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Traditional uses of dispersed trees in the pastures of the mountainous region of Tabasco, Mexico

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Abstract The rapid deforestation in the state of Tabasco due to extensive livestock farming has resulted in the decrease of the original forest cover. Only 4% of the original vegetation remains and that vegetation is concentrated in the mountainous regions of the state. This destructive process continues due to support by the current government livestock policies. Under these circumstances, the traditional silvopastoral systems of dispersed trees can present an option for reversing and mitigating deforestation practices. The objective of this study was to generate information on the tree species common to silvopastoral systems of dispersed trees in the pastures for two mountainous areas in Tabasco. In the study, 64 tree species, representing 26 plant families were identified. All species were characterized as multipurpose, with at least three reported uses and a maximum of seven for each species. In total, nine categories of local uses were identified for the trees. The main category of use was fuel (firewood), followed by timber and shade for the livestock. Although leguminous species (Fabaceae) were dominant, these species were utilized for uses other than the provision of fodder. Since 12 of the total species identified were recognized as sources of food for animals; the assumption that livestock farmers do not recognize the utility of these species for improving production yields is apparent. The results suggest that there is potential need to expand research and offer further education on the subject in Tabasco.

Keywords Ethnobotanical · Fabaceae · Silvopastoral systems · Tacotalpa · Tenosique

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Introduction

In the Tabasco State, Mexico, extensive livestock ranching is one of the main activities for the rural communities. The growth of livestock ranching has developed as a consequence of the elimination of the local vegetation. Until the second half of the 1950s, the state was covered in large part by rainforest vegetation (Toledo et al. 1995). Five decades of governmental incentive policies for the development of extensive livestock ranching, particularly in the *ejidos* or communal lands (Sánchez et al. 2005), have reduced the area of forests and natural rainforests from 49% coverage in 1940, to 8% in 1992 (Palacio-Prieto et al. 2000) and to 4% in the first decade of the 21st century (INEGI 2005). Currently, remnants of the rainforest are mostly concentrated in the Sierra Sur of Tabasco, the mountainous region bordering the neighboring Chiapas State. Possibly, these remnants of rainforest will be converted into pasture lands; where, in spite of the technical, financial and environmental problems that livestock farming is facing, this practice continues to be promoted.

An alternative that can reverse this process of deforestation is the implementation of silvopastoral systems as means of land use, characterized by the biological interaction of perennial woody plants with grassland areas and/or animals. In this case, the fundamental goals are the diversification and optimization of production with a focus on the sustainability of the lands utilized for local livestock practices (Casanova-Lugo et al. 2014); and restricting further advance of livestock production in the remaining forested areas. In this context, dispersed trees in pastures (DTP), the second most frequently employed silvopastoral systems in the mountain range of Tabasco, becomes the most feasible option for the initiation of change in the local livestock culture (Grande et al. 2010). Under this system, trees are retained in pastures as they fulfil diverse functions for both the producer and the environment. Furthermore, they create a favorable habitat for certain species and improve the connectivity among tree-covered landscapes (Esquivel-Mimenza et al. 2011; González-Valdivia et al. 2014; Harvey and González 2007). Additionally, recent studies have documented that these systems promote successful carbon capture and the conservation of water and air (Jose 2009; Casanova-Lugo et al. 2011; Nair 2012).

Although there is a generalized culture of acceptance and practice of DTP among producers in Tabasco; relevant information is lacking on the use of the local trees. For example, information is needed on the factors that affect decision making or offer an empirical basis for developing important strategies to incorporate trees into livestock farming, thereby fostering conservation of woody species in these systems. Hence, the objective of this study has been to identify the uses of dispersed trees by farmers in the pastures of the Sierra Sur in the Tabasco State, Mexico, as an initial approach for the promotion of silvopastoral management on the basis of folk knowledge and for increasing the success of its implementation and adoption, as suggested by Cabrera-Pérez et al. (2013).

Materials and methods

Study area

The study was conducted from August to December 2013 at Villa Luz and Zunu-Patastal in the municipality of Tacotalpa (Sierra sub-region) and in Santo Tomás, Nuevo Progreso and Ignacio Allende in the municipality of Tenosique (Fig. 1). These five localities are located in the mountainous areas of Tabasco State (Mexico), forming part of the same mountainous province that extends towards Chiapas State (Mexico) and Guatemala from 17°15′ and 17°45′N to 90°38′ and 93°46′W, with altitudes varying from 50 mm to 1000 m. The area is located at the margins of the protected areas within the Sierra of Tabasco and the Usumacinta Canyon, which border the state of Chiapas. Furthermore, Tenosique is adjacent to Guatemala, whose rain forest is better conserved. The physiographic conditions are similar, although variations exist in the average annual temperature and precipitation; and the local land use conditions (INEGI 2009).

The climate is humid and warm with abundant rainfall throughout the year (Am) or during summer (Am) (INEGI 2000). In Tacotalpa, the average annual temperature is 25.6 °C. The average maximum monthly temperature is 29.2 °C in May, and the average minimum monthly temperature is 22 °C in December and January. The annual precipitation is 4014 mm, with an average monthly maximum of 588 mm in October and an average monthly minimum

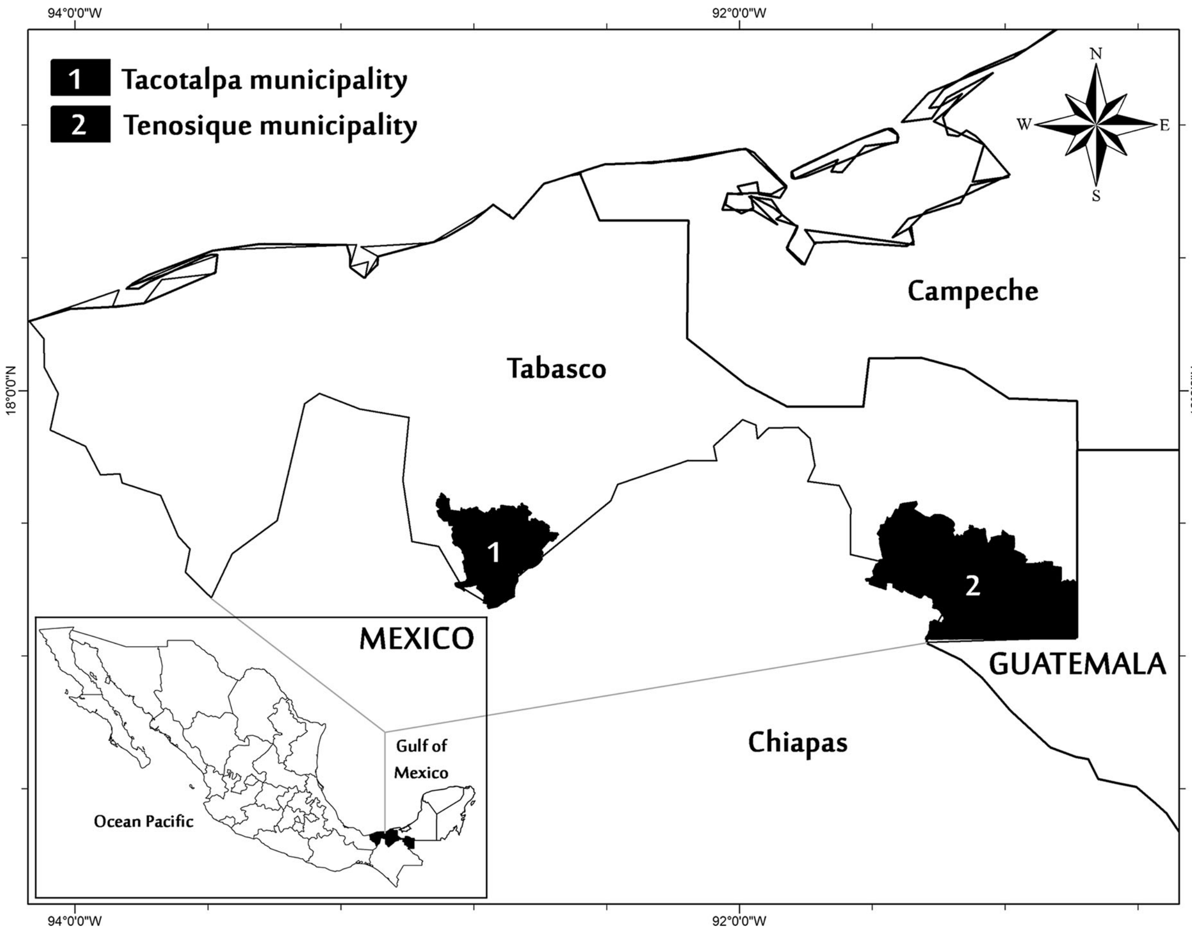


Fig. 1 Location of the study sites

of 132 mm in April. In Tenosique, the average annual temperature is 26.3 °C. The average maximum monthly temperature is 30.5 °C in May, and the average minimum temperature is 22 °C in December and January. The annual precipitation is 3282 mm (INEGI 2000).

Soil is predominantly Fluvisol Gleyc; with structure characterized as that of a recent alluvial, clayey marsh soil, with high organic matter content, water saturation, fine texture and poor permeability. These sites are appropriate for sustaining pastures and small areas of permanent seasonal agriculture due to their moderate to low fertility.

A large portion of the rainforest remnants of Tabasco can be found in this area. The vegetation is characterized by fragments of rainforest contained within a mosaic of secondary vegetation of varying ages, which is the result of agricultural and pastoral livestock activities on flat or semi-flat surfaces (Ochoa-Gaona et al. 2008). The rainforest remnants, in their most conserved state, reach 30 meters in height and consist of three tree strata, including an herbaceous strata formed by plants from the Araceae and Marantaceae families, ferns, lianas and several types of orchids (Grande et al. 2010). The most common tree and palm species: *Attalea butyracea* (Mutis ex L.f.) Wess.Boer (american oil palm), *Calophyllum brasiliense* Cambess. (barí), *Castilla elastica* Sessé (rubber tree), *Ceiba pentandra* (L.) Gaertn. (ceiba), *Cordia alliodora* (Ruíz & Pav.) Oken (cypre), *Nectandra ambigens* (S.F.Blake) C.K.Allen (laurel), *Sabal mexicana* Mart. (Mexican palmetto), *Spondias mombin* L. (jocote), *Tabebuia rosea* (Bertol) DC. (pink poui) (Grande et al. 2010; Maldonado et al. 2008).

Criteria for site selection

Before sampling sites were selected through numerous field visits and surveys carried out in the region to identify the livestock systems utilizing DTP (Fig. 2). A detailed questionnaire was used to obtain biophysical information on the local management system, including age, type of management, tree species used and planting density, among other parameters (Table 1). Afterwards, sites (sampling units) that fulfilled the following criteria were selected: minimum of 24 trees ha^{-1} with a diameter at breast height > 10 cm and grazed for a minimum period 8 h day^{-1}. A total of 16 ranches were selected: six were located in the community of Tacotalpa and 10 in Tenosique. Within each ranch, an area of approximately 1 ha was randomly selected for analysis.

Floristic inventory

In each sampling unit, all the trees were counted and identified. The mensuration techniques utilized for these systems were described in Martínez-Encino et al. (2013). The description of the functional types was based on Pennington and Sarukhán (2005) and Jiménez et al. (2010), who characterized the main uses and the origins of the trees at the study sites. The identification and final taxonomic determinations were conducted by comparisons with specimens in the Plant Collection of the Universidad Juárez Autónoma de Tabasco.

Ethnobotanical data

The taxonomic identities of the species were determined and the origin data (natural or introduced) were collected and representative samples were deposited at UJAT herbarium with collection numbers of first author (CRVP) (see Table 2). Afterwards, landowners (Appendix Table 3) of the locations where the dispersed tree systems had been characterized were asked to participate in a specially designed individual survey. Using tree samples, interviewees were asked to identify species by their vernacular names and to list their local uses. In this way, the categories for tree use were created to represent those locally known and mentioned.

Results

Of the 64 woody species recorded in the floristic inventory, 62 were identified (Table 2). The reported tree uses in the surveyed localities were placed under nine use categories: (1) timber (2) firewood, (3) fodder, (4) fruit trees, (5) fences, (6) posts, (7) shade, (8) medicinal and (9) for attracting honeybees, in addition to the option of undetermined use (UD). All species studied had multiple uses according to the criteria established by Cabrera-Pérez et al. (2013).

The tree species identified in these livestock systems with dispersed trees of varying densities in pastures represented 26 botanical families (Fig. 3). Of the total tree species studied, 25% belonged to the family Fabaceae (leguminous plants), followed by Malvaceae (9%). The families Anacardiaceae, Bignoniaceae, Boraginaceae, Moraceae and Sapindaceae each represented 5% of the total trees. The rest of the species were dispersed among 21 families, altogether representing 38% of the total samples. Finally, 3% tree species (2 species) remained unidentified.

Discussion

A study carried out in the state of Tabasco by Grande et al. (2010) in silvopastoral systems that are characterized by dispersed trees in pastures demonstrated that 31.4% of the reported tree species came from the legume family. Similarly, other studies in the tropical regions has reported similar trends (Cabrera-Pérez et al. 2013; González-Valdivia et al. 2012) and in fact, in a dry seasonal forest, approximately 38% of all plant species were identified as Fabaceae members (Casanova-Lugo et al. 2014). Earlier studies coincide with the results of the current study, suggesting that the legume family has the greatest presence in livestock systems with dispersed trees in pastures. However, only four of 16 species (*Dialium guianensis* (Aubl.) Sanwith, *Enterolobium cyclocarpum* (Jacq.) Griseb., *Gliricidia sepium* (Jacq.) Walp., and *Lonchocarpus guatemalensis* Benth.) were mentioned as sources of fodder; whereas most were considered shade providers for the local livestock (12 of 16 Fabaceae species). This observation is relevant since majority of the leguminous plants are potential sources of fodder (15 species) and may form part of living

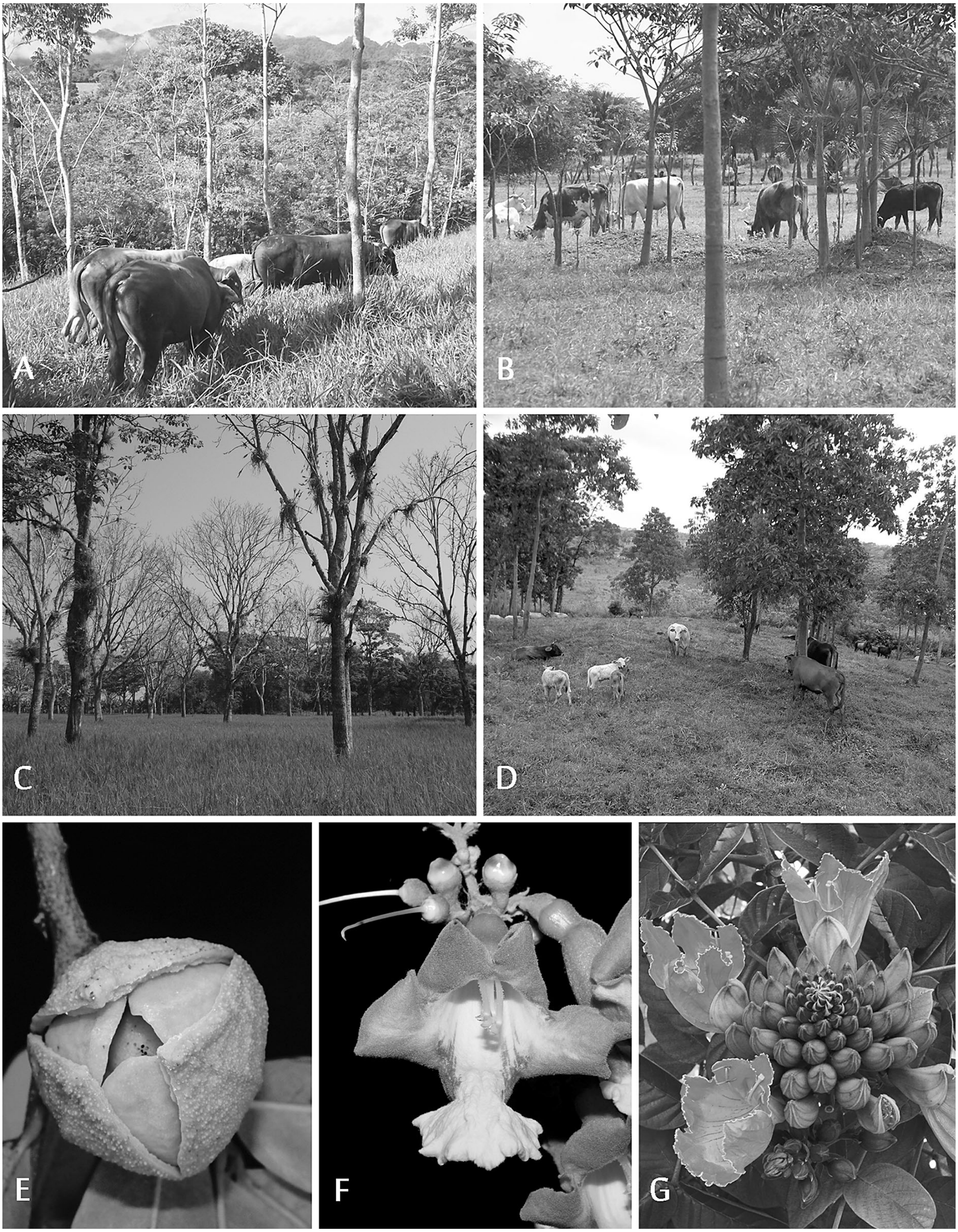


Fig. 2 Pastures with native and non native plants in the mountains of Tacotalpa and Tenosique in Tabasco, Mexico. **a**–**d** Examples of livestock systems with dispersed trees. **e**–**g** Non native plants. E. *Annona muricata*. F. *Gmelina arborea*. G. *Spathodea campanulata*

Table 1 General characteristics of transitional silvopastoral systems (SPS) in the Sierra Sur of Tabasco, Mexico. Source: Martínez-Encino et al. (2013) (modified)

Characteristics	Description	
	Tenosique	Tacotalpa
Production objectives	Fattening	Fattening
	Breeding	Breeding
	Dual purpose (meat and milk)	Dual purpose (meat and milk)
Cattle breeds	Zebu × Swiss	Zebu × Swiss
	Brown Swiss	
Average total area, ha	22.7 (± 5.7)	12.7 (± 3.8)
Average size of herd	32.3 (± 9.8)	19.8 (± 5.9)
Average cattle concentration, indv/ha	1.4 (± 0.2)	1.6 (± 0.3)
Average days of grazing	18.3 (± 1.8)	7.7 (± 0.3)
Average herbaceous coverage, %	57.4 (± 1.9)	67.7 (± 1.9)
Main grasses	*Brachiaria brizantha* (A.Rich) Stapf	*B. decumbens* Stapf
	Paspalum sp.	*Paspalum* sp.
	Pennisetum purpureum Schumach.	*B. brizantha*
	B. decumbens	*Pennisetum purpureum*
Average tree density, indv/ha	48 (± 8.2)	93 (± 17.0)
Level of specialization	Supplements and food are purchased	Supplements and food are not purchased
	Daily wage workers are hired	Daily wage workers are not hired
	Veterinary services	Veterinary services

Averages (± standard error)

fences (8 species) or provide timber products (7 species). This pattern was common for all of the botanical families studied and their respective species in the context of studied livestock systems, similar to the pattern encountered by Cabrera-Pérez et al. (2013) in the mountain range of Tenosique. The potential increase in the profitability and productivity of livestock farming do not appear to be promoted in the Tabasco region, including the use of leguminous plants as fodder. Thus, education on the subject should be provided to the producers if this region.

Producers reported a total of 9 uses for DTP (Fig. 4). Of the mentioned uses, 83% of the species were useful for firewood, followed by use for timber products (61%), shade for animals (55%), fruit trees (45%), attracting honeybees (44%), medicinal uses (31%) and living fences (22%). Only 16% of the species were reported as sources of fodder, and finally, 11% were cited for use in creating posts. All species had at least 3 reported uses, reflecting the tendency to include these types of tree species in the agroecosystems in the mountainous regions of Tabasco.

Similarly, Casanova-Lugo et al. (2014) reported 80% of the tree species in a regenerating dry tropical forest in Michoacán were used for fodder, 38% for firewood, 32% for diverse timber uses, 27% for manufacturing tools, 24% for obtaining medicines, 22% for attracting honeybees, 16% for fruits and 14% for delimiting parcels by means of living fences, in addition to their use for posts and shade (14 and 7%, respectively). However, González-Gómez et al. (2006) indicate that in the silvopastoral systems with natural regeneration, trees are mainly used for firewood (28.3%), posts (25.2%), medicine for humans (15.2%), preparation of indigenous tools (14.6%), human consumption (13.5%) and medicine for animals (3.3%). Cabrera-Pérez et al. (2013) reported that the flora in the Tenosique mountain range is mainly used for firewood, whereas its use as animal fodder is quite limited. These findings are in agreement with the present study, given that firewood was identified as the

Table 2 Floristic list of dispersed trees in mountain pastures of Tacotalpa and Tenosique in Tabasco, Mexico

Family	Species	Common name	Uses	Origin	Collector
Anacardiaceae	*Astronium graveolens* Jacq.	Jobillo	1, 2, 5,7	N	*CRVP 1*
Anacardiaceae	*Mangifera indica* L.	Mango	1, 2, 4, 8, 9	NN	*CRVP 2*
Anacardiaceae	*Spondias mombin* L.	Jobo	1, 2, 8	N	*CRVP 3*
Annonaceae	*Annona muricata* L.	Anona	2, 4, 8,9	NN	*CRVP 4*
Araliaceae	*Dendropanax arboreus* (L.) Decne. & Planch.	Caracolillo	2, 6,7	N	*CRVP 5*
Arecaceae	*Bactris gasipaes* Kunth	Pejibaye	3, 4, 7	NN	*CRVP 6*
Arecaceae	*Cocos nucifera* L.	Coco	2, 4, 9	NN	*CRVP 7*
Bignoniaceae	*Parmentiera aculeata* (Kunth) Seem.	Cuajilote	2, 3, 4, 5, 7	N	*CRVP 8*
Bignoniaceae	*Spathodea campanulata* P.Beauv.	Tulipan	1, 2, 3, 4	NN	*CRVP 9*
Bignoniaceae	*Tabebuia rosea* (Bertol.) DC.	Macuilis	1, 2, 7, 9	N	*CRVP 10*
Boraginaceae	*Cordia alliodora* (Ruíz & Pav.) Oken	Bojón	1, 2, 5, 6	N	*CRVP 11*
Boraginaceae	*Cordia stellifera* L.M.Johnst.	Candelero	1, 2, 4, 7	N	*CRVP 12*
Boraginaceae	*Ehretia tinifolia* L.	Nance pea	2, 4, 9	N	*CRVP 13*
Burseraceae	*Bursera simaruba* (L.) Sarg.	Palo mulato	1, 3, 5, 7, 8, 9	N	*CRVP 14*
Calophyllaceae	*Calophyllum brasiliense* Cambess.	Barí	1, 2, 3	N	*CRVP 15*
Calophyllaceae	*Mammea americana* L.	Mamey	2, 4, 9	NN	*CRVP 16*
Cannabaceae	*Aphananthe monoica* (Hemsl.) J.F.Leroy	Escobillo	1, 2, 7	N	*CRVP 17*
Combretaceae	*Terminalia catappa* L.	Almendro	1, 2, 4, 5	N	*CRVP 18*
Fabaceae	*Albizia adinocephala* (Donn.Sm.) Record	Cola de pescado	2, 5, 6, 7	N	*CRVP 19*
Fabaceae	*Dialium guianense* (Aubl.) Sandwith	Guapaque	1, 3, 4, 6, 8	N	*CRVP 20*
Fabaceae	*Diphysa americana* (Mill.) M.Sousa	Plumillo	2, 7, 9	N	*CRVP 21*
Fabaceae	*Diphysa robinioides* Benth. & Oerst.	Chipilín	2, 5, 7, 9	N	*CRVP 22*
Fabaceae	*Enterolobium cyclocarpum* (Jacq.) Griseb.	Piche	1, 2, 3, 4, 7, 8	N	*CRVP 23*
Fabaceae	*Gliricidia sepium* (Jacq.) Walp.	Cocoíte	2, 3, 5, 8, 9	N	*CRVP 24*
Fabaceae	*Haematoxylum campechianum* L.	Palo tinto	2, 5, 6, 8, 9	N	*CRVP 25*
Fabaceae	*Inga vera* Willd.	Guatope	2, 4, 7, 9	N	*CRVP 26*
Fabaceae	*Lonchocarpus guatemalensis* Benth.	Palo gusano	2, 3, 5, 7, 9	N	*CRVP 27*
Fabaceae	*Lysiloma latisiliquum* (L.) Benth.	Cola lagarto	1, 2, 5, 7	N	*CRVP 28*
Fabaceae	*Ormosia schippii* Standl. & Steyerm.	Colorín	1, 2, 7	N	*CRVP 29*
Fabaceae	*Piscidia piscipula* (L.) Sarg.	Jabín	1, 2, 5, 7	N	*CRVP 30*
Fabaceae	*Pithecellobium dulce* (Roxb.) Benth.	Guamuchil	2, 4, 5	N	*CRVP 31*
Fabaceae	*Platymiscium yucatanum* Standl.	Chulul	1, 2, 7	N	*CRVP 32*
Fabaceae	*Schizolobium parahyba* (Vell.) S.F.Blake	Guanacastle	1, 2, 7	N	*CRVP 33*
Fabaceae	*Vatairea lundelli* (Standl.) Record	Amargoso	2, 4, 7, 8	N	*CRVP 34*
Lamiaceae	*Gmelina arborea* Roxb. ex Sm.	Melina	1, 2, 4	NN	*CRVP 35*
Lamiaceae	*Tectona grandis* L.f.	Teca	1, 2, 7	NN	*CRVP 36*
Lauraceae	*Persea Americana* Mill.	Aguacate	1, 2, 4, 5, 7, 9	NN	*CRVP 37*
Lauraceae	*Persea schiedeana* Nees	Chinín	2, 4, 7	N	*CRVP 38*
Malpighiaceae	*Byrsonima crassifolia* (L.) Kunth	Nance	1, 4, 8, 9	N	*CRVP 39*
Malvaceae	*Ceiba pentandra* (L.) Gaertn.	Ceiba	1, 7, 9	N	*CRVP 40*
Malvaceae	*Guazuma ulmifolia* Lam.	Guácimo	2, 3, 4, 5, 8, 9	N	*CRVP 41*
Malvaceae	*Pachira aquatica* Aubl.	Zapote de agua	2, 5, 7, 9	N	*CRVP 42*
Malvaceae	*Pseudobombax ellipticum* (Kunth) Dugand	Amapola	1, 2, 5	N	*CRVP 43*
Malvaceae	*Theobroma bicolor* Bonpl.	Pataste	1, 2, 5, 7, 9	NN	*CRVP 44*
Malvaceae	*Trichospermum mexicanum* (DC.) Baill.	Majagua	1, 2, 9	N	*CRVP 45*

Table 2 continued

Family	Species	Common name	Uses	Origin	Collector
Meliaceae	*Cedrela odorata* L.	Cedro	1, 2, 8, 9	N	*CRVP 46*
Meliaceae	*Swietenia macrophylla* King	Caoba	1, 2, 4, 7	N	*CRVP 47*
Moraceae	*Artocarpus altilis* (Parkinson) Fosberg	Castaña	2, 4, 8	N	*CRVP 48*
Moraceae	*Brosimum alicastrum* Sw.	Ramón	1, 2, 3, 4, 7, 8, 9	N	*CRVP 49*
Moraceae	*Ficus insipida* Willd.	Chimón	4, 7, 8	N	*CRVP 50*
ND	ND	ND	1, 2, 6,7	ND	*CRVP 51*
ND	ND	Samarindillo	1, 2, 7	N	*CRVP 52*
Polygonaceae	*Coccoloba uvifera* (L.) L.	Uva de playa	1, 2, 4, 8, 9	N	*CRVP 53*
Rubiaceae	*Simira salvadorensis* (Standl.) Steyerm.	Chacaguante	1, 2, 8	N	*CRVP 54*
Rutaceae	*Citrus sinensis* (L.) Osbeck	Naranja	2, 4, 8, 9	NN	*CRVP 55*
Rutaceae	*Zanthoxylum kellermanii* P.Wilson	Tachuelillo	1, 2, 4, 7, 8	N	*CRVP 56*
Salicaceae	*Zuelania guidonia* (Sw.) Britton & Millsp.	Trementina	2, 6, 7	N	*CRVP 57*
Sapindaceae	*Cupania dentate* DC.	Quebrahacha	1, 2, 6	N	*CRVP 58*
Sapindaceae	*Sapindus saponaria* L.	Jaboncillo	1, 2, 7, 8	N	*CRVP 59*
Sapindaceae	*Melicoccus oliviformis* Kunth	Guaya	1, 2, 4, 7, 9	N	*CRVP 60*
Sapotaceae	*Pouteria sapota* (Jacq.) H.E.Moore & Stearn	Zapote	1, 2, 4, 5, 7, 9	N	*CRVP 61*
Simaroubaceae	*Simarouba glauca* DC.	Coralillo	1, 2, 7	N	*CRVP 62*
Urticaceae	*Cecropia obtusifolia* Bertol.	Guarumo	1, 3, 4	N	*CRVP 63*
Verbenaceae	*Lippia cardiostegia* Benth.	Sasnich	2, 8, 9	N	*CRVP 64*

(1) Timber, (2) firewood, (3) fodder, (4) fruit, (5) living fences, (6) posts, (7) shade, (8) medicinal and (9) attracting honeybees

ND undetermined, *N* native, *NN* non native. Collector: *CRVP* = Carlos R. Villanueva-Partida

main use for dispersed trees in pastures, although the proportion of species for said use is greater in comparison to that reported by González-Gómez et al. (2006). However, the use of trees species of dry forests and secondary forests as fodder or as a fodder compliment is more common, in addition to its usage as green manure (Pinedo-Vasquez et al. 1990).

The differences in the results and in the proportions of species per category of use may be explained by the nature of the studied systems and the conditions specific to each region. In general and in agreement with Ochoa-Gaona et al. (2012) and Cabrera-Pérez et al. (2013), species of DTP in the mountainous regions of Tabasco demonstrate multiple uses. Of the total number of species, 90.5% have three to five reported uses, whereas nearly 10% have six or seven documented uses (Fig. 5).

Notably, the majority of tree species (84%) found in livestock systems are remnants of the native vegetation or the result of natural succession. In contrast, only 16% of the trees were non native species, including *Annona muricata* L., *Bactris gasipaes* Kunth, *Cocos nucifera* L., *Spathodea campanulata* P. Beauv., *Mammea americana* L., *Gmelina arborea* Roxb., *Persea Americana* Mill., *Citrus sinensis* (L.) Osbeck, *Theobroma bicolor* Bonpl., and *Tectona grandis* L.f. (Fig. 6).

In relation to their origins and in agreement with Beer et al. (2003), several trees present in pastures are remnants of the original rainforest and are conserved for their ability to offer shade and their use as timber. In other cases, farmers plant trees, such as fruit trees or introduced species. However, many native and non native trees have begun to regenerate naturally and maintain significant populations in pastures; some of these trees are the product of natural seed dispersal by wind, birds, livestock, and other herbivores, whereas others regenerate from stumps (Beer et al. 2003). In addition to shade, DTP offer other benefits for livestock, such as high quality fruits and fodder in

Fig. 3 Number of species for botanical families of dispersed trees in pastures in the mountains of Tacotalpa and Tenosique in Tabasco, Mexico

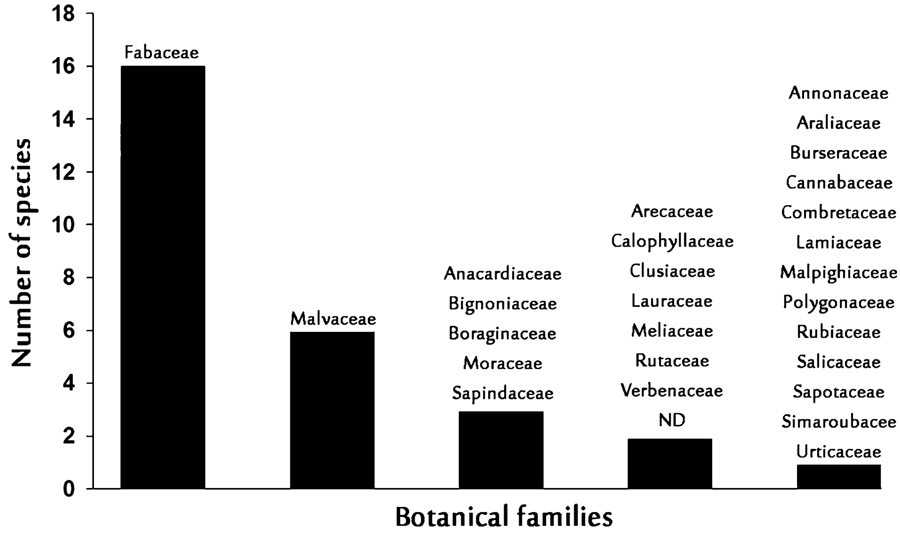
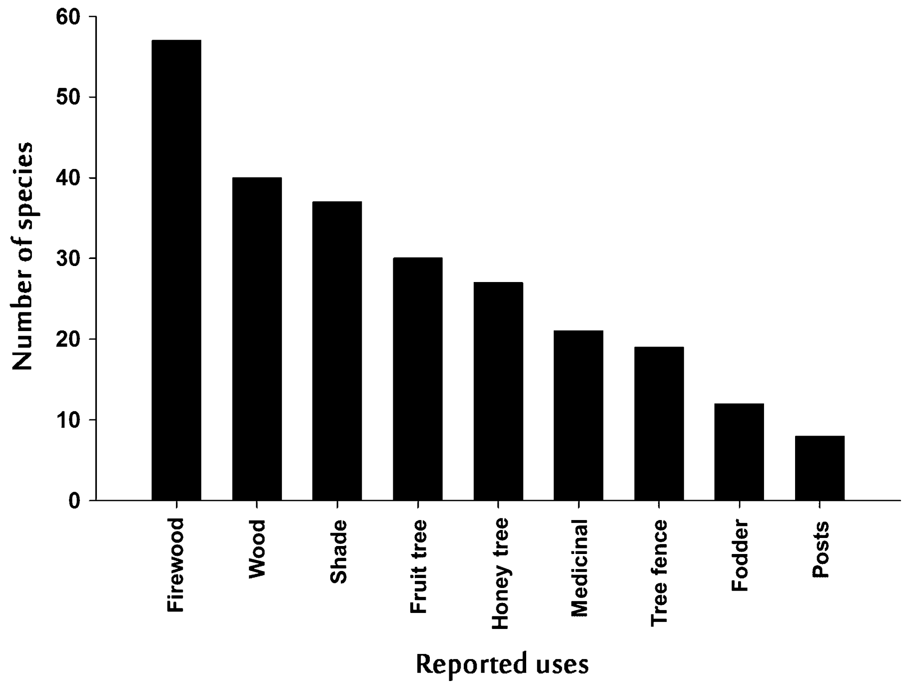


Fig. 4 Main uses of dispersed trees in pastures in the mountains of Tacotalpa and Tenosique in Tabasco, Mexico



comparison to grasses; especially during the dry season, when the digestibility and nutritional quality of tropical grasses are considerably reduced (González-Valdivia 2003). This allows producers to increase their income because in addition to obtaining traditional livestock products (meat, milk and cheese); they are also able to commercialize fruits, firewood and timber. Furthermore, with DTP, producers also provide environmental services, such as the capture of carbon and the conservation of biodiversity, ultimately contributing to improved soil quality and the conservation of water and air quality (Jose 2009).

Conclusion

Leguminous plants (Fabaceae) are the most abundant in the local silvopastoral systems such as the dispersed

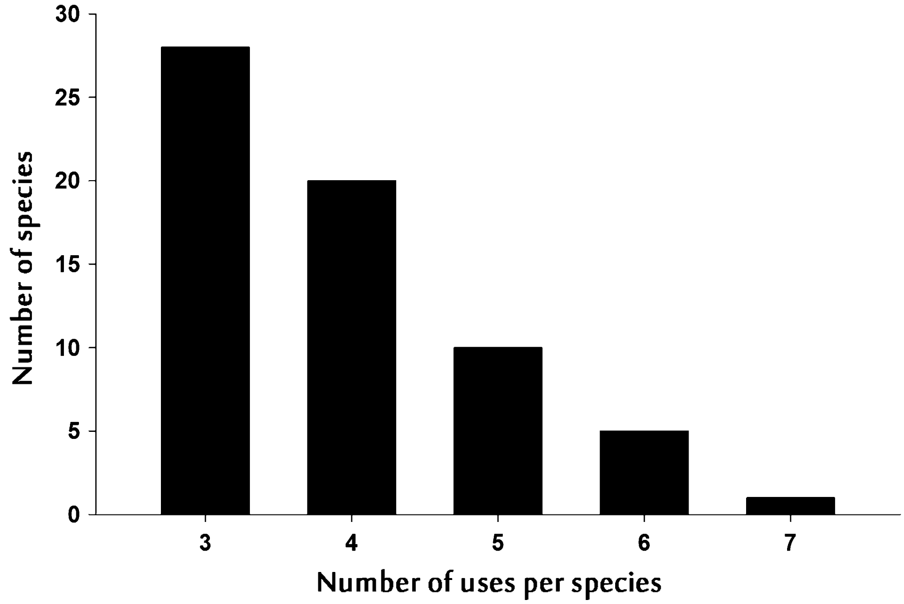


Fig. 5 Number of species that provide each use attributed to dispersed trees in pastures in the mountains of Tacotalpa and Tenosique in Tabasco, Mexico

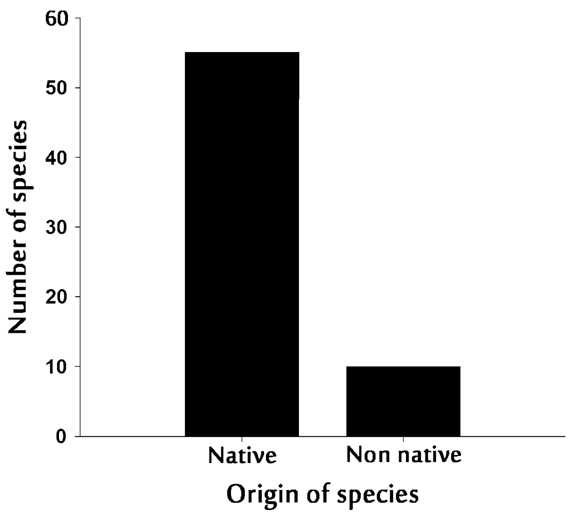


Fig. 6 Origin of the dispersed trees in pastures in the mountains of Tacotalpa and Tenosique in Tabasco, Mexico

trees in pastures (DTP) found in the mountainous regions of Tabasco. These plants do not appear to be utilized for their limited potential as fodder; but, rather for other uses such as fuel and timber. All tree flora encountered in the DTP systems were used for fuel and timber, although the use of trees as shade for livestock was also observed to be important. Overall, tree species possess a great diversity of uses (nine reported uses); in this study, all species were characterized as having multiple uses (more than three). In addition to being sources of firewood, timber, and shade; they also serve as posts, offer fodder and fruit, attract honeybees and have important medicinal uses. Finally, the majority of dispersed trees were remnants of the original native vegetation. Therefore, these systems contribute to the conservation of woody species through their use and should be promoted in areas with livestock in the Tabasco State, Mexico.

Appendix

See Table 3.

Table 3 General characteristics of informants that were interviewed in the mountain region of Tabasco, Mexico

Name	Age (years)	Sex	Level of study	Municipality	Localities
David Gómez Cruz	60	Male	None	Tenosique	Ignacio Allende
Nicolas Pérez Díaz	55	Male	Primary	Tenosique	Ignacio Allende
Julia del Cármen Sánchez	41	Female	Primary	Tenosique	Ignacio Allende
Domingo Díaz Sánchez	45	Male	Primary	Tenosique	Ignacio Allende
Alfonso Vera Jiménez	38	Male	Primary	Tenosique	Nuevo Progreso
Rigoberto Vera Jiménez	50	Male	Primary	Tenosique	Nuevo Progreso
Camilo Jimenez Vera	57	Male	None	Tenosique	Nuevo Progreso
Isidro Pérez Torres	60	Male	None	Tenosique	Nuevo Progreso
Mario Cruz Madrigal	52	Male	None	Tenosique	Santo Tomas
Juan Lazaro Vásquez	32	Male	Primary	Tenosique	Santo Tomas
Jorge González González	65	Male	None	Tacotalpa	Zunu Patastal
Reynaldo López Martínez	59	Male	None	Tacotalpa	Zunu Patastal
Manuel Morales	54	Male	None	Tacotalpa	Zunu Patastal
Bartolo Díaz Díaz	63	Male	Primary	Tacotalpa	Villa Luz
Braulio Cruz Hernández	56	Male	Primary	Tacotalpa	Villa Luz
Domingo Álvarez López	67	Male	None	Tacotalpa	Villa Luz

Primary = elementary or primary education

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