Environ Dev Sustain (2009) 11:1005–1029
DOI 10.1007/s10668-008-9164-1

Rural fences in agricultural landscapes and their conservation role in an area of *caatinga* (dryland vegetation) in Northeast Brazil

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Received: 5 February 2008 / Accepted: 14 July 2008 / Published online: 1 August 2008

Abstract Fences are very common in rural areas, and represent important landscape elements in both tropical and temperate climate regions. In spite of their marked presence and importance, fences have been little studied, principally in Brazil. The present study examined the types of fences, the diversity of species used in their construction, as well as the diversity of their uses in a rural community in the municipality of Caruaru, Pernambuco State, northeastern Brazil. Fifty meters of fence-line in each of 50 rural properties in the community were examined, noting the diameter, height and identity of all vegetation elements used in their composition. Semi-structured interviews were also held with their builders in order to obtain information concerning fence uses. In the total of 2,500 linear meters of fence-line, 4,953 individual plant elements were identified, belonging to 51 different species. A majority of the fence elements were non-living fence posts, although the number of living posts was high. Of the total number of fence elements, 66.7% were native to the *caatinga* region. The large number of native species used as non-living fence posts indicates an intensive use of the *caatinga* vegetation and suggests the need to stimulate the use of living fence posts for conservation purposes.

Keywords Ethnobotany · Wood resources · Agroforest systems · Seasonal tropical forests · Rural communities

1 Introduction

Fences are very common structures in rural tropical landscapes due their widespread use in controlling domestic animal movements, protecting cultivated areas, and defining the

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borders of private properties (Budowski and Russo 1993). In an attempt to diminish costs and labor related to fence construction and the maintenance of decaying posts, farmers have been incorporating live trees and shrubs into their fence-lines, and the use of these living-fences has been gradually expanding in rural landscapes as a result of their low cost and durability (Ayuk 1997). In regions where deforestation and conversion to pasture and farm land has essentially removed all tree cover from the landscape, living fence-lines often represent the only local tree cover (Harvey et al. 2005).

Fences are omnipresent objects in the landscape of rural NE Brazil, an area of 8,000,000 km^2 dominated by dryland *caatinga* vegetation (Bucher 1982). The semi-arid climate there is marked by high temperatures, intense solar radiation, and rainfall that is poorly distributed throughout the year (Reis 1976; Reis et al. 2006), factors that also contribute to human poverty. Fences take on an important role in this region in protecting small agricultural plots and water tanks from free roaming livestock.

Many different materials are used for constructing fences in northeastern Brazil, and most of them are derived from natural products, such as straw, agricultural by-products, wooden poles and leather, which minimize construction costs. In the past, many stone walls were built (a custom probably introduced by the Portuguese settlers) but these durable and artistic fences are gradually disappearing from the regional landscape (Barros 1985).

With the advent of regional development and the official stimulation of the National Department of Roads and Highways (DNER), barbed wire and fenceposts harvested from the local vegetation has come to dominate fence construction in the interior regions of NE Brazil (Barros 1985). The use of native woods as fenceposts has resulted in the removal of more than 15 million posts from the *caatinga* region; and *Mimosa caesalpiniifolia* Benth. (common name *sabiá*) has been one of the principal species harvested, due to its highly resistant wood (Figueirôa et al. 2005). Although the quantity of trees harvested for fence posts does not approach the amounts removed for fuelwood, charcoal and timber that represent the principal uses of forest products in NE Brazil (Sampaio 2002; Figueirôa et al. 2006; Ramos et al. 2008a, b; Sá e Silva et al. 2008).

Living fences are increasing being used to protect small landholdings, and they are often planted right next to the old fences with the intention of eventually substituting them, with two species much used: *Euphorbia tirucalli* L. (common name *avelós*) and *Commiphora leptophloeos* (Mart.) J. B. Gillett (common name *imburana de cambão*) (Barros 1985; Figueirôa et al. 2005).

In spite of the marked presence of fences in the landscape of northeastern Brazil, they have not yet been subjected to any significant scientific investigations. The present study represents the first systematic ethnobotanical examination of this subject and investigates the strategies employed in the use of fences within the *caatinga* region, the species used in their construction, the volume of wood used, and the species most harvested.

2 Materials and methods

2.1 Study area

Investigations were carried out in the community of Riachão de Malhada de Pedra (8°14′18″ S, 35°55′20″ W) at 530 m amsl. This community is situated within the municipality of Caruaru (Fig. 1), in the *agreste* (dry forest) region of Pernambuco State, NE Brazil. Caruaru is located 132 km inland from the coast and the state capital of Recife, and

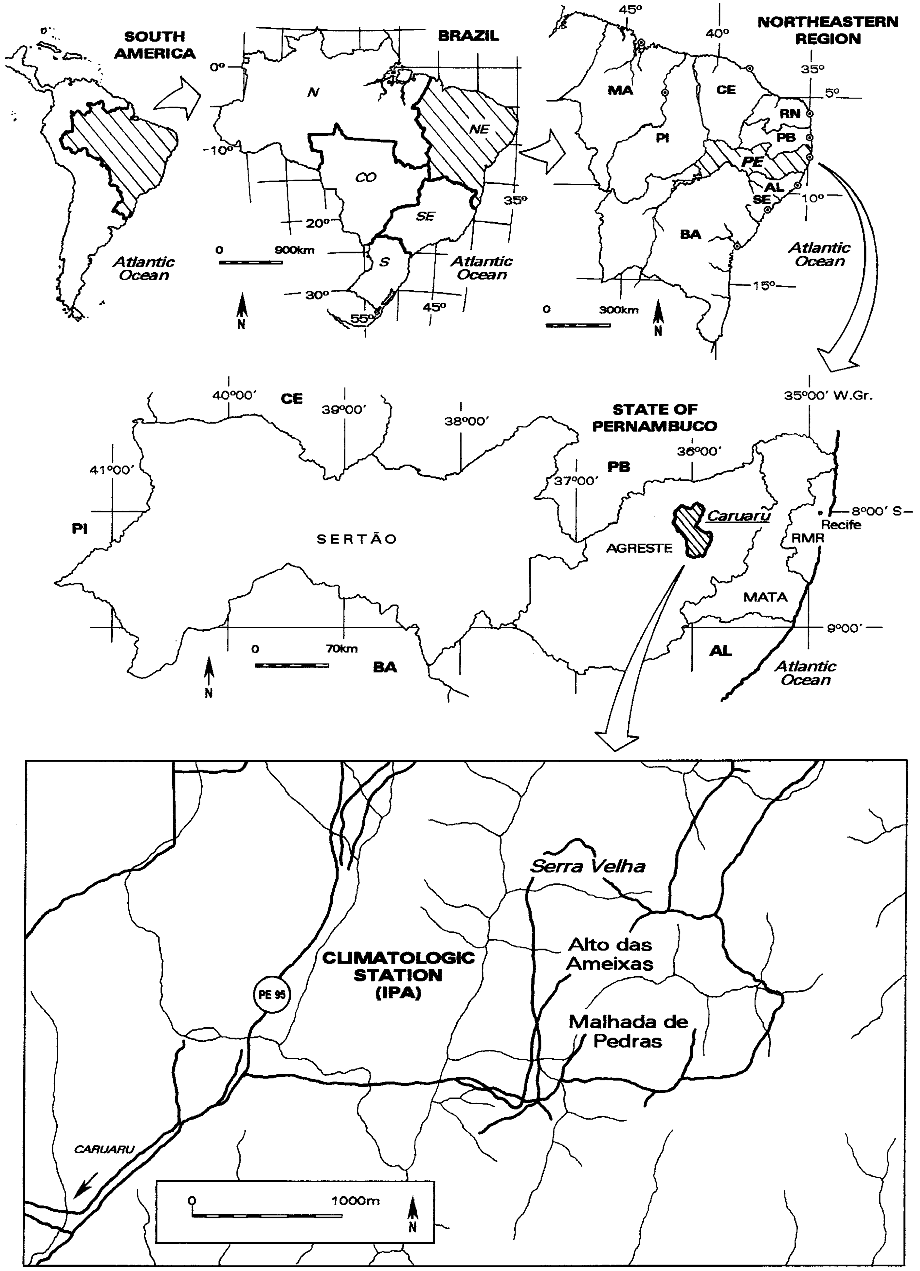

Fig. 1 Localization of the study area in the municipality of Caruaru, Pernambuco State, northeastern Brazil (*Source*: Monteiro et al. 2006)

has a hot semi-arid climate with an average annual temperature of 24°C and an average annual rainfall of 609 mm. The municipality had a population of 253,634 in the year 2000, with 36,227 inhabitants in rural areas (IBGE 2000).

Riachão de Malhada de Pedra belongs to the District of Gonçalves Ferreira, in the rural zone of the municipality, and is located about 9 km from the municipal center. In 2004 this community had 117 residences and 438 inhabitants. Their principal economic activities were subsistence agriculture and small-scale cattle farming (Lucena et al. 2007, 2008). The community is located near a ~20 hectare fragment of hipoxerophytic *caatinga* vegetation that belongs to the Empresa Pernambucana de Pesquisa Agropecuária (IPA) experimental station (530 m amsl) and represents the only area of primary vegetation in the region. The region also has some areas of secondary vegetation established on abandoned fields. Much of the land in the community has been occupied by residences and small commercial buildings, but there are also open areas used for agricultural or raising cattle. Agriculture is largely limited to planting of corn, beans, manioc, and vegetables, while animal husbandry is poorly developed due to the limited economic resources of the inhabitants. For most of the year the semi-arid climate lends a poor and dry aspect to the landscape, but in the rainy season the vegetation is quite exuberant and landscape depressions fill with water.

The primary native vegetation in the study area is shrub-arboreal, and the plants are generally deciduous, thorny, and have small leaves and other xerophytic characteristics. Succulent plants are also common in the region, especially representatives of the families Cactaceae and Bromeliaceae. Xerophytic adaptations are essential to plant survival in an area where the dry season predominates for most of the year and the rainy season is concentrated into only a few months (Araújo et al. 2007). The study area, however, is not in one of the most arid regions as it is located in the *agreste* meso-region where annual rainfall can reach 1,000 mm due to residual humidity present in the southeast winds (Rizzini 1997; Prado 2003).

Even though the rainy season in the study area is slightly longer, the vegetation there is very similar to the driest neighboring caatinga zones and they share the principal plant families: Fabaceae, Euphorbiaceae, Cactaceae, and Capparaceae (Alcoforado-Filho et al. 2003), and some of the species found there are considered common in the *caatinga* vegetation, such as *Schinopsis brasiliensis* Engler., *Caesalpinia pyramidalis* Tul., *Anadenanthera colubrina* (Vell.) Brenan., *Myracroduon urundeuva* Allemão, *Bauhinia cheilanta* (Bong.) Steud., *Croton blanchetianus* Baill., and *Maprounea guianensis* Aubl. (Araújo et al. 1995; Ferraz et al. 1998; Alcoforado-Filho et al. 2003).

2.2 Data collection

2.2.1 Inventories of the fences

Floristic data was gathered from properties that had more than 50 m of fence-line. This fence length was chosen as it allowed the inclusion of a reasonably large number of fences among a universe of fence-lines with highly variable extensions. A longer cut-off length would have excluded a large portion of the samples from the analyses for of the 117 properties in the community, only 50 had fences extending 50 m or more. The 50 m extension of each of these fence lines was then surveyed to determine the species composition of the fence elements. To establish the volume of wood incorporated into the fences, the height and diameter (≥3 cm at soil level) of all elements were measured (dead and living posts, and trees). The 3 cm minimum diameter used is a convention for most *caatinga* vegetation surveys (Rodal et al. 1992; Sampaio 1996; Araújo and Ferraz 2004).

The fence elements were classified into the following categories: (1) dead posts composed of wood native to the *caatinga* vegetation; (2) resprouting posts composed of wood native to the *caatinga* vegetation; (3) posts composed of material not derived from the native *caatinga* vegetation (including material derived from constructions); (4) mature plants that were present before the fence was erected. The sampling only considered fences composed of plant materials, and so excluded materials such as stones and concrete posts. Additionally, if the person directly responsible for their construction and/or maintenance could not be identified or located, those fences were not included in this survey.

The annotation of the vernacular names of the fence elements and the collection of fertile botanical material were performed simultaneously with the floristic analysis. These steps were undertaken as part of the *guided-tour* technique in which field excursions were made along the fence-lines themselves, in the forest fragment near the community and in the garden plots, roads and cultivation areas while in the company of the person directly responsible for the fences (Albuquerque and Lucena 2004a, b). Plant materials collected were prepared as herbarium specimens (Ming 1996) and identified using the specialized literature and by comparison with specimens stored at the Vasconcelos Sobrinho Herbarium (PEUFR) at the Federal Rural University of Pernambuco. The botanical families were organized according to APG II (2003). After identification, the material was incorporated into the PEUFR herbarium, and duplicates sent to the Professor Geraldo Mariz Herbarium (UFP) at the Federal University of Pernambuco.

2.2.2 Local knowledge concerning the fences

Local knowledge about fences was investigated through the application of 38 semi-structured interviews (Albuquerque and Lucena 2004a, b) with the residents directly responsible for the construction and/or maintenance of 50 fences present in the community. These interviewees varied in age form 19 to 78 years, and included 34 men and four women. Interviews were undertaken with the authorization by the residents themselves after being fully informed about the objectives of the work. The presence of other people was generally avoided during the interviews in order not to influence the responses offered by the informants.

The questions posed during the interviews included personal information such as full name, nick-name, age, sex, occupation, time spent living in the community, as well as questions about fences, such as: which are the best plants to use in constructing fences, and why? Where can those plants be acquired? How long does a post last before needing to be replaced? How does one start making a fence? What maintenance does a fence require after its construction? What type of fence is most preferred, and why? Are any products harvested from the fence-line? What are fences used for? What are the advantages and disadvantages of living fences? What are the advantages and disadvantages of using non-living fence posts? Who taught you how to make fences? Are the materials currently used to make fences the same as those used in the past? What other materials were used in the past, and why did people stop using them? What type of fence lasts the longest? What is the best time of year to construct a living fence?

The responses given by all the informants were pooled and ranked, and the plants with the largest number of citations were considered those most preferred by the community. Those species that received few citations were considered non-preferred.

2.3 Volume of the wood used for constructing fences

The quantity of wood used in fence constructions in the community examined was calculated for each of the species by using the following formulae (Sternadt 2001; Araújo and Ferraz 2004):

1. $D = c/\pi$
2. $A = (\pi/4) \times D^2$
3. $V = A \times L$

Where D = diameter of the post; c = circumference of the post; A = basal area; V = volume of the wood; L = length of the post; $\pi = 3.14$.

The capacity of the local vegetation to sustain fence post harvesting was evaluated by comparing the volume of each species encountered in the fencelines with their volumes in the forest fragment near the community. The composition of the forest fragment had previously been determined by means of floristic and phytosociological surveys undertaken in 2003–2006 (Lucena et al. 2007, 2008; Oliveira et al. 2007).

2.4 Data analysis

Data was analyzed employing five quantitative techniques: frequency (which measures the frequency with which each of the species occurs in the fence lines); diversity index (which evaluates the contribution of each individual species within the total diversity of the fences); equitability index (which measures how the different species contribute to total use, independent of the number of species used); consensus use value (which measures the degree of agreement among the interviewees in relation to a given species being useful or not as a fence element); importance value index (which measures the proportion of the interviewees that cited a given species as important; this index was only calculated for preferred species) (Table 1) (Byg and Balslev 2001; Silva and Albuquerque 2004). Differences between the volume of native species and the volume of exotic species used in the fences were evaluated using the Kruskal–Wallis test (Zar 1996).

3 Results

3.1 Species richness, diversity, and types of fences

A total of 4,953 elements were found within the 50 fence-lines analyzed, including 2,877 dead and 2,076 live posts. The number of elements in each of the 50 m lengths of fences varied from 13 to 350, with an average of 57.54 dead posts and 41.52 live trees per fence. The fence elements encountered belonged to 51 plant species distributed among 46 genera and 26 families. Almost all of the genera were represented by only a single species, indicating great taxonomic diversity. Six plants could only be identified to the genus level, and two others only to the family level. Fifteen species could not be identified due to the absence of any fertile material, although the popular names of some allowed their tentative classification, as in the case of the “catolé” palm tree (*Syagrus oleracea* (Mart.) Becc., “agave” (*Agave* sp.), “tambor” (*Enterolobium contortisiliquum* (Vell.) Morong, and the fruit tree “umbu-cajá” (*Spondias* sp.); other species had been bought commercially and were not from the survey region, as was the case of the plants known as “canduru” and “sucupira” (Table 2).

Of the total number of species identified, 66.67% were native to the *caatinga* region, while 33.33% were exotic plants. The families with the greatest species richness were Euphorbiaceae and Fabaceae, with 12 and 16 species, followed by Anacardiaceae, with six species. The genera with the greatest number of species were *Croton*, *Jatropha*, *Acacia*, and *Mimosa*, with three species each. The number of native species per fence varied from 0 to 15, while the number of exotic species varied from 0 to 6. The numbers of native

Table 1 Measures of use and knowledge as calculated for the species utilized in fence construction in Riachão de Malhada de Pedra a rural community in the municipality of Caruaru, Pernambuco State, northeastern Brazil

Indices	Formulas	Description
Frequency	**Fsp** = Total number of residences in which species X is used / total number of fence maintainers (or residences) × 100	Measures the frequency with which each of the species is encountered in the fences.
Diversity Index	$\mathbf{SD_{tot} = 1/\Sigma P_s^2}$ Where P = n° of times that a species appears / n° of times that all species appear	Evaluates the contribution of each species to the total diversity seen in the fences.
Equitability Index	$\mathbf{SE_{tot} = SD_{tot}/n}$ Where n = number of species studied	Measures how different species contribute to total use, independent of the number of species used.
Use consensus Value	$\mathbf{UC_s = 2\ n_s / n{-}1}$ where, n_s = the number of people that use a given species, and n = total number of informants (or residents)	Measures the degree of agreement among informants concerning whether a given species is useful or not.
Importance Value Index	$\mathbf{IV_s = n_{is}/n}$ Where n_{is} = number of informants that consider a given species as more important and n = total number of informants (or residences).	Measures the proportion of informants that cite a given species as more important.

Adapted from Byg and Balslev (2001) and Silva and Albuquerque (2004)

species were greater than the numbers of exotic species in all of the fences analyzed. On the average, there were 8.2 native species and 1.4 exotic species per 50 m length of fenceline. One hundred and seventy one individual fence elements could not be identified even by their vernacular name. These elements were composed of re-cycled construction material or materials said to have come from other regions identified only as "Pará State" or "down south".

The most abundant species was *Jatropha mollissima*, with 1,548 elements encountered, followed by *Anadenanthera colubrina*, represented by 489 elements, and *Commiphora leptophloeos*, with 410 elements (Fig. 2). The most frequently encountered species was *A. colubrina*, with 92% (Table 2). The total species diversity was 1.002, and the total equitability of the species was 0.013, which indicated that the species were not distributed uniformly among all the fences.

The 4,953 fence elements encountered were classified into four categories of posts. Category 1 (dead posts native to the *caatinga* region) had the highest number of elements (2,537), distributed among 48 species, while category 2 (live posts native to the *caatinga*) had 2,018 elements, distributed among 18 species (Fig. 3). Categories 3 and 4 (posts made of materials not originated from the *caatinga* region and adult plants) demonstrated reduced numbers of elements. Category 3 comprised 287 elements belonging to 27 species, while category 4 comprised 23 elements belonging to 12 different species. A total of 88 fence elements could not be placed into any of the categories as they could not be identified by the interviewees - usually dead posts quite degraded by weathering and/or termites.

Three basic fence types were identified in the field: dead fences (composed only of non-living posts); living fences (composed predominantly of living elements); and composite fences (composed of both dead and living elements in reasonably similar numbers) (Fig. 4). Living or mixed fences were mostly found along roadsides, as their dense nature

Table 2 Numbers of fence elements and their frequencies for each species employed in fence construction in the Riachão de Malhada de Pedra rural community in the municipality of Caruaru, Pernambuco State, northeastern Brazil

Botanical family species	Vernacular name	NE	FR(%)	Ucs
Anacardiaceae				
Anacardium occidentale L.	Cajueiro	4	8	0.163
Mangifera indica L.	Mangueira	2	2	0.041
Myracroduon urundeuva Allemão	Aroeira	85	44	0.898
Schinopsis brasiliensis Engl.	Braúna	108	50	1.020
Spondias mombin L.	Cajá	58	36	0.735
Spondias purpurea L.	Siriguela	2	4	0.082
Annonaceae				
Annona muricata L.	Graviola	3	2	0.041
Annona squamosa L.	Pinha	1	2	0.041
Apocynaceae				
Aspidosperma pyrifolium Mart.	Pereiro	19	6	0.122
Nerium oleander L.	Espirradeira	1	2	0.041
Arecaceae				
Cocos nucifera L.	Coco	9	10	0.204
Bignoniaceae				
Tabebuia sp.	Pau d'arco	4	8	0.163
Boraginaceae				
Cordia alliodora (Ruiz & Pav.) Cham.	Fré-jorge	49	18	0.367
Cordia globosa (Jacq.) Kunth.	Maria preta	2	2	0.041
Brassicaceae				
Crateva tapia L.	Trapiá	6	12	0.245
Burseraceae				
Commiphora leptophloeos (Mart.) J. B. Gillett.	Imburana	410	66	1.347
Cactaceae				
Pilosocereus pachycladus subsp. *pernambucoensis* (F. Ritter) Zappi	Facheiro	2	4	0.082
Caricaceae				
Carica papaya L.	Mamão	2	4	0.082
Clusiaceae				
Clusia sp.	Gameleira	1	2	0.041
Euphorbiaceae				
Croton argyroglossus Baill.	Sacatinga	2	2	0.041
Croton blanchetianus Baill.	Marmeleiro	174	34	0.694
Croton rhamnifolius Willd.	Velame	3	2	0.041
Euphorbia cotinifolia L.	Crote-roxo	164	22	0.449
Euphorbia tirucalli L.	Avelós	8	2	0.041
Jatropha curcas L.	Pinhão manso	2	4	0.082
Jatropha gossypiifolia L.	Pinhão roxo	2	4	0.082
Jatropha mollissima (Pohl) Baill.	Pinhão	1548	80	1.633
Manihot dichotoma Ule	Maniçoba	10	10	0.204
Sapium sp.	Laço	1	2	0.041

Table 2 continued

Botanical family species	Vernacular name	NE	FR(%)	Ucs
Sapium lanceolatum (Müll. Arg.) Huber	Burra-leiteira	271	62	1.265
Sebastiania jacobinensis (Müll. Arg.) Müll. Arg.	Leiteiro	2	2	0.041
Fabaceae				
Acacia farnesiana (L.) Willd.	Jurema branca	31	14	0.286
Acacia paniculata Willd.	Unha de gato	53	2	0.041
Acacia piauhiensis Benth.	Calombi branco	103	26	0.531
Albizia polycephala (Benth.) Killip**.**	Comodongo	20	6	0.122
Anadenanthera colubrina (Vell.) Brenan.	Angico	489	92	1.877
Bauhinia cheilantha (Bong.) Steud.	Mororó	143	38	0.775
Caesalpinia pyramidalis Tul.	Catingueira	175	46	0.939
Erythrina velutina Willd.	Mulungu	9	12	0.245
Machaerium hirtum (Vell.)	Capa garrote	72	30	0.612
Mimosa caesalpiniifolia Benth.	Sabiá	52	18	0.367
Mimosa sp.	Coração de nego	5	2	0.041
Mimosa tenuiflora (Willd.) Poir.	Jurema preta	215	42	0.857
Parapiptadenia sp.	Miguel Corrêa	2	4	0.082
Piptadenia stipulacea (Benth.) Ducke	Calombi preto	37	26	0.531
Prosopis juliflora (Sw.) DC.	Algaroba	124	38	0.775
Senna martiana (Benth.) H.S. Irwin & Barneby	Canafista	4	8	0.163
Geraniaceae				
Geranium sp.	Pinhãozinho de flor	1	2	0.041
Malpighiaceae				
Malpighia glabra L.	Acerola	3	6	0.122
Malvaceae				
Hibiscus rosa-sinensis L.	Papoula	31	4	0.082
Meliaceae				
Cedrela odorata L.	Cedro	4	8	0.163
Myrtaceae				
Eucalyptus sp.	Eucalipto	4	8	0.163
Eugenia uvalha Cambess	Ubaia	7	4	0.082
Nyctaginaceae				
Guapira laxa (Netto) Furlan	Piranha	28	14	0.286
Rhamnaceae				
Ziziphus joazeiro Mart.	Juá	14	8	0.163
Rubiaceae				
Rubiaceae 1	Quina quina	3	4	0.082
Sapindaceae				
Talisia esculenta (A. St.-Hil.) Radlk.	Pitomba	13	10	0.204
Solanaceae				
Capsicum parvifolium Sendtn.	Pimentinha	1	2	0.041
Nicotiana glauca Graham	Apara raio	13	4	0.082
Solanum americanum Mill.	Pimenta de sabiá	1	2	0.041
Verbenaceae				

Table 2 continued

Botanical family species	Vernacular name	NE	FR(%)	Ucs
Lippia sp. 1	Camarazinha	1	2	0.041
Lippia sp. 2	Alecrim	24	6	0.122
Others				
Not identified 1	Agave	59	12	0.245
Not identified 2	Cabraíba	5	4	0.082
Not identified 3	Canduru	1	2	0.041
Not identified 4	Chorão	8	8	0.163
Not identified 5	Coco catolé	21	8	0.163
Not identified 6	Goiabinha	1	2	0.041
Not identified 7	Gravatá	2	2	0.041
Not identified 8	Imbiriba	2	4	0.041
Not identified 9	Maria mole	5	2	0.041
Not identified 10	Oiti	17	2	0.041
Not identified 11	Rabo de cavalo	1	2	0.041
Not identified 12	Rama branca	12	14	0.286
Not identified 13	Sucupira	3	2	0.041
Not identified 14	Tambor	2	2	0.041
Not identified 15	Umbu-cajá	2	2	0.041

NE = total number of fence elements, FR = frequency of occurrence of these elements in the fences, Ucs = Use-consensus value

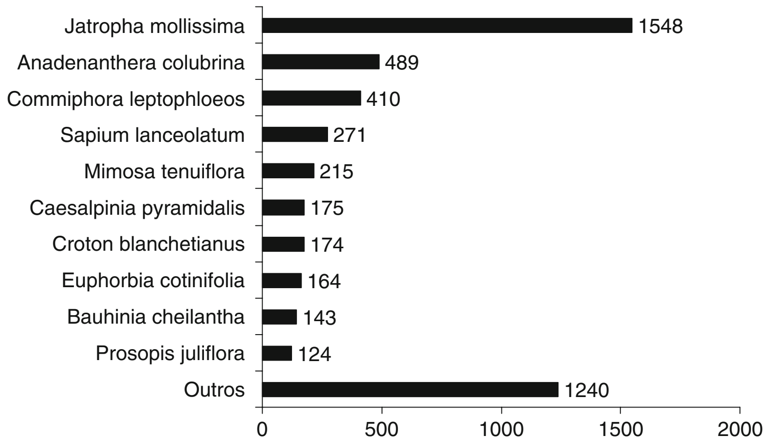

Fig. 2 Numbers of elements of the most abundant species employed in fence construction in the Riachão de Malhada de Pedra rural community in the municipality of Caruaru, Pernambuco State, northeastern Brazil

offered more protection against animals and/or unauthorized visitors. Non-living fences, on the other hand, were more commonly used to delimit pasture lands and corrals, where, according to the informants who maintained the fences, the use of non-living materials reduced contact between the cattle and plant species that produce toxic latex, such as *J. mollissima, Euphorbia cotinifolia*, and *Euphorbia tirucalli*. These plants were reputed to

Fig. 3 Numbers of fence elements registered in each category in the Riachão de Malhada de Pedra rural community in the municipality of Caruaru, Pernambuco State, northeastern Brazil. Category 1 = fence posts derived from native *caatinga* plants; Category 2 = fence posts derived from resprouted native *caatinga* plants; Category 3 = fence posts derived from material not original to the *caatinga* region; Category 4 = adult plants that were already in place when the fences were constructed

be capable of killing an animal if eaten. Non-living fences were also frequently used to define and protect areas planted with crops, as they produce no shade.

3.2 Measures of the knowledge of the individuals that maintain fences and the use-patterns of these fences

A majority of the individuals responsible for the maintenance of the fences (76.31%) indicated their preference for living fences as these present a number of advantages - including high capacities for resprouting and self-repair and because they provide shade for their animals. Only a few interviewees cited disadvantages to the use of living fences, noting only that *C. leptophloeos* was difficult to manage due to the abundance of thorns (5.26%), and that *J. mollissima* might stain their clothes with its latex and shade their crops (2.63%).

Only a few advantages of using non-living fences were cited, such as the ease of stringing the barbed wire during construction (7.89%) and esthetic considerations (2.63%), as some interviewees thought these fences were better looking. A majority of the interviewees, however, pointed out the disadvantages of non-living fences, among them the biodegradable nature of the posts (52.63%) that limits their useful life, and the related fact that they need to be replaced periodically (31.58%) over time scales that vary according to the species in question.

A majority of the fences in the community (28) were mixed fences, formed by non-living elements alternating with live posts. Fences were only rarely composed solely of dead posts (4) and no fence was composed solely of living elements, although some (3) had very high numbers of living elements (which contributed to the large over-all number of living posts recorded in the survey) (Fig. 5). The mixture of live and dead elements in most fences is due to the fact that dead posts are used to string the barbed wire during the construction of the fences, while the live posts are later interpolated for additional support.

The species most indicated by the interviewees as useful in constructing fences were *Sapium lanceolatum* and *J. mollissima,* with 24 citations each, followed by *C. leptophloeos* and *A. colubrina,* with 22 and 20 citations, respectively; these species were therefore

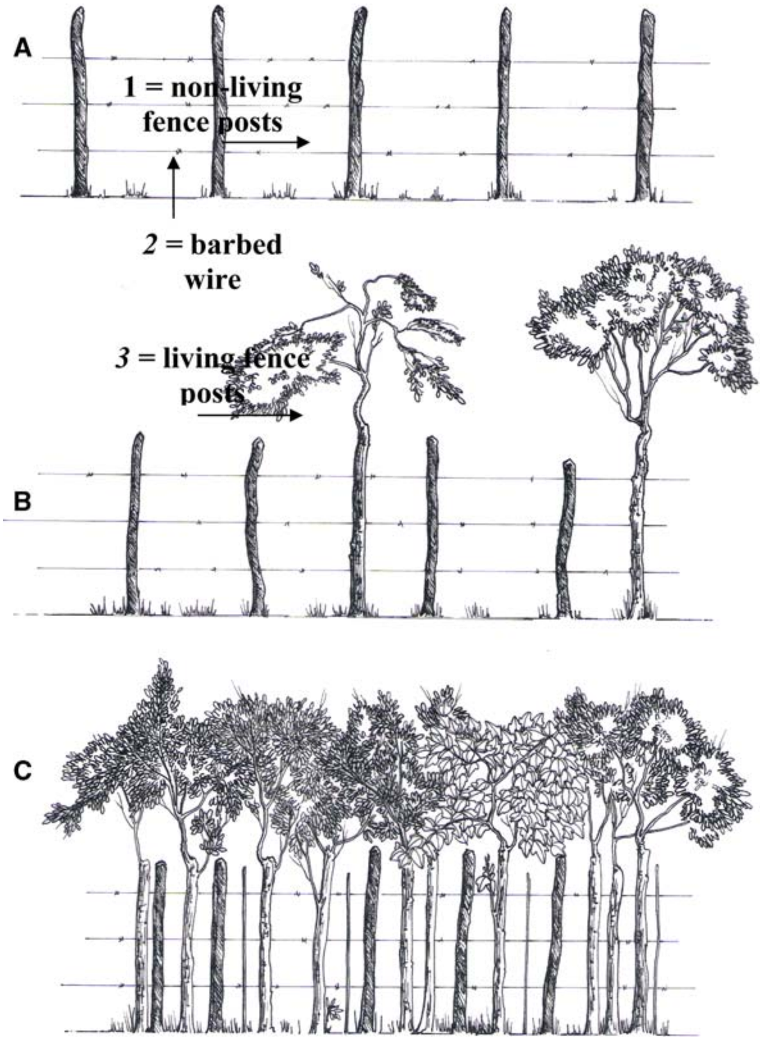

Fig. 4 Types of fences encountered in the Riachão de Malhada de Pedra rural community in the municipality of Caruaru, Pernambuco State, northeastern Brazil. A = non-living fences (formed only by non-living posts), B = mixed element fences (formed by similar number of living and non-living posts), C = living fences (formed by an elevated number of living elements in relation to dead posts). 1 = Dead post. 2 = Barbed wire. 3 = living post

considered the "preferred species" (Table 3). This information was confirmed by data from the use-value consensus, with these same species demonstrating the highest values. It is important to note that the majority of the species preferred for fence construction are native *caatinga* species, even though some of them are no longer found in the forest fragment adjacent to the community (Table 3).

When questioned about the places of origin of the posts, 26.31% of the interviewees replied that they had been purchased, although a majority (42.10%) indicated that the material had been harvested from the forest fragment adjacent to the community (even though this practice is officially prohibited by the agency responsible for that wooded

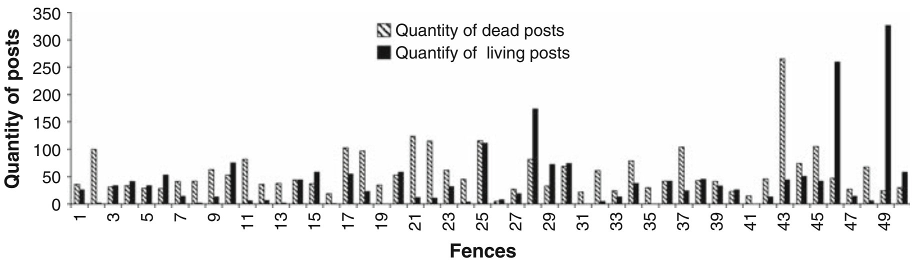

Fig. 5 Numbers of living and non-living fence elements encountered in 50 fencelines examined in the Riachão de Malhada de Pedra rural community in the municipality of Caruaru, Pernambuco State, northeastern Brazil

Table 3 Plants species preferred for constructing fences (as indicated by the people who maintain them) in the Riachão de Malhada de Pedra rural community in the municipality of Caruaru, Pernambuco State, northeastern Brazil

Preference order	Species	Citations	Iv	UC	Presence in fragment near the community
1	*Sapium lanceolatum* (Müll. Arg.) Huber.	24	0.48	1.30	Yes
1	*Jatropha mollissima* (Pohl) Baill.	24	0.48	1.30	Yes
2	*Commiphora leptophloeos* (Mart.) J. B. Gillet	22	0.44	1.20	Yes
3	*Anadenanthera colubrina* (Vell.) Brenan	20	0.40	1.08	Yes
4	*Spondias mombin* L.	13	0.26	0.70	Not/exotic
5	*Mimosa tenuiflora* (Willd.) Poir.	12	0.24	0.65	Not/native
6	*Caesalpinia pyramidalis* Tul.	11	0.22	0.59	Yes
7	*Schinopsis brasiliensis* Engl.	10	0.20	0.54	Yes
8	*Erythrina velutina* Willd.	10	0.20	0.54	Not/native
9	*Mimosa caesalpiniifolia* Benth.	8	0.16	0.43	Not/native
10	*Myracroduon urundeuva* Allemão	7	0.14	0.38	Yes

IV = Importance Value, UC = Use Consensus Value

area). Some of the interviewees cited other harvesting locations, such as their own property (23.68%), cuttings from mature plants from the fence itself (5.26%), or other areas near the community (10.52%).

In terms of the initial construction of the fence-line, 52.63% of the interviewees stated that their fences were initiated by the placement of dead but resistant posts in order to first stretch the barbed wire and secure it with wire staples. After the wire was in place, living posts were interpolated among the dead elements in order to guarantee support for the fence. A majority of the informants (86.84%) stated that the living posts should only be installed during the dry season, for they will rot rather than resprout if planted during any other time of the year.

In terms of caring for the fences, 34.21% of the interviewees cited the importance of trimming the live elements periodically, 28.95% indicated only the need for occasionally substituting the posts and wire, 10.53% said that they cleaned the fencelines, while the rest of the informants indicated that they did not actively perform any maintenance on the fences (26.31%).

A majority of the interviewees (84.21%) indicated that the materials that they used to erect fences were essentially the same as those that had been employed by their parents and ancestors. Only 15.79% of the informants noted that earlier generations had used materials that are not employed at the present time, such as "avelós" (*E. tirucalli*) and stone. The former lost favor because of its severe toxicity, while the latter represents a much more labor intensive technique.

3.3 Fences: functions and harvested products

The people responsible for maintaining fences attributed different functions to these structures, the most of these important being: protecting their animals and their crops (78.95%), protecting their lands from free roaming cattle or from the non-authorized entrance by other people (39.48%), and establishing property lines (13.16%) (Fig. 6).

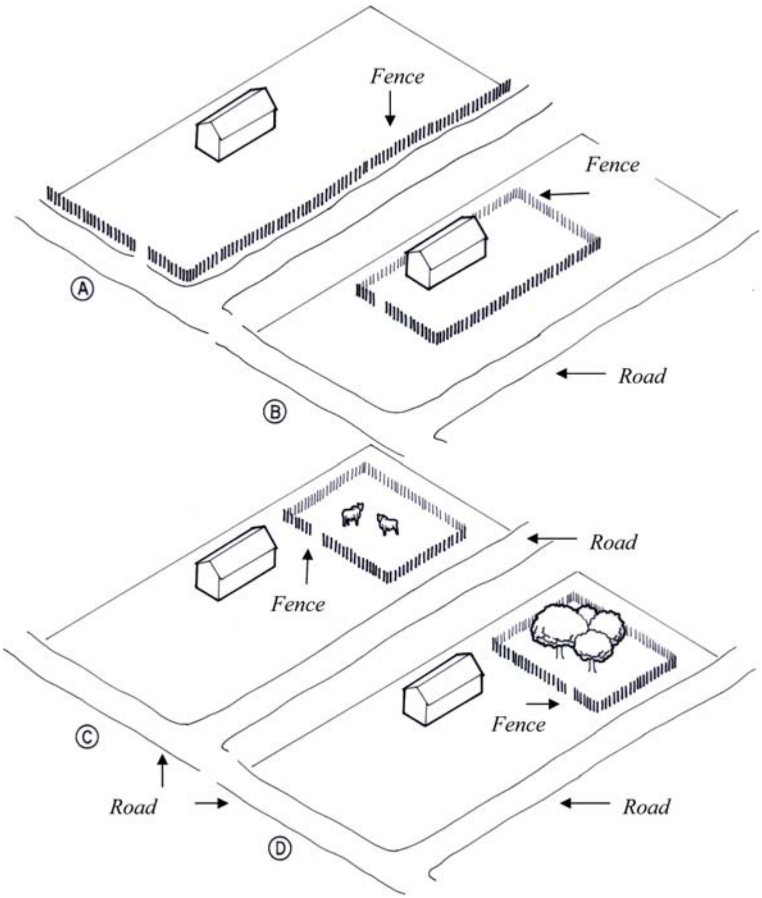

Fig. 6 Disposition of the fences in the Riachão de Malhada de Pedra rural community in the municipality of Caruaru, Pernambuco State, northeastern Brazil. A = fences surrounding entire rural properties, B = fences surrounding only residences, C = fences protecting animals, D = fences protecting planted areas

According to the interviewees, a number of products can be obtained from live fence elements, such as folk medicines, edible fruits, food for birds, forage for cattle, and wood for construction uses and for fuel (fire wood and charcoal). The products most frequently cited as being harvested from fencelines include posts for constructing new fences (31.58% of the interviewees) and fuelwood (23.60% of the interviewees). The latter material can be harvested from live elements of the fence or as old dead posts that are no longer truly functional components of that structure.

The species most cited as a medicinal plant was *J. mollissima*. The latex of this plant is used to heal wounds and is said to be prescribed to treat skin ailments; no information was available in the pharmacological literature to confirm this information, however. One of the interviewees noted that living species in the fence lines also fulfilled ecological functions by providing food for bird species.

3.4 The volume of wood utilized in constructing fences

The 2,537 dead posts encountered in the fences surveyed represented a total volume of 28.37 m^3 of wood; and of this total, 21.43 m^3 represented native *caatinga* species, while 4.44 m^3 was derived from exotic species (the balance represents wood from unidentified species). *A. colubrina* presented the largest volume of wood from dead fence posts (7.35 m^3), as well as the greatest number of dead elements (Table 4). *S. mombin* furnished the second largest volume of wood (1.92 m^3), followed by *Prosopis julifora* and *Schinopsis brasiliensis* (Table 4). Among the species identified, *S. mombin* demonstrated the highest average volume per post, followed by *Mangifera indica* and *Cocos nucifera*, with 0.071, 0.047 and 0.044 m^3, respectively (all of these being exotic species). The native *caatinga* species with the highest average volumes per post were *Manihot dichotoma*, *Senna martiana* and *Sebastiana jacobinensis*, the first two with 0.021 m^3 per post, and the latter with 0.016 m^3 (Table 4). In general, the native plants had a greater average volume per post (0.34 m^3) than the exotic plants (0.14 m^3), this difference being significant by the Kuskal–Wallis test at a 5% probability level.

In terms of living fence elements, the total of 2,101 elements had a total volume of 30.15 m^3 of wood, of which 19.61 m^3 represented native *caatinga* plants. *J. mollissima* was the native species with the greatest total volume of wood in the live fences, with 8.35 m^3 (Table 4), followed by *S. mombin* and *C. leptophloeos*, with 6.46 and 6.18 m^3, respectively. As was also seen with dead fence elements, *S. mombin* was among the exotic species with the largest average wood volume per post (0.19 m^3) in the live fences, together with *A. squamosa* and *Talisia esculenta*, with 0.21 and 0.19 m^3, respectively. *C. pyramidalis* and *Mimosa tenuiflora* were among the native plants with the largest average wood volume per post (Table 4).

4 Discussion

4.1 Richness, diversity, and fence types

Fences in the Riachão de Malhada de Pedra community demonstrated similar floristic richness (34 native species) when compared to the numbers of arboreal species (39 species) recorded in the *caatinga* forest fragment adjacent to that settlement in surveys undertaken by Alcoforado-Filho et al. (2003). However, only 16 species used in fences were observed in the forest fragment during this survey. The presence of the same native species in both

Table 4 Total volume of extracted wood (m^3) and the quantity of dead posts and live posts used in fence construction in the municipality of Caruaru, Pernambuco State, northeastern Brazil

Species	Vernacular name	Quantity of dead posts	Total volume dead posts (m^3)	Quantity of live posts	Total volume live posts (m^3)
Acacia farnesiana (L.) Willd.	Jurema branca	31	0.224	0	0
Acacia paniculata Willd.	Unha de gato	53	0.499	0	0
Acacia piauhienses Benth.	Calombi branco	104	0.373	0	0
Albizia polycephala (Benth.) Killip.	Comodongo	20	0.268	0	0
Anacardium occidentale L.	Caju	1	0.000001	3	0.2537
Anadenanthera colubrina (Vell.) Brenan	Angico	485	7.347	4	0.1414
Annona muricata L.	Graviola	3	0.025	0	0
Annona squamosa L.	Pinha	0	0	1	0.2109
Aspidosperma pyrifolium Mart.	Pereiro	19	0.176	0	0
Bauhinia cheilantha (Bong.) Steud.	Mororó	142	1.025	1	0.0025
Caesalpinia pyramidalis Tul.	Catingueira	174	1.480	1	0.4076
Capsicum parvifolium Sendtm.	Pimentinha	1	0.002	0	0
Cedrela odorata L.	Cedro	7	0.106	2	0.1870
Clusia sp.	Gameleira	1	0.015	0	0
Cocos nucifera L.	Coco	8	0.357	1	0.0001
Commiphora leptophloeos (Mart.) J. B. Gillet	Imburana	93	0.718	317	6.1863
Cordia alliodora (Ruiz & Pav.) Cham.	Fré-Jorge	47	0.585	2	0.1920
Cordia globosa (Jacq.) Kunth.	Maria preta	2	0.001	0	0
Crateva tapia L.	Trapiá	3	0.034	3	0.0007
Croton argyroglossus Baill.	Sacatinga	2	0.007	0	0
Croton blanchetianus Baill.	Marmeleiro	173	0.778	1	0.00003
Croton rhamnifolius Willd.	Velame	0	0	3	0.0113
Erythrina velutina Mart.	Mulungu	6	0.097	3	0.1389
Eucalyptus sp.	Eucalipto	4	0.063	0	0
Eugenia uvalha Cambess	Ubaia	7	0.107	0	0
Euphorbia cotinifolia L.	Crote roxo	14	0.090	148	0.6881
Euphorbia tirucalli L.	Avelós	4	0.024	4	0.5300
Geranium sp.	Pinhãozinho de flor	0	0	1	0.0001
Guapira laxa (Netto) Furlan	Piranha	28	0.167	0	0
Hibiscus rosa-sinensis L.	Papoula	11	0.081	20	0.6447
Jatropha curcas L.	Pinhão manso	1	0.0001	1	0.0027
Jatropha gossypiifolia L.	Pinhão roxo	1	0.001	0	0
Jatropha mollissima (Pohl) Baill.	Pinhão	251	0.980	1296	8,3518
Lippia sp. 1	Camarazinha	0	0	1	0.0362
Lippia sp. 2	Alecrim	24	0.240	0	0
Machaerium hirtum (Vell.)	Capa garrote	72	0.848	0	0
Malpighia glabra L.	Acerola	1	0.028	0	0

Table 4 continued

Species	Vernacular name	Quantity of dead posts	Total volume dead posts (m^3)	Quantity of live posts	Total volume live posts (m^3)
Mangifera indica L.	Mangueira	2	0.095	0	0
Manihot dichotoma Ule.	Maniçoba	1	0.022	9	0.1874
Mimosa caesalpiniifolia Benth.	Sabiá	52	0.456	0	0
*Mimos*a sp.	Coração de nego	5	0.026	0	0
Mimosa tenuiflora (Willd.) Poir.	Jurema preta	210	1.464	5	0.5987
Myracroduon urundeuva Allemão	Aroeira	83	0.869	2	0.1265
Nerium oleander L.	Espirradeira	0	0	1	0.0636
Nicotiana glauca Graham	Apara raio	4	0.064	4	0.0968
Tabebuia sp.	Pau darco	4	0.025	0	0
No identified 10	Oiti	8	0.072	9	0.6114
No identified 11	Rabo de cavalo	1	0.006	0	0
No identified 12	Rama branca	12	0.085	0	0
No identified 13	Sucupira	3	0.089	0	0
No identified 14	Tambor	2	0.020	0	0
No identified 15	Umbucajá	0	0	1	0.0193
No identified 2	Cabraíba	5	0.289	0	0
No identified 3	Canduru	1	0.017	0	0
No identified 4	Chorão	8	0.182	0	0
No identified 5	Coco catolé	20	0.602	1	0.0001
No identified 6	Goiabinha	1	0.002	0	0
No identified 8	Imbiriba	2	0.021	0	0
No identified 9	Maria mole	5	0.004	0	0
Parapiptadenia sp.	Miguel Corrêia	2	0.021	0	0
Piptadenia stipulacea (Benth.) Ducke	Calombi preto	33	0.265	3	0.0622
Prosopis julifora (Sw.) DC.	Algaroba	123	1.757	3	0.4566
Rubiaceae 1	Quina quina	3	0.027	0	
Sapium lanceolatum (Müll. Arg.) Huber.	Burra leiteira	69	0.444	202	2.7829
Sapium sp.	Laço	0	0	1	0.0022
Schinopsis brasiliensis Engl.	Braúna	107	1.706	1	0.0234
Sebastiania jacobinensis (Mull. Arg.) Mull. Arg	Leiteiro	2	0.032	0	0
Senna martiana (Benth.) H.S. Irwin & Barneby	Canafista	4	0.087	0	0
Solanum americanum Mill.	Pimenta de sabiá	1	0.016	0	0
Spondias mombim L.	Cajá	27	1.920	34	6.4609
Spondias purpurea L.	Siriguela	1	0.020	1	0.0036
Talisia esculenta (A. St.-Hil.) Radlk.	Pitomba	10	0.043	3	0.5837
Ziziphus joazeiro Mart.	Juá	12	0.193	2	0.0798

the fragment forest and the living fencelines suggests that these fences may serve as important reservoirs for propagules of these species, helping to guarantee the survival of populations of these plants in the region.

Of the 51 different plants encountered in the fence lines, only 14 species (*Acacia farnesiana*, *Anacardium occidentale*, *A. muricata*, *A. squamosa*, *Cedrela odorata*, *C. nucifera*, *Cordia alliodora, Crateva tapia*, *E. cotinifolia*, *Hibiscus rosa-sinensis*, *Jatropha curcas*, *M. indica*, *S. mombin,* and *S. purpurea*), 22 genera, and 20 families have been reported to be utilized in fence construction in other tropical regions in the world (Crane 1945; Budowsky and Russo 1993; Reyes and Rosado 1999; Levasseur et al. 2004; Harvey et al. 2003, 2005). This small species overlap is almost certainly due to the differences in floristic composition in these different areas. A majority of the 14 species encountered in fences in other regions are minor components there, with the exception of *S. mombin*, which is widely employed in fencelines in Cuba (Crane 1945). However, according to the interviewees, the local use of *S. mombin* is actually decreasing as its fruits apparently lend a disagreeable flavor to the milk.

In spite of the large number of species utilized for constructing fences they do not all contribute in the same proportion in erecting these barriers—with only 10 species accounted for more than half of the total number of fence elements. A similarly unequal species distribution was reported by Harvey et al. (2003, 2005) for fences in Costa Rica and Nicaragua. These authors encountered a total of 161 species of plants incorporated into fences, but in three of the four areas studied less than five species were used in any given fenceline, with a single species predominating over the rest.

Of the 10 most abundant species in the fences examined here, eight were native to the *caatinga* region, and six (*J. mollissima, A. colubrina, C. leptophloeos, C. pyramidalis, S. lanceolatum*, and *B. cheilantha*) were present in the forest fragment adjacent to the community (Alcoforado-Filho et al. 2003). Of these latter six species, only *C. pyramidalis* and *B. cheilantha* demonstrated densities greater than 10% in the forest fragment. The low densities of all these species in the forest area, combined with the harvesting pressure for use in fences, suggests that these populations may disappear from the area, and argue for a closer examination of the dynamics of these tree populations.

Of the most abundant species in the fences, *A. colubrina* appears to be the most threatened, for in addition to being used in fences it is also widely used as fuelwood and to manufacture charcoal both in the study area (Ramos et al. 2008a, b) as well as in other *caatinga* areas in NE Brazil (Figueirôa et al. 2005). The quality of its wood and its resistance to decay also make it one of the most preferred species for use in rural constructions in the community of Airi, in the municipality of Floresta, Pernambuco State (Ferraz et al. 2005).

J. mollissima and *C. leptophloeos*, the first and third most abundant species in the fences, occur in the forest fragment adjacent to the community of Riachão de Malhada de Pedra at low densities (0.44 and 1.53%, respectively) (Alcoforado-Filho et al. 2003). However, fence construction does not appear to be the primary factor responsible for the low densities of these species in the forest fragment, for these posts are normally cut from adult plants already incorporated into fencelines. Figueirôa et al. (2005) also noted the use of *C. leptophloeos* in live fences in other areas of NE Brazil, but their study did not indicate how the posts became incorporated in the fences.

4.2 Measures of knowledge among the people who maintain fences, and how these fences are used

The frequent use of dead posts in fences in the community studied appears to be due to the ease of constructing this type of barrier, as well as the fact that maintenance (trimming) is practically unnecessary—which represents one less chore for the farmers. A similar situation was noted by Levasseur et al. (2004) in Ségau, Mali—where a majority of the farmers used dead fence posts and recognized advantages of this type of construction, including the ease of rotation of crop areas (as the dead posts could easily be removed and relocated). Additionally, the farmers mentioned that they could more easily use the posts as fuelwood if the fence was for some reason no longer needed. Ayuk (1997), however, considered that the advantages offered by non-living fences might not compensate the disadvantages related to frequently replacing post material that is easily degraded by termites and other agents.

The advantages of constructing living fences are not yet fully appreciated by the farmers in the study area, at least as compared to inhabitants of other regions with long traditions of using living fences such as found in Central America and Europe. Among the benefits associated with the use of living fences are low costs, high durability, improvement of soil quality, secondary products (fruits, etc), protection, the production of biomass, etc., all of which have fomented the use of these living barriers (Budowski 1987, 1998; Ayuk 1997; Levasseur et al. 2004).

One interesting characteristic of the living fences in the study area is that they were not composed solely of live elements. It is a common practice to incorporate dead posts into these same fencelines, forming what we have called a mixed-fence. Mixed-fences are very interesting because they not only serve the farmer's needs (durability), but also aid conservation interests—as this type of construction demands less harvesting of the native vegetation. For this reason, the practice of using living elements in fences should be promoted in other regions, although these constructions are not at all exclusive to the study area and been reported in Costa Rica and Nicaragua (Harvey et al. 2003, 2005; Budowski and Russo 1993).

The local preference for utilizing species with high sprouting capacities such as *J. mollissima, C. leptophloeos*, and *S. lanceolatum* may contribute to the conservation of other plants that do not have any re-sprouting capacity, such as *A. colubrina*, locally preferred for fence posts, and also harvested for civil construction, fuelwood and charcoal (Figueirôa et al. 2005). In addition to conserving those species, an increase in the use of living fences in the community examined here would result in economic gains for the local population, as there would be no need to replace degraded posts - normally an economic burden for farmers with low income levels. The economic benefits associated with live fences, combined with the difficulty of acquiring materials for fence construction, has resulted in the adoption of these living barriers by low income populations throughout tropical America (Budowski 1987).

The species that demonstrated the greatest use-value consensus in the present study were also those most preferred for fence construction and the most abundant. It is worth pointing out, however, that the most important species for a community are not always those that are most abundant or most important from an ecological point of view (Albuquerque et al. 2005 a, b). As the people involved in fence construction harvest from the forest fragment adjacent to the community, the vegetation there must certainly be altered by this use-pressure, especially in relation to those preferred species with dense and low water-content wood but that are not capable of resprouting from severed post sections (as is the case of *A. colubrina, M. tenuiflora*, and *C. pyramidalis*). However, these species do have a high capacity for resprouting from cut stumps that remain intact and otherwise undisturbed in the ground (Sampaio et al. 1998; Figueirôa et al. 2006). This harvesting pressure is not seen, on the other hand, with species that resprout from cut posts, such as *J. mollissima, C. leptophloeos* and *S. lanceolatum* as these species (with low density and high water content wood) are harvested principally from existing fences, and not from the remnant forest patch. There is a certain risk, however, that this cloning could make these fences more susceptible to future destruction by infectious agents (Budowski and Russo 1993).

It should be noted that the people involved in fence construction take a certain amount of care in choosing to the best time of the year to erect living fences and likewise also avoid using barbed-wire to avoid damaging the living trees. Budowski and Russo (1993) and Baggio and Heuveldop (1982) likewise commented on the time of year recommended for planting the living posts, and their informants went on to detail the necessity of cleaning the posts, cutting the top and base correctly, of allowing for a “rest” period before planting, and of recognizing the best lunar period for establishing rooting.

The techniques for maintaining live fences were not well appreciated by the interviewees in the present study, which may represent an obstacle for their wider use. In countries such as Costa Rica and Nicaragua, on the other hand, maintenance of living fences is performed with a certain frequency, guaranteeing their development, durability, and efficiency. For example, these fences are trimmed regularly in order to avoid excessive shading in adjacent agricultural plots or pasture lands (Harvey et al. 2003, 2005) and to avoid their becoming top-heavy if their root system is very superficial (Baggio and Heuveldop 1982). Additional maintenance involves the placement of new posts to close gaps and to thicken the fenceline itself (Budowski 1987; Budowski and Russo 1993; Levasseur et al. 2004). Also, living fences that grow for long periods of time tend to become tall but very thin at their base, compromising their role as wind-breaks (Gabriel and Pizo 2005). Routine maintenance of living fences is also very important for maintaining their floristic diversity. Deckers et al. (2004) observed that well managed live-fences demonstrated greater species richness than non-managed fencelines.

4.3 Fences: functions and secondary products

Studies focusing on fences have demonstrated that these barriers take on diverse functions according to their type (live or non-living fences) and to the regions in which they are found. In the community examined in the present work, the farmers/ranchers attributed only basic functions to their fences, such as protection and the definition of their lands. These observations were similar to those of Harvey et al. (2003, 2005) in their study of the productive and ecological roles of fences in Central America. On the other hand, other studies have demonstrated that fences composed of living elements are attributed many other roles within agricultural systems, such as controlling erosion, serving as wind-breaks, some species of trees used are capable of fixing nitrogen and of improving soil drainage, production of organic material, in addition to their esthetic and architectural roles (Budowski 1987; Budowski and Russo 1993).

The ecological functions of fences formed from living elements were not greatly known by the inhabitants of the community examined here. Other studies, however, have pointed out the importance of this type of fenceline in maintaining biodiversity. In areas used for cattle ranching these fences provide a semi-natural habitat for many species of birds (Hinsley and Bellamy 2000; Jobin et al. 2001; Pierce et al. 2001), offering food for these animals (Budowski 1998; Gabriel and Pizo 2005), as well as habitat, nesting areas, and resting (Budowski 1998), and they function as corridors linking adjacent forests, which is especially important for birds with limited flight capacity (Gabriel and Pizo 2005). Living fences can also contribute to the conservation of biodiversity in agricultural landscapes, increase tree cover, and aid in soil conservation (Harvey et al. 2003, 2005).

Some of the interviewees who maintain the fences in the Riachão de Malhada de Pedra community recognized fences as sources of natural resources for the population (especially those formed by living elements) and were aware of the fact that they decreased harvesting pressure on the species within the forest fragment adjacent to the community, although these views were generally not very well spread throughout the community. In other regions of the world products harvested from living fences have contributed to their increased popularity and construction. Studies have demonstrated that fuelwood and wood used in the construction of new fences can be harvested from living fencelines without recourse to cutting the native vegetation (Budowski and Russo 1993). These fencelines also furnish forage (Budowski 1987; Budowski and Russo 1993; Harvey et al. 2003) and shade for the cattle (Harvey et al. 2003, 2005), which, according to Clavero (1996) represents an economic boost for animal production. Additionally, medicinal products and food stuffs (Baggio and Heuveldop 1982; Budowski and Russo 1993; Reyes and Rosado 1999; Levasseur et al. 2004), as well as honey and ornaments can be harvested from living fences. The economic importance of the natural products harvested from living fences varies from one location to the next, but remains basically limited to fulfilling family necessities.

4.4 Volume of the wood used for constructing fences

The intensive utilization of wood originating from areas of native vegetation for fence construction represents a potential problem for some local species. Many tree species cannot be found in large quantities in the local vegetation fragment and these populations may not resist continuous harvesting to construct new fences. According to information supplied by members of the local community, a fence usually needs to be replaced every three and a half years on the average. It was not possible to obtain precise information about how long any particular species lasts before requiring substitution.

Examples of species that cannot support current rates of harvesting include *A. colubrina, B. cheilantha*, and *M. urundeuva*, which are represented by 2.52, 1.03, and 0.78 m^3 of above-ground trunk volume in one hectare of local forest fragment vegetation, respectively, according to calculations made by Lucena et al. (2008) and Oliveira et al. (2007). In the case of some tree species, the total volume of wood available in the forest fragment is less than that which would be needed to replace all of the current fences. A viable alternative to continued harvesting would be to establish a nursery and supply seedlings of locally important trees that could be offered to the farmers for planting on their own lands to minimize future harvesting in the forest fragment.

The majority of the living wood volume in the fences in the survey area represented native species. This fact is extremely positive in light of the fact that these fence elements contribute to the population sizes of useful species in the region. *J. mollissima* demonstrated the greatest volume of any native species in the living fences, and these fenceline populations contribute significantly to the number of plants occurring in the region, especially since the *caatinga* forest fragment adjacent to the community retains less than 1 m^3 per hectare of this wood (Lucena et al. 2008).

Only *S. mombin* appears among the top five plants with the largest wood volumes in both living and non-living fences. However, its high volume is not associated with the quantity of posts encountered (which is low in both fence types), but rather in the generally large sizes of the individual elements. The small numbers of posts made from this species reflects the value of the fruits produced by the living trees, and fence makers are usually loath to cut them down.

In summary, the extraction of wood for fence construct has two implications in the region examined: (1) a decrease in vegetation cover in the area when non-living fences are used; (2) when living fences are used they represent a germplasm bank of native species. Living fences have contributed to the maintenance of certain native tree species in the region.

5 Conclusions

The people who construct/maintain the fences in the Riachão de Malhada de Pedra community employ a wide variety of species for this purpose, but concentrate on just a few native species. The preference for native species has reduced the populations of these plants in the forest fragment where these posts are harvested, as is the case with *A. colubrina*, which suffers heavy harvesting pressure in the area and does not re-sprout as a cut post.

Living (or mixed living/non-living) fences supply various useful products, although few fence makers in the community are aware of this fact or make use of those products. This demonstrates that the potential advantage of these fences is little appreciated, and indicates the need for environmentally oriented educational efforts directed towards making these communities more aware of the ecological and productive potential of the plants in the area and stimulating their use in fences.

The harvesting of wood to construct non-living fences has contributed to a decrease in local vegetation cover; but the construction of living or mixed fences favors the maintenance of biodiversity.

The utilization of mixed-element fences by the community offers a compromise solution for the conflict between the necessities of using the land but at the same time conserving natural resources. Mixed-element fences would attend both the demands of the farmers (as they are durable and functional) and the proposals of conservationists (as they reduce the demand for posts derived from native species that do not easily resprout).

Finally, the wide use of native species to construct fences and the small populations of some of these plants in the forest fragment in the study area suggest the necessity of creating a tree nursery within the community that could supply seedlings to the farmers and therefore promote a long term increase the populations of these preferred species.

Acknowledgements The authors would like to thank the Empresa Pernambucana de Pesquisa Agropecuária (IPA) in Caruaru and its Director, Sr. Jair Pereira, for logistic support provided during the research; CNPq, for the grant to the first author and the productivity grant awarded to U.P. Albuquerque; the researchers at the Laboratório de Etnobotânica Aplicada da Universidade Federal Rural de Pernambuco, especially Reinaldo Farias Paiva de Lucena, Patrícia Muniz de Medeiros, Alyson Luiz Santos Almeida, and Marcelo Alves Ramos, for their help in the field research; the Riachão de Malhada de Pedra community, in the municipality of Caruaru, for their hospitality and assistance during our work there and especially for the rich local knowledge passed on, in part, to us.

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