ± 70^{a}	323 ± 95^{a}	517 ± 87^{b}	P<0.01
Build_l	38.9 ± 14.1^{b}	31.4 ± 8.1^{b}	14.5 ± 3.2^{a}	P<0.05
Weight	21 ± 1	24 ± 2	20 ± 1.0	NS
Age	240 ± 23	230 ± 10	240 ± 23	NS

Means with different letters show significant differences between groups.

TABLE IV
MEAN VALUES ± STANDARD ERROR AND SIGNIFICANCE LEVEL OF PRINCIPAL ECONOMICAL VARIABLES FOR GROUPS IDENTIFIED

Variable	Groups 1	Groups 2	Groups 3	p
n	15	5	9	-
Invest	9,017 ± 2,500^{a}	30,754 ± 24,723^{b}	40,221 ± 7,840^{b}	P<0.001
Invest_l	760 ± 99^{a}	2,593 ± 853^{c}	1,439 ± 632^{b}	P<0.05
Invest_s	57.2 ± 15.2^{a}	316.9 ± 70.6^{c}	193.8 ± 58.5^{b}	P<0.001
I_B	2.6 ± 0.6	5.9 ± 3.4	1.6 ± 0.6	NS
I_M	9.1 ± 3.3^{a}	18.3 ± 6.0^{b}	3.3 ± 0.8^{a}	P<0.05
Income	1,766 ± 373^{a}	1,623 ± 374^{a}	7,062 ± 1,230^{b}	P<0.0001
Income_s	11.3 ± 1.5^{a}	17.2 ± 2.1^{b}	31.2 ± 6.6^{c}	P<0.0001
Income_l	168.3 ± 18.5	158.3 ± 32.2	191.4 ± 46.2	NS
Income_p	97.8 ± 2.2	97.6 ± 2.4	98.1 ± 1.9	NS
Cost	2,055 ± 374^{a}	3,257 ± 614^{ab}	4,689 ± 682^{b}	P<0.000
Cost_s	14.8 ± 2.8^{a}	34.3 ± 1.6^{b}	19.3 ± 3.6^{ab}	P<0.000
Cost_l	216.7 ± 29.4^{ab}	313.8 ± 43.7^{b}	124.8 ± 20.7^{a}	P<0.05
Amor_s	3.8 ± 0.8^{a}	8.6 ± 0.7^{ab}	10.3 ± 0.6^{b}	P<0.001
Amort	28.8 ± 1.9^{a}	25.7 ± 1.9^{a}	62.9 ± 10.1^{b}	P<0.001
Feed	0.5 ± 0.1^{a}	3.9 ± 0.4^{b}	0.9 ± 0.3^{a}	P<0.001
Feed_p	0.4 ± 0.2^{a}	11.3 ± 2.1^{b}	0.6 ± 0.3^{a}	P<0.000
C_Lab_s	7.8 ± 1.3^{a}	15.9 ± 3.6^{b}	6.4 ± 1.9^{a}	P<0.001
C_Lab_p	60.0 ± 9.9^{b}	46.6 ± 4.8^{a}	39.4 ± 12.8^{a}	P<0.05
C_Lab	0.51 ± 0.08	0.67 ± 0.08	0.71 ± 0.18	NS
Lab_f	100.0 ± 0.0^{b}	100.0 ± 0.0^{b}	83.7 ± 10.4^{a}	NS
Lab_l	5.94 ± 1.22^{b}	6.42 ± 0.19^{b}	2.47 ± 0.93^{a}	P<0.001
Lab_ s	0.40 ± 0.10^{b}	0.72 ± 0.06^{c}	0.30 ± 0.10^{a}	P<0.0001
Age_f	49.4 ± 3.5	46.6 ± 6.8	58.2 ± 1.4	NS
GM	799 ± 320^{b}	-159 ± 120^{a}	3,847 ± 858^{c}	P<0.000
GM_l	79.8 ± 31.0^{ab}	-13.4 ± 11.2^{a}	126.8 ± 50.5^{b}	P<0.05
NM	-711 ± 420^{b}	-5,134 ± 564^{a}	1,568 ± 984^{c}	P<0.001
NM_s	-4.1 ± 1.8^{ab}	-55.3 ± 7.3^{a}	5.8 ± 2.7^{b}	P<0.000
Prof	-8.05 ± 6.66^{a}	-7.54 ± 7.72^{a}	4.15 ± 4.50^{b}	P<0.05

Means with different letters show significant differences between groups.

larger cost, rising to 60 ± 9.9% of the total cost. Net margin and profitability rate were around -4.1 ± 1.8 $/ha and -8.05 ± 6.66%, respectively, which reveals the low feasibility of this group of farms. Although farms of this group showed negative net margin values, they keep on the productive activity what allows appreciating; as far as know the familiar labour have got low or no opportunity cost and the social function of this type of production that acts as generator of employment. These findings are in accordance with others smallholder subsistence goat production [8, 28].

Group 2: Semi-extensive technological system

This group contains 15% of the farms, which was of smaller size (58 ± 6 goats and ovine production 9.7 ± 3.7% LU) and higher technological and intensification levels, primarily feed and reproductive efficiency; in line with the advantages indicated by Aréchiga et al. [7] for goat production in Mexico. Beside investments denoted a higher technological level than the remaining groups, most notably the investment in buildings (5.9 ± 3.4%) and machinery (18.3 ± 6.0 %). Thus the developed land used for handling pens and accommodation was 31.4 ± 8.1 m^2/LU being 24.25 ± 6.5 % of the surface covered areas. Unlike the other groups, 33.3 ± 3.3% of the livestock area was owned by the producers, which according to Toro–Mujica et al. [44], encourages access to credit and investment.

The feeding of the flock was based on the grazing of natural grasslands and dry forest resources, although the sup-

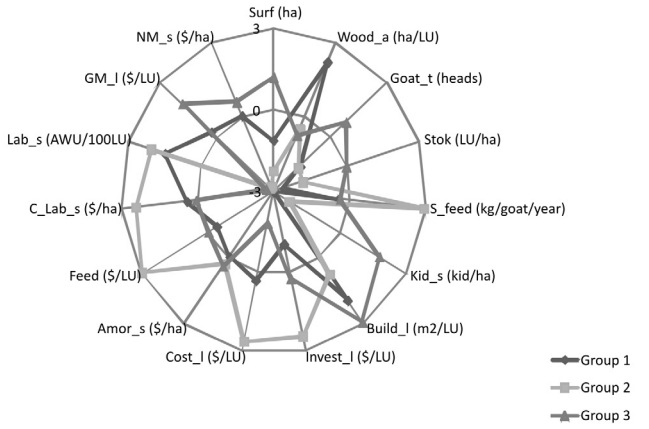

FIGURE 1. MAIN VARIABLES THAT EXPLAIN THE DIFFERENCES BETWEEN GROUPS OF FARMS. THE VARIABLES HAVE BEEN PREVIOUSLY STANDARIZED.

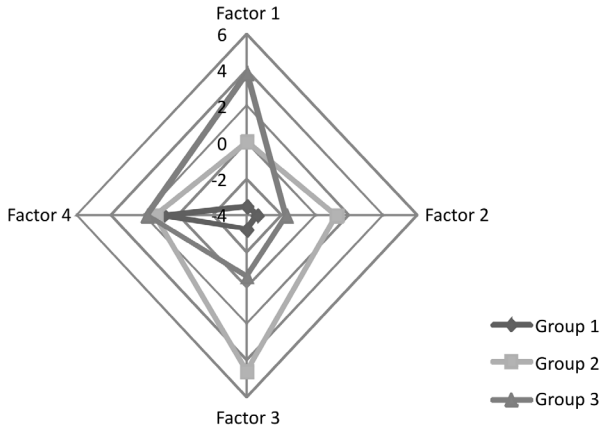

FIGURE 2. MEAN FACTOR SCORES IN THE THREE GROUPS OF FARMS.

plementary feeding was used during most of the year, with an average of 17.0 ± 3.2 kg/goat/year contribution. The contribution of external inputs improved productive performance (0.31 ± 0.08 kid/ha) and total incomes reached 17.2 ± 2.1 $/ha. However, the productivity of the system was lower than other semi-extensive systems described by Ruiz et al. [40], Toro-Mujica et al. [44] and Alexandre et al. [3] in the Caribbean. In general, the small ruminant production has low productivity per animal in the different countries of the world. Thus it's described by Niznikowski et al. [30] in Central and Eastern Europe, Ayalew et al. [8] in Ethiopia and confirms the existence of technical inefficiency in production system. By other hand, similar values were reported in Oman by Zaibet et al. [49].

Similarly, the labour productivity (6.42 ± 0.19 AWU/100LU) is inefficient as compared to groups 1 and 3 and also the level of technology available. An explanation might be that the family constitutes the sole workforce of the farm, with low cultural level and low skilled; similar to the results has been found in Oman and Ethiopia. Part of familiar earned income consists of the subsistence of kids, which is about 15.5 ± 3.2%.

Low productivity and the excessive use of labour cause losses and negative profitability (-7.54 ± 7.72%). Possible reasons of low productivity are high labour cost, and no use economies of scale, so cause losses and a negative profitability in the farms of this group. Higher incomes do not compensate for the high spending in depreciation (8.6 ± 0.07 $/ha), labour (15.9 ± 3.6 $/ha) and food (3.9 ± 0.4 $/LU) with respect to the other groups. In accordance with Kumm [27] pointing that not only small-scale structure are severe competition disadvantages in small ruminant production (resulting in, e.g., high labour demand per goat but also short grazing season, etc). Likewise, than farms belonging first group, they keep on in the activity because manpower have a low or null opportunity cost [22]. Regardless of its profitability, farms of group 1 and 2 provide employment to exclude farmers, help maintaining human presence and activities in rural and, in many cases, remote areas.

Group 3: Traditional commercial extensive system

This group contains 27% of farms, and related to extensive farms of larger surface (288 ± 72 ha on average) and livestock size (averaging 51.2 ± 16.6 LU). Eighty three percent of the farms focused exclusively on the goat production and only 17% combine caprine and ovine production. Like group 1, feeding was based on free dry forest grazing with high stocking rate (0.20 ± 0.05 LU/ha), without supplementary feeding.

Although they were primarily family businesses (83.7%) the use of external labour was more common. The level of household consumption corresponds to 10 ± 2.4 % of produced kids.

These farms were more efficient in the use of the labour (2.47 ± 0.93 AWU/100LU), and that is reflected in a higher productivity (0.72 ± 0.15 kid/ha), total income (31.2 ± 6.6 $/ha), and lower total cost (19.3 ± 3.6 $/ha). The levels of profit were lower than those obtained by Gaspar et al. [21] in Spanish farms, the difference is explained partly by the amount of the subsidies received in Spain. Also the economic performance was lower than those obtained in Czech Republic, Slovenia and Eslovaquia, where many of farms were not profitable if the owner's salary and the costs of the invested capital were taken into account [30].

The technological and investment levels in this group of farms are similar to Group 1, although they differ in their economic performance. Group 3 farms generate earnings (5.8 ± 2.7 $/ha) due to the scale effect and the more reasonable use of production factors.

However, the high ratio of land in public ownership limits access to credit, the incorporation of technological improvements and the progress of the caprine activity, according to Bedotti et al. [9] and Paz et al. [34]. Thus, Hamadeh et al. [24]

points out that ownership of the land can directly influence the productivity and defines the feeding system of the farm. In this context, Devendra and McLeroy [14], Arbiza [6], Benavides [10] and Abreu [1] indicate that the lack of economic resources, livestock area and alternative sources of food are the main limitations for goat producers in the tropics to adopt more cost-effective alternatives.

Finally, within the feasible strategies for encouraging the development of these systems, consideration should be given to the implementation of policies of access to ownership of public lands, as well as active policies of microfinance to small producers excluded from the formal credit system. On the other hand, the environmental compensation, proposed as an incentive to the conservation of the biodiversity of the forest [19], would allow diversification of incomes. This strategy could contribute to improving the profitability of all systems, making them viable options for investment, as well as contributing to the setting of the population through the generation of employment and wealth in this depressed rural area.

CONCLUSIONS

The goat farms in the Northwest region of Dominican Republic show high heterogeneity and structural shortcomings that determine its technical and economic results. The intensification, productivity, diversification, technological level and farm size are the main aspects with greater discriminating power for the classification of caprine farms in this region.

Three groups of farms were identified, all family farms based on the use of the subtropical dry forest with low technological level. Group 1 farms (Traditional subsistence) are of medium size and develop an extensive production system with traditional management on public lands. The level of technology and the stocking rate are low and it shows negative economic performance. Group 2 (Semi-extensive technological) is low in productivity and has negative returns, with a medium technological level, higher ovine production and greater proportion of land in ownership. Finally Group 3 (Traditional commercial), consists of farms of large size and low technological level. They base their feeding exclusively on free publicly owned dry forest grazing, use external labour more efficiently and yield benefits.

Groups 1 and 3 account for 75% of farms and improvement measures should be aimed towards planning the use of land in areas of public ownership, encouraging conservation and sensible use of the natural resources of the dry forest which is characteristic of this zone.

Finally the future of farms in Group 2 is uncertain and its viability is dependent upon fundamental changes to the system, such as the improvement of the production management, increase of stocking rate, implementation of strategic supplementation and the increase of the productivity of the labour force.

BIBLIOGRAPHIC REFERENCES

[1] ABREU, P. Identificación y caracterización de los sistemas de producción caprina predominantes en República Dominicana. Centro Agronómico Tropical de Investigación y Enseñanza, Turrialba, Costa Rica. Pp 65-76. 1990.

[2] ACERO, R.; GARCÍA, A.; MARTOS, J.; PEÑA, F.; RODRÍGUEZ, J.; DOMÉNECH, V. Análisis de gestión de las explotaciones caprinas extensivas de la sierra norte y este de Jaén. **Arch. Zoot.** 52: 67-76. 2003.

[3] ALEXANDRE, G.; GONZÁLEZ-GARCÍA, E.; LALLO, C.H.O.; ORTEGA-JIMENEZ, E.; PARIACOTE, F.; ARCHIMÈDE, H.; MANDONNET, N.; MAHIEU, M. Goat management and systems of production: Global framework and study cases in the Caribbean. **Small Rum. Res.** 89: 193-206. 2010.

[4] ANDERBERG, M. Hierarchical clustering methods. In: **Cluster Analysis for Applications.** Academic Press. New York, United States. Pp 150-187. 1973.

[5] ANDERSEN, E.; ELBERSEN, B.; GODESCHALK, F.; VERHOOG, D. Farm management indicators and farm typologies as a basis for assessments in a changing policy environment. **J. of Environ. Manag.** 82: 353–362. 2007.

[6] ARBIZA, S. Los caprinos en México. In: **Producción Caprina**. A.G.T. Editor. México, 135 pp 1986.

[7] ARÉCHIGA, C.F.; AGUILERA, J.I.; RINCÓN, R.M.; MÉNDEZ DE L. S.; BAÑUELOS, V.R.; MEZA-HERRERA, C.A. Role and perspectives of goat production in a global World. **Trop. and Subtrop. Agro**. 9:1-14. 2008.

[8] AYALEW, W.; KING, J.M.; BRUNS, E.; RISCHKOWSKY, B. Economic evaluation of smallholder subsistence livestock production: lessons from an Ethiopian goat development program. **Ecol. Econ.** 45: 473-485. 2003.

[9] BEDOTTI, D.; GÓMEZ, G.; SÁNCHEZ, M.; GARCÍA, A.; MARTOS, J. Aspectos sociológicos de los sistemas de producción caprina en el oeste Pampeano (Argentina). **Arch. Zoot.** 54: 599-608. 2005.

[10] BENAVIDES, J. La producción caprina como un componente en sistemas agroforestales. 1era. versión. Centro Agronómico Tropical de Investigación y Enseñanza, Turrialba, Costa Rica. Pp 46-56. 1989.

[11] CARNÉ, S.; ROIG, N.; JORDANA, J. La cabra blanca de Rasquera: Caracterización estructural de las explotaciones. **Arch. Zoot.** 56: 43-54. 2007.

[12] CASTEL, J.M.; MENA, Y.; DELGADO–PERTÍNEZ, M.; CAMÚÑEZ, J.; BASULTO, J.; CARAVACA, F.; GUZMÁN-GUERRERO, J.L.; ALCALDE, M.J. Charac-

terization of semi-extensive goat production systems in Southern Spain. **Small Rum. Res.** 47:133-143. 2003.

[13] CONAPROPE. Las cifras del sector ovicaprino de República Dominicana. Consejo Nacional de Producción Pecuaria, Santo Domingo, República Dominicana. Pp 4-6. 2004.

[14] DEVENDRA, C.; MCELROY, Q.B. Challenges for increased productivity and improved livelihoods. In: **Goat and sheep production in the tropics**. Longman, London. Pp 32-34. 1982.

[15] DEVENDRA, C. Animal production and rainfed agriculture in Asia: potential opportunities for productivity enhancement. **Outlook on Agricult.** 29:161-175. 2000.

[16] DIGEGA. Base de datos censo ovino-caprino del noroeste. Subdirección Pecuaria del Noroeste, Valverde, República Dominicana. Pp 356. 2005.

[17] ESCOBAR, G.; BERDEGUÉ, J. Conceptos y metodología para la tipificación de sistemas de fincas: la experiencia de RIMISP. In: **Tipificación de sistemas de producción agrícola, Santiago de Chile.** RIMISP. Pp 13-44. 1990.

[18] FOOD AND AGRICULTURE ORGANIZATION (FAO). Sampling Methods for Agricultural Surveys. Food and Agriculture Organization of the United Nations Statistical Development, Series 3, Rome. Pp 270. 1989.

[19] FOOD AND AGRICULTURE ORGANIZATION (FAO). Ayudando a desarrollar una ganadería sustentable en América Latina y el Caribe: Lecciones a partir de casos exitosos. Food and Agriculture Organization of the United Nations, Rome. Pp 101. 2008.

[20] FRÍAS–MORA, J.J. Situación actual y perspectivas de conservación de las razas caprinas en peligro de extinción en la provincia de Jaén. Producción Animal. Universidad de Córdoba, Córdoba, España. Pp 125-145. 1998.

[21] GASPAR, P.; ESCRIBANO, A.; MESIAS, F.J.; DE LEDESMA, A.R.; PULIDO, F. Sheep zfarms in the Spanish rangelands (dehesas): Typologies according to livestock management and economic indicators. **Small Rum. Res.** 74: 52-63. 2008.

[22] GASPAR, P.; ESCRIBANO, A.J.; MESÍSAS, F.J.; ESCRIBANO, M.; PULIDO, A.F. Goat systems of Villuercas-Ibores area in SW Spain: Problems and perspectives of traditional farming systems. **Small Rum. Res.** 97: 1-11. 2011.

[23] GIORGIS, A.; PEREA, J.; GARCÍA, A.; GÓMEZ–CASTRO, G.; ANGÓN, E.; LARREA, A. Caracterización técnico-económica y tipología de las explotaciones lecheras de la Pampa (Argentina). **Rev. Científ. FCV-LUZ**. XXI (4): 340-352. 2011.

[24] HAMADEH, S.; SHOMO, F.; NORDBLOM, T.; GOODCHILD, A.; GINTZBURGER, G. Small ruminant production in Lebanon´s Beka´a Valley. **Small Rum. Res.** 21:173-180. 1996.

[25] HAIR, J.; ANDERSON, R.; TATHAM, R.; BLACK, W. Análisis Factorial. In: **Análisis Multivariante**. Pearson Prentice Hall, Madrid. Pp 34-43. 1999.

[26] INSTITUTO DOMINICANO DE INVESTIGACIONES AGRARIAS Y FORESTALES (IDIAF). Proyecto para la instalación del centro de ovinos y caprinos tropicales de la línea Noroeste. Santo Domingo, República Dominicana. Pp 85. 2002.

[27] KUMM, K.I. Profitable Swedish lamb production by economies of scale. **Small Rum. Res.** 81:63-69. 2009.

[28] LOBLEY, M.; BUTLER, A.; REED, M. The contribution of organic farming to rural development: an exploration of the socio-economic linkages of organic and non-organic farms in England. **Land Use Polic.** 26: 723-735. 2009.

[29] MALHOTRA, N. Análisis discriminante. In: **Investigación de Mercados**. Pearson Educación, México. Pp 532-558. 2004.

[30] NIZNIKOWSKI, R.; STRZELEC, E.; POPIELARCZYK, D. Economics and profitability of sheep and goat production under new support regimes and market conditions in Central and Eastern Europe. **Small Rum. Res.** 62: 159-165. 2006.

[31] NUNCIO-OCHOA, G.; NAHED-TORAL, J.; DÍAZ–HERNÁNDEZ, B.; ESCOBEDO–AMEZCUA, F.; SALVATIERRA–IZABA, B. Caracterización de los sistemas de producción ovina en el estado de Tabasco. **Agrocien.** 35: 469-477. 2001.

[32] OFICINA NACIONAL DE METEOROLOGÍA (ONAMET**).** Atlas climatológico de la República Dominicana. Santo Domingo, República Dominicana. Pp 12. 2004.

[33] PAZ, R.; ÁLVAREZ, R.; CATAÑO, L. Parámetros técnico-productivos y tipologías en los sistemas caprinos en áreas de secano. **ALPA.** 8: 59-68. 2000.

[34] PAZ, R.; CATAÑO, L.; ÁLVAREZ, R. Diversidad en los sistemas cabriteros tradicionales y estrategias tecnológico–productivas. **Arch. Zoot.** 57: 207–218. 2008.

[35] PEACOCK, C.; SHERMAN, D.M. Sustainable goat production—some global perspectives. **Small Rum. Res.** 89: 70–80. 2010.

[36] PENG, Z.; BAO, C.; ZHAO, Y.; YI, H.; XIA, L.; YU, H.; SHEN, H.; CHEN, F. Weighted Markov chains for forecasting and analysis in Incidence of infectious diseases in jiangsu Province, China. **J. Biomed. Res**. 24: 207-214. 2010.

[37] PEREA, J.; MATA, H.; GARCÍA, A.; CASTALDO, A.; GÓMEZ, G.; ACERO, R. Aspectos técnicos y sociales de las explotaciones ecológicas lecheras del noroeste de España **Rev. Científ. FCV-LUZ**. XX (6): 633-639. 2010.

[38] PICÓN, E.; VARELA, J.; REAL, E. Clasificación y segmentación post hoc mediante el análisis de conglomerados. **Análisis Multivariable para las Ciencias Sociales.** Pearson, Prentice Hall. Pp 416-450. 2003.

[39] ROSARIO, P.J.; LÓPEZ, J.H. La ruralidad dominicana. Reflexiones para la lucha contra la pobreza. Instituto Dominicano de Investigaciones Agropecuarias y Forestales (IDIAF). Santo Domingo, República Dominicana. 218 Pp. 2006.

[40] RUIZ, F.A.; CASTEL, J.M.; MENA, Y.; CAMÚÑEZ, J.; GONZÁLEZ–REDONDO, P. Application of the technico-economic analysis for characterizing, making diagnoses and improving pastoral dairy goat systems in Andalusia (Spain). **Small Rum. Res.** 77: 208–220. 2008.

[41] SECRETARÍA DE ESTADO DE AGRICULTURA (SEA). Diagnostico del subsector ganadero de la República Dominicana. **Ganadería ovina y caprina.** Santo Domingo, República Dominicana. 123 pp 1999.

[42] SOLANO, C.; BERNUÉS, A.; ROJAS, F.; JOAQUÍN, N.; FERNANDEZ, W.; HERRERO, M. Relationships between management intensity and structural and social variables in dairy and dual-purpose systems in Santa Cruz, Bolivia. **Agric. Syst.** 65: 159-177. 2000.

[43] SPSS para Windows. 2005. Versión 14.0.0. Chicago: SPSS Inc.

[44] TORO–MUJICA, P.; GARCÍA, A.; GÓMEZ–CASTRO, G.; PEREA, J.; RODRÍGUEZ–ESTÉVEZ, V.; ANGÓN, E.; BARBA, C. Organic dairy sheep farms in south-central Spain: Typologies according to livestock management and economic variables. **Small Rum. Res.** 104: 28-36. 2012.

[45] URIEL, E.; ALDÁS, J. Análisis de Conglomerados. In: **Análisis multivariante aplicado**. Paraninfo, Madrid. Pp 47-86. 2005.

[46] USAI, M.G.; CASU, S.; MOLLE, G.; DECANDIA, M.; LIGIOS, S.; CARTA, A. Using cluster analysis to characterize the goat farming system in Sardinia. **Livest. Prod. Sci.** 104: 63-76. 2006.

[47] VALERIO, D.; GARCÍA, A.; ACERO, R.; PEREA, J.; GÓMEZ, A.G. Caracterización social y comercial del sistema ovino y caprino de la región noroeste de República Dominicana. **Intercien.** 34: 637-644. 2009.

[48] VRIES, J. Goats for the poor: Some keys to successful promotion of goat production among the poor. **Small Rum. Res.** 77: 221-224. 2008.

[49] ZAIBET, L.; DHARMAPALA, P.S.; BOUGHANMI,H.; MAHGOUB, O.; AL-MARSHUDI, A. Social changes, economic performance and development: the case of goat production in Oman. **Small Rum. Res.** 54: 131-140. 2004.