Integral typification of goat systems of Santa Elena province, Ecuador

Tipificación integral de sistemas caprinos de la provincia de Santa Elena, Ecuador

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Resumen

Como paso previo para proponer estrategias de desarrollo en sistemas de producción caprina (SPC) de la provincia de Santa Elena, Ecuador, se propuso tipificar los sistemas mediante indicadores socio-económicos, productivos y ambientales. Se encuestó a 172 productores sobre composición familiar y participación en el trabajo, tecnología adoptada, comunicaciones, composición del hato, existencias ganaderas, uso del suelo, ingresos, infraestructura y servicios básicos, acceso a las explotaciones, asistencia técnica y capacitación, trabajo e ingresos extraprediales, manejo e instalaciones, fuente de agua y suplemento alimenticio, aspecto reproductivo, dificultades en la producción de caprinos, comercialización de caprinos. Se redujo el número de variables mediante análisis de componentes principales (ACP) y pruebas de χ^2, para las variables cuantitativas y cualitativas, respectivamente. Con las CP que explicaron el 80 % de la variabilidad se llevó a cabo un análisis de conglomerados (AC) que dividió a los establecimientos en 7 grupos. Mediante un análisis de correspondencias múltiples (ACM) se identificaron asociaciones entre grupos y modalidades de las variables cualitativas. Las variables que más aportaron a la diferenciación de los grupos de SP estaban relacionadas con la producción caprina, el tamaño de la familia, las producciones avícola, agrícola, porcina y bovina, la participación en el trabajo de la familia, los ingresos por beneficios sociales, el tamaño de la finca y la tecnología adoptada. Dos grupos eran mixtos; uno con mayor actividad porcina; dos se caracterizaron por la cría de cabras para el consumo cuyos ingresos provenían de fuentes externas y dos grupos se definieron por la edad de sus productores.

Palabras clave: Indicadores económicos, indicadores productivos, indicadores socio-culturales, sistemas de producción, cabras.

Abstract

As a preliminary step to propose development strategies in the goat productive systems (SPC) of the Santa Elena province, Ecuador, the SPC were typified by means of socio-economic, productive and environmental indicators. A sample of 172 producers was surveyed on family composition and participation in work, adopted technology, communications, composition of the herd, livestock stock, land use, income, infrastructure and basic services, access to farms, technical assistance and training, off-farm work and income, management and facilities, water sources and food supplement, reproductive aspects, difficulties in the production of goats, marketing of goats. The number of proposed variables was reduced by principal component analysis (PCA) and χ^2 tests for quantitative and qualitative variables, respectively. Based on the main components that explained 80 % of the variability, a conglomerate analysis (CA) was carried out, resulting in the division of the SPC into 7 groups. Through a multiple correspondence analysis (MCA), associations between groups and modalities of qualitative variables were identified. The variables that contributed most to the differentiation of SPC groups were related to goat production, family size, poultry, agricultural, pig and bovine production, participation in family work, income from social benefits, the size of the farm and the technology adopted. Two groups were mixed, one with a predominance of livestock activity and the other with agricultural activity; a group with greater swine activity; two groups were characterized by the breeding of goats for consumption, whose income came from external sources; and two groups were defined by the age of their producers.

Keywords: Economic indicators, productive indicators, socio-cultural indicators, production systems, goats.

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1   Introduction

Knowing the reality of production systems is necessary in order to propose solutions to critical situations, implement genetic improvement plans, assess the environmental impact of livestock, among others. The identification of strengths and weaknesses allows to propose strategies that should be specific to each type of production units if there was diversity between the systems of a region (Cabrera et al., 2004; Dufumier, 1990).

It is recommended to propose development alternatives along with the producers for productive subsistence systems (Macías, 2015), with the aim of stimulating deep personal interest in the care of animals and crops; offering more products for sale through a better use of what is available locally (biological resources, native vegetation, livestock, etc.); introducing knowledge and technology along with the assessment of skills, existing knowledge and experiences; collaborating with producers to do a better performance (Hodges et al., 2014). On the other hand, subsistence systems host valuable zoogenetic resources that need to be preserved because they have evolved in their adaptation to adverse environments and there are moments in which genetic biodiversity is being lost (Núñez-Domínguez et al., 2016; Dorji et al., 2017).

Differentiated groups can be identified and typified from the initial state analysis and system characterization. Different methods for carrying out stratification based on a wide range of environmental, productive, economic and social aspects, which meet different objectives, have been proposed. Another form of stratification of systems is the application of statistical grouping methods (Robinson et al., 2011).

The goat production systems (SPC) of the province of Santa Elena (PSE), Ecuador, are low-income subsistence systems. Santa Elena has the highest percentage of goats at the coastal level (53 %) and 7.2 % of the country's total stocks (Sistema Nacional de Información, 2018). As a pre-development step, it was proposed to test whether there is heterogeneity among the province's goat systems. A process was carried out which included: surveying establishments, survey to the producers and classification of prevailing production systems using socio-cultural, productive and economic indicators.

2   Materials and methods

Santa Elena is a province located in the coast of the Republic of Ecuador, located southwest of the Ecuadorian coast. Politically, it is divided into three parishes: La Libertad, Salinas and Santa Elena (3668.9 km^2). The latter is the largest parish of the province, with a high rural population. It has 67 communes registered at the Agricultural Provincial Directorate of Santa Elena (Ministerio de Agricultura y Ganadería, 2018).

Based on oral information received from the community and the Ministry of Agriculture and Livestock (MAG), 586 goat production systems were identified, with an estimated total of 11,977 heads, in the 3 climatic zones in which the province is divided. Within each zone, a frequency distribution of the number of goat producers was performed according to the herd size. The total number of establishments to be sampled was estimated through the application of the finite sample formula (FAO, 2012). Once the total sample size was defined, stratified sampling was performed by zone and herd size using proportional allocation.

A structured survey was designed for the producers, taking as reference those used by Falagan (1988), Bedotti (2000) and Lanari (2004), including socio-cultural, productive and economic aspects (Tables 1, 2 and 3).

It was tested whether there were differences between agro-ecological zones by means of a multivariate variance analysis (MANOVA) for the quantitative variables. In order to decrease the number of variables: the association degree between the 27 quantitative variables was estimated to define the exclusion of those variables that had the same characteristic ($r > 0,70$); and a main component analysis (ACP) was performed (Peña, 2002), with the components explaining at least 80 % of the total variability chosen.

With the main components selected through a cluster analysis (AC) (Dallas, 2000), production systems were classified into homogeneous groups by applying: the hierarchical method, the Euclidean

distance and the Ward method (Ward, 1963). The profiles of each group (G) were described by the standardized averages of all variables and represented on a radial chart.

For the 77 qualitative variables, the relative frequencies for each of the resulting producer groups of AC and the total frequencies were estimated. Pearson tests were performed ($p < 0,05$) with the aim of selecting the variables with significant differences between the groups. With the selected variables, a multi-match analysis (CMA) was performed to identify the most important associations between the modalities of the qualitative variables (Greenacre, 1984) and the groups of the producers. Statistical calculations were performed with the professional Infostat programme (Di Rienzo et al., 2008).

3 Results

On the basis of the information received on the total number of producers per zone, they were distributed according to the size of the herd, and the sample was estimated at 229. The proportional allocation by area and size of the herd is detailed in Table 4. Out of these, 22 % were not surveyed by different reasons: duplicate information, absence of the producer at the time of the visit, abandonment of the activity, etc. None of the producer belonging to the semi-wet zone was surveyed due to inaccessibility to the area at the time of the survey. A total of 172 establishments were not taken into account, 69 in the dry area and 103 in the semi-arid area.

Table 1. Quantitative variables related to socio-cultural, productive and economic aspects

Type of information	Variables	
Family composition and participation in the work	Age of the producer reflected in years	ED
	Number of family members living in the same house	TP
	Number of people who work exclusively in the farm	PD
	Number of people who work exclusively outside the farm	PF
	Number of people who work inside and outside the farm	PDF
Technology used	Knowledge of the reproductive cycle	GCR
	Degree of health control	GCS
Communication	Distance to the town that the producer has more communication with (km)	DL
Composition of the herd (number of heads per category))	Female goat	CHVA
	Female nanny goat	CBLA
	Female kid	CBTA
	Male goat	CHVO
	Male nanny goat	CHTO
	Male kid	CBTO
Livestock inventory	Goat	EC
	Bovine	EB
	Swine	EP
	Poultry	EA
Use of the soil	Hectares sown	HaS
	Surface of the farm in hectares	HaF
Revenue in $ the last year	By the sale of agricultural crops	$IAG
	By the bovine sale	$IB
	By the caprine sale	$IC
	By the swine sale	$IP
	By the poultry sale	$IA
	By other external sources	$IEX
	By other social benefits	$IBS

The MANOVA results showed no significant differences between the two agroecological zones for the quantitative variables (Table 1). Therefore, from now on the analyses are presented taking the two zones together.

Out of the 27 original quantitative variables, were excluded: a) the variables related to the composition of the herd since they were highly correlated with EC; b) distance to the location that the producer has more communication with by not contributing to the total variability in the first ACP analysis. A second ACP was performed with the remaining 20 variables. The first 12 components explained 87% of the total variability, and these were interpreted based on the coefficients with more weight of each component and their signs.

The analysis of conglomerates carried out with the first 12 main components divided the production facilities into 7 groups distributed in both agroecological zones. More than half of the establishments were in the G5 (23.8%) and G6 (30.2%). The lowest percentage was shared by the G3 (2.3%) and G7 (4.07%). The G1, G2 and G4 accounted for 14%, 17.4% and 8.1%, respectively.

Table 6 shows the averages of the 20 variables for each of the 7 groups and the overall average. Figure 1 depicts the standardized averages of variables using a general radial chart. The black circle indicates the zero or average value of each standardized variable. For example, the G3 has above-average values for family work in the farm (PD) and goat income ($IC), although goat stocks are below the average it is the group with the highest poultry production.

Qualitative variables that did not provide variability within groups and had a relative frequency for a category higher than 95% PEN, TTI, PVI, TVI, SAL, ALC, MAL, VAC, TEM, IOF, ICA, CEC, TI, SCT, CDC, DOB, VRE, LCO, FPA) were excluded from the analysis. For example, 100% of the producers expressed electricity lighting service for SAL.

Tests χ^2 for the remaining 58 variables showed significant differences ($p < 0,05$) between the seven groups for 9 of them (DAP, ACT, RAT, RCA, LOC, APA, MCP, OC, MPR).

Table 2. Qualitative variables related to socio-cultural and economic aspects

Data of the producer	Infrastructure, basic services	Access to the land	Organizational	Labour
-Interviewed Person (PEN) -Gender (SEX) -Marital Status (ECI) -Level of Studies (EDU) -Social Security (SEG) -Assistant (AYU) -Successor (SUC)	-Land tenure (TTI) -Housing ownership (PVI) -Housing type (TVI) -Housing construction material (MCV) -Housing status (EVI) -Lighting service (SAL) -Drinking water supply (DAP) -Water access medium (MAA) -Use of energy to prepare food (UEN) -Sewerage service (ALC) -Sewerage medium (MAL) -Access to technology (ACT)	-Location with more communication (LCO) -Access roads (VAC) -Type of road (TCA) -State of the road (ECA) -Means of transportation (MTR)	-Participates in an organization (POrg) -Organization in which the person participates (OPA) -Receives technical assistance (RAT) -Institution from which the person receives technical assistance (IRA) -Type of institution (TIS) -Applies Techniques (ATE) -Observed Results (ORE) -Receives training (RCA) -Is interested in receiving training(IRC)	-Second employment (EEE) -Type of entity in which he works (TET) -Type of employment (TEM) -Type of work he performs (TLR) -It has other income sources (OFE) -Origin of the income from other sources (IOF)

The ACM showed that in the first dimension the use of technical assistance and training were significant (RATsi and RCAsi), and in the second the non-access to technology (ACTno). These first two dimensions explained 37 % of the variability of sociocultural and management variables. The third, fourth and fifth dimensions were related to the interest of receiving or not training, and the sixth with the farm as a grazing area of the goats.

3.1 Overview of the production systems of Santa Elena Peninsula

Most goat herd owners are male, with elementary school studies (61 %), with peasant social insurance, and whose helpers in the handling of goats is a family member, and it is sure that their children would continue with the breeding of goats.

Producers participate in the communal meetings and only one-third claimed to having received technical assistance, most of the beneficiaries were those producers who participated in state projects and who introduced goats from other areas in the last two decades. There is a strong interest of small producers of the PSE in improving goat production (94 %), despite the highest current incomes not coming from goat production but from other external sources. They have extra income from jobs of private companies and on a temporary basis or receive the Human Development Bonus (BDH).

Table 3. Qualitative variables related to the goat production aspect

Management and infrastructure of goat systems	Water source and food supplementation	Reproductive aspect	Difficulties in the production of goats	Commercialization of goats
-Place of origin of goats (LOC) -Grazing system (SPA) -Grazing area (APA) -The goats of the neighbor graze in the same place (CVP) -Water/food implementation used in the field (ICA) -Farmyards for the goats (CEC) -Farmyard owner (PCO) -Farmyard location (UCO) -Construction material walls and floor (MCP) - Roof construction material (MCT) -Use of implements in the water/food pen (UI) -Type of water/food implements (TI) -Implement manufacturing material (MFI) -Implement origin (PI) -Goats are released every day (SCT) -Time in which goats are taken inside (HSC) -Goats are locked every day (ECT) -Time in which goats are locked (HEC) -Daily control of goats (CDC) -Maximum distance that goats walk (km) (DMC) -A dog helps with the goats (TPC) -Other paddock (OC)	-Purchase of the food supplement (CSA) -Goat water fountain (FAG)	-Parity Control (CPA) -Obtaining of Male Breeders (ORM) -Difficulty for obtaining breeders (DOB) -Interest in buying males (ICM) -Obtaining of female breeders (ORH)	-Diseases (ENF) -Problems in the production of goats (PPC) -What is needed to improve the production (MPR)	-Goat product obtained (PCO) -Breeding objective (OCR) -Reasons to sale (MVE) -Way the animal is sold (FVE) -Sale of breeders (VRE) -Places of marketing (LCO) -Payment method (FPA) -Difficulties in marketing (DCO)

The goat establishments of the PSE are located in communal areas and with housing with low average conditions. All the farms have electric lighting, without sewerage, with access to water through the public network (57 %). The province has access with unpaved roads, in poor condition, and there is no public transportation.

The handling of the goats is free grazing, without using any implements for water and food in the field. The producers have their own pens, located near the house. In general, producers release the goats and lock them when they return. In winter, animals can stay in the countryside for up to 3 months. Goats get their food in the field, if producers grow corn, goats take advantage of the stubble from the crop and in some cases they receive food scraps in the driest seasons. Supplementation is not a common practice because of the costs involved. The water consumption of goats comes from natural sources, except in the dry season, when they are forced to look for other sources of water (drinking water). Males remain with females in the herd, until they are sold once they are 8 months old.

No practices such as castration are used. Most male breeders are self-produced. Goats are detected when they are about to give birth, separate and retain in the paddock. The degree of health control (GCS) is very low, with some kind of health problem.

The product obtained is meat, and very few obtain milk or take advantage of manure as fertilizer; only 24 % breed exclusively for sale, 16 % sell them for the family sustenance and 84 % sell their animals due to family emergencies. The sale of goats is made by walking in the houses or farms and only 5 % is sold to the commercial canton of the province and other localities in cash. Only 6 % of producers rarely sell some male as breeder.

Table 4. Total number of producers of goats and producers to survey by area according to the herd size

Herd size	Total number of producers			Number of producers to be surveyed		
	Semi-arid area	Dry area	Semi-wet area	Semi-arid area	Dry area	Semi-wet area
5-25	290	159	2	113	62	1
26-45	54	24		21	9	
46-65	15	9		6	4	
66-85	7	5		3	2	
86 and more	13	8		5	3	
Total of producers/area	379	205	2	148	80	1
Total goats/area	7.363	4.594	20			

Fuente: MAG, FEDECOMSE, Asociación de Capricultores, Casas Comunales, productores (Información oral)

3.2 Specific characteristics of the groups of goat production systems in the province of Santa Elena (Table 6 and Figure 1):

Group 1: it is constituted by families with lots of family members with the highest average of people working outside the farm. They have very low knowledge of the reproductive cycle (CR) and health control (CS), they received very little technical assistance and training, and have access to the use of technology. They have the lowest livestock stocks, including goats, and low numbers of planted hectares. They have farms with the lowest surface. They have other incomes by social benefits which are higher than the average.

Group 2: it is constituted by young producers with mid-sized families, their members commit at least part of their working day to work on the farm. They have the highest degree of knowledge of CR and CS, half of them received technical assistance and/or training. The farms have the largest total area and planted area. Livestock stocks are below the overall average, 71 % corresponds to goat stocks. They have the highest total income and the highest

sales income from agricultural products, they are among the highest goat earners and with external incomes.

Group 3: the age of the producers is close to the average, with numerous family members working mainly in the farm. They have good knowledge of the CR and poor CS, all the establishments in the group received technical assistance and training. The poultry stocks are the highest and the number of hectares planted is one of the highest. They have high revenue from the sale of agricultural products and goats, and the highest revenue from poultry sales. They have low external incomes.

Group 4: the age of the producers is on the average; it has the smallest number of family members, and they work inside and outside the farm. The level of CR knowledge is above the average, even though they received very little technical assistance and training. They have the highest swine stocks and average goat stocks, with intermediate areas of sown hectares. They have the highest swine sales revenue and intermediate extra income.

Group 5: they are the oldest producers with the lowest number of family members who work mainly in the farm. The degree of knowledge of the CR is close to the average, but the CS is one of the lowest. They received little technical assistance

and training. They are the ones with the least access to technology. Livestock stocks are low, but they have average goat stocks. The number of hectares planted is the lowest, it is the second group with the highest size of the farm. Social benefit income (BDH) is the highest and extra incomes are the lowest.

Group 6: they are the youngest producers with intermediate family size and high number of people working in the farm. The knowledge of CR and CS are close to the average, they received little technical assistance or training. They have farm with the highest surface, the area is sown and have low livestock stocks. They have the highest extra incomes and lowest incomes for social benefits.

Group 7: they are middle-aged producers, they have small families whose members work inside and outside the farm. They have a high degree of CR knowledge and very high CS; also, they have access to technology. They received technical assistance and training. It is the second group in livestock stocks, and they have the highest goat and bovine stocks, and intermediate swine stocks. They have farms with very high surface. It is the group with the highest incomes from the sale of cattle and goats, and they have one of the highest incomes by the sale of swine. It is the second group with high total incomes.

Table 5. Interpretation of the first twelve main components

Component	Interpretation		Explained variability (%)	Accumulated %
Y_1	Goat production		14	14
Y_2	Size of the family		12	26
Y_3	Poultry production		10	36
Y_4	Agricultural production *vs* swine production		9	45
Y_5	Bovine production		8	54
Y_6	Participation at work:	PD	6	60
Y_7		PDF	5	65
Y_8		PF	5	70
Y_9	Incomes by social benefits		5	75
Y_{10}	Size of the farm		4	79
Y_{11}	Technology use:	GCR	4	83
Y_{12}		GCS	3	87

Table 6. Averages by number of stablishments

Groups	1	2	3	4	5	6	7	General average
ED	55.1	49.5	57.7	57.3	71.6	46.4	55.3	56.1
TP	6.75	4.97	5.00	3.71	2.80	4.81	3.43	4.50
PD	1.68	1.65	3.13	1.52	1.43	2.12	1.57	1.87
PF	1.14	0.08	0.00	0.39	0.02	0.02	0.14	0.26
PDF	0.78	0.66	0.35	0.40	0.24	0.39	0.50	0.47
GCR	2.83	5.20	4. 25	4.50	4.02	4.12	5.00	4.27
GCS	0.88	2.90	1.50	1.71	1.49	1.90	2.57	1.85
EC	11.5	24.6	21.0	24.1	25.8	16.1	54.6	25.40
EB	1.04	4.07	0.25	1.79	1.83	0.48	31.3	5.82
EP	0.42	1.23	3.50	10.6	0.49	0.65	4.29	3.02
EA	3.13	4.57	76.2	8.07	0.61	2.23	3.86	14.10
HaS	0.96	2.89	1.63	1.00	0.51	0.80	0.71	1.210
HaF	3.54	8.48	5.00	4.54	6.76	2.01	7.71	5.43
$IAG	412	1941	1147	277	110	333	1091	759
$IB	25.4	52.7	0.00	42.9	7.32	5.00	607	105
$IC	41.2	225	355	164	175	84.4	355	199
$IP	0.00	12.3	50.0	396	0.00	12.9	146	88.2
$IA	4.08	9.33	540	22	0.00	3.85	0.00	82.7
$IEX	2316	2222	690	2039	472	2688	1522	1707
$IBS	551	481	450	429	759	404	429	500
∑ing	3350	4945	3232	3370	1524	3531	4150	3443
∑Ex	16.1	34.4	101	44.6	28.8	19.4	94	48.3

ED: age of the producer, **TP:** number of family members living in the same house, **PD:** number of people who work exclusively in the farm, **PF:** number of people who work exclusively outside the farm, **PDF:** number of people working inside and outside the farm, **GCR:** knowledge of the reproductive cycle, **GCS:** degree of health control, **EC:** goat stocks, **EB:** bovine stocks, **EP:** swine stocks, **EA:** poultry stocks, **HaS:** hectares planted, **HaF:** area of the farm in hectares, **$IAG:** total sale of agricultural crops, **$IB:** total bovine sale, **$IC:** total sale of goats, **$IP:** total swine sales, **$IA:** total poultry sales, **$IEX:** income from other working activities, **$IBS:** income from social benefits,**∑Ing** total income, **∑Ex** total stocks.

4 Discussion

The classification of the PSE's goat production systems allowed defining the common characteristics of the 172 establishments, and identifying the heterogeneity present by classifying them into 7 groups, distributed homogeneously throughout the province. Two mixed groups were found, one with a predominance of livestock activity (G3) and one of agricultural activity (G2); a group committed more to swine livestock activity (G4); 2 groups defined by the rearing of goats for the consumption whose income comes from external sources (G1 and G6); and 2 other age-defined groups of their producers, whose income comes from the older social benefit group (G5) and the younger external income group (G6).

Similar variables were used in other regions to classify establishments (Coronel de Renolfi, M. and Ortuño, S., 2005; Costa et al., 2008; Garcia et al., 2010; Hernández et al., 2011; Gómez, 2013; Hernández et al., 2013; Chivangulula et al., 2014; Umunna et al., 2014; Barboza, 2018). This work also included incomes with the aim of identifying different subsistence strategies.
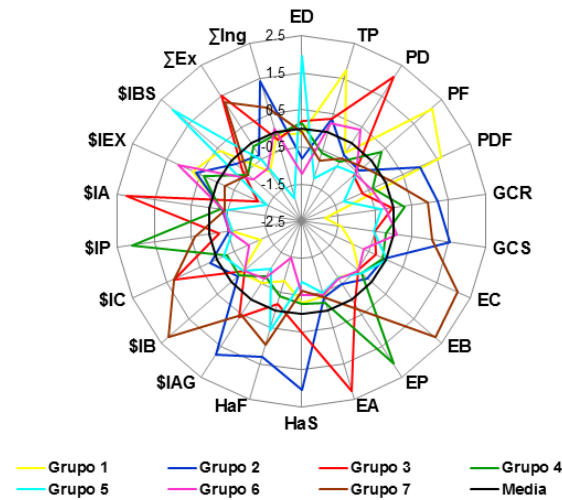
Figure 1. Profile of the seven groups belonging to the productive systems

The goat establishments of the PSE are located in the rural area, on communal land with the right of possession. In other countries, other forms of land tenure were found: property, occupants or located on tax lands (Hernández et al., 2011; Vargas et al., 2014; Torres, 2014; Bedotti, 2000). The level of education is an important aspect to highlight when carrying out specific programs that help improve the goat production. 61 % of PSE producers completed elementary school. These results differ from those reported in other countries, where more than 60 % of producers did not have any study (Serrano, 2010; Falagan, 1988; Luque, 2011; Bedotti et al., 2005; Gómez, 2013; Fikru and Gebeyew, 2015; Hagos et al., 2016).

The continuity in the rearing of goats by the owners' children, observed in 62 % of the surveys, is another aspect to be highlighted because it allows the possibility of proposing longer-term strategies. This percentage is higher than 42 % presented in Murcia, Spain (Falagan, 1988), but less than 80 % or more elsewhere (Bedotti, 2000; Luque, 2011; Gómez, 2013).

97 % of the PSE systems are family systems, the owner is responsible for the care of goats, without hiring any paid staff. While the majority were men (63 %), only 37 % were women, number which is higher than the 20 % observed in Mexico and Ethiopia (Serrano, 2010; Tsegaye, 2009; Hagos et al., 2016). The presence of women in goat activities could be related to the type of animal being bred and to the management (Serrano, 2010).

According to Devendra's classification of goat systems Devendra (2015), PSE systems are categorized as extensive and free grazing. Owners were not found to lease farms or land for the exclusive use of their animals. This is similar to what was mentioned in Venezuela, Colombia, Peru and Ethiopia (Valerio et al., 2010; Guerrero et al., 2012; Gómez, 2013; Hagos et al., 2016); but different from other places where grazing grounds are leased (Carné et al., 2007).

The overall average of goats per herd in the PSE is 25. The low number could be explained by: a) theft and predation; b) the breeding target: only 25 % of producers sell their animals to meet part of their basic needs, the rest raise them as a means of saving; c) low technology incorporation and low-technical assistance that generates low incomes as in other regions (Costa et al., 2008; Valerio et al., 2010; Hernández et al., 2011; Navarro et al., 2011; Gómez, 2013); d) land tenure of another person or the community (Bellido et al., 2001).

The annual income for the 7 groups is variable, with a monthly average of $287. All groups are well below meeting the basic monthly needs of producers since, according to INEC, the monthly basic foodbasket (CFB) at the time of this study was $425.

The goat systems of the PSE have characteristics of family rural systems, with a subsistence economy with less than 25 goats per herd, with monthly incomes that do not allow them to access the basic food basket; therefore, they do not cover the basic needs of the producers and their families. They are part of the the marginal category proposed by the Instituto Nacional de Estadística y Censos (2010) and the Ministerio de Agricultura y Ganadería (2018). However, they have knowledge and experience gained over time in the management and care of biodiversity. The management of this biodiversity acquired over years, as well as a set of knowledge and practices, which is not easy to describe, should not disappear (Jarvis et al., 2011). Despite the low availability of assets and low levels of productivity, family farming is a major supplier of popular staple foods (FAO/BID, 2007; Hodges et al., 2014).

5   Conclusions

The goat production systems of the province of Santa Elena have been classified for the first time. The results obtained in this research show that there is heterogeneity between the goat systems in Santa Elena, and they are a contribution to take into account when planning options to enhance their development.

Acknowledgment

References

Barboza, M. (2018). Caracterización de los sistemas de producción caprinos en la región huetar norte de costa rica.

Bedotti, D. (2000). *Caracterización de los sistemas de producción caprina en el Oeste pampeano (Argentina)*. Tesis doctoral, Córdoba, España.

Bedotti, D., Gómez, A., Sánchez, M., García, M., and Martos, P. (2005). Aspectos sociológicos de los sistemas de producción caprina en el oeste pampeano (argentina). *Archivos de zootecnia*, 54(208):599–608. Online: https://bit.ly/2KULJFr.

Bellido, M., Escribano, M., Mesías, F., Rodríguez de Ledesma, A., and Pulido, F. (2001). Sistemas extensivos de producción animal. *Archivos de Zootecnia*, 50(192):465–489. Online: https://bit.ly/2GEdqOL.

Cabrera, D., García, A., Acero de la Cruz, R., Castaldo, A., Perea, J., and Peinado, J. (2004). Metodología para la caracterización y tipificación de sistemas ganaderos. *Documentos de trabajo 1. Dpto. Producción Animal. Universidad de Córdoba*, 1:Online: https://bit.ly/2UU6TrW.

Carné, S., Roig, N., and Jordana, J. (2007). La cabra blanca de rasquera: Caracterización estructural de las explotaciones. *Archivos de Zootecnia*, 56(213):43–54. Online: https://bit.ly/2W49Wu5.

Chivangulula, M., Torres, V., Varela, M., Morais, J., Mario, J., and Sánchez, L. (2014). Characterization of the livestock production cooperative systems in the municipality of caála, huambo province, republico f angola. *Cuban Journal of Agricultural Science*, 48(2):97. Online: https://bit.ly/2Wi0LGR.

Coronel de Renolfi, M. and Ortuño, S. (2005). Tipificación de los sistemas productivos agropecuarios en el área de riego de santiago del estero, argentina. *Problemas del Desarrollo. Revista Latinoamericana de economía*, 36(140):64–88. Online: https://bit.ly/2ZtrClb.

Costa, R., Almeida, C., Pimenta, E., Holanda, E., and Santos, N. (2008). Caracterização do sistema de produção caprino e ovino na região semi-árida do estado da paraíba, brasil. *Archivos de Zootecnia*, 57(218):195–205. Online: https://bit.ly/2L05DPo.

Dallas, E. (2000). *Métodos multivariados aplicados al análisis de datos*. International Thomson Editores, México.

Devendra, C. (2015). Dynamics of goat meat production in extensive systems in asia: Improvement of productivity and transformation of livelihoods. *Agrotechnoly*, 4(1):131. Online: https://bit.ly/38Z81xP.

Di Rienzo, J., Casanoves, F., Balzarini, M., González, L., Tablada, M., and Robledo, C. (2008). Infostat, versión 2008, grupo infostat.

Dorji, J., Tamang, S., and Dorji, T. Y. (2017). Decline of jakar sheep population in pastoral communities of bhutan: A consequence of diminishing utility, alternate income opportunities and increasing challenges. *Policy and Practice*, 7(4):Online: https://bit.ly/2EEVyl9.

Dufumier, M. (1990). *Importancia de la tipología de unidades de producción agrícolas en el análisis de diagnóstico de realidades agrarias*, pages 63– 81. Online: https://bit.ly/392KjAV. Red Internacional de Metodología de Investigación de Sistemas de Producción - RIMISP, Santiago de Chile.

Falagan, A. (1988). Caracterización productiva de la raza caprina murciana-granadina en la región de murcia. aspectos técnicos y sociales. Technical Report 63, Instituto Nacional de Investigaciones Agrarias. Ministerio de Agricultura, Pesca y Alimentación, MAPA. Colección Monografías INIA., Madrid.

FAO (2012). Phenotypic characterization of animal genetic resources. fao animal production and health guidelines no. 11. rome.

FAO/BID (2007). Políticas para la agricultura familiar en américa latina. oficina regional de la fao para américa latina y el caribe.

Fikru, S. and Gebeyew, K. (2015). Sheep and goat production systems in degehabur zone, eastern ethiopia: Challenge and opportunities. *Advances in Dairy Research*, 3(2):134. Online: https://bit.ly/2QkZiPa.

Garcia, A., Perea, J., Acero, R., Angón, E., Toro, P., Rodríguez, V., and Gómez, A. (2010). Caracterización estructural de los sistemas ganaderos de las dehesas andaluzas. *Archivos de Zootecnia*, 59(228):577–588. Online: https://bit.ly/2DBCYKp.

Gómez, N. (2013). *Caracterización estructural, morfológica y genética de la población de cabras autóctonas de la región Apurímac del Perú*. Tesis doctoral.

Greenacre, M. (1984). *Theory and Applications of Correspondence Analysis*. Academic Press, London.

Guerrero, L., Tellezz, J., Vera, M., Garza, B., Rincón, J., Martínez, B., Serrano, N., and Vargas, J. (2012). Caracterización de los sistemas de producción caprinos presentes en el municipio de jordán, santander, colombia. *AICA*, 2:171–174. Online: https://bit.ly/2Wh6kFv.

Hagos, G., Kebede, K., Benerje, A., and Wolde, Z. (2016). On-farm phenotypic characterization of begait goat and their production system in western zone of tigray, ethiopia. *International Journal of Research and Innovation is Earth Science*, 3(1):15–20. Online: https://bit.ly/2Zwi1tE.

Hernández, J., Franco, F., Villarreal, O., Camacho, J., and Pedraza, R. (2011). Caracterización socioeconómica y productiva de unidades caprinas familiares en la mixteca poblana. redalyc, sistema de información científica, red de revistas científicas de américa latina, el caribe, españa y portugal. *Archivos de Zootecnia*, 60(230):175–182. Online: https://bit.ly/2Dy2ccN.

Hernández, P., Estrada, J., Avilés, F., Yong, G., López, F., Solís, A., and Castelán, O. (2013). Tipificación de los sistemas campesinos de producción de leche del sur del estado de méxico. *Universidad y Ciencia, Trópico húmedo*, 29(1):19–31. Online: https://bit.ly/2voDOWB.

Hodges, J., Foggin, M., Long, R., and Zhaxi, G. (2014). Globalisation and the sustainability of farmers, livestock-keepers, pastoralists and fragile habitats. *Biodiversity*, 15(2-3):109–118. Online: https://bit.ly/35qpCeZ.

Instituto Nacional de Estadística y Censos (2010). Fascículo santa elena.

Jarvis, D., Padoch, C., and Cooper, D. (2011). *Manejo de la agrobiodiversidad en los ecosistemas agrícolas*.

Lanari, M. R. (2004). *Variación y diferenciación genética y fenotípica de la cabra criolla Neuquina en relación con su sistema rural campesino*. Tesis doctoral.

Luque, C. (2011). *Caracterización y evaluación de las razas caprinas autóctonas españolas de orientación cárnica*. Tesis doctoral.

Macías, A. (2015). *Propuesta de mejoramiento en la gestión de pequeños productores caprinos en Capitanejo, Santander*. Doctoral dissertation.

Ministerio de Agricultura y Ganadería (2018). Entrega de nombramiento a los cabildos comunales electos para el periodo 2018. online: https://bit.ly/2kFfT3j.

Navarro, M., Fernández, G., and Perezgrovas, R. (2011). Characterization of majorera goat production systems in the canary islands. in bernués a. (ed.), boutonnet j.p. (ed.), casasús i. (ed.), chentouf m. (ed.), gabiña d. (ed.), joy m. (ed.), lópez-francos a. (ed.), morand-fehr p. (ed.), pacheco f. (ed.). economic, social and environmental sustainability in sheep and goat production systems. zaragoza: Ciheam /fao/cita-dga. 205-210. *Options Méditerranéennes: Série A. Séminaires Méditerranéens*, (100):Online: https://bit.ly/2vjW8A3.

Núñez-Domínguez, R., Ramírez-Valverde, R., Saavedra-Jiménez, L. A., and García-Muñiz, J. G. (2016). La adaptabilidad de los recursos zoogenéticos criollos, base para enfrentar los desafíos de la producción animal. *Archivos de Zootecnia*, 65(251):461–468. Online: https://bit.ly/2QPVGEa.

Peña, D. (2002). *Análisis de Datos Multivariante*. Mc Graw-Hill, España.

Robinson, T. P., Thornton, P. K., Franceschini, G., Kruska, R. L., Chiozza, F., Notenbaert, A., Cecchi, G., Herrero, M., Epprecht, M., Fritz, S., You, L., Conchedda, G., and See, L. (2011). Global livestock production systems. *FAO & ILRI*, page Online: https://bit.ly/35i8cBf.

Serrano, M. (2010). Análisis del sistema de producción de cabras con fines lecheros en la región de libres, puebla. Tesis de maestría, México.

Sistema Nacional de Información (2018). Encuesta de superficie y producción agropecuaria continua (espac) 2004-2013.

Torres, P. (2014). Caracterização e modelagem dos sistemas de produção de caprinos leiteiros. Master's thesis, Macaíba/RN – Brasil.

Tsegaye, T. (2009). Characterization of goat production systems and on-farm evaluation of the growth performance of grazing goats supplemented with different protein sources in metema woreda, amhara region, ethiopia. M.sc. thesis, science in agriculture (animal nutrition).

Umunna, M., Olafadehan, O., and Arowona, A. (2014). Small rumiant production and management systems in urban area of southern guinea savanna of nigeria. *Asian Journal of Agriculture and Food Science*, 2(2):107–114. Online: https://bit.ly/2ZIh8hW.

Valerio, D., García, A., Acero, R., Perea, J., and Tapia, M. an Romero, M. (2010). Caracterización estructural del sistema ovino-caprino de la región noroeste de república dominicana. *Archivos de Zootecnia*, 59(227):333–343. Online: https://bit.ly/2QIiPIy.

Vargas, J., Serrano, C., Martínez, D., Rodríguez, G., and Zaragoza, L. (2014). Caracterización de los sistemas de producción caprina en el municipio de aratoca, santander sobre la cuenca del río chicamocha. *AICA*, 4:234–236. Online: https://bit.ly/2vj794B.

Ward, H. (1963). Hierarchical grouping to optimize an objective function. *Journal of the American Statistical Association*, 58:236–244. Online: https://bit.ly/2ZwusFX.