

Chapter 7 Adaptability and rusticity of zebu breeds over pure European breeds in the climates of the Mexican tropics

Capítulo 7 Adaptabilidad y rusticidad de las razas cebú sobre las razas Europeas puras en los climas del trópico Mexicano

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Abstract

This investigation was carried out in a production unit in the north of the state of Puebla, Mexico, located between the parallels 19° 47 '06 "and 19° 58 '12" north latitude and 97° 18 '54 "and 97° 23 '18" in western longitude. With the aim of carrying out the phenotypic differences (coat color, ear morphology, horns, profile and body condition) between the zebu breeds (Brahman, Guzerat, Indubrasil) with the highest demand in the livestock region. Likewise, describe its adaptability to tropical climates that exceed 30 °C and its superiority over synthetic and pure European breeds destined for meat production (Beefmaster, Charbray, Brangus, European Swiss, Angus and Hertford). Phenotypic characteristics were recorded individually for each of the animals using descriptive statistics to establish the breed patterns. A total of 37 stallions with variable age and weights were evaluated. The main breeds evaluated were Brahman (2.70%), Indubrasil (54.05%), Guzerat (2.70%) crossbreeds European Swiss (13.51%) and Zebu x European Swiss (27.02%), which presented very specific phenotypic characteristics among these breeds. Despite the data collected from the zebu breeder associations, there is very little information on the phenotypic differences of the zebu breeds that have been present for centuries in the systems under which it survives, demonstrating at the same time its greater adaptability and superiority. to tropical soils and pastures, when compared with synthetic and pure European breeds intended for meat production.

Cattle, Zebu, Adaptability, Breeds, Tropics

Resumen

Esta investigación se llevó a cabo en una unidad de producción en el norte del estado de Puebla, México, ubicada entre los paralelos 19° 47 '06 "y 19° 58 '12" de latitud norte y 97° 18 '54 "y 97° 23 '18" en longitud occidental, con el objetivo de realizar las diferencias fenotípicas (color de pelaje, morfología de las orejas, cuernos, perfil y condición corporal) entre las razas indias (Brahman, Guzerat, Indubrasil) de mayor demanda en la región ganadera. Asimismo, describe su adaptabilidad a climas tropicales que superan los 30 °C y la superioridad sobre las razas europeas puras destinadas a la producción de carne y leche (Suizo Europeo, Brahman x Suizo Europeo). Las características fenotípicas se registraron individualmente para cada uno de los animales utilizando estadísticas descriptivas para establecer los patrones de raza. Se evaluaron un total de 37 sementales con edad y peso variables. Las principales razas evaluadas fueron Brahman (2.70%), Indubrasil (54.05%), Guzerat (2.70%) Suizo Europeo (13.51%) y cruza Cebú x Suizo Europeo (27.02%), que presentaron características fenotípicas muy específicas entre estas razas. A pesar de los datos recogidos de las asociaciones de criadores de cebú, existe muy poca información sobre las diferencias fenotípicas de las razas indias que han estado presentes durante siglos en los sistemas bajo los que sobreviven, demostrando al mismo tiempo su mayor adaptabilidad y superioridad a los suelos y pastos tropicales, en comparación con las razas europeas puras destinadas a la producción de carne y leche.

Bovinos, Cebú, Adaptabilidad, Razas, Trópico

Introduction

Zebu breeds originated in 1900, with the importation of cattle from countries such as India and France, in order to develop new breeds that could adapt to certain tropical zones (Cañas *et al.*, 2008). Cattle raising in almost all Latin American countries began when the colonizers brought cattle from temperate countries, which did not find favorable conditions for expansion in their new environment. In general, the efforts of technical services to introduce and adapt improved European breeds were unsuccessful. Imports by thousands of breeders, carried out at different times, yielded poor results and European thoroughbreds did not survive, perished due to lack of adaptation or were absorbed when crossed with native cattle (Montes *et al.*, 2009).

The establishment of European breeds in the tropics has been done with obvious difficulty. Practice has shown the difficulties of raising European cattle in tropical regions. When encountering adverse conditions, cattle rot rapidly and after a few generations are no longer the size of those that preceded them; meat and milk production is reduced, the birth rate decreases and the mortality rate increases (BIF, 2002).

The inability of the European bull to eliminate excess body heat hinders adaptation to regions with hot climates and low nutritional quality of forages. Zootechnical climatology studies demonstrate the difficulties of raising fine, highly specialized animals in tropical and subtropical areas. Under these conditions, livestock production in the tropics is limited to raising native breeds, some already in the process of improvement, or imported livestock of Asian origin. Therefore, it was necessary to resort to a bovine type natural to the tropics (ASOCEBU, 2007).

The Zebu breeds emerged as a cattle saving breed, revitalizing the blood of exhausted herds of Creole cattle, with low economic performance or giving conditions of resistance to improved cattle of European origin. Brazil was the first importer of Asian breeds, multiplying the efforts for their introduction, extending them throughout the national territory and beginning to take care of their improvement (BIF, 2002).

Cattle of Zebu or Hindustani origin are breeds that have attracted attention for their great adaptation to tropical climates, hardiness and resistance to the adverse conditions of the tropical environment. Brazil and India are tropical countries. The cattle that live and prosper in that Asian nation, in spite of all adverse factors, were the cattle naturally indicated to populate Brazil, thus understanding the value of *Bos indicus* for its cattle (Domínguez *et al.*, 2003). The objective of this study was to determine the phenotypic differences (coat color, morphology of the ears, horns, profile and body condition) between the zebu breeds (Brahman, Guzerat, Indubrasil) most in demand in a livestock production unit in the northern part of the State of Puebla. Likewise, to describe their adaptability to tropical climates that exceed 30 °C and their superiority over synthetic and pure European breeds for meat production (Beefmaster, Charbray, Brangus, Swiss European, Angus and Hereford).

Material and Methods

This research was carried out in a production unit in the north of the state of Puebla, Mexico, located between parallels 19° 47 '06" and 19° 58 '12" north latitude and 97° 18 '54" and 97° 23 '18" west longitude. The objective was to carry out the phenotypic differences between the Indica breeds most in demand in the cattle region. For this purpose, a form was developed with a capacity for 37 animals, which was used to record the number and breeds encountered during the tours. To better locate the cattle herds, we had the valuable collaboration of the manager of the livestock production unit, who was a key informant on the breeds evaluated. On several occasions it was necessary to enter the production unit through long roads that can only be accessed on foot or on horseback, sometimes even crossing rivers that are quite low due to the dry season.

In order to carry out the phenotypic differences between the Indica breeds, a format was developed, which was used to record the phenotypic characteristics individually for each of the animals, such as: breed type, sex, age, coat color, type of horn, direction of the ears and body condition. Some important aspects of the management given to the animals and the particular environment in which they were found were also recorded, such as the type of predominant vegetation and the degree of utilization of the paddocks or grazing areas. The body condition of the cattle evaluated was also recorded by direct observation of the animal, according to a subjective scale ranging from 1 (skinny) to 5 (fat). The data were captured in a general information bank (Microsoft Office Excel package), from which descriptive statistics were performed taking into account the database of the evaluated breeds. (paquete Minitab, versión 10.1).

Results and Discussion

This study determined that, in a single production unit of 400 hectares, there are Indica breeds and their crosses (n=37 bulls), whose existence is officially recognized at the international level, among them: Brahman, Guzerat, Indubrasil, Swiss European and the F1 cross (Table 7.1). These breeds have undergone significant improvements, to the point of constituting, in certain aspects, different and improved types of the equivalent Hindustani varieties, even with new characteristics acquired by virtue of the action and especially of a great genetic selection of these breeds. So that the development of livestock does not constitute, from the socioeconomic point of view, a delay in agriculture, it is necessary to introduce new and better methods of breeding and fattening, animal feeding and sanitary defense, pasture improvement, fodder preparation, selection and improvement of Indian breeds, using breeds such as the European Swiss and the Brahman x European Swiss crosses (F1) (De Lira, 2008).

Table 7.1 Breeds and crossbreeds of cattle evaluated at the production unit

Total animals	Brahman	Indubrasil	Guzerat	Swiss European	Cross (F1) Brahman x European Swiss
37	1	20	20	5	10
%	2.70	54.05	2.70	13.51	27.02
Body Condition	3.5	4.0	3.2	3.0	3.0

Source: Own Elaboration/2021

As can be seen in Table 7.2, three Indica breeds, one European breed and an F1 cross were located in the production unit evaluated. It was observed that there are very notable phenotypic differences between the Indica breeds, European Swiss and the Brahman x European Swiss cross (F1). According to the statistical and descriptive analysis, the predominant breed was the Indubrasil (54.05%) with a body condition of 4.0, which since its creation has shown great hardiness, masculinity, maternal ability, meat and milk production, excellent feed conversion in fattening bulls and great adaptability to climate, pastures and soil in a tropical climate.

Table 7.2 Phenotypic differences between the breeds and crossbreeds of cattle evaluated in the production unit

Race	Coat color	Ear morphology	Horn morphology	Head profile	Body condition range
Brahman	White Gray Red	Short and slightly dangling	Tilted upwards instead of downwards and outwards	Straight	2.0 - 4.0
Guzerat	Light gray Dark gray	Elongated and oblique broad ears	Rather thick long horns of circular section; implanted vertically and projected upward symmetrically in the form of an arc like a half lyre and ending in a backward direction	Subconcave	2.0 - 4.0
Indubrasil	White Gray Red	They are large pendants, long up to the middle of the neck and the tip is directed forward.	The horns are black, medium-sized and laterally set, directed backwards	Subconvex	2.0 - 4.0
Swiss European	Light brown Dark brown	They are short and outward facing, giving the appearance of a tree leaf.	The horns are white with black tips, medium or small, some of them do not present	Straight	2.0 - 4.0
Brahman x European Swiss (F1)	Light gray Dark gray Light brown Dark brown	They are short, slightly bent at their extremities, directed outwards	The horns are black, short and laterally set.	Straight	2.0 - 4.0

Source: Elzo et al. (2003)

Brahman breed

Noting that Brahman cattle (Fig. 7.1 and 7.2) emerged from four *Bos indicus* breeds that contributed to the foundation of the American Brahman; Guzerat, Nelore, Gyr and Krishna Valley, which arrived in the United States in different shipments between 1854 and 1946. These animals were carefully crossbred, strictly selected and rigorously culled to form a new beef breed that would adapt to the world's most hostile tropical and subtropical climates. Now established in 60 countries around the world, it has improved meat production around the world, making meat production more efficient in the tropics (Elzo et al., 2003). Phenotypically they are large in size, the head is long compared to other meat producing breeds. The horns generally appear tilted upward instead of downward and outward, as in the European horned breeds. Short, slightly pendulous ears, voluminous belly, straight profile, short thick neck, well defined hump centered on the shoulders, loose and mobile skin, large dewlap, all combined with excellent meat characteristics and muscular expression. The color varied from light red to black, with gray being the predominant color (Montes et al., 2008).

Figure 7.1 Gray Brahman**Figure 7.2** Red Brahman

Source: Montes et al. (2008)

Guzerat breed

The Guzerat breed (Fig. 7.3 and 7.4) originated in the northern and southwestern region of India. The animals of this breed show in both sexes a majestic appearance and great presence when walking, as they carry their heads erect, with voluminous and striking horns (Castaño, 2003). In short, their appearance denotes physical strength. The head is moderately wide and short in the male, and longer and narrower in the female; subconcave profile, straight face and wide muzzle, pigmented in black; large black eyes with meek expression; long horns quite thick of circular section; implanted vertically and projected upwards symmetrically in the form of an arc like a half lyre and ending in a backward direction; wide, elongated and oblique ears; its short neck is relatively thick.

The body well developed, with a deeper and longer thorax, hump of good size and shape; limbs of medium length, strong bones. Black skin colors and dark and light gray coat in both males and females, large and pendulous foreskin and both birth weight and growth rate are similar in both sexes (Arboleda et al., 2008).

Figure 7.3 Guzerat dark gray**Figure 7.4** Guzerat light gray

Source: Arboleda et al. (2008)

The selection of this breed led to produce animals with good finishing aptitudes for butchering, demonstrating in practice and in weight gain tests. The same result for milk production, instituting selective programs and individual cow productivity controls with the purpose of founding the dairy Guzerat. Specimens of this breed were transported to the United States at the beginning of the 9th century and then had a preponderant participation in the integration of the Brahman breed and even some specimens (females and males) were taken to Central and South American countries, achieving significant progress. The average birth weight is 28 kg and at weaning (adjusted to 210 days) is 1184 kg. Bulls in good condition can weigh 730 kg (478 kg at 4 years of age) and adult cows 460 kg. However, males have been recorded reaching 110 kg and females 780 kg (Cañas et al., 2008).

Indubrasil breed

It should be noted that the Indubrasil breed originated in the Triangulo Mineiro Brazil, located in the west of the state of Minas Gerais and particularly in the surroundings of Uberaba, at the beginning of the 20th century. The Indubrasil arrives through crossbreeding of Asian breeds such as Gyr, Guzarat and Nelore. And initially it was named as Brazil induced cattle for having in a single breed the best characteristics of the three breeds introduced in Brazil (Montes et al., 2009). A very important characteristic of the breed is its typical ears, which are hanging ears that can range from medium to large, the shape of the ear varies, but they are directed with the tip forward (Fig. 7.5 and 7.6).

Figure 7.5 Ears on male Indubrasil



Figure 7.6 Ears on female and calf Indubrasil



Source: Teyer et al. (2003)

It is an animal of large body volume, the color of the coat ranges from light gray, dark gray and red, it is a vigorous breed like the Nelore, with a somewhat nervous temperament (Fig. 7.7 and 7.8). Gyr cattle maintain some characteristics of the subconvex head profile. The horns are medium-sized and laterally implanted, directed backwards, reports of adult males of the Indubrasil breed are that they are animals that can exceed 1200 kg in weight, and cows can weigh up to 750 kg. The most common data can be that males range between 800-1200 kg live weight and cows between 500-700 kg live weight. In the case of weight gain, the Indubrasil cattle breed shows excellent values according to management conditions, which can range between 400 grams and 1000 grams per day, with an average of 650 grams. Indubrasil is currently present in several countries in the world such as Venezuela, Colombia, Costa Rica, Panama, Guatemala, Mexico, Thailand, South Africa and Australia (Montes et al., 2009).

Figure 7.7 Indubrasil dark gray



Figure 7.8 Indubrasil red



Source: Chan et al. (2010)

This breed has shown its versatility both as a pure breed and in crossbreeding with other breeds. In the case of Mexico, this breed is used to cross it with European Swiss to increase meat production and adaptability and hardiness, as well as crosses with American Swiss breeds, achieving a greater increase in milk production of Indubrasil cows (Elzo et al., 2003).

Breed Swiss European

The Swiss European breed (also known as Brown Swiss) originates from the middle eastern part of Switzerland in Europe, is famous all over the world and is the second breed for milk yield. In Switzerland it competes with the Simmental for milk and meat supply. Phenotypically it is characterized by its medium size, short, fine and soft hair; pigmented skin; shows a black color on the exposed part as the muzzle, the horns are white with black tips, medium, small or absence of them, directed outward and upward, curving at the tips. The head is broad and moderately long. The back is broad and the dorsal line straight. The chest is deep, ribs arched and the hindquarters are fleshy (Castaño, 2003).

López et al. (2009) reported that the Swiss European breed is recognized for its excellent short, thick, short legs and black hooves, traits necessary for the evolution of the breed in the Swiss Alps, which gives it advantages in grazing. The udder is well developed, attached and has excellent teats. Its outer coat is of a single light to dark brown color (Fig. 7.9 and 7.10).

Figure 7.9 Swiss European light brown



Figure 7.10 Swiss European light Brown



Source: Castaño et al. (2003)

Adult animals are strong and of good weight, cows can weigh from 600 kg to 700 kg and bulls from 950 kg to 1000 kg, but there are specimens of both sexes with more weight. Regarding their milk yield, the current average is 7,200 kg adjusted at adult age with 4.0% fat, these averages are those of the United States of America, which is the highest in the world for this breed. The Swiss-Austrian average is 5,103 kg and Germany 6,030 kg (López et al., 2009). The average for Swiss-Mexican cattle is irrelevant, since this breed is not left as dairy cattle in an intensive system, as in the case of cattle from the United States of America, but is produced as dual purpose cattle (1,500 to 2,000 kg per lactation) although in tropical regions averages of 3,200 to 4,000 kg are reported for this breed, which cannot be doubted given the good adaptation shown in warm climates by Swiss European cattle (Chan et al., 2010).

Brahman x Swiss European cross (Suiz - Boo)

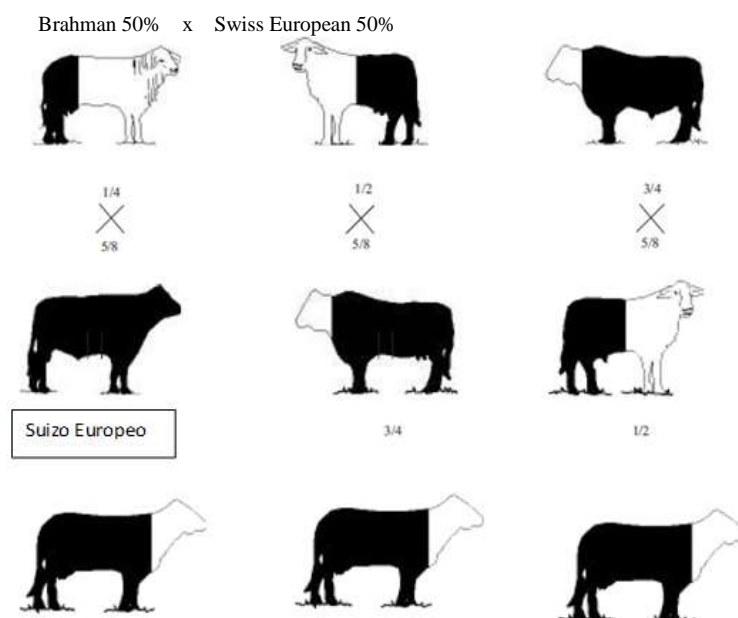
The recognition of the Suiz-Bú breed in Mexico dates back to the 80's. This breed was generated with the purpose of obtaining an animal suitable for tropical conditions and efficient production, contemplating characteristics such as docility, longevity, hardiness, precocity, conversion (fast development), fertility, calving ease, maternal ability, marked pigmentation, as well as adequate milk (rich in fat) and meat production (AMCSB, 2016). Dual-purpose cattle systems are considered a traditional livestock production system in the tropical region, where cows are milked once or twice a day with the support of the calf and their main source of food is green forage. Animal production in the tropics represents one of the most important alternatives that Mexico has to reduce the milk deficit, due to the number of cows available and the amount of basic usable natural resources, such as soil, water and pasture. However, the improvement of milk production in tropical conditions depends on direct factors related to the animal and genotype, as well as environmental factors such as feeding, management, days in lactation and number of calving (Chan et al., 2010).

In many countries with tropical climates, crossbreeding of Indian breeds with European breeds (Swiss European, Swiss American, Jersey, Holstein, among others) has been a common practice in dual-purpose herds to improve traits of composition and production of milk, meat, adaptability to the environment, survival and fertility. Among these traits, it has been observed that fertility has the greatest impact on cattle efficiency (López *et al.*, 2009).

The percentages of blood obtained are contractions of $1/2$, $3/4$, $5/8$, with cases up to $15/16$. The F1, which provide 50% of the sire and 50% of the dam (Fig. 7.11), are better for tropical conditions. Crossbreeding allows the introduction of favorable genes and takes advantage of racial complementarity and heterosis. Breed complementarity allows breeders to capitalize on the strengths of the different breeds, since no single breed is superior in all traits that affect profitability. In Mexico, the dual-purpose production system is mainly constituted by crosses between Brahman and European Swiss (Cabrera *et al.*, 2013).

A crossbred animal can become purebred over time according to the crossbreeding system used. It is called an absolving system, in which a pure A breed is crossed with a pure B breed and the offspring that is born absorbs the pure genes. The use and implementation of these breeds in the tropics brings with it a series of advantages to be taken into account, more resistant to sanitary conditions, younger age and higher weight at puberty, better birth weights and calving facilities, higher milk and meat production with higher weaning weights (AMCSB, 2016).

Figure 7.11 Type of crossbreeding to obtain the Suiz-Bú breed



Source: López *et al.* (2009)

In this example we are looking at the crosses necessary to reach a ratio of $5/8$ Swiss European and $3/8$ Brahman, starting from a pre-existing genetic base. With F1 animals crossed with a $3/4$ Swiss European and $1/4$ Brahman, they must be crossed with an F1. The dominant proportion of one or the other breed is determined by the breeder based on what he wishes to have for his cattle. This process of crossbreeding must be accompanied by evaluations and selections of the females to be used and a serious choice of bulls to be used in each crossbreeding. To achieve excellent results we must choose excellent specimens, it is a costly procedure, but it will be worth it (López *et al.*, 2009).

Phenotypically it is characterized by its tall stature, short, fine and soft hair; pigmented skin, medium sized black horns, directed outwards and upwards, curving at the tips. The head is broad, moderately straight, with broad back and straight dorsal line, deep chest, arched ribs and the hindquarters are fleshy. Excellent straight and thickly set, black hooves, well-developed udder, well attached and excellent teats. The external coat (Fig. 7.12 and 7.13) is characterized by being a single light to dark brown color (AMCSB, 2016).

Figure 7. 12 Suiz-Bú light brown**Figura 7. 13** Suiz-Bú dark Brown

Source: AMCSB (2013)

Conclusions

Practice has shown the difficulties of raising European cattle in the tropical region, facing adverse conditions, where cattle decline rapidly and after a few generations no longer have the size of those that preceded them. Meat and milk production is reduced, birth rate decreases and mortality increases, the impossibility of European cattle to eliminate excess body heat makes it difficult to condition them in tropical climates. Therefore, it is necessary to cross zebu breeds with European breeds and simultaneously obtain milk and meat, in addition to increasing the potential for adaptation to tropical conditions.

References

- Arboleda, E., Cerón, M. & Cotes, J. (2008). Heterocigosis individual y materna en poblaciones bovinas multirraciales de diferentes sistemas para producción de carne en el trópico. *Revista Livestock Research for Rural Development*, Vol. 20 (12).
- ASOCEBU. (2007). Evaluación genética de bovinos asiáticos. *Revista mensual*, México, D.F., Vol. (1).
- Asociación Mexicana de Criadores de Ganado Suiz-Bú de Registro A.C (AMCSB). 2013. Reglamento técnico.
- BIF. (2002). *Guidelines For Uniform Beef Improvement Programs*. Eighth Edition, The University of Georgia. EE. UU. pp. 161.
- Cabrera, NA., Lammoglia, VMA., Daniel, RIC. & Elorza, MP. (2013). Efecto del genotipo sobre la producción láctea en vacas Europeo Lechero x Cebú de doble propósito. *Rev. Biol. Agropec. Tuxpan* 1, 51-57.
- Cañas, J., Ramírez, J., Arboleda, O., Ocho, J., Vergara, C. & Muñoz, M. (2008). Estimación de parámetros genéticos para peso de razas de carne. *Revista Veterinaria de Córdoba*, Vol. 13(1).
- Castaño, L., Gómez, M. & Quijano, J. (2003). Heredabilidad y correlaciones entre peso al destete y a los dieciocho meses en un hato de ganado de carne. *Revista. Journal Ciencias Pecuarias*, Vol. 16 (2).
- Chan, EKF., Nagaraj, SH. & Reverter, A. (2010). The evolution of tropical adaptation: comparing taurine and zebu cattle. *Anim. Genet*, 41, 467-477.
- De Lira, T., Rosa, ME. & Garnerio, A. (2008). Parámetros genéticos de características productivas y reproductivas em cebuínos de corte (revisão). *Ciencia Animal Brasileira*, Vol. 9(1).

- Domínguez, VJ., Núñez, DR. & Ruíz, FA. (2003). Influencias ambientales e índice de constancia para características de crecimiento en ganado bovino Tropicarne. *Revista Técnica Pecuaria México*, Vol. 41(1), 1-18.
- Elzo, M., Martínez, G., Gonzales, F. & Huertas, H. (2003). Variabilidad y predicciones genéticas aditivas, no aditivas y totales para características de carne en el rebaño multirracial sanmartinero-cebú del centro de investigaciones la libertad. *Revista Colombiana de Ciencias Pecuarias*, Vol. 16 (1).
- López, BB., Esperón, SAE., Martínez, MS., Carmona, MMA. & Contreras, AH. (2005). Efecto del año, mes, sexo de la cría y número de parto sobre el peso al nacimiento de cuatro razas cebuinas en el trópico húmedo. *Congreso Nacional de Buiatria*:115.
- López, OR., García, RC., García, JGM. & Ramírez, RV. (2009). Producción de leche de vacas con diferente porcentaje de genes *Bos taurus* en el trópico mexicano. *Téc. Pecu. Méx.*, 47, 435-448.
- Manrique, PC. (2003). Conociendo la genética de la raza. *El Cebú*, 305:48-50.
- Montes, D., Vergara, O. & Prieto, E. (2008). Una nota sobre los factores que afectan el peso al destete en ganado cebú Brahman. *Revista Livestock Research for Rural Development*, Vol. 21(9).
- Montes, VD., Vergara, GO., Prieto, ME. & Rodríguez, PA. (2009). Estimación de los parámetros genéticos para el peso al nacer y al destete en ganado bovino de la raza Brahman. *Rev. MVZ Córdoba*, Vol. 13(1), 1184-1191.
- Segura, CJA. (2018). Comportamiento hasta el destete de un hato cebú comercial en el sureste de México. *Livest. Res. Rural Develop.*, Vol. 2(1).
- Teyer, R., Magaña, JG., Santos, J. & Aguilar, C. (2003). Comportamiento productivo y reproductivo de vacas de tres grupos genéticos en un hato de doble propósito en el sureste de México. *Revista Cubana Ciencias Agrícolas*, 37(4), 363-370.