Original Article

Typification of small and medium family livestock production systems in The Ríos, Ecuador

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Abstract

In the Ríos, Ecuador, small family systems that use trees and shrubs in feed animals are recognized as a source of livestock production, so it would be practical to classify them. White Objective typifies livestock farms in the province's north, emphasizing trees and shrubs in animal feed. Random sampling was applied. Out of a total of 320 farms, 98 were chosen at random (case under study). The experiment was carried out in different places that comprise the cantons: Buena Fé, Valencia, Quevedo y Quinsaloma. Menans of multivariate analysis classified cases. Factor analysis (FA) and cluster analysis (CA) were used. For the FA several extraction methods were explored, finally selecting the method of categorical principal components. The study showed that the variables originated in order of priority three components, which explained more than 73% of the total variance. It was observed that 18 variables of the total were represented with factor loadings higher than 0,75 in some components. The hierarchical conglomerate defined the grouping and classification of the farms. At 30% of the Euclidean distance, three groups were obtained, which define the organization of the herd and the productive purpose. The groups were basically differentiated by the size of the farms, the use they give to the trees, the number of hectares dedicated to pastures, and the species of trees they have in the pastures.

Keywords: trees, shrubbery, groups, farms, pasture.

Introduction

Cattle activity in Ecuador is distributed by region according to the country's agroclimatic characteristics: the Sierra area with a temperate climate and specialized intensive systems that represent 50.6% of the national census and the Coastal areas, and the East with 36 .3 and 13.1%, respectively, where the hot climate and the dual-purpose system predominate (Varela, 2018).

The Ríos province is located in the coastal region, with an economy determined by agricultural activity representing 14.18% of national production, including livestock activity. 41,712 producers, of whom 47% produce in lots of up to five ha, the remaining 53 in areas that vary from five to 50 ha and more support this (Varela, 2018).

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On the other hand, the agricultural systems of the Ecuadorian coastal region intensified, due to the advance of deforestation, the indiscriminate burning of crop residues, the expansion of agricultural areas and the incorporation of new technologies by producers, both national and foreign (Reina, 2016).

As a result, livestock farming has been affected, determined by the increase in floods, the existence of more attractive economic-productive alternatives, the increase in the areas of short-cycle crops such as soybeans, corn and rice, and the little knowledge of the ecological possibilities that the region presents for livestock production (INEC, 2018).

Those mentioned above determined that there is a low use of local resources and ignorance of the potential of pastures and forages in the region, which can be used based on livestock development. As a result, producers do not have production goals, there is seasonal movement of animals to areas unsuitable for livestock and, as a consequence, the availability of milk and meat in the locality decreases.

Due to the above, the objective of this study was to classify the livestock production farms in the northern area of Los Ríos province, with emphasis on those that use pastures, trees and shrubs in the feeding of ruminants.

Materials and methods

Research area, climate and soil: The work scenario is The Ríos Province, Ecuador, formed by river valleys and coastal alluvial plains with few depressions (savanna), primarily fertile. Los Ríos is located to the west of the Andes mountain range, forming part of the Coast region, its geographic location is 1º 46' 00" South latitude and 79º 27'00" West longitude at a height of 8 to 110 meters above sea level. The area is 7,175 km2, divided into 13 cantons: Baba, Babahoyo, Buena Fé, Mocache, Montalvo, Palenque, Pueblo Viejo, Quevedo, Quinsaloma, Urdaneta, Valencia, Ventanas and Vinces.

The experiment was carried out at different points in the northern part of the province that includes the cantons: Buena Fé, Valencia, Quevedo and Quinsaloma.

The climate belongs to the zone called Tropical Monsoon; it belongs to the ecological classification Humid Tropical Forest. In this area, as in the province, there are two seasons: summer, which is dry and cool, runs approximately from July to December, as detailed in the table below (Villavicencio, 2004).

Table 1. Climatological characteristics of the northern zone of the Ríos Province

Climatological characteristics	Averages
Temperature (ºC)	27
Precipitation (yearly in mm)	2223.85
relative humidity	84-85 %

The most predominant soils in the study area are Dystrandept and Eutropept. These are presented without drainage restrictions, density less than one g/cc, high cation exchange capacity, good moisture retention, large amount of organic carbon, slightly acidic to neutral pH, rich in organic matter and good fertility. Its use is very wide, supporting all kinds of crops, pastures and trees. Its texture varies from Franco, Franco-Limoso and Limoso (FAO, 2015).

Sample selection and information collection on the farms: Random sampling was applied in the study region (northern area of the province). Of a total of 320 farms, 98 were chosen at random (cases under study), which met the following inclusion criteria: accessibility; distance from the highway, availability of access to markets, the willingness of the producer who would participate in the study, presence of cattle ranching (Alvarez et al. 2014).

To collect information, the methodology used by Giller et al. (2011) that integrates different participatory research tools. This began with a rapid rural diagnosis, which was implemented through interviews and documentary analysis. To this end, a survey was designed that included productive and structural variables. To complement the information, there were existing production records in the local Ministry of Agriculture and Livestock territorial offices. In addition, to obtain point estimates of the variables analyzed in each farm, those used in combination with digitized soil maps, digital elevation models, and climatological temperature and precipitation data were georeferenced.

To typify the farms, the methodologies described by Benitez et al. (2000). To determine the botanical composition of the pastures, the step method was used (t'Mannetje and Haydock 1963).

Variables studied: Size of the farm (ha), size of the paddock (ha), (area of paddocks), pasture areas (ha), number of animals (total head), breed, body condition, no lactation, duration of lactation (days).

Stocking rate/ha, cultivated grass species (introduced and natural), the destination of the animals (milk or meat production), type of farm (traditional, semi-technified, technified), management system (free-roaming, stabled), destination (cutting or grazing).

Facilities: (corral, shed, none), facilities material (cement, cane, metal, others).

Tree management: use of trees on the farm (shade, food, others), where they are planted (scattered in the paddocks, live fences, on the banks of streams, on the boundaries, separating the paddocks, on the banks of pens), species they have, trees are managed (yes, no), acceptability by animals (yes, no).

Production: litres/cows in winter, litres/cows in summer, fattening months, minimum fattening weight, maximum weight, place of sale (house, market).

Statistical analysis: The cases were classified through multivariate analysis: Factor Analysis (FA) and Cluster

Analysis (CA) were used. For FA, several extraction methods were explored, finally selecting the Principal Components method. The rotation method was applied: Varimax normalization with Kaiser and the Bartlett sphericity test was performed, which was highly significant ($P < 0.01$) and the KMO statistic (Kaiser-Meyer-Olkin) with a value of 0.60.

Multivariate Statistics techniques were applied, according to the criteria of DeLeeuw (2005) and Tapia (2007), according to the characteristics of the variables; as there are different measurement scales in the investigation, the Principal Components Analysis is used for categorical data (Correa, 2008).

Within each factor or main component, those indicators with weighting or preponderance factors greater than or equal to 0.75, and the component with its own value greater than or equal to unity ($\lambda \geq 1$) were selected.

A Cluster Analysis was performed, following the sequence used by Vargas et al. (2013), which includes two phases: in the first, Ward's hierarchical clustering method was used, in order to determine a preliminary number of groups (clusters) to form. Progressive grouping levels were explored and the optimal level was defined as the best distribution of the cases under study, according to the groups formed. In the second phase of the AC, the definitive grouping of the cases was obtained; the non-hierarchical K-means method was used, specifying as a starting point the number of clusters identified as optimal in the previous step. The SPSS version 22 program for Windows was used for all of the above.

Results and discussion

The study showed that the variables originated from three components in order of priority, which explained more than 73% of the total variance (Table 2). When analyzing these variables, it was observed that 18 of the total were represented with factor loads greater than 0.75 in some component. The first was the most important and explained 44% of the total accumulated variance, and is related to the variables: size of the farm and paddock, which define the dimensions that are exploited by these producers, in addition to the management system and the pasture fate. The component and the variables are related to the acceptability shown by the animals for the trees they consume, milk production in the summer and body condition.

The first component comprises the variables that define the organization of the herd and the technological alternative that is applied, which have repercussions on the productivity of the system and the environmental situation of the farms studied.

The second component that explains 17.82% of the accumulated variance, with an eigenvalue of 2.61, is related to the variables: facilities, use of trees for food, the type of production destined for the farms, the months of fattening and the place where the sale takes place. For the third component, the variables were related: these trees, weight and breed are managed, which are closely linked to the use of trees on farms, as an alternative for feeding animals.

Table 2. Components that determine the production of agricultural systems where trees and shrubs are used

Components	Variables	Weight factor	Own value	Cumulative explained variance, %
I	Farm size	-0,75	7,28	44,64
	Paddock size	-0,77		
	Type of exploitation	-0,89		
	Management system	-0,76		
	Grass destination	0,78		
	Tree acceptability	-0,76		
	Liters/summer cow	-0,76		
	Body condition	0,78		
	Grazing area (ha)	-0,76		
	Grass species	-0,75		
II	Installation	-0,76	2,61	62,46
	Use of trees	-0,78		
	Production type	-0,82		
	Months of fattening	0,82		
	Place of sale	0,75		

III	Trees are managed	0,76	2,28	73,48
	Maximum weight of animals	-0,75		
	Race	-0,75		

Livestock production in the region is, in general, an alternative for family and local consumption; as well as a way to obtain additional income, a situation that determines inadequate conditions of production and attention to the application of technologies and resources to produce in addition to low productive yields (Filian et al., 2019). Hence the importance of this research for the region under study.

Requelme and Bonifaz (2012) evaluated different strata of the size of dairy production units in various regions of Ecuador and found minimum values of three ha, an aspect that coincided with the results presented in this work. On the other hand, the result indicated the importance in the selection of the variables and the influence they had on the variability of the studied systems. The results presented are similar to those obtained by Chivangulula et al. (2014), who, when using the same model, obtained more than 70% explanation of the total variance in the first three components, pointing out that they only evaluated continuous productive variables.

The size of the farm, which is related to the size of the paddocks that are exploited, appeared in the first component with factors greater than 0.75, although the explained variance was 30%. Vargas et al. (2015), when studying the factors that determine milk production in dual-purpose systems in the Pastaza province reported results higher than these. These authors pointed out that the procedures that lead the livestock processes have a decisive influence on the efficiency achieved in the systems dedicated to milk production. Aspect that is present in this study, although the main objective was to typify the farms that use pastures, trees and shrubs in the animal diet, both for the production of milk and meat.

The number of animals and the area of the farm determine the stocking rate, a variable that decides on the capacity of the system to feed the herds, and which did not appear in the model described due to the high homogeneity in which it was presented. The load on the farms presented an average of 0.95 with a variation between 0.18±2 UGM/ha. The interaction of the stocking rate with the days of occupation determines the intensity of grazing, which is an indirect measure of the possibility of feeding the herds, and of the trampling they do during grazing. This estimate explains the influence of the first component on the productive behavior of the animals (Becerra and Torres 2007).

On the other hand, the management alternative that is applied directly impacts the productivity and the environment of the cattle farm. So Benitez et al. (2007) and Vargas et al. (2015) report that the production alternative determined the productive efficiency and the environmental situation of the grazing area, studies carried out in Ecuador and Cuba, respectively. For their part, Benitez et al. (2007) obtained similar results when evaluating the behavior of livestock in the mountains of eastern Cuba.

The second component explains 17.82% of the total variance of the system and is related to the variables facilities, use of trees, type of production, months of fattening and place of sale; they are a consistent part of the production process. These were important in the system's variability and the characterization of the farms studied. Rodriguez et al. (2011), in studies carried out in Cuba, referred that these variables are very important in the establishment of typologies in peasant farms. However, Candell et al. (2016) affirm that the low yields that these farms present are due to the non-use of concentrate for cattle feeding, the inadequate management of pastures, the non-fertilization of pastures, and mainly because the Creole breed of the farms predominates. Unfortunately, this last aspect was not appreciated in this study.

Another study in Ecuador, showed that the analysis of Principal Components, reflected that the variables originated in order of priority three new components, which explained more than 80% of the total variance (Filian et al. 2019), higher than what was reported in this experiment.

One problem that compromises the sustainability of milk and meat production is the lack of food and its low supply of nutrients. This was evidenced by the producers' different grass species, where the factor load was 0.75 (Table 2). Emphasizing that the profitability of dairy systems is directly associated with the technological level used and the adoption of technologies, their impacts on production constitute key events that can favor the development of the agricultural sector and its competitiveness (García et al., 2015).

This factor is very important, since in these localities the cattle raising system is exclusively extensive. The animals feed, in general, on native grasses. Parsons et al. (2013), in their description of livestock production systems in South Viet Nam, concluded that cooperatives with larger livestock areas, in terms of labor and land, consequently have better incomes. The development of cattle ranching is essential in intensifying and diversifying forage crops. Ramírez (2010) refers that the lack of good quality forage species, adapted to the environmental conditions of various livestock areas, is pointed out as one of the problems that limit the development of livestock activity (Chinvangulula et al. 2014).

This situation is characteristic in tropical lowland livestock systems and coincides with what was reported by Esquivel (2007), showing a higher concentration of trees with DBH between 20 and 60 cm and a low proportion with DBH between 10 and 20 cm. The multiple uses of woody species

constitute an ideal condition for the presence of trees in pastures. 80% of the trees corresponded to forage species, 8.57% were fruit trees, while 7.14% and 4.28% were ornamental and timber species, respectively. In this regard, Esquivel (2007) reports contrasting results in his study, with 50% timber, 27% forage trees and 27% fruit trees. The presence of trees in pastures, in adequate densities, represents an ideal condition from the point of view of animal welfare and a source of additional goods for the rancher (Garzón and Mora, 2014).

On the other hand, the structure of the herds is characterized by the use of different breeds, without an indicator that reflects which behaves more efficiently. Studies carried out in coastal areas of Ecuador reflected mestizo crosses without defined racial types (43.6% for the case of breeding cattle and 59.1% for fattening cattle). In the case of breeding, crosses of Mestizos Charolais (25.8%), Holstein (16.1%) and Parda Alpina (14.5%) are also present. In the case of fattening, the same mestizo crosses are present with equal participation (13.6% respectively) (Ríos and Benítez, 2015). This coincides with the results of this investigation.

The place of sale was another variable that characterized the producers surveyed (Table 2), with a factor greater than 0.75. Reflecting that the greatest number of these decide to negotiate their products in the (market or house). Without considering the degree of associativity, which could allow them better marketing. In this sense, Rios and Benitez (2015) reported that in terms of the degree of associativity, breeding farmers have a higher level of association (40.3%) compared to fattening farmers (37.5%). However, the bargaining power of the organizations of both productive orientations is low.

The cluster or conglomerate analysis that was carried out, grouped the farms according to the distances between them. The three components that explained more than 70% of the total variance were taken as a basis for the production variables. Figure one shows the hierarchical conglomerate that defines the grouping of the farms and table three shows the typification of the farms of the studied samples. At 30% of the Euclidean distance, three groups are obtained, which define the organization of the herd and the productive purpose. Thus, the variables size of the farms, the use they give to the trees, the number of hectares dedicated to pasture, and the species of trees they have in the paddocks typify the farms studied in the northern region of the province. Studies in Ecuador reflected that the use of the conglomerate allows establishing the characterization of farms and their production system. By using variables, such as milk production, management system, use of trees, similar to those studied in this research with high significance (Ochoa et al. 2014).

Another important aspect to highlight is that regardless of the size of the herd and the area of the paddock, the producers in the area use the same management systems and the productive purpose since these were variables where no differences were observed. These conglomerates determine the production above systems, which in turn defines the organization and animals present as elements that imprint the dynamics of the entire system, and that impact cultural expressions (Velazquez and Perezgrovas 2017).

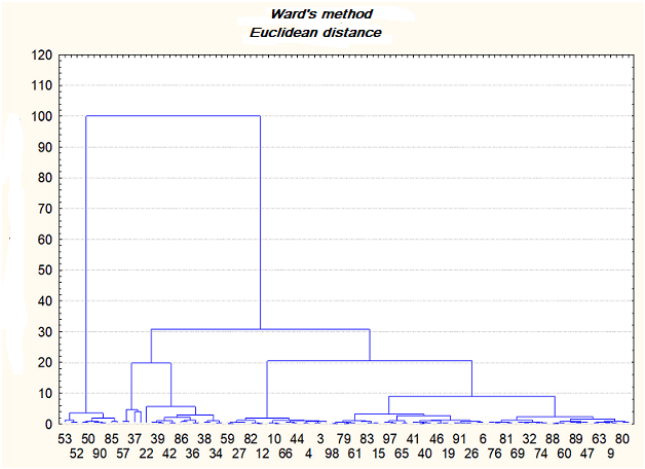

Figure 1. Grouping of farms under study

The groups are differentiated by the size of the farms, their use to the trees, the number of hectares dedicated to pasture, and the species of trees they have in the paddocks. There is no difference in the management of the trees, since in the three defined groups it does not exist. Milk production is low, especially in the summer, and loads are similar, never exceeding one LU/ha. The stocking rate is low, since many producers have farms that exceed 30 ha without having a large number of animals, as can be seen in the number of animals.

The duration of lactation is about 294 days, except for the first group. On the other hand, it was appreciated that the cows in milking are mostly young since the number of lactation does not exceed two years. The variables that define the facilities are similar. In the typified groups, the management system that is carried out is similar, influenced by the livestock culture of the region, and the country. The differences are given in a group that owns dual-purpose farms.

Table 3. Typification of livestock farms that use trees and shrubs in the northern region of The Ríos

Groups	I			II			III		
Variables	N	Mean	SD±	N	Mean	SD±	N	Mean	SD±
Farm size (ha)	9	30,88	3,88	19	44,28	4,69	70	23,27	5,64
Paddock Size (ha)	9	9,88	6,67	19	19,86	8,07	70	9,28	4,77
Number of animals (u)	9	6,11	1,66	19	15,63	2,87	70	8,84	2,97

Fate of animals	9	Milk		19	Milk		70	Meat and milk	
Type of exploitation	9	Traditional		19	Semi-technified		70	Traditional	
Management system	9	Free		19	Free, stabled		70	Free	
Animals load /ha	9	0,80	0,53	19	0,80	0,28	70	1	0,33
Installation	9	Farmyard		19	Farmyard		70	Farmyard, shed	
Materials	9	Cement and cane		19	Cane		70	Cane	
Pasture area (ha)	9	9,83	1,68	19	19,28	2,69	70	8,67	0,48
Grass species	9	Brachiaria		19	Eriochloa polystachya		70	Brachiaria dictyoneura	
Fate of grass	9	Grazing		19	Grazing		70	Grazing	
Use of trees in the farm	9	Food		19	Other uses		70	Food and shadow	
Where are they planted the tress	9	Living fences			Living fences		70	Scattered in the paddock. living fences	
Tree or shrub species	9	Tithonia		19	Citrus sinensis		70	Erythrina, Citrus	
You manage the trees?	9	no		19	no		70	no	
Liters/cow in winter	9	3,2	0,83	19	4,27	0,44	70	3,76	0,61
Liters/cow in summer	9	0,88	1,05	19	1,52	0,84	70	0,93	0,98
Months of fattening	9	-	-	19	-	-	70	33,31	3,03
Min. weight fattening (Kg)	9	-	-	19	-	-	70	460	45,07
Max. weight fattening (kg)	9	-	-	19	-	-	70	600	0,01
Sales place	9	market		19	market		70	House , market	
Body condition	9	1,55	0,72	19	1,68	0,88	70	2	0,86
Lactation number	9	2	0,11	19	1,68	0,08	70	1,89	0,06
Duration of lactation (días)	9	299	6,94	19	294,52	8,36	70	294	7,08

On the other hand, this study showed that there is low use of local resources in livestock development, and producers do not have production goals. These results coincide with those reported by Filian et al. (2019), when characterizing the agricultural production systems with cattle in the province of Los Ríos, Ecuador. These authors refer to the dependency that is made on inputs and the underuse that exists of local resources. In this regard, Paz et al. (2014) pointed out that the increase in the use of energy from fossil sources expresses processes of intensification of the productive systems and shows a potential ecological risk, which can be reduced by the use of green energy sources, such as wind, bioenergy and solar energy, or by a substantial increase in the efficiency of energy use.

Conclusion

Family production livestock systems in the northern area of Los Ríos province are determined by three components that explain 73.48% of the variance, which are related to variables that define the size of the farms, the areas of pasture, tree acceptability, summer milk production, and grass species. At 30% of the Euclidean distance, three groups of farms were distinguished, differing in the size of the paddock, the areas destined for grazing, and the number of animals. This coincides with the use they give to the trees and the species they possess.

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