Resources, Reproductive Performance, and Animal Management on Equine Breeding Farms in Azuay, Ecuador

David Duchimaza Borja, Ximena Morocho Farez*, José Alberto Bertot Valdés**, Ángel Vázquez Gil**, Raúl Guevara Viera*, Rafael Ochoa Méndez*, Guillermo Guevara Viera**

*** University of Cuenca, Ecuador**

**** Ignacio Agramonte Loynaz University of Camagüey, Cuba**

guillermo.guevara@ucuenca.edu.ec

ORCID: https://orcid.org/0000-0003-3832-9090

ABSTRACT

Background: The general operations of horse breeding systems are seldom studied. The aim of this paper was to carry out a thorough characterization of horse farms in the province of Azuay, Ecuador.

Methods: Out of the 63 breeding farms authorized by the state agency of Azuay with more than five animals, and operational for over two years, 45 were chosen for sample collection. The information considered variables area, pasture, animals, zootechniques, reproduction, health, and expenses. The analysis showed the basic statigraphs, principal components with Varimax rotation and k-mean cluster analysis, and the statistics for each cluster.

Results: The first component explained more than a third of total variation, and related the determining variables of infrastructure, total area, pasture, and area for facilities. The second component is co-related to the number of parturitions and estrus repetition. The third component is co-related to management and greater animal wellbeing. Two clusters with differences in terms of area, number of animals, availability of resources, and reproductive performance, were found.

Conclusions: Today, the main factors to tackle horse system improvements in the province of Azuay are grassland improvements, animal management, and reproductive performance.

Key words: *horse system, principal components, cluster*

INTRODUCTION

Equine farms are generally not studied as part of livestock raising systems due to the nature of their purpose, which is mostly devoted to recreation and sports. In such cases, interest is place on the animals' individual features. Few countries have developed a well-established meat processing industry, and the number of evaluations, in addition to the poor husbandry practices, are not enough (Catelli, Caviglia, Tassara, and Giménez, 2006), in contrast to farms where other species, like bovines and ovines are raised (Toro-Mujica *et al.*, 2011, Rodríguez, Flores, León, Pérez, and Aguilar, 2018).

The analysis of principal components allows researchers to reduce the number of dimensions and understand the relationships and influences within the large number of factors that intervene and determine changes in the systems. However, it has only been performed to race horses for phenotypic studies (Park *et al.*, 2011) or mare handling (Posta, Komlósi, and Mihók, 2007).

Accordingly, the availability of important information would be greater if the systems' integrity were dealt with comprehensively. Also, their current levels should be defined to compare advances in the short and mid-terms, which might help adjust performance, correct unfavorable trends, and enhance the current values. There are hundreds of variables in equine raising systems; therefore, the most important part will be to reduce them and define the most determining and most variable factors for decision-making. Establishing comprehensive differentiation will contribute to it.

The aim of this paper was to perform a comprehensive characterization of horse farms in the province of Azuay, Ecuador, emphasizing on their resources and reproductive outcome.

MATERIALS AND METHODS

This research was done in the province of Azuay, in southern Ecuador, with a total extension of 8,639 km^2. To the north, it has borders with the province of Cañar; to the south, with the provinces of El Oro and

Loja; to the east, with the provinces of Morona Santiago and Zamora Chinchipe; and to the west, with the province of Guayas. The province is located on 30 ° 05' 00'' south latitude, and 79° 20' 00'' west longitude, according to the National Geospatial-Intelligence Agency (2017). The weather conditions range from tropical to glacial, thanks to its geographical location, with two distinct seasons (humid and dry). The temperatures vary between 8 and 33 °C throughout the year, with mean precipitation values of 789 mm, and relative humidity of 55%.

Forty-five out of 63 breeding farms recorded in the Equine database (2016) of the State Agency for Phyto and Zoo Sanitary Control of Azuay, which is linked to Agroquality (2016), were studied. The farms with less than five animals and no more than two years of work were excluded.

First, a pilot sample comprising 12 farms was analyzed, which facilitated adjustment of the definitive survey. It comprised 56 questions asked personally based on previous consent, including a visit and tour of the horse farm in the company of the manager. A tour was made of the facilities and fields, which included a record of the physical characteristics and management practices.

Particularly, the study provided data and general characteristics of the farms, facilities, grazing areas, and variables related to nutrition, health and sanity, reproduction, economy, and sales.

The basic statistical values were determined. The Analysis of Principal Components included scale variables, with a variation coefficient greater than 40%. Then the correlations between the said variables were determined, many of which were greater than 0.5, with a $P<0.05$ significance. The Kaiser-Meyer-Olkin tests were performed, with an outcome greater than 0.7; Bartlett sphericity was also performed ($P<0.01$). VARIMAX rotation was implemented. The components with auto-value below the farm, and the variables within the component in relation to it (less than 0.50), were discarded. Later, cluster analysis (CA) k-mean was performed with the final variables of APC. SPSS 22 was used for statistical analysis.

RESULTS AND DISCUSSION

Although an increase in the number of horse raising farms (HGF) was produced in Azuay, some of these farms have a short existence; therefore, this investigation was directed to the farms older than 2 years.

The outcome of the Kaiser-Meyer-Olkin and Bartlet sphericity tests allowed for the application of the APC. Three principal components, explaining more than 78% of total variance, were described (Table 1). These components described the most relevant elements on the HRF in the province of Azuay. This information is useful, considering the present and future of horse raising. The first component explained more than a third of the total variation and related the most important resources of a horse-raising farm. This first factor gathered the determining variables of infrastructure, total area, pasture, and area for facilities, which are not so influential for other species. Moreover, they were closely correlated to investment in maintenance and monthly expenses, and animal resources.

Table 1. Principal components, auto-values, primary variables, correlations, and variances

Principal component (Auto-value)	Variables	Correlation	Total variance %	Total accumulated variance %
Resources (6.13)	Total area (ha)	0.89	34.70	34.70
	Investment in maintenance ($)	0.88		
	Grassland (ha)	0.88		
	Area of facilities (ha)	0.72		
	Monthly expenses ($)	0.70		
	Total animals (u)	0.64		
Reproduction (1.82)	Number of parturitions (u)	0.93	22.04	56.74
	Repetition of estrus (u)	0.88		
Animal management (1.42)	Number of stablemen (u)	0.84	21.35	78.09
	Total of people (u)	0.74		
	Amount of hay (kg)	0.73		

	Number of troughs (u)	0.62	
Kaiser-Meyer-Olkin test	(P=0.733)	Bratlett test (P<0.01)	

The second component described more than 20% total variance, and it was correlated to two variables of the reproduction subsystem. The number of parturitions was one of the most relevant results for the sustainability of herds and estrus repetition. The latter is influenced by several factors, like the ones related to proper detection management, absence of rectal palpation, diseases, and genetic, nutritional, and environmental factors, according to Paredes, Higuera, and Hernández (2013). Another important element is the social environment; for instance, Wespi, Sieme, Wedekind, and Burger (2014) noted that the exposure of mares to a mature stud during the transition phase between anestrus and estrus, increased fertility. Additionally, Claes *et al.* (2017) reported that both the involuntary intervals and the follicular phases lasted longer, and the diversion of the follicle occurred later in older mares. Additionally, the changes in the follicle parameters associated to age were closely linked to a low count of antral follicles.

In this species, which has specific characteristics, the elements related to animal management and greater wellbeing was evident in the third principal component. The large number of staff and general people guarantees better care, attention, resources, and closer contact between humans and horses. Increased hay availability, which is essential to these herbivores, improved their nutrition, and their body condition is self-explanatory by the analysis. There was also a positive correlation of this component to the number of troughs, comfort was increased, and animal fights are prevented (Córdova, Villa, Huerta, and Rodríguez, 2017).

Cluster analysis (Table 2) showed that the smaller group used the total area more than five-fold, plus more grassland, and more areas for facilities than the larger group. Because of the larger area for grass, they did not consume hay, but the stocking rate was lower and the supply of feedstuffs was three-fold higher. Hence, a greater amount of food is guaranteed.

Table 2. Characteristics of the two groups of farms

Variables	Groups			
	Limited resources (n=42)		More resources (n=3)	
	Mean	SE	Mean	SE
Total area (ha)	5.9	0.85	30.0	7.64
Grassland (ha)	5.1	0.83	24.7	7.86
Area for facilities (ha)	0.7	0.06	2.7	0.33
Number of troughs (u)	11.5	1.60	25.3	4.84
Amount of hay (kg)	1.4	0.40	0.0	0.00
Amount of feed (kg)	1.5	0.15	4.0	1.15
Stocking rate (kg/ha)	2.7	0.38	1.01	0.49
Number of stablemen (u)	1.5	0.12	2.7	0.33
Staff total (u)	4.0	0.26	7.3	1.33
Monthly expenses ($)	1106.5	136.78	1014.0	410.13
Total animals (u)	16.8	1.58	71.0	9.50
Number of mares (u)	7.9	0.83	25.7	8.09
Number of pregnant mares (u)	4.6	0.56	22.7	13.68
Number of parturitions (u)	4.0	0.55	22.3	13.86
Repetition of estrus (u)	0.7	0.13	3.7	0.88
Age at first parturition (years)	3.8	0.25	3.3	0.33
Number of services per gestation (u)	2.5	0.14	2.7	0.33
Birth rate per female	0.5	0.07	0.8	0.28
Births per hectare (u/ha)	1.4	0.26	1.0	0.74

Age at weaning (years)	1.5	0.15	1.7	0.33

The farms comprising more land had four-fold more animals total, but just tree-fold more mares and two-fold more troughs. They also owned more than double the amount of troughs. The monthly expenses were similar. Concerning staff and horse farms, one out of four workers is exclusively in charge of animals in small areas, whereas in the large facilities, three out of seven men work in the stables only.

These horse systems showed that the group on fewer resources fertilized about 50% of females, and they had low estrus repetition. Meanwhile, the other group, with greater resources, reached a gestation rate above 75%, though they underwent higher repetition of estrus, which may be related to greater nutrition and body condition that have effects on reproduction, as reported by Ishii *et al*. (2013), and Morley and Murray (2014).

CONCLUSIONS

Today, grassland improvements, animal management, and reproductive performance, are the main factors to consider for improvements of equine systems in Azuay province.

ACKNOWLEDGMENTS

The authors wish to thank AGROCALIDAD agency in the province of Azuay, and the local horse breeders.

REFERENCES

Agrocalidad. (2016). *Agencia de regulación y control fito y zoosanitario*. Retrieved on April 27, 2019, from http://www.agrocalidad.gob.ec

Catelli, J. L., Caviglia, J. F., Tassara, M. L. y Giménez, R. (2006). Producción de equinos para carne. *Revista de Ciencias Agrarias y Tecnología de los Alimentos*, *24* (1), 1-12.

Claes, A., Ball, B. A., Scoggin, K. E., Roser, J. F., Woodward, E. M., Davolli, G. M., Squires, E. L. y Troedsson, M. H. (2017). The influence of age, antral follicle count and diestrous ovulations on estrous cycle characteristics of mares. *Theriogenology*, *97* (2), 34-40.

Córdova A.I., Villa, E.A.M., Huerta, R.C. y Rodríguez, B.E.D. (2017). Factores externos que pueden ocasionar estrés en caballos. *Revista Complutense de Ciencias Veterinarias*, *11*(1), 43-68.

Ishii, M., Shimamura, T., Utsumi, A., Jitsukawa, T., Endo, M., Fukuda, T. y Yamanoi, T. (2001). Reproductive performance and factors that decrease pregnancy rate in heavy draft horses bred at the foal heat. *Journal of Equine Veterinary Science*, *21*(3), 131-136.

Morley, S. A. y Murray, J. A. (2014). Effects of body condition score on the reproductive physiology of the broodmare: a review. *Journal of Equine Veterinary Science*, *34*(7), 842-853.

National Geospatial-Intelligence Agency. (2017). *Bethesda, MD*, USA. Retrieved on April 27, 2019, from https://geografiainfo.es/nombres_geograficos/name.php?uni=-1368374&fid=1579&c=ecuador

Paredes, P., Jiménez, C. y Hernández, A. (2013). Diámetro del cuerpo lúteo y niveles de progesterona sérica, durante el ciclo estral en yeguas criollas colombianas. *Revista MVZ Córdoba*, *18*(3), 3829-3835.

Park, J. E., Lee, J. R., Oh, S., Lee, J. W., Oh, H. S. y Kim, H. (2011). Principal components analysis applied to genetic evaluation of racing performance of Thoroughbred race horses in Korea. *Livestock science*, *135*(2-3), 293-299.

Posta, J., Komlosi, I. y Mihok, S. (2007). Principal component analysis of performance test traits in Hungarian Sporthorse mares. *Archives Animal Breeding*, *50*(2), 125-135.

Rodríguez Mejía, S., Flores Sánchez, D., León Merino, A., Pérez Hernández, L. M. y Aguilar Ávila, J. (2018). Diagnóstico de sistemas de producción de bovinos para carne en Tejupilco, Estado de México. *Revista mexicana de ciencias agrícolas*, *9*(2), 465-471.

Toro-Mujica, P., García, A., Gómez-Castro, A. G., Acero, R., Perea, J., Rodríguez-Estévez, V., Aguilar, C. y Vera, R. (2011). Technical efficiency and viability of organic dairy sheep farming systems in a traditional area for sheep production in Spain. *Small Ruminant Research*, *100*(2-3), 89-95.

Wespi, B., Sieme, H., Wedekind, C., & Burger, D. (2014). Exposure to stallion accelerates the onset of mares' cyclicity. *Theriogenology*, *82*(2), 189-194.

.

Received: 2-8-2019
Accepted: 3-26-2019

AUTHOR CONTRIBUTION

Author participation included the following: Conception and design of research: DCB, XMF, GEGV; data analysis and interpretation: DCB, XMF, JABV, AVG, RGV, ROM, GGV; redaction of the manuscript: XMF, JABV, AVG, GEGV.

CONFLICT OF INTERESTS: None