



Perceptions and Use of Native Forests in the Arid Chaco of Córdoba, Argentina

Cecilia Trillo, Sonia Colantonio, and Leonardo Galetto

Research

Abstract

The human population in the arid Chaco forests of Argentina is composed mainly of stockmen carrying out ancestral practices. Plant uses in this biogeographic region are relatively well known, but the forest perception by local populations was not studied so far. A total of 77 stockmen and other local salaried people were interviewed with semi-structured interviews, and herbarium specimens were produced with the informants. A Likert scale was used to obtain perceptions of the forest value. We registered 124 plant species, particularly forage woody plants, which have a variety of uses. More than 100 species overlapped with a survey of the region more than one century ago. Stockmen carry out ancestral practices such as cutting, collecting, and storing dry fruit, creating elaborate **cercos**, and know substantially more forage plants. The results suggest that the local population as a whole has a positive perception of the forests, regardless of their main occupation, and needs the forest to reinforce stockmen's traditions (**criollos**) through daily activities.

Introduction

Traditional ecological knowledge can be defined as the cumulative body of knowledge, practices, and beliefs evolved by adaptive processes and handed down through generations by cultural transmission of the relationships among living organisms (including humans) with their environment (Berkes 1999). This concept implies environmental perceptions shaped by religion, ethics, and other sets of beliefs. In this context, local forest inhabitants use their traditional ecological knowledge for obtaining multiple services and resources that support their daily activities. In addition, forests provide both urban and rural populations with products from different species, such as building and crafts materials, fuel, dietary supplements,

and medicinal plants (Cunningham 2001). The most common products from South American forests are firewood, coal, and quality woods for different purposes. However, there are many non-timber goods used for local subsistence or for national and international trading (FAO 2009, Phillips *et al.* 1994).

Subtropical Chaco forests have been dramatically reduced, mainly by soybean expansion (Zak *et al.* 2008). The residents of the dry Chaco woodlands have different occupations (e.g., stockmen and urban or semi-urban people, with salaried employees or small-scale traders). For their subsistence, they usually sustain extensive cattle farming and non-irrigated crops applying traditional knowledge and techniques (Trillo *et al.* 2010). Forest resources seem to be essential for stockmen mainly because of the agricultural expansion into the driest and most marginal areas of this region. Previous ethnobotanical research focused on plant uses such as edibility (Arenas 1999), healing (Arenas 2000, Barboza *et al.* 2009, Filipov 1997, Idoyaga Molina 2001, Trillo *et al.* 2010), dye (Trillo *et al.*

Correspondence

Cecilia Trillo, Cát. Diversidad Vegetal II, FCEfyN, Universidad Nacional de Córdoba, ARGENTINA.
ceciliatrillo1@gmail.com

Sonia Colantonio, Cát. Antropología Biológica y Cultural, FCEfyN, Universidad Nacional de Córdoba, CONICET, ARGENTINA.

Leonardo Galetto, Cát. Diversidad Vegetal II, FCEfyN, Universidad Nacional de Córdoba e IMBIV (UNC-CONICET), ARGENTINA.

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2007), or forage (Muiño 2010, Scarpa 2007). Few studies considered the economic value of Chaco plants (Muiño 2010, Scarpa 2007).

Although local residents are linked in different ways to the remaining forests and may have different views regarding forest goods, perceptions of the forest have not yet been studied. According to Padua (1994), it is assumed that perceptions represent a nexus between the individual psychological condition (i.e., motivational, emotional, perceptual, and cognitive processes) and the external objects (forest plants, in this case). For this biogeographic region the link between the relatively well known plant uses and the forest perception by resident people was not previously studied.

There are few historic documents that mention the knowledge and/or techniques used for rural activities in the Chaco region of Córdoba province. The traditional economic activity in the dry Chaco woodlands was the extensive farming of cattle, goats, and sheep (Celton 1993, Río & Achával 1905), with basic practices associated with the management of forage plants and cattle (Díaz 2007). The present ethnobotanical study about the local knowledge of the forest and particularly about the forage plants or the associated practices to obtain resources in this marginal landscape, aims to contribute to fill this documentation gap.

The main objective of this study was to compare plant uses and forest perceptions between the local populations with different occupations (stockmen and other occupations) that determine a different daily relationship with the forests. The inhabitants' perception of the forest would be a key point to better understand their daily practices, forest management, and conservation approaches. This study intended to (1) record the plant uses of residents of the Chaco forests in its western region and to compare the persistence of this knowledge with data from one century ago, (2) compare the forest perceptions between stockmen and other occupations, and (3) describe the traditional practices of stockmen associated with forage plants.

Materials and Methods

Study area

The Guasapampa valley (Minas department, Córdoba province) is a rural area located at 31°0'S and 65°22'W. It has an extent of 20 km long and 6 km wide and an altitude ranging from 540 to 750 masl. The annual average temperature is 18°C, with an annual precipitation of 400–500 mm, occurring mainly during summer (Di Tada & Bucher 1996). There are three main villages: La Playa, Guasapampa, and Totorá Huasi, with 163, 193, and 24 inhabitants, respectively (Figure 1).

The Minas department is one of the more economically relegated regions within the province of Córdoba, with critical levels of illiteracy and unemployment (González 1999). The main productive systems are extensive cattle farming, forest exploitation, mining, and non-irrigated agriculture (Bergamín 1992, Trillo *et al.* 2010).

The plant communities are representative of the Chaco Seco (i.e., dry) phytogeographic region (Cabrera 1976). The flora consists of woody species such as *Aspidosperma quebracho-blanco* Schldl., *Schinopsis lorentzii* (Griseb.) Engl., *Lithrea molleoides* (Vell.) Engl., *Prosopis flexuosa* DC., *Acacia aroma* Gillies ex Hook. et Arn., *Flourensia oolepis* S.F.Blake, *Ruprechtia apetala* Wedd., *Celtis iguanaea* (Jacq.) Sarg., *Senegalia gilliesii* (Steud.) Seigler & Ebinger, and *Larrea divaricata* Cav. Most of this region has been disturbed mainly by logging, cattle farming, and fires during the last 30 years. Secondary forests are characterized by few trees and many shrubs (Cabido & Pacha 2002), including *A. aroma*, *Acacia caven* (Molina) Molina, *Condalia microphylla* Cav., *F. oolepis*, *Croton lachnostachyus* Baill., *Aloysia gratissima* (Gillies & Hook.) Tronc., *Ephedra triandra* Tul., and *Heterothalamus alienus* (Spreng.) Kuntze., and have showed major recent changes in their structure (Zak & Cabido 2002).

The population

Inhabitants of the Guasapampa Valley identify themselves as **criollos**. **Criollos** are the descendants of Europeans and regional ethnic groups, catholic and Spanish speakers (Celton 1993). The population of the northwestern Córdoba province in the pre-Hispanic 16th century was constituted of 600 **pueblos** or regional ethnic groups according to the Spanish conqueror at 16th century, Jerónimo Luis de Cabrera (Celton 1993). The families lived in little towns near rivers and developed basic agriculture (e.g., corn, pumpkins), weaving, and ceramics. When the Spanish began to settle in the area, native ethnic groups began a process of dispersion and erosion of their cultural and administrative organization and eventually became mixed people (Celton 1993). Today, their descendants carry out activities related to livestock farming, subsistence agriculture, and textile production. They live in houses called **ranchos**, which are surrounded by little orchard-gardens and rustic fences called **cercos** to protect their sheep and goats.

The historic continuity of the practices associated with stock raising was documented by Río and Achával (1905). These geographers reviewed the economic activities in the province since the 17th century and included in their research the study of J. Hieronymus' *Plantae Diaphorae Florae Argentinae*, published in the *Bulletin of National Science Academy* in 1882, which described the nutritional, medical, and other uses of native plants.

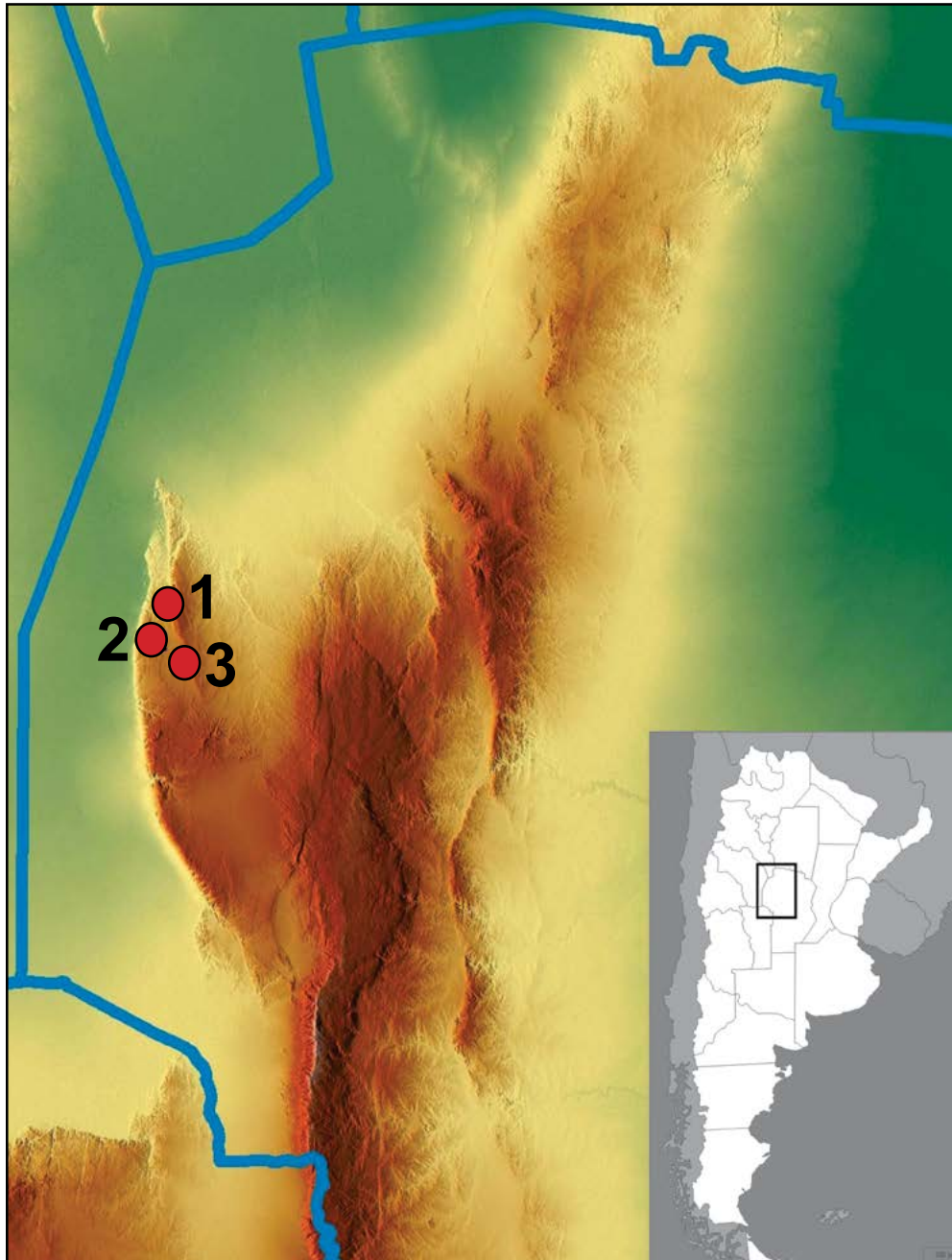


Figure 1. Study area and main mountain ranges (sierras) and villages (1: Totorá Huasi, 2: La Playa, and 3: Guasapampa) in the Guasapampa valley, Minas department, Córdoba province, Argentina.

In recent times economic progress has generated new opportunities so many inhabitants of this rural area now have different occupations. Interviewees were classified as “stockmen” or with a “different occupation” based on both their occupation and their main monetary income. A “stockman” was defined as a man or woman who owns cattle, goats, horses, or sheep, and sometimes sells medicinal plants, cheese, wool, wood, or honey. Every day, they walk at least a few kilometers into the forest to feed

their animals. A “different occupation” was defined as a man or woman who works in the villages’ urban zone (e.g., at a school, a police station, a store, or a mine). These categories were usually self-defined by the interviewees, but in those few cases that they did not do so, we categorized them based on their daily activities and their most important income.

Data collection

Most of the adult residents in each village were interviewed (80%). Data were collected through semi-structured interviews (Bernard 1995, Padua 1994) about daily activities, plant uses, forest perceptions, and their traditions. A total of 77 inhabitants were interviewed, both men and women, from 16 to 70 years old: 33 stockmen (12 men and 21 women) and 44 having different occupations (16 men and 28 women). Each informant gave data about gender, age,

family, place of birth, parents’ origin, principal activities for their subsistence and income, daily route for those activities, water access for human and stock consumption, forest access, plant collection, etc.

Perceptions of the forest and the natural environment were quantified using ordinal data with a Likert-type scale (Likert 1932) which was used to obtain perceptions of the forest as being the natural environment offered

to residents. In Likert-type scale questions, the informant gave an opinion or stance about one item (i.e., different essential resources that they need for subsistence: forage plants for animals, medicine, furniture, etc.). Six questions were specifically asked to quantify their forest perception (i.e., importance of the forest to provide forage, medical, dye, and veterinary plants, and also other products or pleasure sensations). The term “forage” was utilized to refer to all the food used to feed animals (i.e., products of vegetable origin and used without transformation, except for dehydration and milling). These questions were numerically quantified by means of three options in descending grade of importance: very important, important, and less important (3, 2, and 1, respectively). Finally, the informant examined the herbarium specimens to check and/or confirm plant uses. The herbarium collections consisted of 99 plant species that were created with the help of key informants from the three towns. These exsiccatae are deposited at the Botany Museum of the National University of Córdoba (CORD).

Using the information documented in the database from Río and Achával (1905), we have compared the plants cited by the current inhabitants with those plants used over a century ago. This methodological approach is proposed by Medeiros (2009).

Statistical analyses

SPSS 11.5 statistical package was used to compare the number of plants with different uses known by stockmen and inhabitants with different occupations using t-tests. Wilcoxon tests were run to compare the forest perceptions of stockmen and salaried employees. The modes

obtained for each question/category were used to compare data (Padua 1994).

The cultural significance that inhabitants attributed to different plant resources was analysed using a community valuation. This analysis was intended to estimate the cultural importance of the different plants and to determine the agreement among the local people regarding the usefulness of such plants. The cultural value was calculated for each species of the herbarium following the formula proposed by Phillips and Gentry (1993): $VU_{is} = \sum (U_{is} / n_{is})$. The use value (VU_{is}) was calculated by totalling all the uses mentioned for a given plant in each event by the interviewees (U_{is}), and then dividing this value by the total number of events in which the informants gave information on the species (n_{is}). This index is interpreted as a measure of the importance of these plants for the residents of this region. It also shows the level of agreement among local people about the utility of these plants.

Results

Plant uses

A total of 123 plant species from 47 botanical families were mentioned by informants in relation to the different uses (Table 1). One species each of lichen, fungus, insect, and reptile were also mentioned. The average number of cited species is 37.5 (range: 8–85). Most residents mentioned 3–44 species; few of them knew more than 44 or less than 3 species.

A small number of species ($n = 20$) presented a wide consensus (i.e., 50 to 90% of the inhabitants), but most spe-

Table 1. Useful plants and other organisms mentioned by residents in Guasapampa Valley, Córdoba, Argentina. Uses: F-forage (106 spp.), M-medical (83 spp.), V-veterinarian (34 spp.), N-nutritional (17 spp.), D-dyes (42 spp.), FI-fuel (19 spp.), T-tools (7 spp.), Fu-furniture (4 spp.), C-corrals (10 spp.), Sh-shade (6 spp.), Ma-magical (2 spp.), Mo-mordant (2 spp.), S-silos (1 sp.), So-soap (1 sp), Cl-clean the water (1 sp). The 20 highest cultural use values are in bold. Green font indicates that a species was previously mentioned in Río and Achával (1905) with an asterisk (*) indicating the use category from 1905.

Scientific name	Vernacular name	Consent	Use value	Use(s)
Parmeliaceae (lichen)				
<i>Usnea amblyoclada</i> (Müll.Arg.) Zahlbr	barba de piedra	2	-	M*, D
Anemiaceae				
<i>Anemia tomentosa</i> (Savigny) Sw.	doradilla	25	1.05	F, M*
Equisetaceae				
<i>Equisetum giganteum</i> L.	cola de caballo	5	-	M*
Lycopodiaceae				
<i>Phlegmariusus saururus</i> (Lam.) B.Øllg.	cola de quirquincho	1	-	M*
Pteridaceae				
<i>Argyrosma nivea</i> (Poir.) Winham	culandrillo	5	0.1	F, M*

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Ephedraceae					
<i>Ephedra triandra</i> Tul.	tramontana	24	0.66	F, M*	
Amaranthaceae					
<i>Alternanthera pungens</i> Kunth	yerba del pollo	20	0.64	F, M*	
<i>Amaranthus hybridus</i> L.	amaranto, yuyo colorado	8	0.11	F	
<i>Atriplex undulata</i> (Moq.) D.Dietr.	cachiyuyo	38	0.75	F, M, D*, MA	
<i>Chenopodium album</i> L.	yerba de la perdiz	2	0.16	F, M*	
<i>Dysphania ambrosioides</i> (L.) Mosyakin & Clemants	paico	17	0.51	F, M*	
Anacardiaceae					
<i>Lithraea molleoides</i> (Vell.) Engl.	molle	33	0.95	F, M*, D, V, N*	
<i>Schinopsis lorentzii</i> (Griseb.) Engl.	orco quebracho	32	0.91	F, M*, D, Fu*, FI	
<i>Schinus areira</i> L.	aguaribay	1	-	M*	
<i>Schinus fasciculata</i> (Griseb.) I.M.Johnst.	molle pispo o pispito	37	0.55	F, D, Sh, FI, C	
Apocynaceae					
<i>Araujia brachystephana</i> (Griseb.) Fontella & Goyder	tasi	1	0.57	F, M*, N*	
<i>Aspidosperma quebracho-blanco</i> Schltld.	quebracho blanco	9	0.65	F, M*, D*, V, Mo, C, FI*	
<i>Vallesia glabra</i> (Cav.) Link.	ancoche, coquillo	15	0.41	F, N, M*, V, T	
Aristolochiaceae					
<i>Aristolochia argentina</i> Griseb.	charrúa	7	0.27	F, M*	
Asteraceae					
<i>Achyrocline</i> sp.	lavanda del campo	2	0.14	F, M	
<i>Achyrocline satureioides</i> (Lam.) DC.	vira-vira	38	0.95	F, M*, D	
<i>Ambrosia tenuifolia</i> Spreng.	altamisa	9	0.29	F, M*	
<i>Artemisia douglasiana</i> Besser ex Besser	matico	3	0.19	F, M*	
<i>Baccharis articulata</i> (Lam.) Pers.	carqueja	11	0.76	F, M*, D	
<i>Baccharis salicina</i> Torr. & A.Gray	chilca amarga	11	0.43	F, M*, D, T	
<i>Cyclolepis genistoides</i> D.Don	palo azul	29	1.16	F, M*, D	
<i>Flaveria bidentis</i> (L.) Kuntze	fique o balda	13	0.49	F, M*, D*	
<i>Flourensia oolepis</i> S.F.Blake	chilca del campo	18	0.23	F, D*	
<i>Gaillardia megapota mica</i> (Spreng.) Baker	topasaire	15	0.67	F, M*	
<i>Grindelia pulchella</i> Dunal	tiñe rosado	1	0.07	F, D*	
<i>Heterothalamus alienus</i> (Spreng.) Kuntze	romerillo	1	-	D*	
<i>Jungia polita</i> Griseb.	zarparrilla	33	1.07	F, M*	
<i>Pluchea dodonaeifolia</i> (Hook. & Arn.) H.Rob. & Cuatrec.	suncho, chilca dulce	11	0.43	F, M*, D, Mo, T	
<i>Pluchea sagittalis</i> (Lam.) Cabrera	lucera	1	0.03	F, M*	
<i>Porophyllum obscurum</i> (Spreng.) DC.	yerba del venado	1	0.04	F, M*	

<i>Schkuhria pinnata</i> (Lam.) Kuntze ex Thell.	matapulga	17	0.77	F, M*, V*, T
<i>Senecio pampeanus</i> Cabrera	pichanilla	4	0.1	F, V
<i>Taraxacum officinale</i> F.H.Wigg.	diente de león	1	-	M*
<i>Thymophylla pentachaeta</i> (DC.) Small	guillermite	32	0.91	F, M*
<i>Trixis divaricata</i> (Kunth) Spreng.	contrahierba	29	1.07	F, M*, D, V, Ma
<i>Verbesina encelioides</i> (Cav.) Benth. & Hook.f. ex A.Gray	mirasol	11	0.19	F, M*
<i>Xanthium cavanillesii</i> Schouw ex Didr.	abrojo	4	0.08	F, V
<i>Xanthium spinosum</i> L.	cepacaballos	6	0.35	F, M*, V
<i>Zinnia peruviana</i> (L.) L.	clavelillo	8	0.18	F, D
Bignoniaceae				
<i>Amphilophium carolinae</i> (Lindl.) L.G.Lohmann	cancana	9	0.19	F
Boraginaceae				
<i>Heliotropium amplexicaule</i> Vahl	yerba meona	12	0.26	F, M*
<i>Nama undulata</i> Kunth	matagusano	7	0.48	F, M*, V*
Bromeliaceae				
<i>Dyckia floribunda</i> Griseb.	penca de las piedras	9	0.16	F
<i>Tillandsia aizoides</i> Mez	suelda	-	-	F
<i>Tillandsia capillaris</i> Ruiz & Pav.	suelda	46	0.79	F
<i>Tillandsia duratii</i> Vis.	suelda	-	-	F, M*, N
Buddlejaceae				
<i>Buddleja cordobensis</i> Griseb.	pulmonaria, sanalotodo	10	0.2	F, M*
Cactaceae				
<i>Acanthocalycium spiniflorum</i> (K.Schum.) Backeb.	penca	-	-	F
<i>Gymnocalycium ochoteranae</i> Backeb.	penca	39	0.58	F
<i>Opuntia ficus-indica</i> (L.) Mill.	tuna	30	-	F*, M*, N
<i>Opuntia sulphurea</i> Gillies ex Salm-Dyck	penca del burro	30	-	F
Cannabaceae				
<i>Celtis iguanaea</i> (Jacq.) Sarg.	tala	33	0.88	F, M*, D, V, Sh, FI*, N*, C
Capparaceae				
<i>Atamisquea emarginata</i> Miers ex Hook. & Arn.	atamisqui	31	0.71	F, M*
Santalaceae				
<i>Jodina rhombifolia</i> (Hook. & Arn.) Reissek	peje	6	0.43	F, M*, D, V, Sh, FI*
Commelinaceae				
<i>Commelina erecta</i> L.	Santa Lucía	8	0.16	F, M*
Cucurbitaceae				
<i>Cayaponia citrullifolia</i> (Griseb.) Cogn. ex Griseb.	sandía de la víbora	8	0.16	F, M, V

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Euphorbiaceae					
<i>Croton lachnostachyus</i> Baill.	bálsamo	9	0.22	F, M*	
Fabaceae					
<i>Acacia aroma</i> Gillies ex Hook. & Arn.	tusca	49	1.27	F, M*, D, V, FI*, C	
<i>Acacia caven</i> (Molina) Molina	espinillo	34	0.67	F, M*, D, V, FI	
<i>Acacia praecox</i> Griseb.	garabato hembra	8	0.23	F, M, D, FI	
<i>Caesalpinia gilliesii</i> (Hook.) D.Dietr.	lagaña de perro, chosni	5	0.12	F, M, D*, V	
<i>Geoffroea decorticans</i> (Hook. & Arn.) Burkart	chañar	35	1.48	F, M*, FI*, N*	
<i>Medicago sativa</i> L.	*alfalfa	26	-	F*	
<i>Parkinsonia praecox</i> (Ruiz & Pav.) Hawkins	brea	1	-	V	
<i>Prosopis chilensis</i> (Molina) Stuntz	árbol blanco	49	1.51	FI*, N, C	
<i>Prosopis flexuosa</i> DC.	árbol negro	44	1.14	F, D, V, Fu*, Sh	
<i>Prosopis torquata</i> (Lag.) DC.	tintitaco	25	0.49	F, M*, D, V, Fu*, Sh, FI*, N, C	
<i>Senegalia gilliesii</i> (Steud.) Seigler & Ebinger	garabato macho	17	0.28	F, FI*	
<i>Senna aphylla</i> (Cav.) H.S.Irwin & Barneby	pichana	1	-	F, M*, D, FI, C	
<i>Senna corymbosa</i> (Lam.) H.S.Irwin & Barneby	falso cafeto, sen	3	0.05	F, M*	
Gentianaceae					
<i>Gentianella</i> sp.	nencia	1	-	M*	
Hydnoraceae					
<i>Prosopanche americana</i> (R.Br.) Baill.	guaycurú	2		M*	
Lamiaceae					
<i>Hedeoma multiflora</i> Benth.	tomillo	14	-	M*	
<i>Marrubium vulgare</i> L.	yerba del sapo	19	0.94	F, M*	
<i>Minthostachys verticillata</i> (Griseb.) Epling	peperina	8	-	M*	
Loranthaceae					
<i>Ligaria cuneifolia</i> (Ruiz & Pav.) Tiegh.	liga	45	0.93	F, M*, D, V	
Lythraceae					
<i>Heimia salicifolia</i> (Kunth) Link	quebra arado	27	0.39	F, M*, CI,	
Malvaceae					
<i>Sida glabra</i> Mill.	yerba del potro	1	0.19	F	
<i>Sphaeralcea cordobensis</i> Krapov.	malva	14	0.52	F, M*, CI	
Nyctaginaceae					
<i>Bougainvillea stipitata</i> Griseb.	tala falso	10	0.3	F, FI*, N, T*	

Olacaceae					
<i>Ximena americana</i> L.	albarillo	29	0.55	F, D*, N*	
Papaveraceae					
<i>Argemone subfusiformis</i> Ownbey	cardosanto	9	0.39	F, M*, V	
Passifloraceae					
<i>Passiflora caerulea</i> L.	pasionaria	4	-	M*, N*	
Plantaginaceae					
<i>Plantago tomentosa</i> Lam.	llantén	12	0.37	F, M*	
Poaceae					
<i>Avena sativa</i> L.	avena	1		F	
<i>Cenchrus ciliaris</i> L.	pasto, buffer grass	1		F	
<i>Panicum maximus</i> Jacq.	pasto pani	1		F	
<i>Sorghum</i> sp.	*sorgo	1		F	
<i>Zea mays</i> L.	*maíz, choclo	8		F*, V	
Polygonaceae					
<i>Rumex</i> sp.	*lengua de vaca	1	-	F, M*	
<i>Ruprechtia apetala</i> Wedd.	juda, manzano del Campo	42	1.13	F, M*, D, V, C	
Portulacaceae					
<i>Portulaca oleracea</i> L.	verdolaga	33	0.64	F, N*	
Rhamnaceae					
<i>Condalia microphylla</i> Cav.	piquillin	37	1.01	F, M*, D*, N*	
<i>Ziziphus mistol</i> Griseb.	mistol	47	1.51	F, M*, D, V, FI*, N*	
Ranunculaceae					
<i>Clematis campestris</i> A.St.-Hil.	barba de viejo	6	0.1	F	
Rutaceae					
<i>Zanthoxylum coco</i> Gillies ex Hook.f & Arn.	coco	2	-	D*	
Salicaceae					
<i>Salix humboldtiana</i> Willd.	sauce	1	-	D	
Santalaceae					
<i>Jodina rhombifolia</i> (Hook. & Arn.) Reissek	peje	6	0.43	F, M*, D, V, Sh, FI*	
Sapindaceae					
<i>Cardiospermum halicacabum</i> L.	globito, pedorra	8	0.22	F, M*	
Simaroubaceae					
<i>Castela coccinea</i> Griseb.	mistol del zorro	17	0.25	F	
Solanaceae					
<i>Capsicum chacoense</i> Hunz.	aji	26	0.88	F, N*	
<i>Cestrum parqui</i> (Lam.) L'Hér	duraznillo negro	4	0.24	F, M*, D, V	
<i>Grabowskia boerhaaviifolia</i> (L.f.) Schltldl.	fruto de paloma	10	0.13	F	

<i>Lycium ciliatum</i> Schtdl.	piquillín de la víbora	8	0.12	F, M*, V
<i>Lycium elongatum</i> Miers	gualeguay	8	0.11	F
<i>Nicotiana glauca</i> Graham	palán-palán	8	0.53	F, M*, V
<i>Nicotiana longiflora</i> Cav.	flor de sapo	1	-	M*
<i>Nierembergia linariifolia</i> Graham	chuscho	3	0.06	F
<i>Salpichroa organifolia</i> (Lam.) Baill.	uvita del campo	1	0.03	F, N*
<i>Solanum argentinum</i> Bitter & Lillo	duraznillo del burro	15	0.29	F, T
<i>Solanum elaeagnifolium</i> Cav.	quillo	1	0.08	F, So*
Urticaceae				
<i>Urtica urens</i> L.	ortiga	1	-	M*
Verbenaceae				
<i>Aloysia gratissima</i> (Gillies & Hook.) Tronc.	palo amarillo	30	0.97	F, D, M*
<i>Junellia hookeriana</i> (Covas & Schnack) N.O'Leary & P.Peralta	violeta	3	0.08	F
<i>Lippia integrifolia</i> (Griseb.) Hieron.	incayuyo	41	1.34	F, M*, D, V
<i>Lippia turbinata</i> Griseb.	poleo	42	1.34	F, M*, D, V
Zygophyllaceae				
<i>Larrea cuneifolia</i> Cav.	jarilla	2	1.71	M, D*, FI
<i>Larrea divaricata</i> Cav.	jarilla	51	1.71	F, M*, D, V, S, FI, C, T, Fu*
<i>Portieria microphylla</i> (Baill.) Descole, O'Donell & Lourteig	cucharero	5	0.18	F, M*, V, FI
(Class Insecta) Dactylopidae				
<i>Dactylopius</i> sp.	cochinilla	1		D
(Class Agaricomycetes) Ganodermataceae				
<i>Ganoderma lucidum</i> (Curtis) P.Karst	polvo de San Juan	1		V
(Class Sauropsida) Boeide				
<i>Boa constrictor occidentalis</i> Philippi.1873	ampalagua	2		V

cies showed a reduced number of citations (Table 1). Most of the species of wide consensus ($n = 15$) were woody plants (tree or shrub) and presented at least five different uses (Table 1). Moreover, a high cultural value was confirmed for these 20 species by the herbarium.

The number of species mentioned for different uses was variable. Medicinal plants showed a higher number of citations (an average of 16 species per informant), while dyeing and nutritional plants were less cited (an average of two species).

Table 1 shows that the group of forage plant species is the most frequently mentioned. A total of 106 (100 wild and 4 cultivated) species from 47 botanical families were men-

tioned, with an average number of cited species per informant of 22.1 (SD = 16.5; CV = 0.7). Three forage plants (*Prosopis* spp., **algarrobos**; *Ziziphus mistol* Griseb., **mistol**; and *S. lorentzii*, **orco quebracho**) were most frequently mentioned as "excellent" forage, even by people with little or no experience with the forest who only recognized a few plants. In addition, these species presented a high cultural value (Table 1). Forage plants were classified in three groups by the residents: (1) those collected in the summer, like the fruits of *Prosopis* spp. and *Z. mistol*; (2) those for cutting or batting down the foliage (*S. lorentzii*, *Ligaria cuneifolia* (Ruiz & Pav.) Tiegh., *Schinus fasciculata* (Griseb.) I.M.Johnst., *R. apetala*, and *Tillandsia* spp.); and (3) those that are bought or cultivated as *Medicago sativa* L., *Zea mays* L., *Avena sativa* L., *Sorghum* spp., and *Pani-*

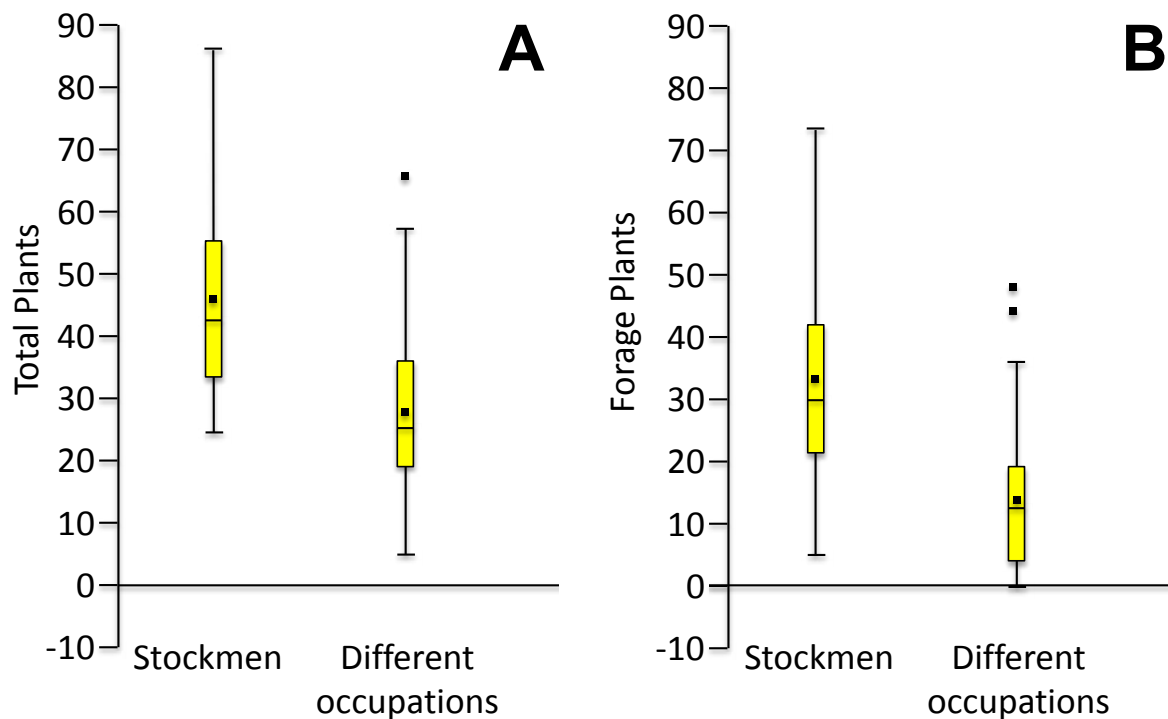


Figure 2. Box-plots for the data recorded on overall and forage plants known by resident stockmen and different occupation in the dry forest of the Chaco region, Córdoba, Argentina. **(A)** Total number of known plants ($t = 4.77$; $p = 0.0001$). **(B)** Total number of known forage plants ($t = 5.41$; $p = 0.0001$).

cum maximum Jacq. Plants in the last category are used in dry years or when forest fires make forage unavailable.

More than 100 species were cited by Río and Achával (1905), and this knowledge (e.g., plant names and uses) is currently available in the region (see Table 1).

Practices associated with forage plants

Stockmen carry out ancestral practices associated with the use of forage plants. Four out of the 37 informants mentioned that they regularly collect dry fruits under natural conditions from **algarrobos** and **mistol**, and that they place them in bags of 50 kg. The bags are stored during the winter in structures near the house and the corrals. Only one resident mentioned the construction of a **pirgua**, a container manufactured as a basket using branches of *L. divaricata* to dry fruits. This structure (1.3 m tall and 3 m circumference) can be used for about two years. Because cows and horses are particularly esteemed, they may receive food supplement of *M. sativa* or fruits of *Prosopis* spp.

Most stockmen (90%) mentioned that they use corrals or **cercos** constructed with a support of *Prosopis torquata* (Lag.) DC. because this species produces the hardest wood. Then they add branches of *A. caven*, *A. gilliesi*, *A. aroma*, *C. iguanaea*, *S. fasciculata*, *R. apetala*, *L. divaricata*, and *A. grattisima*. The **cercos** usually enclose an

area of 2 to 10 hectares that is not used during the rainy season (Spring and Summer) to allow forage to accumulate to be used during Winter. All the **cercos** have a hollow to collect rain water for animals. When the water disappears during the winter, the livestock are guided to the river or water from the family well is used.

Most of the informants (78.6%) used three types of forage: collected, cut, and bought or cultivated. A total of 16.7% fed the livestock only with plants from the forest and never bought supplementary products, and only 4.8% exclusively bought forage. The stockmen used a wide spectrum of alternatives to feed the livestock, depending on the annual rainfall and their economic situation.

Variation of knowledge of forage plants according to occupation

The two types of residents, "stockmen" and "different occupation" (salaried people), differed significantly regarding their knowledge about forage plants. Figure 2 shows the average number of recognized plants by stockmen and salaried people, as well as the average number of forage plants known by these two groups. There are significant differences between groups ($t = 4.77$, $p = 0.0001$, and $t = 5.41$, $p = 0.0001$, respectively). The Chi-square of uniformity test showed there are no significant differences between the frequency of stockmen and inhabitants with other occupations ($X^2 = 1.57$; $p = 0.21$).

Table 2. Valuation of plants (according to a Likert-type scale) from dry Chaco forests of Córdoba, Argentina, comparing residents who are either stockmen or have different occupations. The values are the median for each category and for the different plant uses (3 = higher valuation, 2 = intermediate valuation, 1 = low valuation).

Plant uses	Stockmen (range)	Different occupation (range)	Statistics
Forage	3 (1–3)	3 (1–3)	W = 1155, p = 0.47
Medical	2 (1–3)	2 (1–3)	W = 1052, p = 0.46
Dye	2 (1–3)	1 (1–3)	W = 1036, p = 0.78
Veterinarian	1 (1–3)	1 (1–3)	W = 1081, p = 0.73
Furniture	3 (1–3)	3 (1–3)	W = 1079, p = 0.73
Sensation	3 (2–3)	2 (2–3)	W = 1163, p = 0.42

Forest perception

Table 2 shows the perception levels for forest plants categorized by different uses, comparing the two main occupations of the residents. Although there are some differences in the perception among plant uses, no statistical differences were found between residents categorized as stockmen or different occupation.

Discussion

Residents of the Guasapampa Valley possess an important ethnobotanical knowledge. This conclusion is based on the wide diversity of uses mentioned for 123 species, satisfying a great diversity of needs—some vital and others immaterial—but also on the comparison of this existing knowledge with the ethnobotanical knowledge registered over 100 years ago (Río & Achával 1905, Trillo *et al.* 2010). Moreover, the knowledge of resources is of utmost importance because it both allows stockmen's daily activities and retains traditions and practices that identify them as **criollos** (Trillo 2010). According to Benz *et al.* (2000), the valuation of the forest as a venue for meeting residents' economic needs and the use of plants for other uses are factors that help a community maintain the practices inherited from past generations.

The main patterns highlighted in this study are two-fold. First, the knowledge of plants is not homogeneously distributed among rural residents of Guasapampa Valley but is rather related to the people's daily activities since stockmen showed a higher general knowledge of plant uses than inhabitants with different occupations, particularly on forage plants. Secondly, the inhabitants' positive perception of the forest values is generalized and independent of their main occupation.

These patterns can be compared from a global perspective and interpreted at the regional and local spatial scales. At a global scale, a similar direct correlation between residents' knowledge of plant resources and positive feelings toward forests was previously reported, independently of differences in their socioeconomic character-

istics (e.g., Hayati *et al.* 2009, Karppinen 1998, Majumdar *et al.* 2008).

At the regional scale, the context is different because there are continuous expansions of agriculture over the few remaining forest fragments (Zak *et al.* 2008). Native vegetation (woody and herbaceous) is the principal source of forage plants for domestic livestock in the Chaco region (Río & Achával 1905, Scarpa 2007). The practices observed in this study that are associated with the collection, cutting, and buying of forage are environmentally and culturally similar to activities of stockmen from other Chaco locations of Argentina (Arenas & Scarpa 1999, Capparelli & Raffino 1997, Morello & Saravia Toledo 1959, Scarpa 2007). Traditional ecological knowledge, rural practices, and plant uses can be eroded in the short or middle time with consequences for rural people who obtain multiple services and resources that support their daily activities in a semiarid region.

At the local scale, inhabitants of Guasapampa Valley perceive the forest as a space to satisfy multiple daily requirements that not only involve economic aspects (mainly the maintenance of their livestock), but also satisfy medical and emotional necessities (e.g., passing of the **criollos** tradition to their children or living at a place that provides them with pleasant sensations). Stockmen have the knowledge and traditions to overcome dry years using different strategies for assuring the survival of their livestock. For example, goats consumed between 60–80% of native bushes during the dry season in a study of goat keepers performed a few kilometers away from Guasapampa Valley (Nai Bregaglio *et al.* 1999). Traditional knowledge may be useful when stockmen and inhabitants with different occupations share the landscape for different activities. Regarding the value of particular species in the Guasapampa Valley, it is interesting that the most valued ones are woody plants and few herbs. The higher comparative importance of woody plants for people is probably because they provide forage for animals during the whole year, but in particular during the dry season of this semiarid environment.

Forests worldwide can provide goods and many ecological services, but they are severely endangered, particu-

larly those from Chaco (Zak *et al.* 2008). The modification of functional aspects of many plant species and their interactions in the Chaco region can be related to forest loss and fragmentation (Galetto *et al.* 2007, Grilli *et al.* 2012). Intensification of agriculture does not necessarily contribute to global hunger reduction. As Tschardt *et al.* (2012) pointed out, food security and food sovereignty need to increase in areas where the hungry live, based on robust, eco-efficient approaches which incorporate natural biodiversity patterns and processes to increase sustainable productivity. The forest perception by the **criollos** and their plant knowledge evidenced in this study are linked to their practices, which relate to forest management decisions that are opposite to the process of agriculture expansion linked to the on-going forest loss in the Chaco region.

Conclusion

What are the most important implications of the observed relationships between plant knowledge, stockmen and salaried employees, and the generalized positive perception of the forest values in the Chaco-region? Results suggest that rural communities living in the Chaco forests preserve much of their knowledge and traditional practices associated with the collection, storage, and maintenance of many plant species, particularly regarding those that are used to feed animals. Secondly, ethnobotanical knowledge reflects links (products, needs, and emotions) between residents and the forest, mainly for stockmen because they depend on the forest to provide for livestock. Thirdly, despite significant cultural and economic changes during the last century that could have affected stockmen's traditions, they use the forests not only for daily activities but also to reinforce their identity as **criollos**.

Kleijn *et al.* (2009) proposed that agricultural intensification is the main driver of biodiversity decline, but at the same time, it helps sustain the growing world population. It is reasonable to recognize social conflicts due to changes in land use, particularly in the Chaco region. This study showed that it would be important to evaluate the residents' forest perception when defining conservation strategies on landscapes. In particular, residents consider the forests to be very significant places in the economic sense and also maintain a strong emotional link with them. These results might have relevant connotations in environment conservation. This approach may be complementary at the moment of designing conservation strategies that incorporate knowledge, use of the available resources, and socio-economic characteristics of the Chaco region. Biodiversity and cultural conservation can be advocated not only for pragmatic reasons but also for ethical reasons.

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