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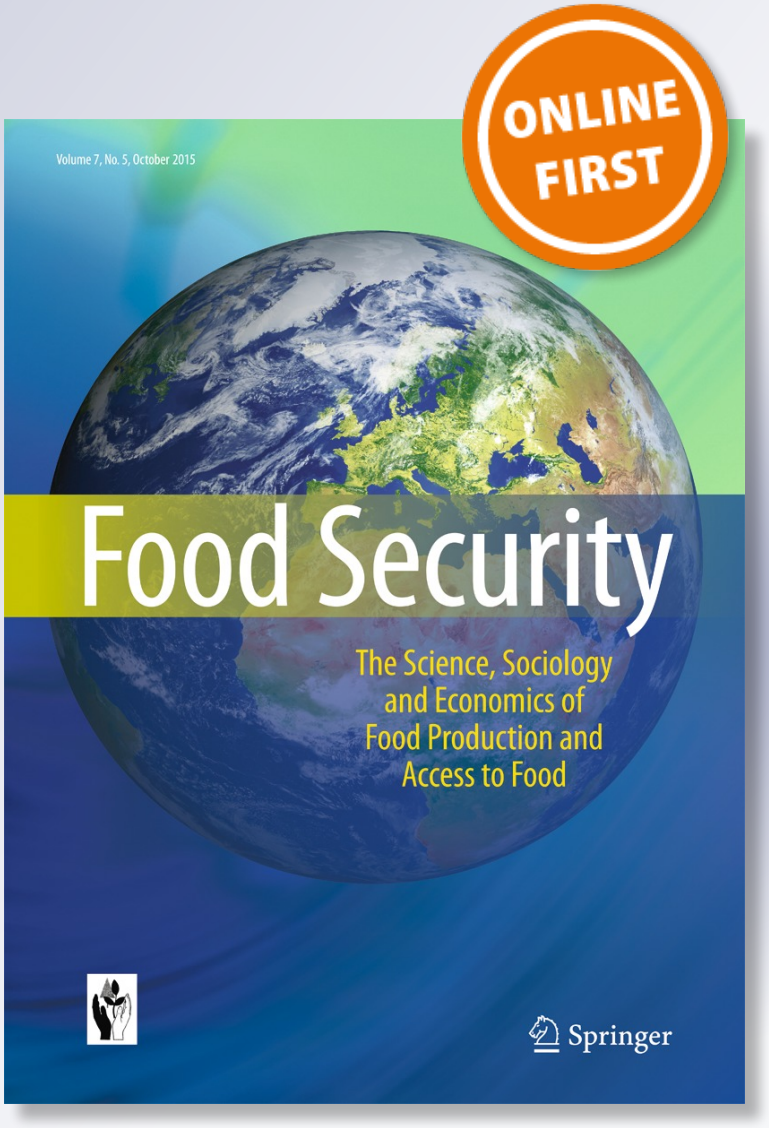
Food Security
The Science, Sociology and Economics of Food Production and Access to Food

ISSN 1876-4517

Food Sec.
DOI 10.1007/s12571-015-0514-1



Springer

Food Sec.
DOI 10.1007/s12571-015-0514-1

ORIGINAL PAPER

Horticultural practice and germplasm conservation: a case study in a rural population of the Patagonian steppe

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Received: 14 May 2014 / Accepted: 30 September 2015

Abstract Local food production has recently been encouraged and strengthened in order to lessen the adverse effects of global food crises. In the present study we evaluated the current situation with respect to horticultural and gathering practices in a rural, isolated population of Northwest Patagonia, located in an extremely harsh environment, and explored its implications for food security. Cultivation patterns, seed origin, plant use and species diversity were analyzed by means of semi-structured interviews. Inhabitants of this community cultivate vegetable-gardens and a high proportion of dwellers collect seeds from previous harvests, mostly of non-perennial plants. This practice contributes to the preservation of local germplasm, mainly used for food production. Plant richness analysis showed that inhabitants of this population cultivate and gather a total of 166 species. Most cultivated species are of exotic origin, whereas a high proportion of gathered species are native plants mainly used for medicinal purposes. These findings suggest that in isolated populations with low access to markets, such as Pilquiniyeu del Limay in Northwest Patagonia, cultivation and production in vegetable gardens not only contributes to their food supply but also favors plasticity and resilience. The experience of these local dwellers could provide inspiration for coping with global environmental changes and for promotion of the emergence of resilient horticultural processes, which might be beneficial for society as a whole.

Keywords Food production · Horticultural practice · Patagonia · Seed collection · Food security

Introduction

Cultivating land promotes the connection of people with their environment, fosters socialization with others, and most importantly, offers necessary food resources for sustenance. Recently, interest has been growing in encouraging and strengthening local food production in order to mitigate the adverse effects of global food crises (e.g. Galhena et al. 2013). Food production from home garden cultivation favors greater independence and autonomy of household nutrition and provides essential resources (Caballero 1992; Kumar and Nair 2004). Vegetable gardens are usually small-scale supplementary food production systems designed by local inhabitants, and sometimes they mimic natural, multilayered ecosystems (Hoogerbrugge and Fresco 1993). In hostile environments such as the Patagonian steppe, dwellers have developed micro-ecosystems for cultivation purposes. These differ from their natural surroundings and ensure the maintenance of horticultural practice and associated traditions.

Resilient strategies help social–ecological systems adapt to change after disturbances, allowing the maintenance of ecological structure and function (Berkes et al. 2003; Blondel 2006; Eyssartier et al. 2011a, b). Small-scale societies, such as local communities, usually resort to strategies that emerge as a consequence of long-standing socio-ecological know-how associated with a dynamic relationship with the environment (Colding et al. 2003; Tengo and Belfrage 2004; Haque and Etkin 2007).

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Published online: 07 November 2015

In ancient times, the Mapuche people used to live in the temperate forests of Chile and Argentina as hunter-gatherers and semi-nomadic horticulturists (Estomba et al. 2006). The arrival of the Spanish in the seventeenth century generated dramatic events that affected people's lives, including their food production and sustenance, health and economic system etc. (Torrejón and Cisternas 2002). Consequently, Northwestern Patagonian inhabitants suffered profound changes in their traditional practices (Bandieri 2005; Lozada et al. 2006; Ladio and Lozada 2008; Eyssartier et al. 2011a, b, 2013). In spite of having been forced to settle in arid environments to which they were unaccustomed, these populations still cultivate land and gather wild plants today (Ladio and Lozada 2003, 2004). Previous studies in Patagonia have demonstrated that horticultural knowledge is conditioned by environmental and social circumstances (Eyssartier et al. 2007, 2011a, b, 2013). Differential patterns of horticultural and gathering practices are observed in communities with different levels of access to markets and degrees of isolation (Eyssartier et al. 2013). In addition, we found that these practices complement each other (Eyssartier et al. 2011a, b); wild, weedy and domesticated plants form a large spectrum of interactions in relation to germplasm conservation. Until now, studies on germplasm conservation recognized different strategies that involve plant diversity such as the planting and transplanting of both native and exotic species, the tolerance of native species that are deliberately left standing in home-gardens and the enhancement or protective activities of plants from both wild and human–made habitats (Casas et al. 2007; Blancas et al. 2010), but little attention has been given to seed collection practices or activities that favor the continuity of this managed diversity into the future. Gathering seeds from previous harvests contributes to the conservation of local germplasm, favoring crop diversity (Bellon 2004; Badstue et al. 2006) and generating a positive impact on food security. The crucial role of agrobiodiversity in in situ conservation has been highlighted as a dynamic mechanism that promotes the adaptation of crops to changing environmental conditions (Altieri 1987; Calvet-Mir et al. 2011, 2012). Moreover, agrobiodiversity in in situ conservation also fosters the maintenance of traditional know-how and crop productivity (Cox 2000; Maffi 2002). In rural populations of Northwestern Patagonia the traditional custom of collecting own seeds from previous harvests is currently diminishing, due to external sources of seed supply and other aspects of western influence (Eyssartier et al. 2011a, b, 2013).

Previous studies have explored horticultural practices in other communities of the region (Eyssartier et al. 2011a, b, 2013) but no research on food security has been conducted in an extremely isolated community, which has suffered relocation in the recent past.

The Mapuche people frequently collected wild plants for medicinal and edible purposes in the past (Ladio and Lozada 2000, 2001) but nowadays, wild plants are mainly gathered for healing purposes as the tradition of gathering edible species has significantly decreased. Moreover, most communities that inhabit arid zones have incorporated exotic wild species, adapting their knowledge of plant gathering to this drier environment (Ladio et al. 2007; Ladio and Lozada 2008, 2009).

The general aim of this study is to evaluate the current situation with respect to horticultural and gathering practices in a rural, isolated population of Northwest Patagonia, located in an extremely harsh environment, and explore implications for food security. We investigated whether vegetable-gardens and gathering wild plants improved household food security and nutrition, thus helping locals deal with their hostile circumstances. Several aspects related to horticultural practices that could contribute to resilience in this remote community were examined, such as gathering own seeds, cultivation areas, crop diversity, common uses of cultivated and gathered plants, biogeographic origin of cultivated species and seed origin. We also explored seed collection in relation to perennial and annual plants. Perennial plants may be short-lived (only a few years) or long-lived, as are some woody plants such as trees.

Methods

Study site

Pilquiniyeu del Limay is a rural population of the northwestern Patagonian steppe, in the Argentine province of Río Negro (Fig. 1). This community is settled at 200 km from the closest urban center of San Carlos de Bariloche, in an isolated area with unpaved roads and infrequent public transport. The Pilquiniyeu community is inhabited by approximately 55 families. It presents harsh environmental conditions, as it receives strong westerly winds, with a mean annual temperature of between 8 and 10 °C and a mean annual rainfall of between 200 and 400 mm. This region belongs to the Patagonian steppe ecosystem, and vegetation cover is characterized by the presence of shrubs and herbs: for example, neneo (*Mulinum spinosum*); charcao (*Senecio filaginoides*); coirón amargo (*Stipa humilis*, *Stipa speciosa*) and *Poa huecu*, *Bromus macranthus*, *Poa ligularis*, *Festuca Argentina* (Cabrera 1976). Moreover, microenvironments of *Larrea nitida* (jarilla), *Colliguaja integerrima* (coliguay), *Schinus* spp. (molles) and *Lycium* spp. can also be identified.

In this population, livestock keeping is the main source of income; while some inhabitants work in the primary school, the only educational public institution.

Pilquiniyeu shares the same Mapuche origin as other communities of the region, and it was declared an aboriginal reservation in 1972. Although Spanish is mostly spoken, a small number of Pilquiniyeu inhabitants also speak the native tongue of Mapuzungun or at least know a few words. Local

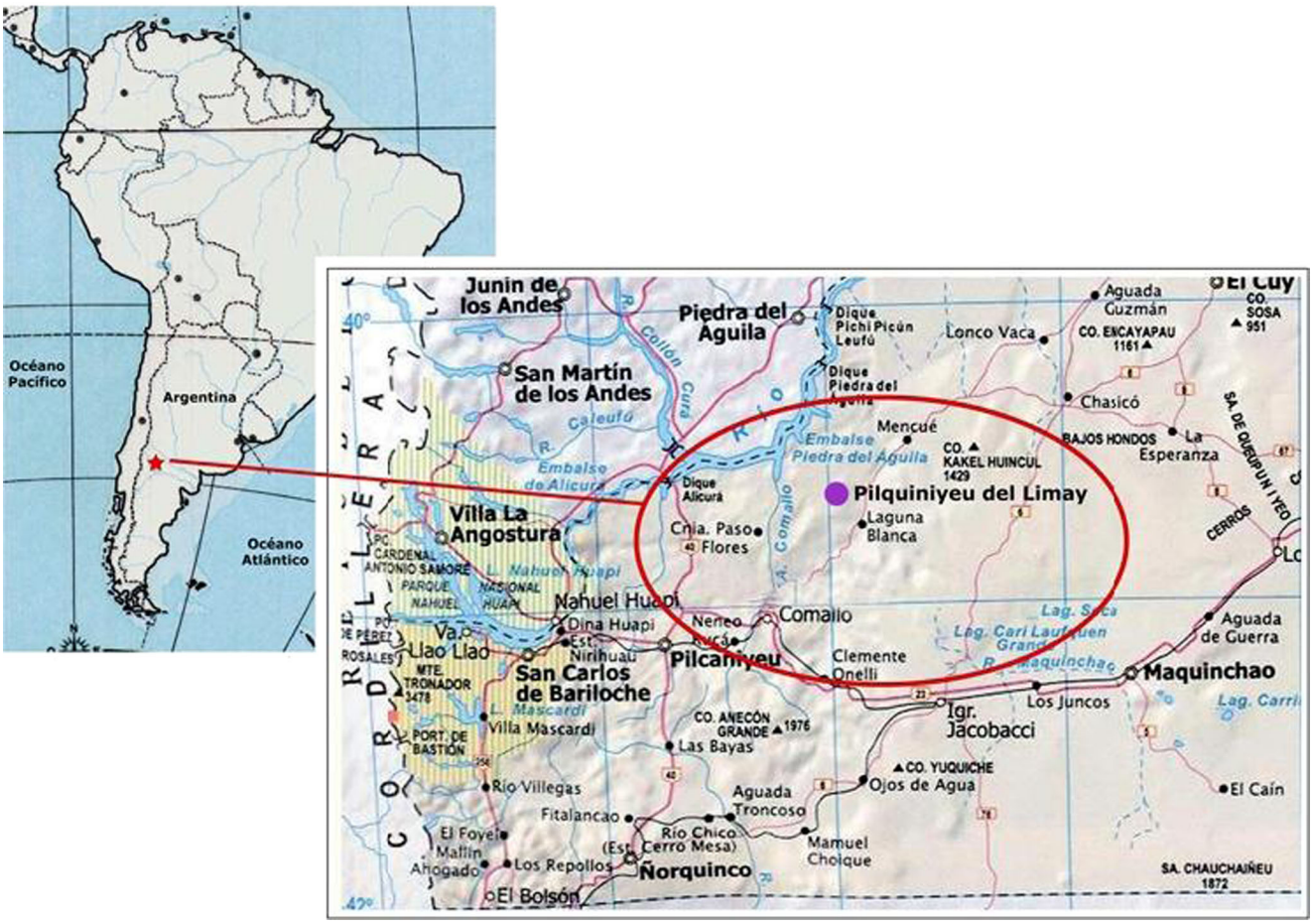

Fig. 1 Location map showing the Pilquiniyeu del Limay community

people in Pilquiniyeu suffered a forced uprooting and relocation in 1987, when the community, which had been located on the banks of the Limay river, was forced to leave the region because of the construction of Piedra del Águila hydroelectric dam (Francioni and Poggiese 1996). This brought about profound changes in several aspects of their lives. At present, inhabitants do not have electricity, but some families have adopted solar panels as an alternative and sustainable source of energy. Pilquiniyeu dwellers receive help and advice from public institutions, such as the National Institute of Agricultural Technology (INTA). They provide materials to build greenhouses for horticultural practice, and exotic plant seeds, such as lettuce (*Lactuca sativa*), chard (*Beta vulgaris* var. *cicla*), broadbeans (*Vicia faba*) and carrot (*Daucus carota*). Seeds are usually provided by the commissioner and extension agents have recently incorporated the use of microtunnels in the region (semi-tubular structures similar to a greenhouse, also covered with plastic, but of smaller dimensions).

Data collection

A total of 19 individuals (14 women and 5 men) were interviewed in Pilquiniyeu del Limay during the summer of 2009. Each domestic unit was selected at random, and in each home we interviewed the person in charge of the family's horticultural practice. Ethnobotanical fieldwork was conducted by means of open and semi-structured interviews with the informants' prior consent (Alexiades 1996; Tuxill and Nabhan 2001). We inquired about personal information (i.e. interviewee's age, gender, educational level, occupation), other aspects related to cultivation in vegetable-gardens, greenhouses and gardens, and their gathering practice. We also asked local dwellers who they consulted for advice in relation to horticultural practices. During in depth interviews, we gathered detailed information about the profound changes the Pilquiniyeu population has undergone due to relocation. We asked dwellers about the impact of this event on their daily lives, and particularly on horticulture and gathering practice. We also asked local dwellers about plants used for cultivation and species gathered in wild areas, their local names and common uses (use-categories). Collection of both wild and cultivated species from vegetable-gardens, greenhouses, and gardens was performed with the assistance of the dwellers, in order to make field herbariums. The latter will be deposited in the Herbarium of Centro Regional Universitario Bariloche (BCRU), following the Correa nomenclature (1969, 1971,

1978, 1984, 1988, 1998, 1999), Marticorena and Quezada (1985) and Ezcurra and Brion (2005).

Data analysis

Qualitative and quantitative analyses of the collected data were performed. The information, based on informants' discourses, was analysed by an interpretative and descriptive approach (Medeiros et al. 2014). The species named were categorized as "native" or "exotic" according to their biogeographic origin in which plants belonging to the Patagonian region were considered natives (Ezcurra and Brion 2005). Species richness was calculated considering the total number of plants cultivated and gathered. Plant use-categories were established in accordance with interviews as edible, ornamental, medicinal, for fodder, for shade or living hedges and other uses. We also calculated the proportion of perennial and annual cultivated species, in order to distinguish those plants that need seed collection.

Non-parametric tests were used to analyze non-normally distributed data (Höft et al. 1999). Cochran's Q test was used to analyze cultivated plant richness, cultivated plant use-categories and cultivated areas use. Moreover, the Sign test was used to compare the proportion of seeds obtained from diverse origins. The t Test was used to evaluate dimensions of cultivated areas and to compare the biogeographic origin between cultivated and collected plants. A Chi square test was used to analyse significant differences among categories of perennial and non-perennial plant species.

Data was analyzed with SPSS 10.0 for Windows. The Difference test was calculated with Statistica, version 6 (StatSoft, Inc 2003).

Results

In this community, food production and plant diversity are historically associated with the use and management of large vegetable-gardens and habitats where plants occur naturally (dwelling surroundings, steppe and human made environments in the case of weeds).

Plant richness analysis showed that Pilquiniyeu inhabitants cultivate and gather a total of 166 species (Tables 1 and 2): 49 species are cultivated in vegetable gardens, 13 in greenhouses and 115 in gardens (Fig. 2). Some species such as lettuce (*Lactuca sativa*), chard (*Beta vulgaris* var. *cicla*), and oregano (*Origanum vulgare*) were found both in vegetable gardens and greenhouses. We found a greater richness of plants in gardens in comparison with the other cultivated areas (Cochran's Q test: 119.806, $p < 0.001$). Inhabitants of Pilquiniyeu cultivate an average of 887 m^2 of vegetable-gardens and 6.5 m^2 of greenhouses (significantly different dimensions, t Test, $p < 0.001$). The use of greenhouses is a recent custom mostly promoted by extension agents. Accordingly, 84.2 % the inhabitants cultivated vegetable-gardens but only 15.8 % used greenhouses (Cochran's Q test, $p < 0.001$). Many of the greenhouses are built as microtunnels, probably related to the harsh climatic conditions experienced by this community, which suffers strong winds and wide variation in temperature. Moreover, when evaluating the biogeographic origin of the cultivated plants, we found that exotic species (92.1 %) are cultivated in higher proportions than native ones (7.9 %). Furthermore, when analyzing wild plant gathering, we found that inhabitants of Pilquiniyeu collect 36 species. These gathered plants have similar proportions of native and exotic origin (55.5 % native vs. 44.4 % exotic plants) and are mainly used for medicinal purposes. Plant species of native origin were more frequently collected than cultivated (t Test, $p < 0.001$).

When comparing plant richness for each category of use, we found that Pilquiniyeu dwellers cultivate 53.8 % of plants for ornamental purposes, 36.2 % for food and 16.9 % for medicinal use (Fig. 3). When comparing plant diversity, we found that ornamental plants are cultivated in a higher proportion than the other use categories (Cochran's Q test, $p < 0.001$).

When we asked local dwellers whom they consulted for advice in relation to horticultural practices, Pilquiniyeu dwellers mentioned that they mainly relied on their own experience (78.9 %). A small proportion of dwellers exchanged horticultural and gathering know-how among neighbors and friends (10.5 %), as well as seed. Inhabitants maintained the tradition of collecting seeds from previous harvests (68.4 %), though they also obtained seeds from extension agents (36.8 %). Seed was rarely bought (10.5 %) and the exchange of seeds with relatives and neighbors was also relatively low (10.5 %) (Fig. 4). We found that 30 % (38 spp.) of the total number of cultivated species (130 spp.) corresponded to non-perennial plants, i.e. seeds that need to be bought, collected or obtained from external agents or other sources of seed supply; while 70 % (92 spp.) were perennial plants. Approximately 70 % of the non-perennial cultivated plants were used for food production, while a lower proportion of species was used for ornamental purposes (26 %). Only one species (3 %) was used as an aromatic plant (*Cuminum cyminum*) and another species (*Medicago sativa*) (3 %) was used solely for fodder (Chi-Square (df = 3): 43.895, $p < 0.001$). The Pilquiniyeu dwellers maintain the custom of collecting seeds from plants cultivated for edible purposes, such as *Lactuca sativa*, *Beta vulgaris* var. *cicla*, *Solanum tuberosum*, *Pisum sativum*, *Vicia faba*, *Zea mays* and *Solanum lycopersicum*, among others. Moreover, flowering herbaceous plants such as *Calendula officinalis*, *Althaea rosea*, *Antirrhinum majus*, *Dianthus barbartus*, *Gaillardia* sp., *Dianthus caryophyllus* and *Tagetes erecta*

Table 1 Plant species recorded in vegetable-gardens, gardens and greenhouses in the Pilquiniyeu del Limay community. Origin: E (exotic), N (native). Common uses: e (edible), m (medicinal), o (ornamental), f (fodder), s/lv (shade/living hedges), ou (other uses). C. A. (Cultivated area): vg (vegetable-garden), g (garden), gh (green house). T.L. (type of lifetime): p (perennial), np (non-perennial). T.R. (type of resource): ft (fruit tree), fp (food plant), ap (aromatic plant), tp (tolerated plant), op (ornamental plant), st (shade tree), fp (fodder plant), lh (living hedge). C.I (Consensus index)

Plant species	Local name	Plant Family	Origin	Common uses	C.A	T.L.	T.R.	C.I
Prunus persica L. Batsch	duraznero	Rosaceae	E	e	vg,g	p	ft	0,53
Lactuca sativa L.	lechuga	Asteraceae	E	e	vg,gh,g	np	fp	0,47
Origanum vulgare L.	orégano	Lamiaceae	E	e,m	vg,gh,g	p	ap	0,47
Beta vulgaris var. *cicla* L.	acelga	Chenopodiaceae	E	e	vg,gh	np	fp	0,42
Malus domestica Borkh	manzano	Rosaceae	E	e	vg,g	p	ft	0,42
Malva sylvestris L.	malva	Malvaceae	E	m	g	p	tp	0,42
Solanum tuberosum L.	papa	Solanaceae	E	e	vg,gh,g	np	fp	0,42
Calendula officinalis L.	caléndula	Asteraceae	E	o	g	np	op	0,37
Pisum sativum L.	arveja	Fabaceae	E	e	vg	np	fp	0,37
Populus nigra L.	álamo	Salicaceae	E	o,s/lv	vg,g	p	st/op	0,37
Vicia faba L.	haba	Fabaceae	E	e	vg,gh,g	np	fp	0,37
Zea mays L.	maíz	Poaceae	E	e	vg,g	np	fp	0,37
Brassica oleraceae var. *capitata* L.	repollo	Brassicaceae	E	e	vg,gh,g	np	fp	0,32
Cucurbita pepo L.	zapallo	Cucurbitaceae	E	e	vg,g	np	fp	0,32
Medicago sativa L.	alfalfa	Fabaceae	E	f	vg,g	np	fp	0,32
Nepeta cataria L.	toronjil	Lamiaceae	E	m	vg,g	p	ap	0,32
Rosa sp.	rosa	Rosaceae	E	o	g	p	op	0,32
Solanum lycopersicum L.	tomate	Solanaceae	E	e	vg,gh	np	fp	0,32
Ulmus sp.	olmo	Ulmaceae	E	o,s/lv	vg,g	p	st/op	0,32
Althaea rosea L. (Cav)	malvón	Malvaceae	E	o	g	np	op	0,26
Coriandrum sativum L.	cilantro	Apiaceae	E	e	vg,gh,g	np	fp	0,26
Petroselinum crispum (Mill.) Nym.	perejil	Apiaceae	E	e	vg,gh	np	fp	0,26
Prunus armeniaca L.	damasco	Rosaceae	E	e	g	p	ft	0,26
Prunus domestica L.	ciruela	Rosaceae	E	e	g	p	ft	0,26
Ribes aureum Pursh.	corinto	Saxifragaceae	E	e,o,s/lv	g	p	lh	0,26
Vitis vinifera L.	parra	Vitaceae	E	o	vg,g	p	ft/st	0,26
Antirrhinum majus L.	conejito	Scrophulariaceae	E	o	g	np	op	0,21
Artemisia absinthium L.	ajenjo	Asteraceae	E	m	g	p	ap	0,21
Populus alba L.	álamo blanco/plateado	Salicaceae	E	o,s/lv	vg,g	p	st/op	0,21
Prunus cerasus L.	guindo	Rosaceae	E	e	g	p	ft	0,21
Pyrus communis L.	peral	Rosaceae	E	e	vg,g	p	ft	0,21
Ribes grossularia L.	grosella	Saxifragaceae	E	e	vg,g	p	ft	0,21
Syringa vulgaris L.	lila	Oleaceae	E	o	g	p	op	0,21
Tamarix sp.	tamarisco	Tamaricaceae	E	o,s/lv	vg,g	p	lh	0,21
?	arvejilla	Fabaceae	?	o	g	p	op	0,16
Allium schoenoprasum L.	chalota	Liliaceae	E	e	vg,g	np	fp	0,16
Artemisia abrotanum L.	éter	Asteraceae	E	m	g	p	ap	0,16
Beta vulgaris var. *rapacea* L.	remolacha	Chenopodiaceae	E	e	vg,gh	np	fp	0,16
Daucus carota L.subsp. *sativus* (Hoffm.)Schübl.et G.Martens*	zanahoria	Apiaceae	E	e	vg	np	fp	0,16
Dianthus barbartus L.	clavelina	Caryophyllaceae	E	o	g	np	op	0,16
Foeniculum vulgare Mill.	hinojo	Apiaceae	E	e	vg,g	np	fp	0,16
Gaillardia sp.	galliardia	Asteraceae	E	o	g	np	op	0,16
Helianthus agnus L.	girasol	Asteraceae	E	e,o	vg	np	fp	0,16
Maytenus boaria Molina	maitén	Celastraceae	N	o,s/lv	g	p	op	0,16
Mentha sp.	menta	Lamiaceae	E	e,m	g	p	ap	0,16
Paeonia lactiflora Pall.	peonía	Ranunculaceae	E	o	g	p	op	0,16

Table 1 (continued)

Plant species	Local name	Plant Family	Origin	Common uses	C.A	T.L.	T.R.	C.I
Raphanus sativus L.	rabanito	Brassicaceae	E	e	vg,gh	np	fp	0,16
Rochea sp.	rochela	Crassulaceae	E	m	g	p	op	0,16
Ruta graveolens L.	ruda	Rutaceae	E	m	g	p	op	0,16
Salix sp.	sauce	Salicaceae	E	o,s/lv	g	p	st/op	0,16
?	margarita	Asteraceae	E	o	g	p	op	0,11
Aeonium sp.	gallinita	Crassulaceae	E	o	g	p	op	0,11
Allium cepa L.	cebolla	Liliaceae	E	e,m	vg,g	np	fp	0,11
Aloysia triphylla (L'Herit.) Britt.	cedrón	Verbenaceae	E	m,o	vg,g	p	ap	0,11
Artemisia sp.	artemisa	Asteraceae	E	m,o	g	p	ap	0,11
Buddleja araucana Phil	pañil	Buddlejaceae	N	m	g	p	tp	0,11
Cheirantus cheiri L.	alelí	Brassicaceae	E	o	g	p	op	0,11
Chenopodium ambrosioides L.	paico	Chenopodiaceae	N	m	vg,g	p	tp	0,11
Chrysanthemum sp.	crisantemo	Asteraceae	E	o	g	np	op	0,11
Cosmos bipinnatus Cav.	cosmos	Asteraceae	E	o	g	np	op	0,11
Cydonia oblonga Mill.	membrillo	Rosaceae	E	e	g	p	ft	0,11
Dianthus caryophyllus L.	clavel	Caryophyllaceae	E	o	g	np	op	0,11
Elaeagnus angustifolia L.	olivillo	Elaeagnaceae	E	o,s/lv	g	p	op	0,11
Helianthus tuberosus L.	girasol de jardín	Asteraceae	E	o	g	p	op	0,11
Larrea nitida Cav.	jarilla	Zygophyllaceae	N	m,o,s/lv	vg	p	tp	0,11
Laurus sp.	laurel	Lauraceae	E	o	g	p	op	0,11
Lonicera sp.	madreselva	Caprifoliaceae	E	o	g	p	op	0,11
Mentha piperita L.	menta San Pedro o inglesa	Lamiaceae	E	e,m	g	p	ap	0,11
Mentha pulegium L.	poleo	Lamiaceae	E	m	g	p	ap	0,11
Pinus sp.	pino	Pinaceae	E	o,s/lv	g	p	st/op	0,11
Plantago lanceolata L.	llantén	Plantaginaceae	E	m	vg,g	p	tp	0,11
Populus angulata Ait.	álamo chileno o carolina	Salicaceae	E	o,s/lv	g	p	st/op	0,11
Prunus persica (L.) Batsch var. *nectarina* (Ait.) Max.	pelón	Rosaceae	E	e	vg,g	p	ft	0,11
Rubus ulmifolius Schott	murra	Rosaceae	E	e	g	p	ft	0,11
Salix babylonica Kunth	sauce llorón	Salicaceae	E	o,s/lv	vg,g	p	st/op	0,11
Solanum melongena L.	berenjena	Solanaceae	E	e	gh	np	fp	0,11
Symphoricarpos albus Blake	perla	Caprifoliaceae	E	o,s/lv	g	p	op	0,11
Tagetes erecta L.	copete	Asteraceae	E	o	g	np	op	0,11
Tanacetum vulgare L.	palma	Asteraceae	E	m	g	p	tp	0,11
Tulipa sp.	tulipán	Liliaceae	E	o	g	p	op	0,11
?	bálsamo	?	?	o	g	p	op	0,05
Acacia sp.	acacia	Mimosaceae	E	o,s/lv	g	p	st/op	0,05
Ailanthus altissima (Mill.) Swingle	árbol del cielo	Simaroubaceae	E	o	g	p	op	0,05
Allium fistulosum L.	cebolla de verdeo	Liliaceae	E	e	vg	np	fp	0,05
Allium sativum L.	ajo	Liliaceae	E	e,ou	vg,g	np	fp	0,05
Aloe sp.	aloe vera	Liliaceae	E	o	g	p	op	0,05
Apium graveolens L.	apio	Apiaceae	E	e	vg	np	fp	0,05
Aquilegia sp.	campanula (arquilegia)	Ranunculaceae	E	o	g	p	op	0,05
Cercis siliquastrum L.	árbol judío	Fabaceae	E	o	g	p	op	0,05
Citrullus lanatus (Thunb.) Matsum. *et* Nakai	sandía	Cucurbitaceae	E	e	vg	np	fp	0,05
Colliguaya integerrima Gillies & Hook.	coliguay	Euphorbiaceae	N	o	vg	p	tp	0,05
Cortadeira araucana staff	cola de zorro	Poaceae	N	o	g	p	tp	0,05
Cucumis sativus L.	pepino	Cucurbitaceae	E	e	gh	np	fp	0,05
Cuminum cyminum L.	comino	Apiaceae	E	e	vg	np	ap	0,05

Table 1 (continued)

Plant species	Local name	Plant Family	Origin	Common uses	C.A	T.L.	T.R.	C.I
Cytisus scoparius L. (Link.)	retama	Fabaceae	E	o,s/lv	g	p	op	0,05
Diostea juncea (Gillies & Hook) Miers.	retamo	Verbenaceae	N	o,s/lv	g	p	op	0,05
Eucalyptus sp.	eucalipto	Mirtaceae	E	o,s/lv	g	p	st/op	0,05
Fabiana imbricada Ruiz & Pav.	palo piche	Solanaceae	N	o	g	p	tp	0,05
Fraxinus sp.	fresno	Oleaceae	E	o,s/lv	g	p	st/op	0,05
Hedera helix L.	hiedra	Araliaceae	E	o	g	p	op	0,05
Humulus lupulus L.	lúpulo	Cannabinaceae	E	o	g	p	op	0,05
Ipomoea batatas (L.) Lam.	batata	Convolvulaceae	E	e	vg,g	np	fp	0,05
Iris germanica L.	lirio	Iridaceae	E	o	g	p	op	0,05
Jasminum sp.	jazmin	Oleaceae	E	o	g	p	op	0,05
Juglans regia L.	nogal	Juglandaceae	E	e,s/lv	g	p	ft	0,05
Kniphobia sp.	tritoma (flor naranja)	Asphodelaceae	E	o	g	p	op	0,05
Laurus nobilis L.	laurel comestible	Lauraceae	E	e	vg,g	p	op	0,05
Lavandula sp.	lavanda	Lamiaceae	E	o	g	p	ap	0,05
Lupinus polyphyllus Lindl.	chocho	Fabaceae	E	o	g	p	op	0,05
Melia azedarach L.	paraíso	Meliaceae	E	o,s/lv	g	p	st/op	0,05
Mentha spicata L.	menta negra	Lamiaceae	E	e,m	g	p	ap	0,05
Narcissus sp.	narcizo	Amaryllidaceae	E	o	g	p	op	0,05
Olea europaea L.	olivo	Oleaceae	E	o,s/lv	g	p	op	0,05
Prunus avium L.	cerezo	Rosaceae	E	e	g	p	ft	0,05
Prunus domestica L.	ciruela amarilla	Rosaceae	E	e	vg	p	ft	0,05
Prunus domestica L.	ciruela roja	Rosaceae	E	e	vg	p	ft	0,05
Ranunculus sp.	yerba de la vaca	Ranunculaceae	E	o	g	p	op	0,05
Rosa rubiginosa L.	rosa mosqueta	Rosaceae	E	o	g	p	op	0,05
Salix viminalis L.	sauce mimbre	Salicaceae	E	o,s/lv	g	p	st/op	0,05
Salix x erythroflexuosa Rag. et R. Alb.	sauce eléctrico	Salicaceae	E	o,s/lv	g	p	st/op	0,05
Salvia officinalis L.	salvia	Lamiaceae	E	m	g	p	ap	0,05
Saponaria officinalis L.	flor de mayo/ramillete (saponaria)	Caryophyllaceae	E	o	g	p	op	0,05
Schinus molle L.	gualeguay	Anacardiaceae	N	o,s/lv	g	p	tp	0,05
Schinus o'donellii Barkley	molle	Anacardiaceae	N	o,s/lv	g	p	tp	0,05
Schinus patagonica (Phil.) I.M Johnst.	laura	Anacardiaceae	N	o	g	p	op	0,05
Thymus vulgaris L.	tomillo	Lamiaceae	E	m	g	p	ap	0,05
Tritricum sp.	trigo	Poaceae	E	e	vg	np	fp	0,05
Viola odorata L.	violeta	Violaceae	E	o	g	p	op	0,05
Viola tricolor L.	pensamiento	Violaceae	E	o	g	np	op	0,05
	rachen (oreja de burro)			m	g	p	op	0,05

were used for ornamental purposes (some of which were also used for medicinal purposes) (Fig. 5). Many of the 92 species of perennial plants corresponded to ornamental plants (41 %), followed by fruit trees (16 %), aromatic species (14 %) and other plants used for shade (14 %). Furthermore, we also found that 12 % of these perennial plants corresponded to tolerated species, such as *Larrea nitida*, *Plantago lanceolata*, *Chenopodium ambrosioides*, *Tanacetum vulgare*, *Buddleja araucana* and *Cortadeira araucana*. The tolerated species are mainly used for medicinal purposes, and to a lesser extent for ornamental use, shade and hedges. Lastly, only two species (2 %) were used for living hedges (*Ribes aureum* and *Tamarix* sp.) (Chi-Square df = 5:47.043, $p < 0.001$) (Fig. 6).

Discussion

The present study highlights the importance of local food production and germplasm conservation, associated with horticultural and gathering practices, in an extremely isolated population settled in a harsh arid environment. Vegetable-garden cultivation is a resilient strategy that favors food

Table 2 Species gathered by Pilquiniyeu del Limay dwellers. Origin: E (exotic), N (native). Plant use: dig (digestive), res (respiratory/antitussive), an (analgesic/anti-inflammatory), der (dermatologic), c.a.s (cultural affiliation syndrome: "empacho", heals the body, seven diseases), adi (antidiarrheal), ren (renal), feb (febrifuge), cir (circulatory), ane (anesthetic), ou (other uses). C.I (Consensus index)

Plant species	Local name	Plant Family	Origin	Plant use
Artemisia absinthium L.	ajenjo	Asteraceae	E	dig/res/feb
Erodium cicutarium (L.) L'Her.ex Aiton	alfilerillo	Geraniaceae	E	dig/an
Tanacetum parthenium (L.) Sch. Bip.	Altamisa	Asteraceae	E	feb
Apium sp.	apio silvestre (ñolquin)	Apiaceae	E	feb
Centaurium cachanlahuen (Molina) B.L.Rob.	Canchalagua/cachenlaguen	Gentianaceae	N	res/feb
Baccharis sagittalis (Less.) DC.	carqueja	Asteraceae	N	dig
Acaena splendens Gillies ex Hook. & Arn.	cepa caballo	Rosaceae	N	ren
Ochetophila trinervis (Gillies ex Hook. & Arn.) Poepp. ex Miers	chacay	Rhamnaceae	N	ren
Senecio filaginoides De Candolle	charcao blanco/santa maría	Asteraceae	N	an/adi/ou
Baccharis salicifolia (Ruiz & Pav.) Pers.	chilca	Asteraceae	N	dig/res
Equisetum bogotense H.B.K.	cola de caballo/limpia plata	Equisetaceae	N	ren
Artemisia abrotanum L.	éter	Asteraceae	E	dig
?	huella	?		res/feb
Larrea nitida Cav.	jarilla	Zygophyllaceae	N	der/an
Plantago lanceolata L.	llantén	Plantaginaceae	E	der/an
Plantago major L.	llantén (hoja más ancha)	Plantaginaceae	E	cir
*Malva sylvestris*L.	malva arrastrada	Malvaceae	E	feb
Marrubium vulgare L.	malva rubia	Lamiaceae	E	res
Mentha sp.	menta	Lamiaceae	E	dig
Schinus johnstonii Barkley	molle	Anacardiaceae	N	dig
Schinus marchandii Barkley	Molle blanco	Anacardiaceae	N	an
Solanum crispum Ruiz & Pav.	natre	Solanaceae	N	res
Valeriana carnosa Sm.	Ñanco lahuen	Valerianaceae	N	res/an
Urtica sp.	ortiga	Urticaceae	E	an/cir
Chenopodium ambrosioides L.	paico	Chenopodiaceae	N	dig/c.a.s
Tanacetum balsamita L.	palma	Asteraceae	E	dig/an/feb
Buddleja araucana Phil.	pañil	Buddlejaceae	N	dig/der/res
Adesmia boronioides Hook.f.	paramela	Fabaceae	N	dig
Galium aparine L.	pega-pega	Rubiaceae	E	ane
Mentha pulegium L.	poleo	Lamiaceae	E	dig/c.a.s
Mentha piperita L.	San Pedro	Lamiaceae	E	dig
Polygonum aviculare	sanguinaria	Polygonaceae	E	cir
Satureja darwinii (Benth.) Briquet	tomillo/té pampa	Lamiaceae	N	dig/res/an
Nassauvia glomerulosa (Lag. Ex Lindl.) D. Don	uña de gato	Asteraceae	N	
Usnea sp.	yerba de piedra	Usneacae	N	ren
Ribes magellanicum Poir.	zarzaparrilla	Saxifragaceae	N	dig/cir

security in this community, which has limited resources and little institutional support. Moreover, due to their restricted access to markets and local food supply systems, collecting their own seeds is crucial for enabling sustainability and food sovereignty. This case study shows how horticultural practice can foster food security in communities facing hostile socio-ecological conditions.

Most inhabitants of the Pilquiniyeu community cultivate fairly large vegetable-gardens and few of them use green-houses. A high proportion of dwellers collect seeds from previous harvests, mostly of non-perennial plants used for food production, thus contributing to the maintenance of local germplasm. Most cultivated species are of exotic origin, whereas native species were gathered and used mainly for medicinal purposes. The practice of gathering their own seeds is an important conservation mechanism as it not only favors the adaptation of crops to local ecological conditions, but also increases food safety and sustainable food production (Prescott-Allen and Prescott-Allen 1982; Altieri and Merrick 1987). Moreover, this in situ conservation practice implies a

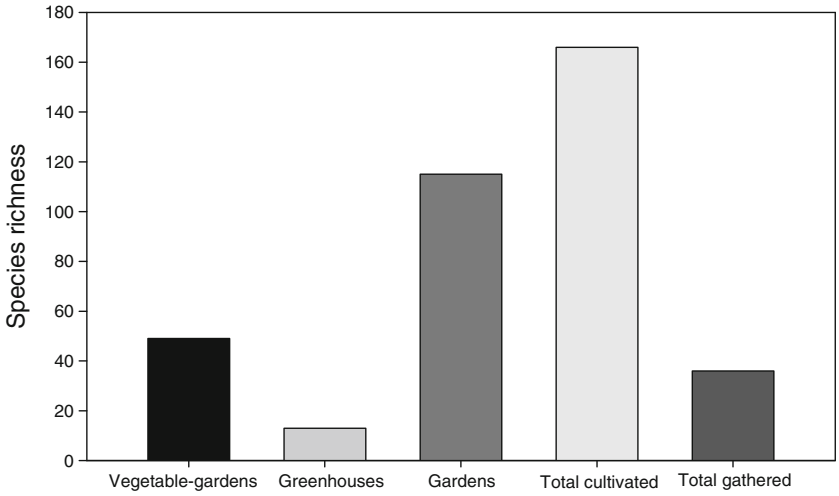

Fig. 2 Cultivated and gathered plant richness in Pilquiniyeu del Limay population

relatively reduced dependency on outside-farm inputs, promoting conservation of local know-how, which could foster food production (Cox 2000; Maffi 2002). Given the crucial role of food production for these isolated dwellers, the custom of collecting seeds from their previous harvests is mostly carried out for edible plants. Moreover, these crops are mainly non-perennial species, so this practice seems to be essential for communal self-organization processes such as food sovereignty and germplasm conservation. The tradition of gathering previously harvested seeds is diminishing in neighbouring communities of this Patagonian region (Eyssartier et al. 2011b). Previous studies conducted in Northwestern Patagonia showed that other rural communities had abandoned this traditional practice mainly due to market economy influence (Eyssartier et al. 2011a, b). Although a low proportion of locals from Pilquiniyeu acquired seeds from extension agents, from interchange or purchase, inhabitants have mentioned that they mainly rely on their own seed as they value the conservation of local germplasm. Other studies propose that seed and knowledge are transmitted together (Vogl and Vogl-Lukasser 2003; Acosta-Naranjo and Díaz-Diego 2008). This could be the case in the Pilquiniyeu population. In open interviews, the dwellers mentioned that during the process of relocation from farther lands to the present settlement, they kept traditionally-used seeds in order to maintain their customs in this new ecosystem. It is likely that this relocation could have increased the awareness of Pilquiniyeu inhabitants of the relevance of conserving local germplasm in their daily lives.

As in other local communities of northwestern Patagonia, cultivation was mainly practiced for food production while gathered plants were mostly used for medicinal purposes (Eyssartier et al. 2011a, b, 2013) However, we found that local communities used a high proportion of gathered native species for medicinal purposes. This preference may be related to the fact that since ancestral times, the Mapuche people have

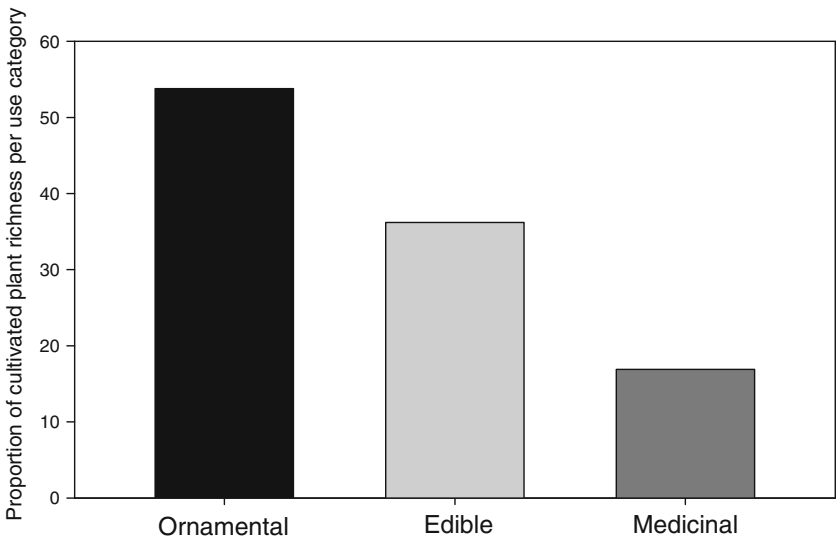

Fig. 3 Proportion of plant richness per use category in Pilquiniyeu del Limay community

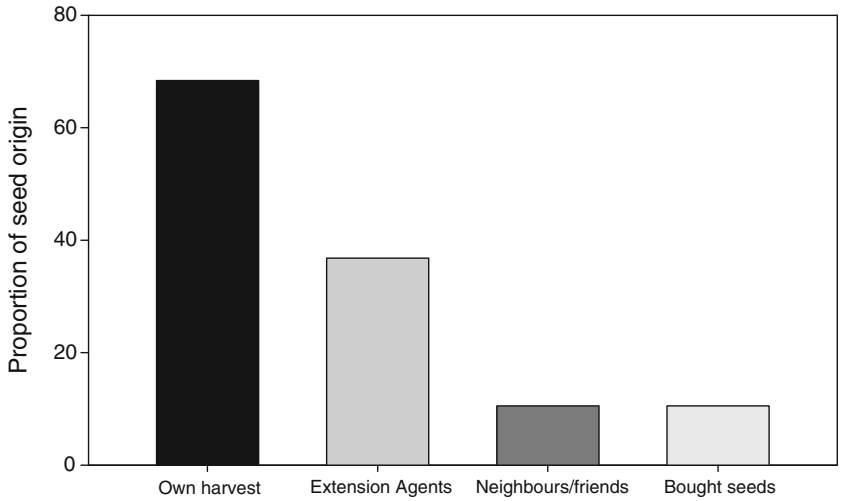

Fig. 4 Proportion of seed origin in the Pilquiniyeu del Limay community

attributed great spiritual significance to gathering medicinal plants from their natural environments (Citarella et al. 1995).

The relocation suffered by this community several decades ago caused by the Piedra del Águila hydroelectric dam brought about severe ecological and social changes. This dramatic episode might have promoted the emergence of resilient processes. For example, members of the community mentioned having gathered seeds from the previous location before moving to the present one. This could have allowed them to continue their horticultural practices, emphasizing the importance of their role in food security in their new isolated ecological context.

Given the extended food crisis, ecologically sustainable systems such as home gardens, which promote alternative ways of food production and germplasm conservation, are especially significant at present. Particularly, food production through horticultural practices is important in both economic and socio-ecological terms. Home garden cultivation fosters the micro-economy of rural people by facilitating access to food and medicinal resources and favors ecological diversity through the conservation of genetic resources. Furthermore,

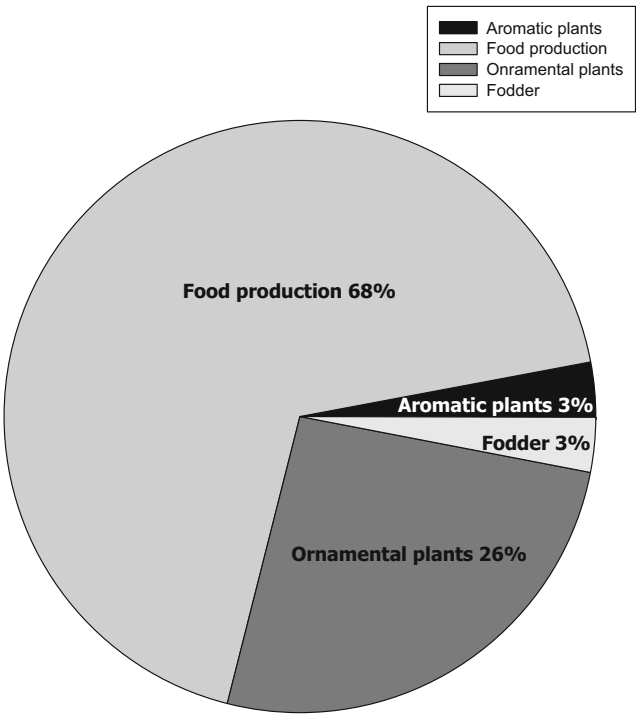

Fig. 5 Proportion of non-perennial cultivated plants per use category in the Pilquiniyeu del Limay community

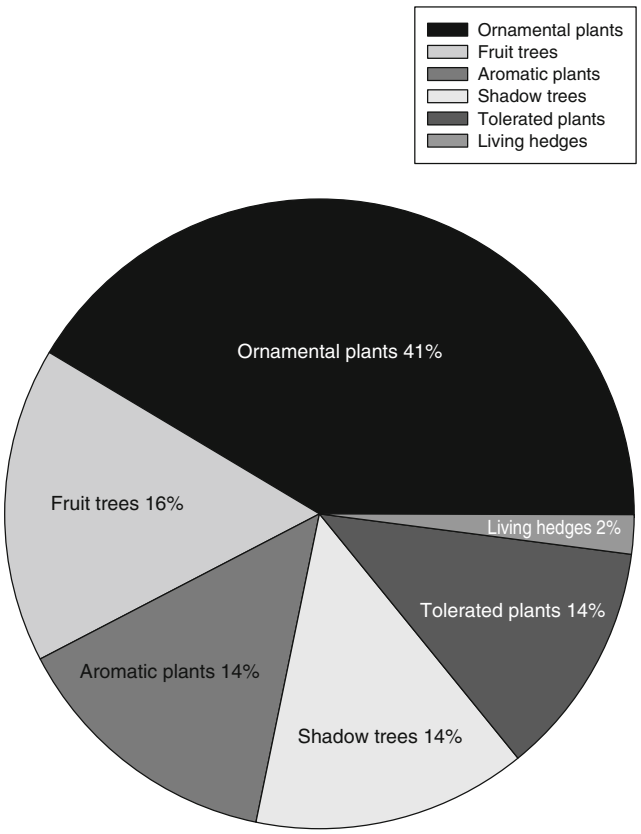

Fig. 6 Proportion of perennial cultivated plants per use category in the Pilquiniyeu del Limay community

local food production promotes the empowerment of rural people, by reducing dependency on the market economy. These phenomena appear to be taking place among the Pilquiniyeu del Limay population, where cultivation and production in vegetable gardens not only contributes to their food supply but also favors plasticity and resilience.

Acknowledgments This research was supported by a postdoctoral dissertation fellowship assigned to Cecilia Eyssartier by the Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), by the Laboratorio de Etnobotánica Aplicada (Universidad Nacional de La Plata, Facultad de Cs. Naturales y Museo) and by INIBIOMA (Instituto de Investigaciones en Biodiversidad y Medioambiente), Universidad Nacional del Comahue of Argentina. We also wish to thank Pilquiniyeu del Limay dwellers for their kind hospitality and helpful field assistance during the study. We also appreciate Audrey Shaw for revising the English version of this manuscript.

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