Typification of the cattle farms in the mountain feet of Los Ríos and Cotopaxi provinces of the Republic of Ecuador

J. Vargas[1], D. Benítez[2], Verena Torres[3], F. Velázquez[4] and O. Erazo[1]
[1]Universidad Técnica Estatal de Quevedo, Matriz: Vía a Santo Domingo, km 1, Quevedo, Ecuador
[2]Instituto de Investigaciones Agropecuarias "Jorge Dimitrov". Carretera Manzanillo, km ½, C.P.85100, Bayamo, Granma, Cuba
[3]Instituto de Ciencia Animal, Apartado Postal 24, San José de las Lajas, Mayabeque, Cuba
[4]Universidad de Granma (UDG), Carretera Manzanillo, km 17 ½, Apartado Postal 21, C.P.85100, Bayamo, Granma, Cuba
Email: jcvb64@yahoo.es

In order to establish tools for adopting sustainable alternatives for cattle production in the tropical mountain foot of the Republic of Ecuador, a participative non-experimental research system was developed in the Los Ríos and Cotopaxi provinces. The methodologies of Benítez *et al*. (2000) and Torres (2005) were applied, as well as others of participative diagnosis. The sample included 60 farms, representing 30 % of those with more than five hectares, devoted to cattle rearing in the region. The cattle systems were typified and their effects on the environment were identified, as well as the needs for their sustainable development. The environmental degradation was associated with the application of production alternatives non-suitable to the environmental characteristics and to the absence of an adequate innovation management system, which considers the social and cultural situation. Three groups of farms were identified, being differentiated by the productive purpose, the land slope, the surface area under exploitation, the herd size and the mechanization level. The alternatives applied did not differ, except in few mechanized farms. Out of the demands identified, solutions were defined for sustainable cattle production. The methodology for the participative rural innovation and the sustainable cattle production of the region was adjusted. This methodology is recommended for the tropical mountain foot of the Republic of Ecuador, as long as the necessary controls are guaranteed to adjust the technologies to the corresponding conditions.

Key words: *typification, farms, productive efficiency, technological alternatives, multivariate analysis, mountain foot*.

The participative rural innovation states that development is only possible through commitment and the permanent and active participation of farmers and public and private institutions involved in the productive chain.

The participative methodologies of rural innovation search for the wide involvement of the different actors of the productive chain, marketing and consumption (Thiele and Bernet 2005, Álvarez *et al*. 2008 and Flores 2009) on planning, achieving, following-up and assessing the different innovation processes.

This active participation contributes to the following-up, assessing and useful life of the adoption technologies and processes, beneficiating farmers. Besides, it is a basic tool for feeding back research and updating the technological alternatives, in function of the changes on the market, the environment and the society (Córdoba *et al*. 2004).

The knowledge on the details of the farms and the identification of their demands is the previous and necessary step to set any participative rural innovation system. The aim of this study was reporting the typification of the cattle farms in the mountain foot of the Los Ríos and Cotopaxi provinces in the Republic of Ecuador; besides identifying the demands of farmers to set a participative rural innovation system.

Materials and Methods

Climatic characteristics of the area under study. It comprises the mountain foot of the Los Ríos and Cotopaxi provinces (figure 1). The mountain surface is of 1 033.61 km^2, 77.7 % corresponding to the Cotopaxi province, and the rest to Los Ríos.

The areas under study occupy 763 km^2. They are administratively divided into two regions, Valencia and La Mana, with a population of 6 304 inhabitants, distributed into 20 communities, with a population density of 8.26 inhabitants/km^2. The main economical activity of this region is agriculture, developed in 704 farms. Out of them, 550 keep certain type of livestock rearing, and 200 have surfaces for livestock rearing surpassing 5 ha (Camacho 2006).

The climate is classified as tropical humid, with seasonal rainfall. The rainy season is from November to April and, it is space variable due to the height effect. Figure 2 shows the rain pattern, and figure 3 that of annual temperatures.

Table 1 shows the characteristics of the soils of the region. Figure 4 refers to the variations of the land slope. Figure 5 presents the climatic regions of this mountain area.

Tretaments and design. Work was conducted with a non-experimental model, controlling as effects the slope, with two levels (lower and higher than 30 %), and the

Figure 1. Location of the areas under study

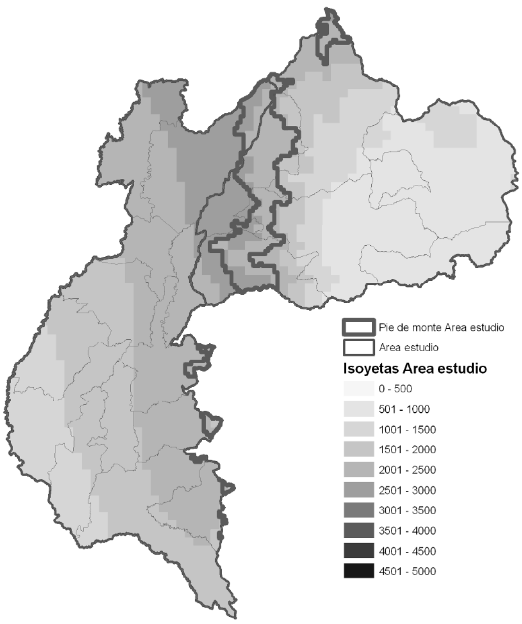

Figure 2. Space distribution of rainfall

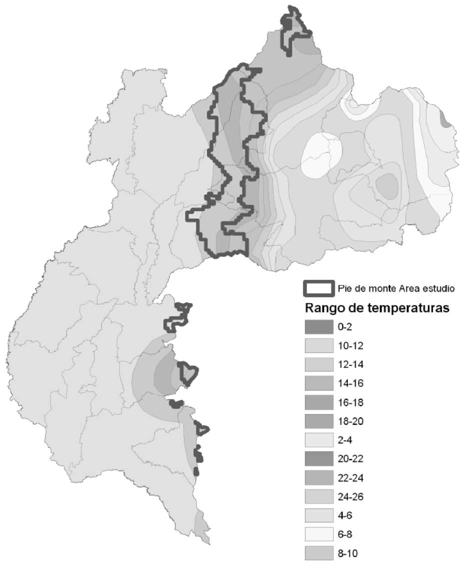

Figure 3. Annual pattern of temperatures

Table 1. Characteristics of the soils in the area under study

Taxonomy	Land surface	Characteristics
Dystrandeps	Slopes between 25 and 70 %	Yellow soils, loamy, deep, with smaller amount of humic acids rather than fluvial. Saturation of bases lower than 50 %. Water holding of 50 to 100 %
	Slopes from 40 to 70 %	Black soils, loamy, saturation of bases lower than 50 %, water holding from 50 to 100 %.
	Slopes up to 40 %	Loamy to sandy soils, deep, with smaller amount of humic acids rather than fluvial. Saturation of bases lower than 50 %. Water holding from 50 to 100 %.
Dystrandeps + Troporthents	Slopes higher than 70 %	Yellow soils, loamy, deep, with smaller amount of humic acids rather than fluvial. Saturation of bases lower than 50 %. Water holding from 50 to 100 %

Source: FAO (2000) and MAGAP (2007)

purpose of the farm (milk or beef production and dual-purpose). The performance of the cattle processes was assessed through a participative diagnosis, evaluating 33 variables of technological, environmental and social nature.

Experimental procedure. In order to typify cattle rearing in the mountain foot of the Los Ríos and Cotopaxi provinces, the methodologies of Benítez *et al*. (2000) and Torres *et al*. (2006) were used. For the study, 200 farms were selected, with more than 5 ha for cattle exploitation. A sample was collected from 60 farms, representing 30 % of the total.

A count was performed to identify the values of the variable body composition in the herds. The frequency of appearance was set for each of the five points established in the methodology. Later, the average body condition of the herd was calculated. The weight of each point was weighted by its frequency of appearance. With this technique, the liveweight of the animals was determined, estimated by the hearth girth measurement with a graduated tape. Tables of estimation were used for each breed. The methodology of dry weight of t´ Mannetje and Haydock (1963) was applied to determine the botanical composition of the pastures. The visual method was used for the pasture biomass yield (Haydock and Shaw 1975). The health control of the farms was evaluated according to the bio-protection norms of the facilities devoted to the rearing of animals of the cattle, buffalo, sheep, goat, and horse species. For the evaluation of the environmental status of the farm, the "Guide of evaluation of the environmental impact for the cattle activity" was used (Ministerio del Ambiente 1999). The Geographical Information Systems (GIS) from each territory, designed in Arviu, were used. They were added the layers of land and soil tenant.

The agricultural soil vocation map was used to define technological alternatives for sustainable cattle production. Also, it was used the database that recorded the measurements of the sample. Indicators were controlled in respect to environmental-technical, social, and health factors, with the objective of typifying these forms of production, defining the generalized technological alternatives, and determining their effect on the economy, the environment, and the society.

The methodology of Torres *et al*. (2006) was applied, permitting the selection of the variables of greatest influence on the variability of the indicators. The similarities between the forms of production under study were established integrally. The tools of factorial multivariate analysis were used for defining the factors that determine the productive efficiency in the cattle farms. The method of principal components was applied for the extraction of the factors, and that of varimax normalized to minimize the factors defining the model. The technique of hierarchical cluster was used for grouping the farms. As grouping strategy, the method of Ward was used, and in order to calculate the matrix of distance, the Euclidian technique. The statistics mean and standard deviation of each group identified were used to establish the types (Statsoft 2003).

Results and Discussion

The productive efficiency in the area under study was determined by three components, which accounted for 79.92 % of the variance accumulated for these cattle systems. Tabla 2 presents these components and the related variables.

The first component accounted for 51.44 % of the total variance accumulated, and it was associated with the variables grazing area and amount of cows in the system. They define the dimensions of the farm and the size of the herd under exploitation. Moreover, this component was also related to the area compatible with the grazing, when performed in the mountain slopes (surface with slopes lower than 30 %), and to the number of groups in which the herd is divided and to the amount of paddocks. At the same time, the component and the enumerated variables were related to the milking cows, the milk produced throughout the year, the birth rate and the eroded area. These data corroborated previous results which are established science.

The variables defining the herd organization and the technological alternative formed this first component. They influence on the productivity of the system and on the environmental situation of the farms under study. Of course, these results are general, as they do not allow a more precise interpretation due to the limitation of the available biological data referred to management and feeding.

The herd size and the farm area establish the stocking rate. This variable determines the capacity of the system to feed the herd, and it was not manifested in the model due to the high homogeneity. The stocking rate in the sampled farms varied from 0.91 ± 0.44 to 1.34 ± 3.98 LAU/ha, excessive values for the slopes of the systems, which were between 35 and 55 % (Benítez *et al*. 2007). This proves there are no necessary controls available to match the stocking rates with the conditions of the farms and improve their efficiency and sustainability.

The number of paddocks in most of the farms was between 3 ± 12 and 7 ± 0, which forced using occupation times between 7 and 30 d. The interaction of the stocking rate with the occupation days determines the grazing intensity, which is an indirect measurement of the herd feeding, as well as the tread of the animals

Tabla 2. Components that determine the efficiency of the cattle production in the tropical mountain foot in Ecuador

Components	Variables	Weighting factor	Eigen value	Explained accumulated variance, %
I	Grazing area, ha	0.88	8.23	51.44
	Grazing compatible area, ha	0.95		
	Cows, heads	0.94		
	Replacement heifers, heads	0.81		
	Milking cows	0.94		
	Production groups	0.63		
	Amounts of paddocks	0.73		
	Milk yield annually, thousands of liters	0.90		
	Births of calves	0.92		
	Eroded area, ha	0.90		
II	Calf weaning age, months	0.89	2.87	69.41
	Cow/sire ratio	0.62		
	Breeding age of the heifer, months	0.94		
	Age at first calving, months	0.92		
III	Land slope, %	-0.89	1.68	79.92
	Amount of pits in 100 meters	-0.88		

during grazing. This estimation accounts for the influence of the first component on the productive behavior of the herds and the environmental situation of the cattle farms (Baldo *et al.*1998, Osechas *et al.* 2007 and Aguirre 2008).

The management alternative should have direct effect on the productivity and the environment of the cattle farm, but the available data do not allow to sufficiently knowing the dynamic performance of these systems. However, Benítez *et al.* (2007) reported for a sample of 845 farms in the mountains of Cuba that the productive alternative determined the productive efficiency and the environmental situation of the grazing area. Ramírez *et al.* (2004) obtained similar results when evaluating the performance of cattle production in the mountains of the Cuban East. However, under these conditions, a systematic and systemic control is demanded to attain higher sustainability and efficiency.

The second component accounted for 17.97 % of the total variance in the system and it was related to the variables weaning age of the calves, cow/sire ratio, breeding age of the replacement heifer and age at first calving in breeders. These variables are a consistent part in breeding. It has been proved that in farms with natural breeding systems, the suckling method influences the duration of the postpartum anestrus length, the pregnancy and birth rates in the herds (Benítez *et al.* 1993, Pedroso and Roller 1996, Pedroso *et al.* 1997, Bertot *et al.* 2000, Benezra 2001, Pérez *et al.* 2001, Álvarez *et al.* 2005 and Viamonte 2005 and 2007).

The replacement heifer rearing system determines the breeding age. This and the procedures with which the breeding process is conducted are elements that affect the breeding efficiency (González-Stagnaro *et al.* 1999 and Rondón 2001). However, aspects related to the feeding balance should be included to determine results with the adequate credibility and accuracy for their better interpretation.

In the third component, the variables land slope and amount of pits in 100 meters of land slide, according to the sense of the slope. This component also accounted for 10.51 % of the total variance of the systems under study. When grazing in the slopes, as the land slope grew, there was rise in the erosion intensity by the combined action of the grazing, compacting the soil and diminishing the water infiltration capacity; besides having increase in leakage and erosion risks Benítez *et al.* 2007). This result agreed with those by other authors (Chaverri-Polini 1998 and FAO 2000, 2007 and 2009), who reported that the land slope, combined with the management alternative, is responsible for the land degradation in areas under mountain slope grazing.

Figure 6 presents the hierarchical cluster that defines the grouping of the farms. Table 3 provides the typification of the farms from the sample. At 50 % of the Euclidian distance, three groups were obtained, being different basically due to their productive aim (milk, beef or both), the land slope, the dimensions of the surface under exploitation, the herd size and the level of technical development.

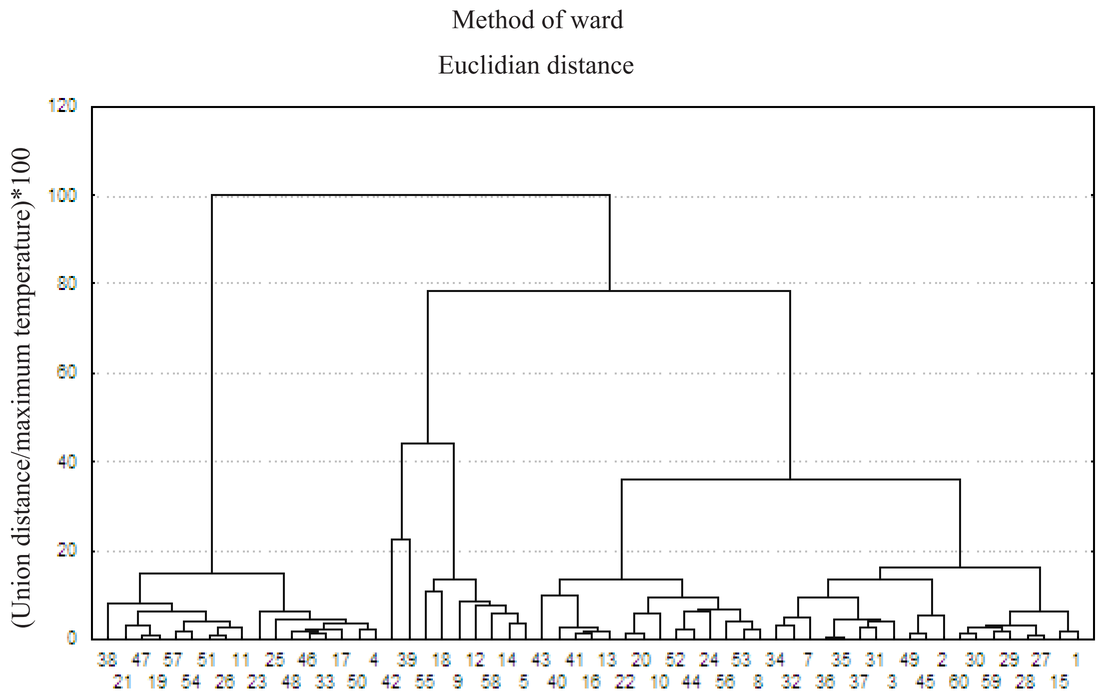

Figure 6. Hierarchical cluster of the cattle farms

The variables that define the technological alternative applied did not differ, except in the farms with low level of technical development. The milk producing farms are dual-purpose and use similar techniques for calf rearing, with weaning ages that coincide with the end of the lactation in cows. This system does not apply any procedure to mitigate the effect of the lactation on the postpartum anestrus (González-Stagnaro *et al*. 1999 and Viamontes 2005 and 2007). The cow/replacement heifer ratio, along with the breeding and first calving ages, denotes the difficulties in the rearing process of replacement heifers (Benítez *et al*. 2007). Although the cow/sire ratio is considered among the optimum indicators, the utilization of multiple yards with sires of different ages and conditions, together with the calf rearing system, predisposes to the inefficiency in the reproductive process (Santiago 1989 and Alvarez *et al*. 2005).

The organization of the herds agreed with the report of several authors (Voisin 1963, Machado 1996, Senra 1999, Fernández *et al*. 2000, Ray 2000, Fernández *et al*. 2001, Juárez 2005, Reyes *et al*. 2005 and Benítez *et al*. 2007). In this study, the rotation in only one group did not facilitate the differentiation in the care of the animals with greater needs. The interaction with long occupation times in the paddocks, due to the reduced number, would possibly force the animals with greatest needs to consume the poorest quality pasture for long times. This may condition a deficit feeding, which would be reflected in the extent of the weed areas, the poor body condition of the herds and the lower milk yield in the third group. However, the long occupation times may not lead the animals to consume the poorest quality pasture, if the reduction in the paddocks were proportional to the rise in the availability, due to the increase in the area of each paddock. The total pasture area and the stocking rate may be kept the same, and this may not be reflected in the poor body condition of the herds, due to the feeding deficit.

In view of these codnitions, according to Senra *et al*. (1985), Senra (2005) and Senra *et al*. (2005), the fundamental cause of the breeding defficiencies would be to have kept the number of animals above the stocking rate capacity, and not setting longer occupation time, due to the reduction in the number of paddocks. The high grazing pressure, together with the poor management by insufficient rest, may lead to overgrazing with increment in weed areas, and lower milk yield, primarily in the third group.

Table 4 shows the herd structure for each of the typified groups. It is distorted, due to the low growth rate of the replacement heifers, delaying the breeding and the first calving ages, which may provoke a the breeding deficiency. Besides, the purpose of the farm also affects the herd structure, because by not being self-sufficient, due to the low breeding rate, animals from other areas should be brought in. This leads to diseases in their respective environments, increasing the lack of sustainability of the exploitation systems.

The health and sustainability risks are high because the preservation measures from the health norms are

Table 3. Typification of the cattle farms of the tropical mountain foot of Ecuador

Groups	Group I			Group II			Group III		
Variables	N	Means	SD	N	Means	SD	N	Means	SD
Height, m asl	17	935.63	196.00	9	840.00	108.00	34	880.48	17.00
Slope, %	17	51.47	14.44	9	35.00	15.00	34	55.09	14.68
Grazing area, ha	17	32.65	28.36	9	174.11	129.00	34	16.93	8.75
Grazing compatible area, ha	17	4.65	8.44	9	121.11	112.00	34	4.45	6.19
Amount of cows, heads	17	0.00	0.00	9	70.00	72.00	34	8.00	5.00
Replacement heifers, ha	17	1.00	3.00	9	34.00	18.00	34	4.00	1.00
Fattening bulls	17	22.00	22.00	9	34.00	61.00	34	5.00	7.00
Global stocking rate, LAU/ha	17	1.33	1.20	9	0.96	0.44	34	1.34	3.98
Milking cows, heads	17	0.00	0.00	9	34.00	34.00	34	5.00	1.00
Production groups	17	1.00	0.00	9	3.00	1.00	34	2.00	1.00
Average age of the herd, years	17	2.48	1.38	9	5.56	1.13	34	5.14	2.26
Calf weaning age, months	17	0.00	0.00	9	7.00	1.00	34	7.00	7.00
Cow/sire ratio	17	0.76	3.15	9	19.00	16.00	34	7.50	0.38
Body condition of the herd	17	2.91	0.48	9	2.77	0.36	34	2.51	0.38
First calving age, months	17	0.00	0.00	9	37.00	4.00	34	42.00	5.22
Number of paddocks	17	3.00	12.00	9	29.00	22.00	34	7.00	0.00
Predominant pasture	17	Molasses		9	Molasses		34	Molasses	
Grazing method	17	Rotational		9	Rotational		34	Rotational	
Weed area, ha	17	1.06	2.54	9	1.00	1.73	34	8.53	7.37
Milk yield, L/cow	17	0.00	0.00	9	6.44	2.31	34	4.41	2.17
Births annually, heads	17	0.00	0.00	9	52.00	59.00	34	4.00	4.00
Eroded area, ha	17	31.65	32.37	9	169.33	140.51	34	16.89	15.24
Amount of pits in 100 m	17	312.00	124.00	9	157.00	102.00	34	303.00	172.00

not applied to control zoonosis (table 5). The odds of brucellosis and tuberculosis are not studied, the requirements to transfer animals are not fulfilled and the biosecurity norms are violated in the farms. The vaccinations against pulmonary edema and blackleg are not fulfilled in 26.7 % of the farms. The incidence of cattle ticks in 36.7 % is high. Ectoparasites are not controlled in 12 %, and there is not veterinary doctor in 88.24 % of the farms. These conditions make them vulnerable to diseases and to obtain poor quality products.

Figure 7 presents the annual dynamics of the index of temperature and relative humidity (ITH), calculated by the area under study. Figura 8 shows the welfare range and the breeds that can be exploited in a sustainable manner in the mountain foot, taking as reference the ITH. The dynamics of the ITH situates the stress area along the year for the *Bos taurus* breeds of European origin, which is modified by the height and the land slope. For the ecosystems of the region, with predominance of high slopes, the recommended breeds are crossbreds of Zebu, Creole, and F1, which

Tabla 4. Structure of the herds in the classified groups

Groups	Group I			Group II			Group III		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Cows	17	1	5	9	70	72	34	8	6
Replacement heifers	17	2	5	9	34	18	34	1	5
Sires	17	0	1	9	2	2	34	1	1
Calves	17	1	5	9	32	18	34	5	5
Fattening bulls	17	24	21	9	34	61	34	7	5
Horses	17	1	1	9	5	5	34	1	1
Other equines	17	1	1	9	2	2	-	-	-

Table 5. Health risks in the area under study, percentage of the total of farms surveyed

Variables	%
Do not take environmental preservation measures	100.00
Do not study the incidence of brucellosis or cattle tuberculosis	100.00
Do not vaccinate against blackleg and/or pulmonary edema	26.70
Keep high infestation of cattle ticks	36.70
Do not control ectoparasites	12.00
Do not keep good hygiene at the milking	57.00
Defficient fencing status	7.00
There is not systematic presence of the veterinary doctor	88.24

are resistant to adverse environments. This, at the same time, is related to the height levels and the slope where the farm is located. Nevertheless, the underfeeding effect should also be considered in these conditions, because it could disguise the influence of other factors.

The factors that lead to stress should be considered to establish the management alternatives of the herds in the cattle farms. The climatic stress is the consequence from the combined action of the temperature with the environmental humidity. The temperatures and the high relative humidity indices lead to heat stress, because they hamper the release of body heat, break the animal homeostasis and force, to the maximum, the regulating capacity of the body to maintain stable the vital functions (Morais 1986, West, 1992 and Gallardo and Vartota 2000).

The high relative humidity provokes stress by reducing the productive and breeding capacity of the herds (Morais 1986, West. 1992, Santos and Lean 2000 and De Villalobos *et al*. 2008). One of the most important measures to counterbalance this is the breed order in the cattle farms (figure 8). For the particular case of the area in view, the landscape relief interacts with the system of grazing management. The outcomes get worse because the maintenance needs of the herds are increased and the productive capacity of the herds is reduced (Benítez *et al*. 2007).

It is concluded that the efficiency of the cattle production in the area under study at the tropical mountain foot is determined by three components, which account for 79.92 % of the variance accumulated in these systems. This value is related to the variables defining the size of the farms and the herd, the technological alternative in practice, the organization of the breeding process, the environmental conditions and the environmental degradation.

Three groups of farms are distinguished being different by the land slope, the land surface under exploitation, the size of the herd and the level of technological development. This is also in correspondence with the productive aim (beef, milk and dual-purpose).

The technological alternatives do not differ between the farms, a regardless the differences in the environment, except in the few farms with high technical development. This conditions the negative environmental effect and the productive inefficiency in the cattle systems.

The health and sustainability risks in the cattle farms are high, due to the biosecurity norms are not considered as part of the work system in those that were classified. In the cattle farms under study there was predominance of high slopes and high environmental humidity, factors that led to stress. These elements are not considered by farmers when ordering the breeds under exploitation or those preferred in the cattle systems.

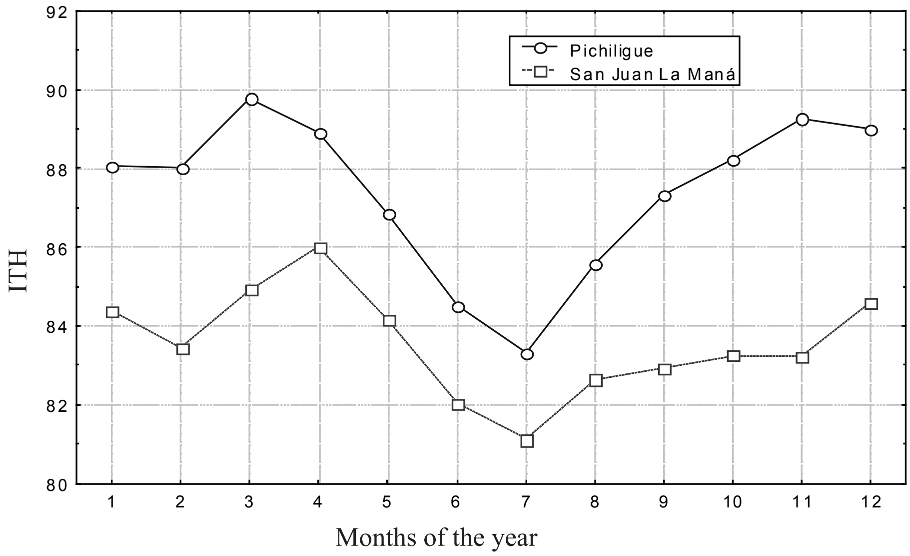

Figure 7. Annual dynamics of the ITH, calculated from the information of the San Juan La Mana and Pichiligue meteorological stations

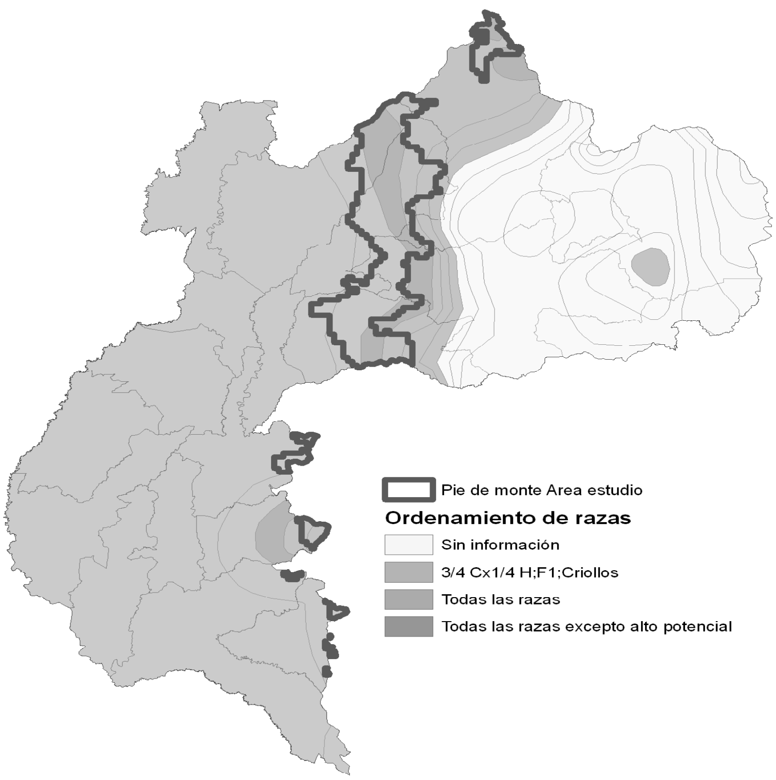

Figure 8. Arrangement of breeds in the region

References

Aguirre, J.A. 2008. Cuencas hidrográficas, servicios ambientales e incentivos para el desarrollo ganadero sostenible de trópico americano. En: Ganadería y medio Ambiente en Centro América. Disponible: <http://www.fao.org/wairdocs/LEAD/x6366s/6366s01.htm#topof page>

Alvarez, S., Bucheli, B., Delgado, R., Maldonado, L., Paz, L., Pozo, A., Rotondo, E. & Thiele, G. 2008. Guía de alcances e impactos de las metodologias participativas sobre innovación rural, Lima 69 p.

Alvarez, J.L., Martínez, G., Montes, I., Orta, S. & Planas, M.T. 2005. Manejo reproductivo Del rebaño de cría. En: Manual de cría vacuna. Tecnología para comentar la eficiencia productiva. Capítulo I. p. 8

Baldo, A., Romero, J., Pieroni, G. & Armendariz, M. 1998. Efecto de la intensidad de pastoreo sobre la eficiencia de cosecha y la calidad del forraje. XVI Congreso Panamericano de Ciencias Veterinarias, Santa Cruz de la Sierra, Bolivia. p. 193

Benezra, M.A. 2001. Comportamiento reproductivo y crianza del becerro en rebaños bovinos de doble propósito. En: Reproducción bovina. Ed. Fundación Giraz, Maracaibo, Venezuela, Capítulo XIII. P.127

Benítez, D., Boza, P., Santiago, O., Ray, J. & Díaz, M. 1993. Particularidades de la vaca de cría. En: Recomendaciones para la alimentación y el manejo del ganado de cría y la hembra vacuna de reemplazo. Ed. Academia, La Habana. p. 1

Benítez, D., Pérez, M.B., Ramírez, S.A., Blanco, A., Camejo, N., Castellanos, M.E., Díaz, V.M., Guerra, J., Guevara, O., Hernández, M., Miranda, M., Pérez, S.D., Ricardo, O., Ricardo, S.O., Rosabel, A. & Vega, P.J. 2007. El manejo de la finca ganadera de montaña. Ed. Alfa Europe Aid, IIA Jorge Dimitrov, Bayamo, Cuba. p. 12

Benítez, D., Pérez, M.B., Ramírez, S.A., Blanco, A., Díaz, M.V., Guerra, J., Guevara, O., Miranda, M., Pérez, S.D., Ricardo, O.S., Ricardo, O.S., Rosabel, A. & Vega, P.J. 2000. Metodología para el perfeccionamiento de la producción ganadera de las zonas montañosas con la implementación de sistemas agropecuarios sostenibles. Informe técnico. IIA Jorge Dimitrov, Bayamo, Cuba. 56 p.

Bertot, J. A., Vázquez A., Avilés, R. & Vázquez, R. 2000. Relación entre los cambios de la condición corporal y la fertilidad postparto en vacas mestizas Holstein x Cebú. Rev. Prod. Animal. 12:103

Camacho, M. 2006. Plan de desarrollo de la parroquia Guesaganda. Consejo provincial Cotopaxi. Secretaría Nacional de Planificación y Desarrollo.

Córdoba, M., Gottret, M.V., López, T., Montes, T., Ortega, A. & Perry, S. L. 2004. Innovación participativa: experiencias con pequeños productores agrícolas en seis países de América Latina. Red de desarrollo agropecuario. Unidad de Desarrollo Agrícola. División de Desarrollo Productivo y Empresarial. Santiago de Chile. p. 77

Chaverri-Polini, A. 1998. Las montañas, la diversidad biológica y su conservación. Es necesario mover montañas. Diversidad biológica y su conservación. Unasylva- Nº 195. Disponible: http://www.fao.org/DOCREP/W9300S/w9300s09.html. Consultado: 7/10/2009

De Villalobos, M., Suniaga, J. & Pulido, F. 2008. Tolerancia al calor y humedad atmosférica de vacas Holstein y mestizas Pardo Suizo-Cebú, en Juspin, Estado de Monagas, Venezuela. Agronomía Tropical 25:243

FAO 2007. Un nuevo enfoque de gestión de cuencas hidrográficas. La nueva generación de programas y proyectos de gestión de cuencas hidrográficas. Libro de consulta para profesionales y autoridades locales, basado en los resultados y recomendaciones de una sistematización de la FAO. Disponible: <http://www.fao.ftp://ftp.fao.org/docrep/fao/ao0644s09.pdf> Consultado: [25/9/2009]

FAO. 2000. Manual de prácticas integradas de manejo y conservación de suelos. FAO. Roma. 220 pp.

FAO. 2009. La larga sombra del ganado. Problemas ambientales y opciones. Documentos FAO. Disponible: http://www.fao.org/docrep/011/a0701s/a0701s00.HTM.Consultado: 5/10/2009

Fernández, J.L., Benítez, D., Gómez, I., Tadrón, I. & Ray, J. 2000. Effect of regrowth age on Brachiaria purpurescens cv aguada in Cauto valley, Cuba. Cuban J. Agric. Sci. 34:257

Fernández, J.L., Benítez, D., Gómez, I., Cordoví, E. & Leonard, I. 2001. Growth dynamics of Brachiaria radicans vc Tanner under edaphic and climatic conditions of Cauto valley in Granma province. Cuban J. Agric. Sci. 35:381

Flores, M. 2009. Innovación en el espacio rural y los nuevos paradigmas de desarrollo sostenible. Documentos FAO. p. 11

Gallardo, M. & Vartota, S. 2000. Estrategias para mejorar la producción de leche en verano. Producir XXL. Año 9. 110:23

González-Stagnaro, C.E., Belloso, S., Goicochea, J., González, R. & Soto, G. 1999. Identificación de los factores causales y control del anestro, principal problema reproductivo en la ganadería mestiza de doble propósito. Premio Agropecuario Banco Consolidado 20:672

Haydock, K. P. & Shaw, N. H. 1975. The comparative yield method for estimating dry matter of pasture. Austr. J. Exp. Agric. Anim. Husb. 15:663

Juárez, H.H.J. 2005. Estudio agrofisiológico y nutricional de materia seca y contenido de proteína en pastos tropicales. Tesis Dr. ICA, La Habana

Machado, R. 1996. Dinámica de algunos indicadores morfológicos y estructurales de Andropogon gayanus CIAT-621 bajo condiciones de manejo intensivo. Efecto de la época y el año. Pastos y Forrajes 19:121 Ministerio del ambiente. 1999. Ley No. 37 ROI 245. Ley de Gestión Ambiental de Ecuador

MAGAP 2007. Políticas de estado para el afroecuatoriano 2007-2020. Presidencia de la República de Ecuador. Quito, Ecuador. 128 pp.

Ministerio del Ambiente 1999. Ley No 37 RO/245. Ley de gestión ambiental de Ecuador. Disponible: <http://www.ambiente.gov.ec/userfiles/47/LEY%20DE%GESTION%20AMBIENTAL.pdf>

Morais, M. 1986. Tolerancia al calor de bovinos Holstein-Cebú. Relación de indicadores adaptativos con la reproducción en novillas. Rev. Salud Animal 8:89

Osechas, D., Becerra, L. & Torres, A. 2007. Interrelación de estrategias usadas en el manejo y aprovechamiento de pastizales en fincas del estado Trujillo. Disponible: http://www//SciELo/serial/fagro/v23a3/body/art/.09.htm. Consultado: 26/10/2009

Pedroso, R. & Roller. F. 1996. Problemática de las repeticiones del celo en la hembra bovina. Revisión bibliográfica. Rev. Cubana Reprod. Anim. 22:1

Pedroso, R., Roller, F., González, N. &Felipe, N. 1997. Diagnóstico de algunas causas de repeticiones de celos en vacas lecheras de rebaños de baja fertilidad. Rev. Cubana Reproduc. Anim. 23:43

Pérez, P.H., Sánchez, R.C. & Gallegos, S.J. 2001. Anestro postparto y alternativas de manejo del amamantamiento en vacas de doble propósito en el trópico. Producción Agraria. Producción Sanidad de Animales 16:257

Ray, J. 2000. Sistema de pastoreo racional para la producción de leche con bajos insumos en suelo vertisol. Tesis Dr. Universidad Agraria de La Habana "Fructuoso Rodríguez Pérez" - Instituto de Ciencia Animal. Mayabeque, Cuba

Reyes, J. J., Senra, A., Vidal, I., González, R. & González, R. 2005. Efecto de la intensidad de pastoreo en el sistema suelo- planta-animal en condiciones de bajos insumos. Comportamiento de vacas Holstein en pastoreo. Rev. Cubana. Cienc. Agríc. 39:153

Rondón, R.G. 2001. Comportamiento de algunos indicadores reproductivos de la vaca criolla en la provincia Granma. Tesis Maestría en Reproducción Animal. Bayamo, Cuba

Santiago, O. 1989. Desarrollo y situación actual del programa del ganado de cría en Cuba. I Reunión Nacional de Cría. Ciudad de La Habana, Cuba. 5 pp.

Santos, R., R. H. & Lean, I. J. 2000. The effect of tropical ambient temperature on productive performance and grazing behaviour of sows kept in a outdoor system. Disponible: http://www.fao.org/livestock/agap/frg/lrrd/lrrd12/2/rica122.

htm. Consultado: 7/11/2009

Senra, A. 1999. Sistemas de alimentación y manejo para la producción de leche en el trópico. Manejo y Alimentación de Rumiantes. II Curso FEPALE-CENSA. Mayabeque, Cuba

Senra, A. 2005. Índices para controlar la eficiencia y sostenibilidad del ecosistema del pastizal en la explotación bovina. Rev. Cubana Cienc. Agríc. 39:13

Senra, A., Martínez, R.O., Jordán, H., Ruiz, T. E., Reyes, J., Guevara, R.V. & Ray, J. V. 2005. Principios del pastoreo eficiente sostenible para el subtropico americano, sin riego. Rev. Cubana Cienc. Agríc. 39:23

Senra, A., Ugarte, J., Menchaca, M. A. & Galindo, J. 1985. Efecto de 8, 4 y 2 cuartones en la variabilidad de la producción de leche, según el día de estancia en el cuartón. Rev. Cubana Cienc. Agríc. 19:136

Statsoft. 2003. Statistica for Windows. Release 6.8 A, Statsoft, Inc. USA.

Thiele, G. & Bernet, T. 2005. Conceptos, pautas y herramientas: Enfoque participativo en cadenas reproductivas y plataformas de concertación. Perú. 172 p

T´Mannetje, L. & Haydock, K. P. 1963. The dry weight rank method for the botanical analysis of pasture. J. Brit. Grassld Soc. 18:268.

Torres, V., Benítez, D., Lizazo, D., Rodríguez, L., Herrera, M. & Álvarez, A. 2006. Metodología para la medición del impacto o transferencia tecnológica en la rama agropecuaria. Instituto de Ciencia Animal, La Habana

Viamontes, M.I. 2005. Conservación y mejora reproductiva del ganado bovino criollo en el Valle del Cauto. I Congreso Internacional de Producción Animal. Ciudad de La Habana, Cuba

Viamonte, M.I. 2007. Comportamiento y mejora reproductiva de hembras Criolla. Experiencia en la región oriental de Cuba. IV Congreso Internacional de Ciencias Veterinarias.

Voisin, A. 1963. Productividad de la hierba. Ed. Tecno, S. A. Madrid, España. 449 pp.

West, J. W. 1992. Estrés calórico. Alimentación y manejo para reducir sus efectos en las vacas holando. Disponible: http://www.produccionbovina.com/clima_y_ambientacion/23-estres_calorico.htm#_top. Consultado: 29/09/2011.

Received: June 8, 2010