







Fodder trees and shrubs used to feed cattle in northern Veracruz, Mexico

Árboles y arbustos forrajeros utilizados para la alimentación de ganado bovino en el norte de Veracruz, México

 **Amalia Cabrera-Núñez** amacabrera@uv.mx ¹*,  **Miguel Lammoglia-Villagomez** mlammoglia@uv.mx, ¹,  **Sara Alarcón-Pulido** saalarcon@uv.mx ¹,  **César Martínez-Sánchez** cesamartinez@uv.mx ¹,  **Rebeca Rojas-Ronquillo** rebrojas@uv.mx ¹,  **Saw Velázquez-Jiménez** velazquez@uv.mx ¹

¹Faculty of Biological and Agricultural Sciences, Universidad Veracruzana. Tuxpan, Mexico.

*Responsible and correspondence author: Cabrera - Núñez Amalia amacabrera@uv.mx. Faculty of Biological and Agricultural Sciences of the Universidad Veracruzana. Carretera Tuxpan-Tampico Km. 7.5, Colonia Universitaria, Tuxpan, Veracruz, Mexico, PC 92890. 017838344350 ext. 46109

ABSTRACT

This work was carried out in the Tamalín Municipality, located at the north of the state of Veracruz, Mexico, between the coordinates 21° 20' north latitude and 97° 49' west longitude, at a height of 140 sea level. The objective of this research was to know the main tree species and fodder shrubs that are consumed by cattle, as well as to identify their different uses. To this end, a survey previously prepared was applied to the local producers. The most relevant results in the production units evaluated showed that the consumption of these trees and fodder shrubs improved the body condition of the livestock (85%) and knowledge of how easily are propagated these tree species (75%). It is very important to emphasize its significant use as living fences, medicinal, poles and in the furniture making. As for the majority of the species studied, they showed acceptable nutritional contents. Highlighting that the Crude Protein (PC) being much higher than that of the tropical grasses (*Panicum maximum*, *Cynodon plectostachyus*) and in several cases, also higher than that of the commercial concentrates (oats, barley, rye).

Keywords: trees, bushes, feeding, bovine, body condition, forage and cattle.

RESUMEN

El trabajo se realizó en el municipio Tamalín, ubicado al norte del estado de Veracruz, México, entre las coordenadas 21° 20' Latitud Norte y 97° 49' Longitud Oeste, a una altura de 140 msnm. El objetivo de esta investigación tuvo la finalidad de conocer las principales especies de árboles y arbustos forrajeros consumidos por los bovinos, los que son establecidos en unidades de producción extensiva, así como identificar sus diferentes usos. Para ello se aplicó una encuesta a los productores de la localidad utilizando un cuestionario previamente elaborado. Los resultados más relevantes en las unidades de producción evaluados, demostraron que el consumo de estos árboles y arbustos forrajeros mejoran la condición corporal de ganado en un 85%, así como la fácil propagación observada en el área de estudio (75%). Es de suma importancia destacar el uso significativo, como: construcción de cercos vivos, medicinales, postes y elaboración de muebles. En cuanto a la mayoría de las especies estudiadas, estas mostraron contenidos nutricionales aceptables. Destacando la Proteína Cruda (PC), siendo muy superior al de los pastos tropicales (*Panicum máximo*, *Cynodon plectostachyus*) y en varios casos, también superior al de los concentrados comerciales (avena, cebada, centeno).

Palabras clave: árboles, arbustos, alimentación, bovino, condición corporal, forraje y ganado.

INTRODUCTION

Trees and fodder shrubs grow naturally in crops, pastures, acahuals and other sites; they are usually used to obtain shade, wood or firewood; however, they can also serve as fodder in cattle feed ([Ku et al., 1999](#)). Their presence could become a very profitable option and even contribute to the conservation and restoration of biodiversity (deforestation and soil degradation), which in recent years has been lost rapidly in areas formerly rich in natural resources ([Calle et al. ., 2011](#)).

[Galeano et al. \(2013\)](#) before this situation, mention that the foliage of tree species can be a good alternative for food sustainability, because they have a great potential as forage (*Gliricidia sepium*, *Paramentiera acuelata*, *Leucaena leucocephala*, *Guazuma ulmifolia*, *Morus alba*) ; that is, a high protein content compared with grasses and biomass yield ([Mtengeti and Mhelela, 2006](#)). Most of these species have leaves that serve as food for cattle, horses, sheep and goats. Some also bear fruit, such as pods that can be used in animal feed; emphasizing that both foliage and fruits can have very good nutritional characteristics ([Pinto et al., 2010](#)).

[González and Cáceres \(2010\)](#), reported that the management and use of fodder trees and shrubs is motivated, among other aspects, by the adaptation of species to regions with prolonged drought, and low supply of grasses. Many species are edible by animals and are naturally available in paddocks, offering: 1) foliage or fruits of reasonable quality, 2) low cost of food production, 3) reduction of production costs due to the decrease in the use of chemical products for weed control, 4) local knowledge of producers about plants consumed in pasture and 5) use of biodiversity and are also a source of protein, energy, minerals and vitamins.

The adaptation of species to regions in times of prolonged drought and low supply of grasses, make them an alternative of edible species for animals, in addition to offer reduction of production costs due to the decrease in the use of chemical products for the weed control, local knowledge of producers on trees consumed in pasture ([Foild et al., 1999](#)).

Similarly, guidelines could be given for the development of sustainable production systems that do not threaten the ecological balance of these areas and that could even improve animal behavior (weight gain, milk production, feed conversion, etc.), without having to depend on other external agricultural inputs. Therefore, food alternatives such as silvopastoral are required to face the dry season, and the association of shrubs with grass for animal production, friendly with natural resources and biodiversity, is appropriate ([Aguirre, 2013](#)).

The use of these forage species is done in the form of grazing, allowing browsing of the animals or in cutting and carrying, which is less common ([Saabreda and Rodríguez, 2018](#)). It is important for the selection of species to take into account the following criteria: 1)

adaptation to the soil and climate conditions of the farm, 2) good forage production, 3) having a good palatability (pleasant to the taste of the animal), 4) have a good nutritional value, 5) tolerate frequent pruning or grazing, 6) good regrowth and growth capacity and 7) not contain substances toxic to animals ([González et al., 2006](#)).

Among the different alternatives available to reduce the environmental deterioration produced by the growth of extensive traditional livestock, the implementation of agroforestry practices (silvopastoralism) has been implemented, which promotes the integration of trees and shrubs with animal production ([Sosa et al., 2004](#)). Likewise, guidelines could be given for the development of sustainable production systems that do not conflict with the ecological balance of these areas, and that could even improve animal behavior (weight gain, milk production, feed conversion, etc.), without having to depend on other external agricultural inputs ([Gascón et al., 2004](#)). Therefore, this project aims to know the main species of trees and fodder shrubs that are consumed by bovines in northern Veracruz, as well as identify their different uses.

Faced with this problem, it is intended in Tamalín municipality, Veracruz, to produce and maintain the balance of the ecosystem, rescuing it through agroforestry. This system offers great diversity, in the first place it offers the following environmental benefits: it favors the biological diversity of flora and fauna, the primary producer of food for humans, animals and the soil, it is the only one capable of harnessing primary energy, it is a great producer of raw materials, gives shelter to other living beings, animals and plants, light regulator to favor the growth of crops (coffee), cleaner of the planet capturing CO₂, regulator of the hydrological cycle of water, provides comfort to different species, favors the nutrient recycling, primary producer of chemical substances for the production of medicines and high sprout capacity ([Sosa et al., 2004](#)).

It is important that in this municipality that the agricultural production units are more profitable, using for it the agroforestry systems, silvopastoral, agroforestry, forestry fruit-pastures. [Cárdenas et al. \(2011\)](#), mention that all these systems are focused towards the use of production techniques more harmonious with the biophysical and socioeconomic realities of the countries of the tropics. Trees are part of a wide variety of agricultural systems, in which they perform a large and large number of functions in the ecosystem; as, for example, protect the environment, and produce vital, economic and social resources. In addition, they contribute to reducing soil losses, protecting and providing lower vegetation cover; which reduces erosion and improves the physical conditions of the same, such as structure, porosity and water retention capacity. Among the diverse benefits that the arboreal wealth offers us, its moderating action in the macro and microclimate stands out, the stabilization and improvement of the soil fertility, lodging of the wild fauna and control of pests and diseases ([Amparo et al., 2018](#)).

MATERIAL AND METHODS

The work was carried out in Palmarillo town, located in Tamalín municipality, in the State of Veracruz, Mexico; located between the coordinates 21 ° 20' North Latitude and 97 ° 49' West Longitude, at an altitude of 140 m a.s.l. This work was carried out with the following activities:

I. Sampling of tree species

This part of the project contemplated the local knowledge of forage tree species in Palmarillo town, considering its adequate production of fast-growing leaves. According to the collection strategy proposed by [Machado et al. \(1999\)](#) the field samplings were made in rectangular plots of 500 m², with a central line of 100 m. of length and two lateral lines with 3 m. from separation; the one that consisted in the identification of the samplings in the field, realizing rectangular plots of 600 m², with a central line of 100 m and two lateral lines with three of separation. The ecological entities and the randomized sampling, preferably, were from a minimum of 20 to 30 individuals, separated as vegetative units, in order to select predisposition towards trees and forages mostly consumed by bovines. In addition to the botanical identification, information was collected on other uses that these species are given and on the traditional forms of agronomic management.

II. Application of the survey

In order to know the main arboreal species that are consumed by cattle, as well as to identify their different uses; a survey was conducted, using a previously prepared questionnaire; considering the following information: name of the owner, location, occupation, forage shrubs that people know, if they are consumable for bovines and which is the most common tree or fodder bush people know in this area. Likewise, criteria to be evaluated were taken into account related to bovines and to fodder trees and shrubs.

This survey was applied directly to 50 farmers and people related to livestock management and who reside in the production unit. The sample size was determined according to the formula proposed by [Odalys et al. \(2008\)](#), used to estimate proportions; choosing the properties at random, located in various previously determined areas.

Once the results of the surveys were obtained, the technique proposed by [Velásquez and Mora \(2008\)](#) was considered, determining the species to be studied based on the highest frequency in being recognized as for fodder use. For each species, samples of each of them were collected and botanically classified: family, gender and species.

III. Chemical composition of tree species

The samples were placed in plastic bags, in the same places where the forage shrubs were identified. The part sampled in most of the species were those parts that are actually consumed by the cattle: buds, leaves and green stems. At least 500 gr were collected of the mature foliage located at a height of less than 2 meters, and considering 8 species selected in the locality; they were taken to the Bromatology Laboratory of the Faculty of Biological and

Agricultural Sciences of the Veracruz University Campus Poza Rica-Tuxpan for analysis, using the methodology proposed by [Van Soest \(1994\)](#).

IV. Statistical analysis

The values obtained in this study related to tree species were processed through frequencies and percentages. For the results of the chemical composition, a completely randomized experimental design was used, considering the tree species as treatments.

RESULTS AND DISCUSSION

The information obtained from the surveys applied to the livestock producers of the Palmarillo community, belonging to Tamalín municipality, located north of Veracruz, Mexico; they show the presence of trees and shrubs with forage potential, allowing the identification of eight species that are particularly desirable and with high levels of digestibility ([Table 1](#)). This served to identify species that normally had another use, as well as to extend the usefulness of those that were used for other purposes. It is important to mention that with the support of this survey information was gathered that in this municipality, the selection of herbaceous plants predominates, and during the drought the bushes constitute the main component of the animal diet. Likewise, the fraction of the plant that is consumed by the animals is also different, observing in some cases the consumption is of leaves, stems and fruits.

In [Table 1](#), trees and fodder shrubs that have been used for thousands of years for various purposes are identified. Some of the advantages over the grasses consumed by bovines are the following: an adequate nutrimental contribution (12-19% of crude protein), they have a permanent production especially in dry season, the consumption by bovines is adequate as to expect changes in their productive parameters (milk and meat), to show tolerance to pruning and to have a regrowth vigorous enough to obtain significant levels of edible biomass production per unit area ([González and Cáceres, 2010](#)). Also, the use of tree species in animal feed, promotes a favorable environment in the rumen that induces better fermentation and digestion of low quality forages ([Gobbi and Casasola, 2003](#))

Table 1. Identification of trees and shrubs with forage potential

Name of species	Scientific name	Family	Fraction consumed
Chaca (tree)	<i>Bursera simaruba</i>	Burseraceae	Leaves, flower
Palo de sol (tree)	<i>Gliricidia sepium</i>	Fabaceae	Leaves
Chote (tree)	<i>Paramentiera aculeata</i>	Bignoniaceae	Leaves, fruit
Ramón (shrub)	<i>Brosimum alicastrum</i>	Magnoliopsida	Leaves, flower
Palo de rosa (tree)	<i>Tabebuia rosea</i>	Bignoniaceae	Leaves
Leucaena (shrub)	<i>Leucaena leucocephala</i>	Fabaceae	Leaves, flower and fruit
Guácima (tree)	<i>Guazuma ulmifolia</i>	Sterculiaceae	Leaves, flower
Morera (shrub)	<i>Morus alba</i>	Moraceae	Leaves, fruit

Finding species that have important characteristics that make them desirable to be established and used, as a source of protein and vegetable energy, improve the animal diet, providing a variety of foods, fodder, fruits and leaves, which allow the animal to vary its diet and increase its level of production ([Das et al., 2016](#)).

With the application of the survey it was possible to determine the use that the producers give to the fodder trees and shrubs, which in their opinion were the most important based on the percentage of use detected in the surveys and the value assigned by the producer to each species, based on the observation made by the producer. Regarding the percentage of utilization commented by the respondents, the knowledge of the producers and their interest in the trees and fodder shrubs are appreciated ([Table 2](#)), which represent a part of their sustenance, use of the herbalist as treatment of some disease, obtaining firewood, as well as the raw material for their livestock.

These results obtained through the survey, allow to identify some species with multiple uses, being able to cover the needs of the producer in terms of forest and forage products. The evaluations carried out can be used to constitute the knowledge base that leads to the alternative development of the improvement of the current systems or the introduction of new practices in the production units in the regions under study. Also to promote the conservation of autochthonous species, since there will always be a potential danger of extinction of these species, due to a possible overuse ([Delgado et al., 2014](#)).

In relation to the most important criteria related to the animal and to the fodder trees and shrubs that were suggested by the surveyed producers, they are observed in [Table 3](#), which presents the most important criteria related to the animal and the forage species that were suggested by the producers surveyed, and that define the forage criteria (trees and fodder shrubs) of the production system. The most relevant criterion in terms of those related by the animal, is the maintenance of body condition (85%) and the increase in milk production (80%).

Table 2. Utilization of fodder trees and shrubs

Species	Usage percentage	Fodder	Posts	Shadow	Medicinal	Alive fences	Firewood
Chaca	15%		✓	✓	✓	✓	✓
Palo de rosa	10%			✓		✓	
Ramón	15%	✓		✓		✓	
Cocuite	10%			✓		✓	✓
Chote	10%	✓	✓	✓	✓	✓	✓
Leucaena	22%	✓	✓			✓	✓
Guacima	20%	✓	✓	✓		✓	✓
Morera	29%	✓		✓	✓		

✓ Uses present in the surveys for each tree species

Table 3. Criteria of the forage value of tree species related to bovines

Forage species	Criteria	Percentage
<i>Morera (Morus alba)</i>	It is very consumed	75%
	Increase in milk production	82%
	Improves meat production	75%
	Maintains body condition	85%
<i>Leucaena (Leucaena leucocephala)</i>	It is very consumed	70%
	Increase in milk production	80%
	Improves meat production	75%
	Maintains body condition	88%
<i>Guácima (Guazuma ulmifolia)</i>	It is very consumed	70%
	Increase in milk production	81%
	Improves meat production	75%
	Maintains body condition	85%

This study differs from that presented by [Pinto et al. \(2010\)](#), revealing that the most relevant criterion in the three regions of Chiapas state was related to the knowledge that tree species are browsed by the animal (78%), followed by the amount of leaf biomass that they possess said species (75%).

Regarding the second criterion related to the knowledge of tree species ([Table 4](#)), the resistance to drought and a high nutritional value of the species *Morus alba* (92%), *Leucaena leucocephala* (90%) and *Guazuma ulmifolia* (85%); demonstrating that most of the characteristics of the trees and forage shrubs as indicators of their forage value, were based on the physical attributes, and that they are easily observed by the surveyed producers; which indicates a high degree of empiricism (100%), in local knowledge.

As for the species studied ([Table 5](#)), they showed acceptable nutritional contents; highlighting the Crude Protein (PC), being much higher than those of tropical pastures, and in several cases, also superior to that of commercial concentrates; due to its high protein quality, the following stand out: *Morus alba* (20.22%), *Guazuma Ulmifolia* (16.72%), *Leucaena Leucocephala* (14.66%), *Gliricidia sepium* (16.28%).

Unfortunately, these trees have been felled to induce grasses for the production of forage; the producers surveyed mentioned that fodder trees and shrubs were born alone, that is, naturally, since they have never been planted ([Foidl et al., 1999](#)). It is necessary to mention that to maintain the productivity of an ecosystem it is necessary to maintain a balance

Table 4. Criteria of forage value of tree species related to fodder trees and shrubs

Forage species	Criteria	Percentage
Morera (<i>Morus alba</i>)	Resists drought	75%
	It is easy to spread	93%
	High nutritional value	92%
	Easily shoots	90%
Leucaena (<i>Leucaena leucocephala</i>)	Resists drought	95%
	It is easy to spread	88%
	High nutritional value	90%
	Easily shoots	92%
Guácima (<i>Guazuma ulmifolia</i>)	Resists drought	80%
	It is easy to spread	81%
	High nutritional value	85%
	Easily shoots	90%

Table 5. Nutritional value of trees and fodder shrubs

Scientific names	PC%	MS%	ED%	EM%	FC%
<i>Bursera simaruba</i>	7.91%	31.99%	3.97%	3.25%	17.46%
<i>Gliricidia sepium</i>	16.28%	23.95%	3.68%	3.02%	11.56%
<i>Paramentiera aculeata</i>	13.13%	27.82%	3.45%	2.83%	27.56%
<i>brosimum alicastrum</i>	11.85%	32.53%	3.22%	2.64%	19.71%
<i>Leucaena Leucocephala</i>	14.66%	27.54%	3.50%	2.90%	19.54%
<i>Tabebuia rosea</i>	8.98%	30.60%	3.11%	2.55%	27.15%
<i>Guazuma Ulmifolia</i>	16.72%	95.29%	3.10%	2.65%	26.37%
<i>Morus alba</i>	20.22%	94.50%	3.97%	3.06%	20.30%

between: soil-nutrients-human-plants (crops), sunlight and water; and that the synergism of these produces the production and perpetuity of ecosystems ([Delgado et al., 2014](#)).

[Rocha et al. \(2013\)](#) agreed that most of the shrubs and forage trees in the tropics show strong variations in the levels of crude protein and digestible energy, which is related to the different ages of each fraction of the shrubs and fodder trees. [Gascón et al. \(2004\)](#) indicated that variations in the nutritional content of the trees and shrubs analyzed could be attributed to a set of variables, such as: characteristics of the species, site of growth and soil type, age of the tree and type of component (fruit or foliage).

[Galeano et al. \(2013\)](#), showed that the chemical composition of *Morus alba* and its nutritional quality are distinctive features of the species. It is a generalized consensus that the mulberry presents an excellent nutritional quality, which has been documented for decades, in addition

the nutritional value of *Morus alba* has been exhaustively studied all over the world ([Calle et al., 2011](#)). From the point of view of the variations in the chemical composition and the nutritional value, in studies carried out with this forage shrub, it is reported that the greatest fluctuation occurs with the factor: cut frequency, fertilization factors, variety and time that they have a substantial influence on the composition and nutritive quality of the biomass ([Velázquez and Mora, 2008](#)).

[Murgueitio and Ibrahim \(2007\)](#), reported that the variation in nutritional content could be attributed to a set of variables, such as: the characteristics of the species, growth site, soil type, age of the tree and fodder shrub, as well as as the type of component (leaf, fruit, stem, and forage). [Holguín et al. \(2008\)](#), conducted a study with calves in the growth stage, demonstrating that, of 84 species consumed, at least once a day, nine of them represented 54% of the total bites of the animals; among which stand out (*Leucaena leucocephala*, *Vachellia farnesiana*, *Morus alba*, *Gliricidia sepium*, *Guazuma ulmifolia*).

[Salas et al. \(2011\)](#) reported that geographical variability turns out to be an important factor for established forage trees and shrubs that have a wide range of distribution, to the extent that, in addition to their natural dispersion, they have suffered a wide artificial dispersion due to the action of the man; with this, in a new ecological niche, plants begin a new evolutionary process, in which they create adaptation strategies to environmental variations ([Cárdenas et al., 2011](#)).

This research coincides with that carried out by [Sosa et al. \(2004\)](#), observed that the selection of the forage species is influenced by the rains that determine changes in the type of vegetation. [Salem et al. \(2007\)](#), indicate that in the rainy months the selection of herbaceous plants predominates and during the drought the trees and fodder shrubs; which are the main component of the diet of bovines, having higher consumption *Morus alba* and *Leucaena leucocephala*.

CONCLUSION

The species identified in the municipality of Tamalín, Veracruz, Mexico, were Chaca (*Bursera simaruba*), Palo de sol (*Gliricidia sepium*), Chote (*Paramentiera aculeata*), Ramon (*brosimum alicastrum*), Palo Rosa (*Tabebuia rosea*), Leucaena (*Leucaena leucocephala*), Guasima (*Morus alba*) and Morera (*Guazuma ulmifolia*); which proved to be naturally available in the production units. Resistance to drought, ease of propagation, nutritive value and regrowth are reported from each species. The nutritional content of the trees in animal feed varies from 7.9 to 20.22% of P.C. and from 2.55 to 3.25 of E.M.

CITED LITERATURE

AGUIRRE OJ. 2013. Características nutricionales de algunas leñosas forrajeras. *Abanico Veterinario*. 3(3):42-51. <https://www.medigraphic.com/pdfs/abanico/av-2013/av133f.pdf>

AMPARO Holguín V, Isis García I, Mora-Delgado J. 2018. *Árboles y Arbustos*. Bogotá, Colombia: Universidad del Tolima. Primera edición electrónica. 133 p. ISBN: 978-958-8932-56-9

CALLE Z, Murgueitio E, Botero LM. 2011. El totumo, árbol de las Américas para la ganadería moderna. *Revista Carta FEDEGAN*. 122: 64-73. ISSN: 0123-2312.

CÁRDENAS C, Rocha C, Mora-Delgado J. 2011. Productividad y preferencia de forraje de vacas lecheras pastoreando un sistema silvopastoril intensivo de la zona alto Andina de Roncesvalles, Tolima. *Revista Colombiana de Ciencia Animal*. 4(1): 29-35. ISSN: 2462-7623.

DAS R, Sailo L, Verma N, Bharti P, Saikia J, Intiwat Kumar R. 2016. Impact of heat stress on health and performance of dairy animals: A review. *Veterinary World*. 9(3): 260-268. DOI: 10.14202/vetworld.2016.260-268

DELGADO D, Hera R, Cairo J, Orta Y. 2014. Samanea saman, árbol multipropósito con potencialidades como alimento alternativo para animales de interés productivo. *Revista Cubana de Ciencia Agrícola*. 48 (3):205. Disponible en: <https://docplayer.es/17474158-Samanea-saman-arbol-multiproposito-con-potencialidades-como-alimento-alternativo-para-animales-de-interes-productivo.html>

FOIDL N, Mayorga L, Vásquez W. 1999. "Utilización del marango (*Moringa oleifera*) como forraje fresco para ganado". En: Sánchez MD, Rosales M. *Agroforestería para la producción animal en Latinoamérica*. Roma, Italia: FAO. 341-350 p. ISBN: 925-304-257-5.

GASCON C, Da Fonseca GAB, Sechrest W, Billmark KA, Sandenson J. 2004. "Biodiversity conservation in deforested and fragmented tropical landscapes: an overview". En: Schroth G, Da Fonseca GAB, Harvey CA, Gascon G, Vasconcelos HL, Izac AM, *Agroforestry and Biodiversity Conservation in Tropical Landscapes*. Washington, DC, USA: Island Press. 15-32 p. ISBN: 978-159-726-744-1

GOBBI JA, Casasola F. 2003. Comportamiento financiero de la inversión en sistemas silvopastoriles en fincas ganaderas de Esparza, Costa Rica. *Agroforestería en las Américas*. 10(39-40):52-60. http://repositorio.bibliotecaorton.catie.ac.cr/bitstream/handle/11554/5923/Comportamiento_financiero_de_la_inversion.pdf?sequence=1&isAllowed=y

GALEANO LM, Gómez MJ, Gómez JE. 2013. Caracterización de los sistemas de pastoreo de pequeños rumiantes en el sur del Tolima. *Revista Colombiana de Ciencia Animal*. 6(1):74-84. ISSN: 2462-7623.

GONZÁLEZ E, Cáceres O. 2010. "Valor nutritivo de árboles, arbustos y otras plantas forrajeras para los rumiantes". En: Milera, M. *Morera un nuevo forraje para la alimentación del ganado*. Matanzas, Cuba: Estación Experimental de Pastos y Forrajes "Indio Hatuey". 157-163 p. ISBN: 978-959-7138-04-4

GONZÁLEZ GJC, Madrigal SX, Ayala BAJ, Juárez CA, Gutiérrez VE. 2006. Especies arbóreas de uso múltiple para la ganadería en la región de Tierra Caliente del estado de Michoacán, México. *Livestock Research for Rural Development*. (18) 8. <http://www.cipav.org.co/lrrd18/85glz188.html>

HOLGUÍN VA, Ibrahim M, Mora-Delgado J. 2008. Evaluación financiera de la inversión en tres prototipos de finca ganadera en el Pacífico Central de Costa Rica. *Acta Agronómica*. 57 (2): 143-152. ISSN: 2323-0118.

KU JC, Ramírez L, Jiménez G, Alayón JA, Ramírez L. 1999. "Árboles y arbustos forrajeros para la producción animal en el trópico mexicano". En: Sánchez MD, Rosales M. *Agroforestería para la producción animal en Latinoamérica*. Roma, Italia: FAO . 161-180 p. ISBN: 925-304-257-5

MACHADO R, Roche R, Toral O, González GE. 1999. Metodología para colecta y conservación y caracterización de especies herbáceas, arbóreas y arbustivas útiles para la ganadería. *Pastos y Forrajes*. 29(33): 181-204. ISSN: 0864-0394, HAL Id: hal-01190065 <https://hal.archives-ouvertes.fr/hal-01190065>

MTENGETI EJ, Mhelela A. 2006. Screening of potencial indigenous browse species in semi-arid central Tanzania. A case of Gairo division. *Livestock Research for Rural Development* . (18)9: 122. ISSN: 0121-3784. <http://www.lrrd.org/lrrd18/9/mten18122.htm>

MURGUEITIO E, Ibrahim M. 2001. Agroforestería pecuaria para la reconversión de la ganadería en Latinoamérica. *Livestock Research for Rural Development* . (13)3: 26. ISSN: 0121-3784. <http://www.lrrd.org/lrrd13/3/murg133.htm>

ODALYS C, Pérez T, Iglesias JM. 2008. Selectividad de especies arbóreas potencialmente útiles para sistemas de producción ganaderos. *Zootecnia Trop*. 26(3): 197-200. <https://tspace.library.utoronto.ca/bitstream/1807/64193/1/zt08027.pdf>

PINTO RR, Hernández D, Gómez H, Pezo D. 2010. Arboles forrajeros de tres regiones ganaderas de Chiapas: usos y características nutricionales, *Universidad y Ciencia*. 26 (1): 19-31. ISSN: 0186-2979. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0186-29792010000100002&lng=es.

ROCHA C, Cárdenas CA, Mora-Delgado J. 2013. Costos de establecimiento de un sistema silvopastoril de sauco (*Sambucus nigra*) y Kikuyo (*Penisetum clandestinum*) en Roncesvalles (Tolima), *Revista Agroforestería Neotropical*. 3:70-76. ISSN: 2248-7433

SOSA EE, Pérez D, Ortega L, Zapata G. 2004. Evaluación del potencial forrajero de árboles y arbustos tropicales para la alimentación de ovino. *Revista Técnica Pecuaria en México*. 42(2):129-131. ISSN: 0040-1889. <http://www.redalyc.org/articulo.oa?id=61342201>

SALAS JE, Agramonte D, Jiménez F, Pérez M, Collado R, Barbón R, La O De Feria O, Chávez M. 2011. Propagación de plantas de *Morus alba* Var. Criolla con el uso de sistemas de inmersión temporal. *Rev. Biotecnología Vegetal*. 11 (2):189-197. ISSN: 2074-8447. <https://revista.ibp.co.cu/index.php/BV/article/view/220/825>

SALEM AZM, Robinson PH, El-Adawya MM, Hassanc AA. 2007. In vitro fermentation and microbial protein synthesis of some browse tree leaves with or without addition of polyethylene glycol. *Animal Feed Science and Technology*. 138(3-4):318-330. <https://doi.org/10.1016/j.anifeedsci.2006.11.026>

SAABREDA LC, Rodríguez PA. 2018. Evaluación nutricional y agronómica de *Morus alba* y *Sambucus nigra* sobre algunos parámetros producidos en ganado lechero. *Revista de investigación*. 6 (002): 189 - 197. ISSN: 2011-5415. DOI: 10.17151/vetzo.2018.12

VAN SOEST PJ. 1994. *Nutritional Ecology of the Ruminant*. Ithaca, NY, USA: Cornell University Press. 476 p. ISBN: 978-0-8014-2772-5

VELÁSQUEZ VR, Mora DJ. 2008. Cobertura arbórea y herbácea en pasturas naturalizadas de fincas ganaderas del Trópico Seco de Nicaragua. *Rev Colomb Cienc Pecu*. 21(4):571-581. ISSN: 0120-0690. <http://www.redalyc.org/pdf/2950/295023543005.pdf>