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Horticultural and Gathering Practices Complement Each Other: A Case Study in a Rural Population of Northwestern Patagonia

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We investigated gathering and cultivating practices and how they complement each other in a rural population of Northwestern Patagonia. We analyzed plant diversity, species similarity, biogeographic origin, and plant use by means of semi-structured interviews and field visits. Pichi Leufu inhabitants used 173 species: 138 cultivated plants, mainly for edible purposes, and 45 wild species principally for medicinal use. Most cultivated species were exotic (91.3%), whereas gathered plants were both native and exotic. While locals maintained vegetable gardens, the adoption of greenhouses improved conditions for certain crops. The integration of novel practices with ancestral knowledge suggests resilient processes in this community, probably reflected in the dynamics of current horticultural and gathering practices, which complement each other.

KEYWORDS horticulture, gathering practice, resilience, traditional knowledge, Patagonia

Wild plant gathering was an ancient practice among aboriginal inhabitants in northwestern Patagonia (Ladio and Lozada 2000, 2001). The Mapuche people frequently collected wild plants for medicinal and edible purposes in the temperate forests of Chile and Argentina. Nowadays, most communities which inhabit arid zones maintain this tradition, incorporating wild plants and adapting their plant knowledge to this drier environment (Ladio, Lozada, and Weigandt 2007; Ladio and Lozada 2008, 2009). Wild plant use in the Mapuche people reflects profound knowledge and know-how, the result of close interaction with their natural resources (Ladio and Lozada 2000).

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In ancient times, locals cultivated the land, developing poly-cultures within natural ecosystems (Mösbach 1992). Their horticultural practice was less destructive than nowadays given that they did not use animals or plough the land (Torrejón and Cisternas 2002). For these people, planting constituted a sacred rite; women performed this task because they represented fertility, whereas men were in charge of preparing the soil (Montaldo Bustos 2004). They used to cultivate native species such as: maize (*Zea mays*), quinoa (*Chenopodium quinoa*), potatoes (*Solanum tuberosum*), pumpkin (*Cucurbita maxima*) and pepper (*Capsicum annum*) before the Spanish conquest (Mösbach 2000; Torrejón and Cisternas 2002; Montaldo Bustos 2004; Pardo and Pizzaro 2005). Around the seventeenth century, the Spanish conquerors arrived and exterminated local populations, amongst whom were the Mapuche. In Argentina, this colonization process continued until the "Desert campaign," a violent military offensive which took place at the end of the nineteenth century. Since these dramatic historical events, Mapuche communities have undergone radical transformations in social, economic and cultural aspects, bringing about notable changes in their customs, diet, health care system and cultivation practices (Torrejón and Cisternas 2002). With time, traditional crops practically disappeared and were replaced by exotic species such as barley, wheat and oats (Pardo and Pizzaro 2005).

Traditional ecological knowledge (TEK) has been defined as a collective body of information, practices, and beliefs about the relationship between living beings and their environment, which has been handed down for generations by cultural transmission (Berkes and Folke 2002; Walker et al. 2004). This corpus of local wisdom includes know-how and knowledge of cultivation and wild plant gathering. It has been proposed that TEK contributes to building resilience (Ladio and Lozada 2008; Eyssartier, Ladio, and Lozada 2011; Ladio, forthcoming [a]).

Resilience refers to the capacity of a system to absorb disturbance and reorganize itself while undergoing change (Berkes and Folke 2002). In this way, locals who have greater plant knowledge, developed in diverse contexts (through horticulture or wild plant gathering), have a greater possibility of integrating ancestral and new practices, recreating their traditional knowledge and adapting to new living conditions.

In Northwestern Patagonia, traditional gathering and cultivation knowledge is conspicuously diminishing and undergoing transformation (Ladio and Lozada 2008; Eyssartier et al. 2011). Whereas most rural communities here still collect wild plants for healing purposes, the custom of gathering edible wild plants has decreased. This fact has promoted a decline in plant diversity in local diets (Ladio and Lozada 2003; Estomba, Ladio, and Lozada 2005; Ladio 2006; Ladio et al. 2007; Molares and Ladio 2009a).

In relation to horticulture, extension agents from Argentine government institutions and certain non-governmental organizations (NGO's) have introduced new practices and technology in several rural communities of the region (Eyssartier et al. 2007, 2011). This was observed in Pilcaniyeu, a

local community close to Pichi Leufu (the study case of this investigation), where more than half of the inhabitants have incorporated the use of greenhouses into their horticultural traditions (68.8%), indicating frequent use of this new technology. Extension agents have also influenced local traditions promoting the cultivation of exotic crops and generating dependence on seed acquisition, instead of encouraging the collection of seeds from their own production (Eyssartier et al. 2011).

The aim of the present study is to describe how a small rural population of the Patagonian steppe develops their traditional plant knowledge in relation to horticulture and gathering. We hypothesize the existence of complementary use of gathering and cultivating practices, favoring resilience in the local community. For this purpose, we will explore different aspects of both traditional practices, analyzing plant diversity, species similarity, biogeographic origin and plant use.

Given the prevalent historical and sociocultural factors described above, we expect to find:

1. A complementary trend in horticultural and gathering practices, and differences between cultivated and collected plants, such that locals will collect a greater proportion of wild plants for medicinal use than for edible purposes, whereas edible resources will be mainly cultivated;
2. Most cultivated species will be exotic, whereas most wild gathered species will be native; and
3. Locals who have greater TEK will have more capacity for learning and adaptation, and this will be reflected in the following ways:
   - Prediction 3.1: locals who gather more wild species will cultivate greater richness of plants;
   - Prediction 3.2: locals who use greater richness of plants will cultivate greater extensions of land; and
   - Prediction 3.3: locals who have incorporated greenhouses will cultivate greater richness in vegetable gardens and gardens.

The main interest of this article is to illustrate how locals who actively maintain, create, and recreate their traditional practices have greater social ecological resilience indicating that TEK contributes to their living conditions and wellbeing. Through the complementation and diversification of activities (such as horticulture and gathering practices), locals are able to make use of a wider repertoire of adaptive responses.

METHODS

Study Site

Pichi Leufu is a rural community located in the province of Rio Negro, Argentina (41°6′S and 70°51′W) and is inhabited by approximately 30 families. The nearest urban center is the city of San Carlos de Bariloche, which

is located approximately 100 km away. This area has a mean annual temperature between 8°C and 10°C and a mean annual rainfall between 200 and 400 mm. Pichi Leufu is characterized by the Patagonian steppe ecosystem, and the dominant vegetation cover consists of shrubs and herbs: neneo (*Mulinum spinosum*); charcao (*Senecio filaginoides*); coirón amargo (*Stipa humilis*, *Stipa speciosa*) and *Poa huecu, Bromus macranthus*, *Poa ligularis*, *Festuca argentina* and other herbs (Cabrera 1976). In this region with valleys and swamps, the Pichi leufu river runs through the community settlement. Because of this river, where locals go fishing and swimming, climatic conditions are more beneficial for cultivation.

Most inhabitants of Pichi Leufu are cattle-raisers, whereas others, who live close to the only two primary schools in the vast territory, work in these educational institutions. Women usually stay at home doing household chores and taking care of cultivated areas; whereas men spend most of their time far from their homes, taking care of the cattle.

Pichi Leufu is a community of mestizo origin; some inhabitants are direct descendants of the Mapuche people, while others have mixed ancestry.

Some public and non-governmental institutions, such as the National Institute of Agricultural Technology (INTA), occasionally visit the zone to provide social and technical assistance. Since 1992, extension agents have provided materials to build greenhouses, tools necessary for horticultural practice and exotic plant seeds, for example, lettuce (*Lactuca sativa*), chard (*Beta vulgaris* var. *cicla*), beans (*Vicia faba*), carrot (*Daucus carota*). However, given the difficult access to Pichi Leufu, seeds are often kept first in the nearby population of Pilcaniyeu, and then distributed to the Pichi Leufu inhabitants by a health agent.

Data Collection

During the summer and fall of 2008, a total of 17 individuals (16 women and 1 men), between 21 and 81 years old, were interviewed. Domestic units were selected at random and only the people directly responsible for cultivated areas were chosen in each family. All informants agreed to take part in semi-structured interviews (Alexiades 1996; Tuxill and Nabhan 2001) in which we gathered personal information such as: interviewee's age and gender, and aspects related to cultivation in vegetable gardens, greenhouses and gardens, and gathering practice. We inquired about cultivated and gathered plant species, local names and common uses (use-categories), biogeographic origin and seed origin. Moreover, open and in-depth interviews were conducted to explore information about Pichi Leufu historical customs.

This information was supplemented with the participation of the dwellers who collaborated with the collection of wild and cultivated species from vegetable gardens, greenhouses, and gardens, in order to make field herbariums. The latter were deposited in the Herbarium of Centro

Regional Universitario Bariloche (BCRU), following the nomenclature of Correa (1969–1999), Marticorena and Quezada (1985), and Ezcurra and Brion (2005).

Data Analysis

Species richness (in total and per person) was calculated considering the total number of plants cultivated and gathered. To determine similarity between gathered and cultivated species, and between different cultivated areas (vegetable gardens, greenhouses and gardens) we used the Jaccard similarity index (Höft, Barik, and Lykke 1999). This index is based on plant presence or absence while taking number of species in common as a proportion of total number of species present, expressed as $JI = (c/[a + b + c]) \times 100$, where c is the number of species in common, a is the number of unique species, for example, in a given cultivated area, and b is the number of species unique to the other area. The consensus index (CI) per species was estimated by calculating the proportion of plants mentioned with respect to the total number of interviewees (e.g., in the case of peas, 14 of 17 persons cited this species, 82% of the population).

Non parametric tests were used to analyze data non-normally distributed (Höft et al. 1999). The Spearman rank correlation was used to analyze associations between cultivated and gathered species richness, and the relationship between total richness of cultivated and wild species with total area of cultivated land ($p < .05$). The Kruskal-Wallis test was used to compare plant richness per person in each cultivated area. Additionally, Cochran's Q test was applied to compare informants who still cultivate in vegetable gardens with those who have incorporated the use of greenhouses, and to compare use-categories of species cultivated in vegetable gardens, greenhouses, and gardens. Lastly, Chi-square test ($p < .05$) was used to evaluate proportion of native and exotic crops and wild plants, as well as native and exotic medicinal wild plants (Höft et al. 1999). Data was analyzed with SPSS 10.0 for Windows.

RESULTS

Horticultural Practice

Horticultural practice is developed in three different areas: vegetable-gardens, greenhouses and gardens. Comparing plant richness proportion among these three cultivated areas, we recorded more species in gardens (44.4%), followed by vegetable gardens (30.3%) and finally greenhouses (25.3%). When analyzing mean species richness per interviewee, more species per person in vegetable gardens (11.1 species), followed by gardens (7.8 species) and greenhouses (4.5 species) were recorded (Kruskal-Wallis

test, $p < .05$). In relation to the use of wild plants, we recorded 5.2 species collected on average per interviewee. According to the interviews, most of the Pichi Leufu dwellers (82.3%) still cultivate in vegetable gardens, while 53% of them have incorporated the use of greenhouses (Cochran's Q test: 2.778, $p = .096$). Interestingly, only 22.2% of the greenhouses were built with the aid of extension agents, who provided economical and technical assistance; whereas 77.8% of the greenhouses were constructed by the dwellers, in collaboration with other members of the family or the community. Additionally, we found that 97% of the cultivated areas corresponded to vegetable gardens. When analyzing species similarity between cultivated scenarios, we observed that the Jaccard index was relatively low (i.e., 25.3% between vegetable gardens and greenhouses, 12.4% between vegetable gardens and gardens, and only 5.9% between greenhouses and gardens).

In Pichi Leufu, vegetable garden mean area was 969.4 m^2 (±1508.52), while greenhouse mean area was 30.3 m^2 (±9.87); indicating that these cultivated areas varied greatly in size. Some locals also cultivate in crofts ("chacras"), which can be described as cultivated areas of greater extension (between 30,000 and 40,000 ha), generally used for growing alfalfa (*Medicago sativa*).

In relation to seed use, we found that a high percentage of Pichi Leufu inhabitants (82.3%) collected seeds from their own production, whereas only 17.6% used seeds from external sources (χ^2_1: 7.118, $p < .005$).

Gathering and Cultivating Practices Complement Each Other: Species Richness Analysis

Pichi Leufu inhabitants used a total of 173 plant species, 80.3% (138 spp.) of which were cultivated plants, whereas 26% (45 spp.) were gathered wild species. Cultivated species were distributed among 43 botanic families (table 1), while collected species belonged to 23 plant families (table 2). The most representative plant family in both cases was Asteraceae (39.5% for cultivated plants and 34.8% for wild plants). From the total of 45 gathered plants, 40 species were collected in the steppe, from nearby sites, generally close to their dwellings, while 5 species were exclusively gathered from anthropic disturbed places such as abandoned lots, which had previously been vegetable gardens (table 2). Moreover, species similarity between cultivated and gathered plants was notably low (Jaccard index: 7%).

In addition, we found that the richness of cultivated species cited per person was associated with the richness of wild plants gathered per person ($r_{17} = .718$, $p = .001$; figure 1). We also observed that wide extensions of cultivated areas were related to higher plant richness per person of cultivated ($r_{17} = .649$, $p < .01$) and wild species ($r_{17} = .792$, $p < .001$; figure 2).

TABLE 1 Plant Species Recorded in Vegetable Gardens, Gardens, and Greenhouses in the Pichi Leufu Community

Plant species	Local name	Plant family	Origin	Common uses	C.A.	C.I.
Pisum sativum L.	Arveja	Fabaceae	Exotic	e	vg, gh	.82
Lactuca sativa L.	Lechuga	Asteraceae	Exotic	e	vg, gh	.82
Beta vulgaris var. *cicla* L.	Acelga	Chenopodiaceae	Exotic	e	vg, gh	.76
Ribes grossularia L.	Grosella	Saxifragaceae	Exotic	e	vg, g	.65
Vicia faba L.	Haba	Fabaceae	Exotic	e	vg	.65
Brassica oleraceae var. *capitata* L.	Repollo	Brassicaceae	Exotic	e	vg, gh	.59
Daucus carota L.subsp. *sativus* (Hoffm.)Schübl.et G.Martens	Zanahoria	Apiaceae	Exotic	e	vg, gh	.59
Allium sativum L.	Ajo	Liliaceae	Exotic	e, m	vg, g	.53
Origanum vulgare L.	Orégano	Lamiaceae	Exotic	e, m	vg, gh, g	.53
Fragaria vesca L.	Frutilla	Rosaceae	Exotic	e	vg, gh, g	.47
Malus domestica Borkh	Manzano	Rosaceae	Exotic	e	vg, g	.47
Apium graveolens L.	Apio	Apiaceae	Exotic	e	vg, gh	.41
Prunus domestica L.	Ciruelo	Rosaceae	Exotic	e	vg, g	.41
Prunus cerasus L.	Guindo	Rosaceae	Exotic	e	vg, g	.41
Solanum tuberosum L.	Papa	Solanaceae	Exotic	e	vg, gh	.41
Petroselinum crispum (Mill.) Nym.	Perejil	Apiaceae	Exotic	e	vg, gh	.41
Nepeta cataria L.	Toronjil	Lamiaceae	Exotic	m	vg, gh, g	.41
Calendula officinalis L.	caléndula/chinita	Asteraceae	Exotic	o	gh, g	.35
Allium fistulosum L.	Cebolla de verdeo	Liliaceae	Exotic	e	vg, gh	.35
Allium schoenoprasum L.	Chalota	Liliaceae	Exotic	e	vg, gh	.35
Lupinus polyphyllus Lindl.	chocho/lupino	Fabaceae	Exotic	o	vg, g	.35
Coriandrum sativum L.	Cilantro	Apiaceae	Exotic	e	vg, gh	.35
Rosa sp.	rosa	Rosaceae	Exotic	o	g	.35
Medicago sativa L.	Alfalfa	Fabaceae	Exotic	f	vg, gh	.29
Allium cepa L.	Cebolla	Liliaceae	Exotic	e	vg	.29
Rubus idaeus L.	Frambuesa	Rosaceae	Exotic	e	vg, gh, g	.29
Narcissus sp.	Narcizo	Amaryllidaceae	Exotic	o	g	.29

(*Continued*)

TABLE 1 (Continued)

Plant species	Local name	Plant family	Origin	Common uses	C.A.	C.I.
Solanum lycopersicum L.	Tomate	Solanaceae	Exotic	e	gh	.29
Tulipa sp.	Tulipán	Liliaceae	Exotic	o	g	.29
Artemisia absinthium L.	Ajenjo	Asteraceae	Exotic	m	vg, g	.24
Syringa vulgaris L.	Lila	Oleaceae	Exotic	o	vg, g	.24
Zea mays L.	Maiz	Poaceae	Exotic	e	vg, gh	.24
Pyrus communis L.	Pera	Rosaceae	Exotic	e	vg, g	.24
Avena sp.	Avena	Poaceae	Exotic	f	vg	.18
Muscari sp	bracito de muñeca/perlita/ firma de salomón	Liliaceae	Exotic	o	g	.18
Spinacia oleracea L.	Espinaca	Chenopodiaceae	Exotic	e	vg, gh	.18
Helianthus annus L.	Girasol	Asteraceae	Exotic	o, s/l.v	vg, g	.18
Godetia amoena (Lehm.) Don	Godesia	Enoteraceae	Exotic	o	g	.18
Iris germanica L.	Lirio	Iridaceae	Exotic	o	g	.18
Malva sylvestris L.	Malva	Malvaceae	Exotic	o	g	.18
Achillea millefolium L.	Milenrama	Asteraceae	Exotic	o	g	.18
Paeonia lactiflora Pall.	Peonia	Ranunculaceae	Exotic	o	g	.18
Raphanus sativus L.	Rabanito	Chenopodiaceae	Exotic	e	vg	.18
Beta vulgaris var. *vulgaris* L.	Remolacha	Chenopodiaceae	Exotic	e	vg, gh	.18
Cytisus scoparius L. (Link.)	Retama	Fabaceae	Exotic	o, s/l.v	vg, g	.18
Salix sp.	Sauce	Salicaceae	Exotic	o, s/l.v	vg	.18
Allium porrum L.	ajo puerro	Liliaceae	Exotic	e	gh	.12
Populus nigra L.	Álamo	Salicaceae	Exotic	o, s/l.v	vg	.12
Alstroemeria aurea Graham	Amancay	Alstroemeriaceae	Native	o	g	.12
Papaver rhoeas L.	Amapola	Papaveraceae	Exotic	o	g	.12
Luma apiculata (DC.) Burret	Arrayán	Myrtaceae	Native	o, s/l.v	g	.12
Allium cepa L.	Cebolla araucana	Liliaceae	Exotic	e	vg	.12
Allium cepa L.	Cebolla colorada	Liliaceae	Exotic	e	vg	.12
Secale sp.	Centeno	Poaceae	Exotic	f	vg	.12
Eschscholtzia californica Cham.	copita de oro	Papaveraceae	Exotic	o	g	.12

Dahlia juarezii Hort.	Dalia	Asteraceae	Exotic	o	gh, g	.12
Prunus armeniaca L.	Damasco	Rosaceae	Exotic	e	vg, g	.12
Foeniculum vulgare Mill.	Hinojo	Apiaceae	Exotic	e	vg, g	.12
Maytenus boaria Molina	Maitén	Celastraceae	Native	o, s/l.v	g	.12
Chrisantemun parthenium (L.) Bernhardi	Margarita	Asteraceae	Exotic	o	g	.12
Mentha sp.	Menta	Lamiaceae	Exotic	m	gh, g	.12
Mentha spicata L.	menta negra	Lamiaceae	Exotic	m	vg, g	.12
Brassica rapa L.	Nabo	Brassicaceae	Exotic	e	vg, gh	.12
Viola tricolor L.	pensamiento	Violaceae	Exotic	o	gh, g	.12
Rheum rhabarbarum L.	Ruibarbo	Polygonaceae	Exotic	e, m, o	g	.12
Sambucus nigra L.	Sauco	Caprifoliaceae	Exotic	e, m, o	vg, g	.12
Helianthus tuberosus L.	topinambur/tupinambo	Asteraceae	Exotic	o	vg, gh	.12
Tritricum sp.	Trigo	Poaceae	Exotic	e	vg	.12
Crocosmia crocosmiflora (Nich.) N.E.Br.	varita de S. José	Iridaceae	Exotic	o	gh, g	.12
Cucurbita maxima var. *zapallito*	Zapallo	Cucurbitaceae	Exotic	e	gh	.12
Picea glauca (Moench) Voss	abeto azul	Pinaceae	Exotic	o	g	.06
Taraxacum officinale Web.	Achicoria	Asteraceae	Exotic	e, m	vg	.06
Aloe sp.	Aloe	Liliaceae	Exotic	m, o	g	.06
Pimpinella anisum L.	Anís	Apiaceae	Exotic	m, o	vg	.06
?	Arvejilla	Fabaceae	?	o	g	.06
Brassica oleraceae L. var. *italica* Plenck	Brócoli	Brassicaceae	Exotic	e	vg	.06
?	Cactus	Cactaceae	Exotic	o	g	.06
Campanula rapunculoides L.	Campanita	Campanulaceae	Exotic	o	vg, g	.06
Hordeum sp.	Cebada	Poaceae	Exotic	f	vg	.06
Allium cepa L.	cebolla inverniza	Liliaceae	Exotic	e	vg	.06
Allium sp.	Cebollita	Liliaceae	Exotic	e	vg	.06
Prunus avium L.	Cerezo	Rosaceae	Exotic	e	g	.06
Fuchsia magellanica Lam.	Chilco	Enoteraceae	Native	o	g	.06
Lupinus arboreus Sims.	chocho silvestre	Fabaceae	Exotic	o	g	.06
Dianthus caryophyllus L.	Clavel	Caryophyllaceae	Exotic	o	gh	.06
Dianthus barbartus L.	Clavelina	Caryophyllaceae	Exotic	o	g	.06

(*Continued*)

TABLE 1 (Continued)

Plant species	Local name	Plant family	Origin	Common uses	C.A.	C.I.
Nothofagus dombeyi (Mirb.) Oerst.	Coihue	Fagaceae	Native	o	g	.06
Antirrhinum majus L.	conejito	Scrophulariaceae	Exotic	o	g	.06
Ribes aureum Pursh.	corinto	Saxifragaceae	Exotic	e, s/l.v	vg	.06
Cosmos bipinnatus Cav.	cosmos	Asteraceae	Exotic	o	gh	.06
Asparagus officinalis L.	espárrago	Liliaceae	Exotic	e	vg	.06
Consolida ajacis (L.) Schur	espuela de caballero	Ranunculaceae	Exotic	o	g	.06
Symphoricarpos albus Blake	flor de perla	Caprifoliaceae	Exotic	o	g	.06
Gaillardia x glandiflora	girasol de jardín	Asteraceae	Exotic	o	g	.06
Gladiolus sp.	gladiolo	Iridaceae	Exotic	o	g	.06
Amaranthus caudatus L.	kiwicha	Amaranthaceae	Exotic	o	gh	.06
Schinus patagonica (Phil.) I.M Johnst.	laura	Anacardiaceae	Native	o	g	.06
Lactuca sativa L.	lechuga morada	Asteraceae	Exotic	e	gh	.06
Lactuca sativa L.	lechuga repollada	Asteraceae	Exotic	e	gh	.06
Plantago lanceolata L.	llantén	Plantaginaceae	Exotic	m	g	.06
Marrubium vulgare L.	malva rubia	Lamiaceae	Exotic	m, o	gh	.06
Althaea rosea L. (Cav)	malvón	Malvaceae	Exotic	o	g	.06
?	manzanilla	Asteraceae	Exotic	m	g	.06
Malus sp.	manzano (amarillas aromáticas)	Rosaceae	Exotic	e	g	.06
Malus sp.	manzano (amarillas)	Rosaceae	Exotic	e	g	.06
Malus sp.	manzano (rojas)	Rosaceae	Exotic	e	g	.06
Malus sp.	manzano (verdes)	Rosaceae	Exotic	e	g	.06
Chrisantemun maximum Ram.	margarita	Asteraceae	Exotic	o	g	.06
Tanacetum balsamita	menta blanca	Lamiaceae	Exotic	m	g	.06
Berberis darwinii Hook.	michay	Berberidaceae	Native	e	vg	.06
Salix fragalis L.	mimbre	Salicaceae	Exotic	o, s/l.v	vg	.06
Lunaria annua L.	moneda del papa	Brassicaceae	Exotic	o	g	.06
Capsicum annuum L.	morrón	Solanaceae	Exotic	e	gh	.06

Embothrium cocineum J.R. Forst & G. Forst	notro	Proteaceae	Native	o, s/l.v	g	.06
Ulmus sp.	olmo	Ulmaceae	Exotic	o, s/l.v	vg	.06
Tanacetum vulgare L.	palma	Asteraceae	Exotic	m	g	.06
Ribes magellanicum Poir.	parrilla	Saxifragaceae	Native	e	g	.06
Cucumis sativus L.	pepino	Cucurbitaceae	Exotic	e	gh	.06
Petunia hybrida Vilm.	petunia	Solanaceae	Exotic	o	gh	.06
Lomatia hirsuta (Lam.) Diels ex J.F. Macbr.	radal	Proteaceae	Native	o, s/l.v	g	.06
Quercus sp.	roble	Fagaceae	Exotic	o, s/l.v	gh	.06
Rosmarinus officinalis L.	romero	Lamiaceae	Exotic	e, m	vg	.06
Salvia officinalis L.	salvia	Lamiaceae	Exotic	m	g	.06
Salix x erythroflexuosa Rag. et R. Alb.	sauce eléctrico	Salicaceae	Exotic	o, s/l.v	g	.06
Nardophyllum obtusifolium	siete camisas	Asteraceae	Native	o	g	.06
Thymus vulgaris L.	tomillo	Lamiaceae	Exotic	e, m	gh	.06
Oxalis triangularis St. Hilaire	trébol rojo	Oxalidaceae	Exotic	o	g	.06
Viola odorata L.	violeta	Violaceae	Exotic	o	g	.06
Mentha rotundifolia (L.) Huds.	yerba buena	Lamiaceae	Exotic	m	g	.06
Vinca major L.		Apocinaceae	Exotic	o	g	.06
Phlox paniculata L.		Polemoneaceae	Exotic	o	g	.06
Nepeta musinii Henk.		Lamiaceae	Exotic	o	g	.06
Matricaria inodora L.		Asteraceae	Exotic	o	g	.06
Lychnis coronaria (L.) Desr.		Caryophyllaceae	Exotic	o	g	.06
Lilium duricum Ker.		Liliaceae	Exotic	o	g	.06
Hypericum perforatum L.		Clusiaceae	Exotic	o	g	.06
Convolvulus arvensis L.		Convolvulaceae	Exotic	o	g	.06
Calystegia sepium (L.) R. Br.		Convolvulaceae	Exotic	o	g	.06

Note. Common Uses: e (edible), m (medicinal), o (ornamental), f (fodder), s/l.v (shade/living fences). C.A. (Cultivated area): vg (vegetable garden), g (garden), gh (green house). C.I. (Consensus index).

TABLE 2 Species Gathered by Pichi Leufu Dwellers

Plant species	Local name	Plant family	Origin	Collection site	Plant use	C.I.
Adesmia boronioides Hook.f.	paramela	Fabaceae	Native	wild	res/cir	.41
Baccharis sagittalis (Less.) DC.	carqueja	Asteraceae	Native	wild	dig	.35
Artemisia absinthium L.	ajenjo	Asteraceae	Exotic	anthropic/wild	dig/c.a.s	.24
Erodium cicutarium (L.) L´Her.ex Aiton	alfilerillo	Geraniaceae	Exotic	wild	dig/res/feb/aaller	.24
Mulinum spinosum (Cav.) Pers.	neneo	Apiaceae	Native	wild	an/dia	.24
Chenopodium ambrosioides L.	paico	Chenopodiaceae	Native	wild	dig/c.a.s/apar	.24
Buddleja araucana Phil.	pañil	Buddlejaceae	Native	wild	der/inf	.24
Mentha sp.	menta	Lamiaceae	Exotic	anthropic/wild	dig/an/edi	.18
Gunnera magellanica Lam.	nalca	Gunneraceae	Native	wild	res/an/edi	.18
Plantago lanceolata L.	siete venas	Plantaginaceae	Exotic	wild	inf	.18
Apium sp.	apio silvestre	Apiaceae	Exotic	wild	res/feb	.12
Centaurium cachanlahuen (Molina) B.L.Rob.	canchalagua	Gentianaceae	Native	wild	res	.12
Sanicula graveolens Poepp. Ex DC.	cilantro silvestre	Apiaceae	Native	wild	edi	.12
Taraxacum officinale Web.	diente de león	Asteraceae	Exotic	wild	dig/cir/edi	.12
Plantago major L.	llantén	Plantaginaceae	Exotic	wild	inf	.12
Marrubium vulgare L.	malva rubia	Lamiaceae	Exotic	wild	res	.12
Mutisia oligodon Poepp. & Endl.	mutisia	Asteraceae	Native	wild	inf	.12
Valeriana carnosa Sm.	ñanco lahuen	Valerianaceae	Native	wild	res/sed	.12
Urtica sp.	ortiga	Urticaceae	Exotic	wild	cir	.12
Fabiana imbricada Ruiz & Pav.	palo piche	Solanaceae	Native	wild	dig/cir	.12
Sambucus nigra L.*	sauco	Caprifoliaceae	Exotic	anthropic	res/feb	.12
Nepeta cataria L.*	toronjil	Lamiaceae	Exotic	anthropic	sed	.12
Mentha rotundifolia (L.) Huds.	yerba buena	Lamiaceae	Exotic	wild	dig/edi	.12
Medicago sativa L.*	alfalfa	Fabaceae	Exotic	anthropic		.06
?	alfen lahuen	?	Native	wild	an	.06

Usnea sp.	barba de piedra	Usneaceae	Native	wild	dig	.06
Calendula officinalis L.*	caléndula	Asteraceae	Exotic	anthropic	inf	.06
*Acaena splendens*Gillies ex Hook. & Arn.	cepa caballo	Rosaceae	Native	wild	ren	.06
Discaria sp.	chacay	Rhamnaceae	Native	wild		.06
Baccharis salicifolia (Ruiz & Pav.) Pers.	chilca	Asteraceae	Native	wild	dig	.06
Cordaderia sp.	cortadera/colita de zorro		?	wild		.06
Oxalis sp.	culle	Oxalidaceae	Native	wild	res/edi	.06
Artemisia abrotanum L.	éter	Asteraceae	Exotic	wild	dig	.06
Foeniculum vulgare Mill.	hinojo	Apiaceae	Exotic	wild	dig	.06
Equisetum bogotense H.B.K.	limpia plata	Equisetaceae	Native	wild	ren	.06
*Malva sylvestris*L.	malva arrastrada	Malvaceae	Exotic	wild	res/der/inf	.06
Stellaria media (L.) Cirillo	quilloy	Caryophyllaceae	Native	wild	res	.06
Chenopodium album L.	quinguilla	Chenopodiaceae	Exotic	wild	edi	.06
Ruta graveolens L.*	ruda	Rutaceae	Exotic	anthropic	c.a.s	.06
Polygonum aviculare	sanguinaria	Polygonaceae	Exotic	wild	cir/gyn	.06
Satureja darwinii (Benth.) Briquet	tomillo	Lamiaceae	Native	wild	dig	.06
Calceolaria sp.	topa topa	Scrophulariaceae	Native	wild	inf	.06
Nassauvia glomerulosa (Lag. Ex Lindl.) D. Don	uña de gato	Asteraceae	Native	wild		.06
Rumex acetosella L.	vinagrillo	Polygonaceae	Exotic	wild	edi	.06
Margyricarpus pinnatus (Lam.) O. Kuntze	yerba de la perdíz	Rosaceae	Native	wild	gyn	.06

Note. Plant use: dig (digestive), res (respiratory/antitusive), an (analgesic/anti-inflammatory), der (dermatologic), cir (circulatory), sed (sedative), feb (febrifuge), gyn (gynecological), c.a.s (cultural affiliation syndrome: "empacho", heals the body, seven diseases), inf (infections), aaller (anti-allergic), apar (anti-parasitic), dia (diabetes), edi (edible). C.I. (Consensus index).

*species collected from abandoned lots formerly cultivated.

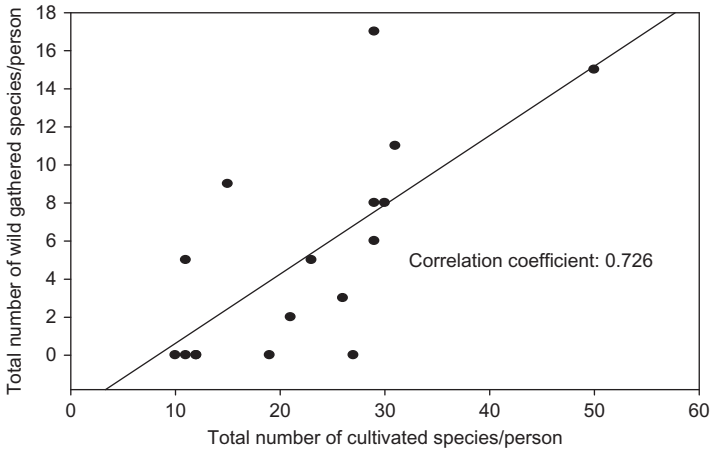

FIGURE 1 Relationship between total number of cultivated species and wild gathered plants, per person.

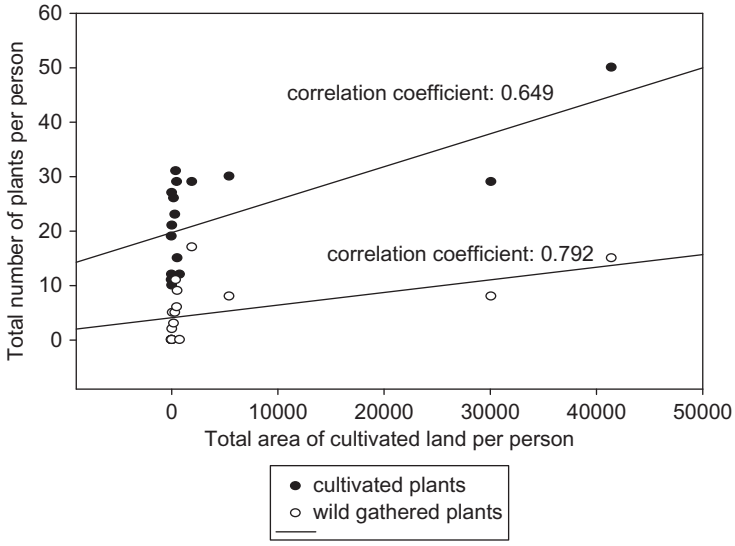

FIGURE 2 Relationship between total area of cultivated land and total number of cultivated and collected species, per person.

Use Categories in Each Practice

In Pichi Leufu, each cultivated scenario had a prevalent purpose. In vegetable gardens, there was a higher percentage (69.5%) of cultivated species for edible purposes, compared to medicinal (16.9%) and ornamental (20.3%) uses (Cochran's Q test: 93.915, $p < .01$). Furthermore, Pichi Leufu dwellers used greenhouses mainly for food production (53.1%) (Cochran's Q test: 68.113, $p < .01$). Lastly, we observed a high proportion (64%) of ornamental

species cultivated in gardens (Cochran's Q test: 134.174, $p < .01$). Only 17.8% of collected wild plants were cited for edible purposes, whereas the majority (82.2%) was for medicinal use.

Biogeographical Origin of Plants

When analyzing geographic origin, we found a high proportion (91.3%) of exotic cultivated plant species (χ^2_1: 96.533, $p < .001$). Most informants named peas (*Pisum sativum*; 82%) and lettuce (*Lactuca sativa*; 82%) as the most frequently cultivated crops, followed by chard (*Beta vulgaris* var. *Cicla*), currants (*Ribes grossularia*), broad beans (*Vicia faba*), cabbage (*Brassica oleraceae* var. *capitata*), carrots (*Daucus carota*), garlic (*Allium sativum*) and oregano (*Origanum vulgare*).

In contrast, only 43.2% of the wild species were exotic; 56.8% being native. Although more native species were collected, no significant differences were found between the proportion of native and exotic wild plants (χ^2_1: 0.2, $p > .05$).

Significant differences were found when comparing the number of collected and cultivated native and exotic species. We found a higher number of native gathered species (24 spp.) than cultivated ones (11 spp.; χ^2_1: 4.829, $p < .02$). On the other hand, Pichi Leufu dwellers cultivated more exotic species (127 spp. cultivated vs 21 spp. Collected; χ^2_1: 75.919, $p < .001$).

Medicinal Cultivated and Collected Plants

The medicinal use most frequently reported was for digestive maladies. Regarding the use of cultivated medicinal plants, 34.5 % of interviewees mentioned using them for gastro-intestinal ailments, *Nepeta cataria* (toronjil) (17.6%) and *Artemisia absinthium* (ajenjo; 11.7%) being the most frequently cultivated. For these disorders, 29% of locals mainly used wild species, *Baccharis sagittalis* (carqueja) being the most frequently cited (29.4%), followed by *Chenopodium ambrosioides* (paico; 17.6%).

Respiratory ailments were mentioned in the second place of importance for both cultivated species (20.7%) and collected ones (21.7%). Dwellers cultivated: *Artemisia absinthium* (ajenjo), *Allium sativum* (garlic), *Marrubium vulgare* (malva rubia), *Salvia officinalis* (sage), *Sambucus nigra* (elder) and *Thymus vulgaris* (thyme) for this ailment. Among collected species, *Adesmia boronioides* (paramela) was mentioned in the first place (23.5%), followed by *Marrubium vulgare* (malva rubia; 11.7%), *Gunnera magellanica* (nalca; 11.7%) and *Centaurium cachanlahuen* (cachanlahua; 11.7%).

When comparing wild and cultivated medicinal plants, we observed that 17.3% (24 species) of the total cultivated species (all exotic) were use for medicinal purposes. In addition, a great proportion (93.3%) of collected wild species were for medicinal purposes. From a total of 42 medicinal wild

plants employed, 45.2% were exotic whereas 52.4% were native (proportions non-significantly different, χ^2_1: 0.095, $p > .05$). Only *Sanicula graveolens* (wild "cilantro"), *Chenopodium album* (quinguilla) and *Rumex acetosella* (vinagrillo) were exclusively used as edible species.

DISCUSSION

In this study we found that Pichi Leufu inhabitants build on their traditional plant knowledge, integrating ancestral and new customs. Gathering and cultivating practices complement each other, as found in other populations with subsistence economy (Milliken and Albert 1997; Price 2006). Pichi Leufu dwellers have developed extensive horticulture know-how mainly applied to edible, exotic species, whilst maintaining their wild plant gathering tradition mostly for medicinal plants. The fact that horticulture and gathering activities, related to edible and medicinal uses respectively, complement each other could suggest the importance of these two practices closely linked in the past. It could also show resilient processes in response to changes in the customs of this population due to historic western influence. The change towards cultivation of exotic species could have propitiated the abandonment of wild edible plant gathering, while maintaining the gathering of medicinal plants which could not be replaced.

In this isolated population, in spite of the co-existence of the State Health system (with sporadic visits of physicians in the area), medicinal plant use has a significant and irreplaceable role because inhabitants can deal competently with ill health. On the other hand, edible wild plant gathering has been stigmatized in some rural communities, because edible plant collection could be associated with poverty (Price 2006). Social stigma related to gathering edible resources is an important issue that needs further exploration.

The cultivation of exotic crops could be related to cultural imposition and historical inertia processes (Montaldo Bustos 2004). It is thought that with the arrival of the Spanish conquerors, locals had to assimilate and adopt crops brought by the invaders as an adaptive survival strategy (Torrejón and Cisternas 2002; Eyssartier et al. 2011). In this way, wheat, barley and other plants of Euro-Asian origin were easily incorporated, replacing ancestral crops cultivated until then. This might have contributed to eroding processes in their cultivation tradition of native crops.

However, in Pichi Leufu, horticultural diversity has been promoted by the inclusion of exotic domesticated plants. At present, one of the most frequent crops cultivated by Pichi Leufu dwellers was peas (*Pisum sativum*), a particular tradition maintained throughout many generations in this community. Together with peas, the most preferred cultivated species was lettuce (*Lactuca sativa*), as also observed in the Pilcaniyeu population (Eyssartier

et al. 2011). This concordant choice might be associated with the fact that lettuce grows easily and develops in a short period of time. This favorable crop could not only provide an abundant source of greens but could also enhance their motivation to cultivate other species in these arid, hostile lands.

The relatively high consensus of cultivated species among Pichi Leufu locals might indicate convergent dietary patterns, suggesting western influence on local food production (e.g., exotic seeds provided by extension agents, incorporation of greenhouses). This could also have contributed to the replacement of local cultivars, promoting homogeneity and increasing the erosion of biological and cultural diversity on a global scale (Etkin 1998). Furthermore, in this region, the forced withdrawal from locals' original habitats and restricted access to natural resources were historical circumstances likely to have influenced the people's diet (Estomba et al. 2005; Lozada, Ladio, and Weigandt 2006; Ladio and Lozada 2008, 2009; Ladio 2010). As a general tendency, the world population is fed with about 20 crops, though more than 15,000 edible plant species have been recorded worldwide (Rapoport and Drausal 2001). The global tendency to rely on cultivation for food production might also have contributed to the increase in horticulture in detriment to gathering practices, bringing about other changes in their traditions.

In accordance to prediction 2, wild plant gathering seems to maintain the use of native species in a significantly higher proportion than for horticulture (91.3% versus 8.7% respectively), although the traditional custom of collecting wild plants is diminishing at present (e.g., Lozada et al. 2006; Ladio and Lozada 2009), a fact mentioned by locals in some of the open interviews. Additionally, the proportion of native and exotic gathered plants was similar to that found in other local communities of Northwestern Patagonia, showing a general pattern of hybridization of foreign flora among locals (Ladio 2004; Ladio et al. 2007; Ladio and Lozada 2008).

In the present study, wild plant gathering tradition mostly involved medicinal resources, probably due to the long history of Mapuche medicine, still persisting in several Patagonian communities (Ladio et al. 2007; Ladio and Lozada 2008; Molares and Ladio 2008, 2009a). In the Mapuche culture gathering medicinal plants from the natural environment is believed to be different than cultivating them (Citarella et al. 1995). From the Mapuche perspective, the Mapu (the earth) provides all the remedies they would need for their survival. In addition, the cultivation of medicinal species close to dwellings facilitates the acquisition of regularly used plants (Molares and Ladio 2009a). Moreover, several studies have shown how horticulture tends to replace the collection of edible plants, a fact that could also be associated with changes in diet and improvement of caloric returns (Bates 1985; Grossman 1998; Rapoport and Drausal 2001).

In Pichi Leufu, very low similarity between gathered and cultivated species was found. This fact supports our first prediction that horticultural

activity is mainly associated with edible purposes and wild plant gathering with medicinal use, indicating that these scenarios are culturally and ecologically different. These results are in accordance with Ladio (forthcoming [b]) that found that dwellers who have a home garden know 70% less about native and exotic wild edible plants than those who do not carry out family horticulture. This could explain why complementation is mainly associated with medicinal but not with edible plants.

The Pichi Leufu dwellers who gathered a higher proportion of wild species, cultivated a greater richness of plants on their lands, in agreement with our prediction 3.1. Moreover, plant richness of cultivated and gathered species increased directly with the area of cultivated land, supporting prediction 3.2. These results support our hypothesis of complementation between wild plant gathering and horticulture traditions, suggesting that resilient processes are at work. Both practices are important aspects of their cultural identity, fostering its maintenance and complementation. Additionally, this particular and holistic cosmovision promotes cognitive, emotional and behavioral bonds towards different plant species, where some are obtain through labor while others are generously given by the environment.

Both horticulture and gathering practices seemed to be part of their daily experience, reflecting a close relationship between their historical, social and ecological contexts.

In the Pichi Leufu community three cultivated areas (vegetable gardens, greenhouses, and gardens) could be distinguished, each with specific characteristics. Gardens were particularly important for this community, commonly surrounding the houses, and a high richness of ornamental species were cultivated here. According to locals' comments during the open interviews, they were motivated to cultivate a wide diversity of domesticated ornamental plants by the desire to make their gardens beautiful. For these dwellers, growing ornamental plants seems to be an activity carried out purely for pleasure. In contrast, the cultivation of ornamental species to such an extent was not observed in the Pilcaniyeu community or in other populations close to urban centers (Eyssartier et al. 2011). This could be associated with the fact that working in public institutions and acquiring urban customs could be reducing spare time for gardening, horticulture or collecting wild plants.

Vegetable gardens presented the highest species richness per person as well as the greatest extensions of land cultivation, indicating that locals maintained the tradition of cultivation in these areas. However, the adoption of a new technology, like the use of greenhouses, provided better conditions for cultivating particular crops such as tomato (*Solanum lycopersicum*), pepper (*Capsicum annuum*), cucumber (*Cucumis sativus*), cabbage (*Brassica oleraceae* var. *capitata*), and pumpkin (*Cucurbita maxima*), which would not be able to grow under the severe climatic conditions of the steppe. Plant richness in vegetable gardens and gardens did not differ between

locals who had incorporated greenhouses and those who had not (as proposed in our prediction 3.3), reflecting that the acquisition of this technology do not negatively impact the cultivating practice in terms of species richness. Conversely, in the nearby Pilcaniyeu community, people had almost replaced the use of vegetable gardens for greenhouses, incorporating new exotic crops (Eyssartier et al. 2011). Interestingly, in Pichi Leufu, the incorporation of new practices did not seem to weaken some traditional customs such as the collection of their own seeds. In Pilcaniyeu, however, gathering seeds from their own production became conspicuously eroded, given that locals practically do not use wild plants and mainly use seeds provided by external institutions (Eyssartier et al 2011). This could indicate that the Pichi Leufu population has a higher level of sustainability, food sovereignty and traditional plant knowledge than Pilcaniyeu, probably due to the greater influence of western culture in the latter community.

In relation to the use of medicinal plants, we found that gastro-intestinal and respiratory were the most frequently cited ailments. Medicinal plant traditional remedies have been much reported for digestive disorders in other studies (Milliken and Albert 1997; Ankli, Sticher, and Heinrich 1999; Schlage et al. 2000; Begossi, Hanazaki, and Tamashiro 2002; Estomba, Ladio, and Lozada 2006; Ladio 2007; Molares and Ladio 2009b). This might be related to the fact that the traditional diet has undergone changes during the last century, increasing the consumption of refined flour, meat and alcohol, while decreasing the consumption of vegetables, resulting in low fiber consumption (Ferrari, Morazzani, and Pinotti 2004).

Horticulture and wild plant gathering are practices that entail cognitive patterns. Neuro-scientific approaches emphasize the role of action (enaction) in cognitive processes (e.g., Varela, Thompson, and Rosch 1992). The act of cultivating, harvesting or collecting plants leads to know-how which results from perception and action processes related to concrete practices. These practices involve structural coupling of the locals with the environment, and with their long history of social and cultural consensus (Maturana and Varela 1984). This cognitive viewpoint highlights the role of imbrications between internal and external processes, influenced by people's own experience, their relationship with the environment and socio-cultural circumstances. These dynamic processes might be reflected in their current horticultural and gathering practices.

CONCLUSION

In conclusion, this case study illustrates how the body of plant knowledge undergoes continuous transformation, integrating old and new customs within changing social and ecological contexts. In the Pichi Leufu community we have observed that the ancient practices of cultivating and gathering

complement each other in the present. Inhabitants have incorporated western technology and knowledge, generating cultural hybridization and the reorganization of the role of wild and cultivated plants in their lives. This suggests the acquisition of resilient strategies to cope with current living conditions. An example of this could be the harvesting of their own seeds, which contributes to diminishing genetic loss while sustaining food sovereignty. The resilient processes found in this community are likely to favor the conservation of cultural and biological diversity while favoring the people's material and spiritual well-being.

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