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Plant diversity in two horticultural farms under organic and conventional management in La Plata, Argentina: A case study.

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ABSTRACT

Cultivated and associated plant diversity, were compared (the last at 3 scales: alpha, beta and gamma), in 2 farms under conventional and organic management in La Plata. The relevé method was used for associated species recording in spring and summer. At farm level we assessed total spontaneous specific richness (γ diversity), genus and family richness. Richness – species total per crop- was used as index of α diversity. We also calculated the median richness per crop sample unit. A randomization method was used to assess the degree for which differences between the observed and expected median richness per crop in a management style are attributable to chance. β diversity values were compared to a random framework, separately for each farm. Results indicate that the organic farm had higher associated diversity at all levels; also, higher number of cultivated plots and species, and proportion of exclusive, perennials, native and utilitarian species. In the organic farm crops with higher or lower median richness than expected, and higher β, indicated higher spatial and seasonal heterogeneity. Conventional management limited spontaneous plants to a reduced, homogeneously distributed group. Other factors may influence associated plant diversity.

KEY WORDS: horticulture, agrobiodiversity, associated diversity, agroecosystems.

RESUMEN

Se comparó la diversidad cultivada y asociada de plantas, la última a 3 escalas (alfa, beta y gamma), en 2 fincas una con manejo convencional y otra con manejo orgánico en La Plata. Se aplicó el método del relevé para las especies asociadas. A nivel finca se determinó la riqueza específica espontánea total (diversidad γ), y la riqueza de géneros y familias. La riqueza - total de especies por cultivo - se usó como índice de diversidad α. Se calculó la mediana de la riqueza por unidad muestral para cada cultivo, aplicándose un método de aleatorización para conocer la significancia de las diferencias entre las medianas observada y esperada por cultivo en un estilo de manejo. Los valores de diversidad β se compararon con un modelo al azar, en cada finca. La finca orgánica tuvo una mayor diversidad asociada en todos los niveles; un número más alto de parcelas y especies cultivadas, de proporción de especies exclusivas, perennes, nativas y utilitarias. En la finca orgánica los cultivos con una mediana de la riqueza más alta o más baja que la esperada, y β más alto, indicaron mayor heterogeneidad espacial y estacional. El manejo convencional limitó las plantas espontáneas a un grupo reducido, homogéneamente distribuido. Otros factores pueden influenciar la diversidad de plantas asociadas.

PALABRAS CLAVES: horticultura, agrobiodiversidad, diversidad asociada, agroecosistemas.

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Introduction

Agricultural biological diversity is a key component of agroecosystems because it provides a broad range of goods and ecological services that are essential for humankind (GLIESSMAN, 2001). Biodiversity in agroecosystems can be expressed as planned and/or associated diversity. The first one is the diversity incorporated into the system by the farmer's decision (e.g. crops) and varies according to management strategies. The associated diversity includes all living organisms that colonize the agroecosystem depending on its management and structure (VANDERMEER and PERFECTO, 1995). Within these components, plant diversity constitutes the base of general diversity (ALTIERI, 1999; SWIFT, 2004). Spontaneous plant species, a part of associated diversity, present in agroecosystems, are primary producers that provide food and habitat for organisms of other trophic levels (ALBRECHT, 2003; MARSHALL et al., 2003).

In the last years, the search for short-term higher profits has led to agroecosystem specialization, which results in a low number of cultivated species and or varieties (GLIESSMAN, 2001; SWIFT et al., 2004), and in a reduced heterogeneity of agricultural habitats in time and space (BENTON et al., 2003). In this sense, modern agriculture has been recognized as one of the main threats to biodiversity conservation (VAN ELSEN, 2000; BENTON et al., 2003).

An important decrease in plant species richness of agroecosystems, including the extinction of some considered weeds, has been reported recently in Europe (TSCHARNTKE et al., 2005). Species losses motivated research programs to assess and preserve agroecosystem diversity (ALBRECHT, 2003) and to search for more sustainable agricultural management practices.

Horticulture is a very important activity in Buenos Aires Province, Argentina, especially near La Plata City. In the last years, a clear tendency towards more costly systems requiring larger external inputs has been observed. These systems are generally associated with a reduction in the number of crops to those more profitable ones. At the same time, there has been an increase in the area of production systems based on low external inputs and more natural processes-support where a trend toward a higher number of cultivated species is observed.

Agricultural practices modify disturbance patterns and the availability of resources affecting colonization process of plant communities (CLEMENTS et al., 1994). In this sense, the diversity, functional characteristics (life cycle, morphotype) and origin (exotic or native) of spontaneous plants growing in cultivated agroecosystems can be associated with different disturbance levels generated by agricultural practices (DE LA FUENTE et al., 1999). These interactions between land use pattern and biodiversity vary according to temporal-spatial scales (EISWERTH and HANEY, 2001).

The impact that different agricultural styles have on biodiversity and particularly on its plant components has been pointed out by HOLE et al. (2005), who found that in almost all of the studies they reviewed, specific diversity was greater in agroecosystems under organic than under conventional management. Similar results were found by Bengtsson et. al. (2005), Roschewitz et al. (2005) and Manhoudt et al. (2007). Benefits of organic management to biodiversity could be related to a greater quality or quantity of cultivated and non-cultivated habitats than in conventional systems (HOLE et al., 2005). This result is attributed to the reduced use of inputs and to a "sympathetic" management of the spontaneous vegetation in the crop field and in field-margins. Benton et al. (2003) argued that maintaining or restoring habitat heterogeneity is a key to conservation or recovery of species diversity. Heterogeneity could indeed be more important to biodiversity than the lack of use of agrochemicals per se or other specific practices (BENTON et al., 2003). Nevertheless, organic agriculture comprises several management techniques that can be influenced by market characteristics (HOLE et. al., 2005) and can be determined by farmer's cultural and ethical considerations (SHEPHERD et al., 2003).

In Argentina, and other regions of the world, associated crop vegetation diversity has been evaluated in extensive systems and at different spatial scales (DE LA FUENTE et al., 1999; POGGIO et al., 2004; ROSCHEWITZ et al., 2005). Some published papers correspond to study cases on diversity of arthropods and plants (PFIFFNER and LUKA, 2000, MOONEN and MARSHALL, 2001). Nevertheless, no studies assessing cultivated and non-cultivated plant diversity in horticultural systems (organic and conventional ones) have been done.

Based on the previous evidence we hypothesize that:

(a) A greater associated plant diversity exists in an organic than in a conventional horticultural system. The higher associated diversity occurs at three proposed spatial scales: within crop (α diversity), between crops (β diversity) and farm total cultivated area (γ diversity).

(b) The expected differences in plant diversity between management systems are expressed in a different floristic composition, origin and functional aspects of the spontaneous species.

The main aim of this study was to quantify the spontaneous plant diversity at different scales in horticultural farms under organic and conventional management. We did a comparative case study of two farms representing contrasting management alternatives in La Plata area. We aim that results and conclusions should help planning an extensive study of the horticultural systems gradient present in this horticultural belt.

Materials and methods

Study area: We studied two farms from the Horticultural Belt (4.000 ha; INDEC, 2002) of La Plata City (34^{o} 8 S 57^{o} 54 W). This region is characterized by the existence of small and medium sized horticultural enterprises (7 ha average area), that provide seasonal vegetables (BENENCIA, 1994). Cultivated plots area varies from 1 row to ca. 0.25 ha. The two farms were similar in area (8 ha), and in their climatic and topographic conditions. Soils are typical Argiudols, annual mean temperature is 15.9 ^{o}C and average annual rainfall is 1092 mm.

Farm selection was based on two contrasting managements systems as a case study. Two farms were evaluated: an organic farm under certification and a conventional farm. The organic farm (OF) did not use synthetic chemical products; and only some organic approved pesticide products were occasionally applied. The selection criteria for OF was that it was the most ancient farm, 18 years previous to the study, producing organic vegetables without a previous history of another management type. Weed control was by hand and mainly at the early stages of crop development. Tillage was done with tools such as chisels and vibrocultivators.

The other farm was a conventional managed one (CF) selected at random from several in the neighborhood accomplishing similar size and ecological conditions than in the OF. Chemical applications included herbicides, insecticides and synthetic and organic fertilizers. Weeds were controlled before sowing and periodically during crop growth by mechanical means, mainly at the early phenological stages of crop. Soil labours was done with a mouldboard plough and cultivator.

Sample methods: in each farm, three spatial units types were defined according to the criteria of land use and or dominant crop as follows: (1) Cultivated plots: defined by the presence of one or more dominant crops. In this case, crops had a similar management type and the farmer considered it as a unit due to its similar life cycle or management techniques. (2) Non-cultivated area: fallow plots with spontaneous vegetation and sometimes, with crop residues left after harvest. (3) Natural boundary: plots dominated by herbaceous spontaneous plants.

Sampling was done exclusively on those cultivated plots, in year 2003, during summer (February and March) and spring (November to beginning of December), avoiding crops in seedling or post-harvest stage. From all cultivated plots, only 108 were evaluated, according to the specified conditions. In each one of these plots, 1 to 5 sample units were defined at random, according to the plot size totalling 250 sample units.

In each sample unit, the relevé method was applied (MUELLER-DOMBOIS and ELLENBERG, 1974; ALBRECHT, 2003). Adequate size of sample units was determined by the minimal area method (BRAUN-BLANQUET, 1972) and varied between 1 and 16 m2. Plant spontaneous species were evaluated and their abundance was estimated using the combined scale of cover-abundance of Braun-Blanquet (BRAUN-BLANQUET, 1972).

Plant diversity assessment: at the farm level, we assessed the total spontaneous specific richness (γ diversity) and genus and family richness registered at least in one season. Species richness and the total list of species present in the inventoried sampling units of each crop, was used as an index of α diversity, as cover-abundance of species was low and very similar among species and crops indicating a low variability of equitability. Additionally, for each crop in each farm we calculated the median richness per unit sample of the crop. A randomization method was used to assess the degree for which the differences between the median richness per crop, observed and modeled, in a determined management style are attributable to chance. The observed richness values were randomly assigned to each sample unit and the richness median was calculated for each crop. This procedure was repeated a thousand times and from the results, we took the 5th and 95th percentiles as the lower and upper confidence limits, respectively (MANLY, 1997). Those crops with a richness median lower than the 5^{th} percentile or higher than 95^{th} percentile were considered with a richness lower or higher, respectively, than expected by random.

Beta diversity was estimated using the Whittaker (1960) index: [(SC/S)–1]; where SC is the total number of species in the system and S is the average number of species per sample (MAGURRAN, 1988). In our study SC is the total number of associated species found in the farm crops, and S was calculated as the mean richness of crops. This β diversity index measures the renewal rate of species between different habitats, i.e. it describes the degree of similarity between habitats in terms of their specific composition. The index value will be lowest when species composition is the same, and highest when no common species are found.

Beta diversity values were compared to a random framework, employing a separate randomization procedure for each farm. For each sample unit in each crop we assigned species at random in a number equivalent to the observed richness. The selection probability of each observed species was proportional to its observed frequency (number of sample units where it was found). With the sample units built with species distributed at random we recalculated the number of species per crop and, later, β diversity. The procedure was repeated a thousand times and the 5^{th} and 95^{th} percentiles were calculated to evaluate if the observed β value was in the range expected by chance.

Results

Cultivated diversity: a higher number of crops, varieties and plots was registered in OF than in CF in both seasons (Figure 1). The number of plots in the OF was lower in spring compared to summer, but no marked differences were observed between seasons in the number of crops and varieties. The number of plots in CF did not vary between seasons. Nevertheless, the number of crops was reduced to one species and one variety in spring.

Floristic composition and Gamma diversity: Considering both farms (16 ha) a total of 66 spontaneous plant taxa was found, representing 21 families (Table 1). A higher number of taxa pertained to Poaceae (20 %) and Asteraceae (20 %). The Solanaceae, Fabaceae, Lamiaceae, Brassicaceae, Malvaceae and Apiaceae represented as a whole 33 % of the total richness. The other 11 families present accounted for the remaining 27% of taxa.

Higher species richness at farm level (γ diversity), genus and families were found in the OF than in CF (Figure 2). In OF, specific richness was higher in summer than in spring; but no evident seasonal differences were observed in CF. The highest plant richness in OF was twice that CF in spring and three times greater in summer .

Eight plant families were recorded only in the OF: Boraginaceae, Fabaceae, Gentianaceae, Lythraceae, Malvaceae, Oxalidaceae, Plantaginaceae, and Solanaceae. All families found in CF were common to both farms.

Dicotyledonous species number was higher than monocotyledonous species in both farms. The proportion of exotic species was higher than that of natives and cosmopolitans in both farms (Table 2). However, the proportion of native species increased in OF. The percentage of annual species was higher than for perennials in both farms, but the proportion of perennials increased in OF.

Several exclusive species were observed in

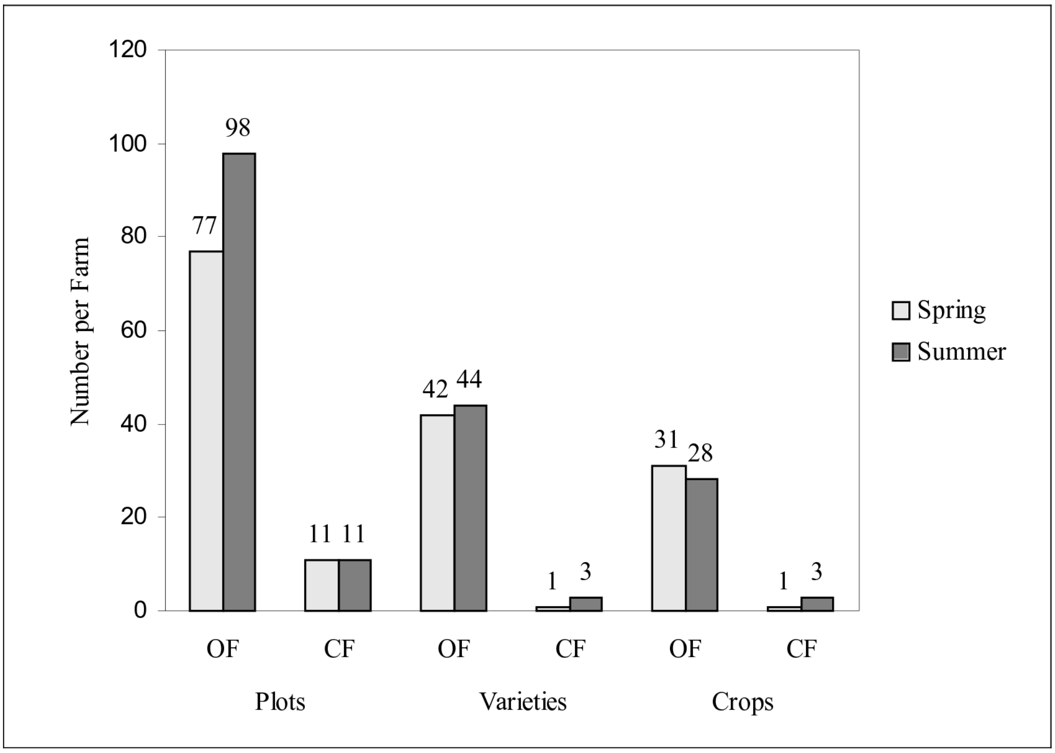

Figure 1. Number of plots, cultivated species and varieties recorded in spring and summer in an organic (OF) and a conventional (CF) farm in La Plata, Argentina.

Table 1. List of spontaneous plant species, genus and families recorded (x) in an a organic (OF) and a conventional (CF) farm in La Plata, Argentina.

Species	OF	CF	Species	OF	CF
[1]*Alternanthera philoxeroides* (Mart.) Griseb.	x	x	[17]*Leptochloa chloridiformis* (Hack.) Parodi	x	x
[1]*Amaranthus quitensis* Kunth.	x	x	[17]*Lolium multiflorum*. Lam.	x	
[2] *Ammi majus* L.	x	x	[13]*Lythrum hyssopifolia* L.	x	
[14]*Anoda cristata* (L.) Schltdl	x		[10]*Lotus glaber* Mill.	x	
[3]*Arctium minus* (Hill) Bernh.	x		[3]*Matricaria recutita* L.	x	x
[3]*Bidens subalternans* DC	x		[12]*Mentha rotundifolia* (L.) Huds.	x	
[2]*Bowlesia incana* Ruiz & Pav.	x	x	[14]*Modiola caroliniana* (L.) G. Don	x	
[5]*Brassica rapa L.*	x		[21]*Nicotiana longiflora* Cav.	x	
[17]*Bromus unioloides* Kunth	x		[15]*Oxalis corniculata* L.	x	
[5]*Capsella bursa-pastoris* (L.) Medik.	x	x	[17]*Panicum bergii* Arechav.	x	x
[11] *Centaurium pulchellum* (Sw.) Druce	x		[17]*Paspalum dilatatum* Poir.	x	
[3]*Carduus acanthoides* L.	x		[10]*Phaseolus vulgaris* L.	x	
[7]*Chenopodium album* L.	x	x	[21]*Physalis viscosa* L.	x	
[3]*Cichorium intybus* L.	x		[3]*Picris echiodes* L.	x	x
[2]*Conium maculatum* L.	x		[16]*Plantago lanceolata* L.	x	
[3]*Coniza bonariensis* (L.) Cronquist.	x		[17]*Poa annua* L.	x	
[8]*Convolvulus arvensis* L.	x	x	[18]*Polygonum aviculare* L.	x	
[2]*Cyclospermum lepthophyllum var leptophyllum*	x		[19]*Portulaca oleracea* L.	x	x
[17]*Cynodon dactylon* (L.) Pers.	x	x	[18]*Rumex crispus* L.	x	x
[9]*Cyperus rotundus* L.		x	[3]*Senecio vulgaris* L.	x	x
[9]*Cyperus sp.*	x		[17]*Setaria geniculata* (Lam.) Beauv.	x	
[21]*Datura ferox* L.	x	x	[17]*Setaria verticillata* (L.) P. Beauv.	x	
[8]*Dichondra microcalyx* (Hallier f.) Fabris	x		[14]*Sida rhombifolia* L.	x	
[17]*Digitaria sanguinalis* (L.) Scop.	x	x	[21]*Solanum sublobatum* W.ex Roem.& Schult	x	
[17]*Echinochloa colona* (L.) Link.	x	x	[3]*Sonchus oleraceus* L.	x	x
[17]*Echinochloa crusgalli* (L.) P. Beauv.	x		[12]*Stachys arvensis L. (L).*	x	
[4]*Echium plantagineum* L.	x		[6]*Stellaria media* (L.) Cirillo	x	x
[17]*Eragrostis sp.*	x	x	[3]*Taraxacum officinale* G.Web.ex F.H. Wigg.	x	x
[3]*Galinsoga parviflora* Cav.	x	x	[10]*Trifolium pratense* L.	x	
[21]*Jaborosa runcinata* Lam.	x		[10]*Trifolium repens* L.	x	
[12]*Lamium amplexicaule* L.	x	x	[22]*Urtica urens* L.	x	x
[3]*Lactuca sativa* L.	x		[20]*Veronica persica* Poir.	x	x
[5] *Lepidium didymum L.*	x	x	[3]*Pascalia glauca* Ortega	x	

Families: [1] *Amaranthaceae*; [2] *Apiaceae*; [3] *Asteraceae*; [4] *Boraginaceae*; [5] *Brassicaceae;* [6] *Caryophyllaceae;* [7] *Chenopodiaceae;* [8] *Convolvulaceae;* [9] *Cyperaceae;* [10] *Fabaceae;* [11] *Gentianaceae;*[12] *Lamiaceae;* [13] *Lhytraceae;* [14] *Malvaceae;* [15] *Oxalidaceae;* [16] *Plantaginaceae;* [17] *Poaceae;* [18] *Polygonaceae;* [19] *Portulacaceae;* [20] *Schophulariaceae;* [21] *Solanaceae ;* [22] *Urticaceae.*

OF. Almost all species in CF were common to the OF (Table 2). Exclusive species were generally rare or scarcely abundant.

Those species common to both farms were generally of annual cycle and of exotic origin. Exclusive species included equal number of annuals and perennials. In OF, the number of native and perennial exclusive plants was twice that of common ones. There was observed a higher proportion of native and perennial species observed in OF compared to CF.

Alpha and Beta diversity: alpha diversity of crops showed a wider range in OF (6 to 35 sps) than in CF (14 to 19 sps). However, the mean α

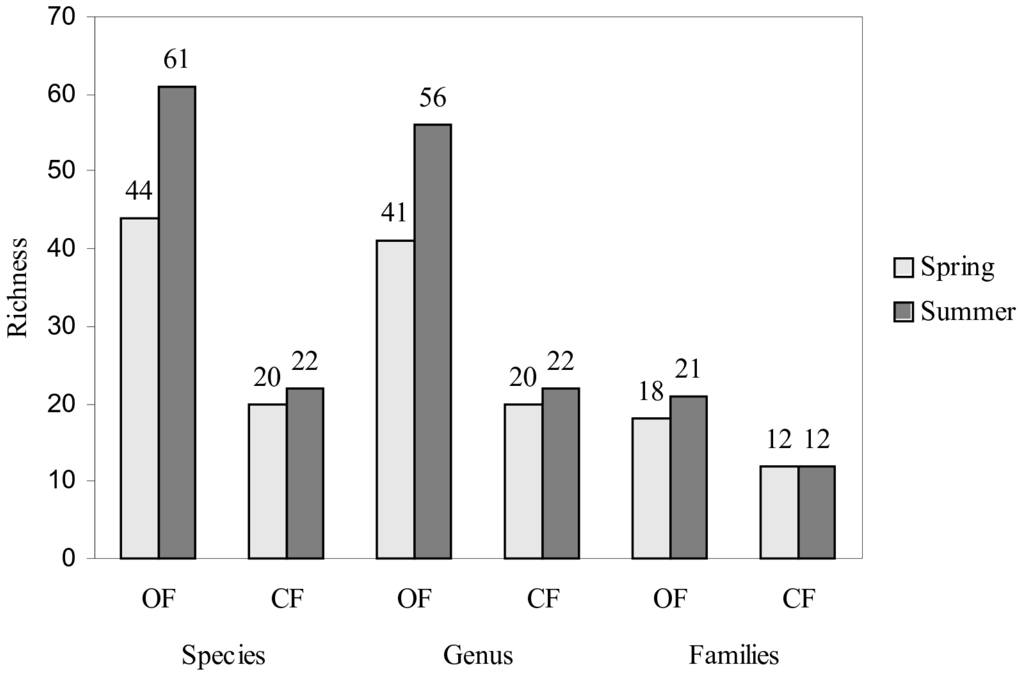

Figure 2. Number of spontaneous plant species, genus, and families, recorded in spring and summer in an organic (OF) and a conventional (CF) farm in La Plata, Argentina.

Table 2: Relative abundance and number of common and exclusive spontaneous plant species, according to their origin and life cycle and morphotype in an Organic (OF) and a Conventional farms (CF) in La Plata, Argentina.

		Relative Abundance (%)		Species number		
	Category	OF	CF	Common	Exclusive	
					OF	CF
Origin	Native	35	26	7	15	-
	Exotic	60	63	17	21	-
	Cosmopolitan	5	11	2	1	1
Life cycle	Annuals	60	70	19	19	1
	Perennials	40	30	7	18	1
Morphotype	Dicotyledonous	79	78	21	28	-
	Monocotyledonous	21	20	5	8	1

richness of all crops was not very different between OF (17±7 sps.) and CF (16±3 sps).

The three observed crops (*Cynara scolymus*, *Zea mays* and *Phaseolus vulgaris*) in the CF had median richness values in the range between the confidence limits expected by chance. In the OF five crops (*Beta vulgaris* var. *cicla*, *Zea mays*, *Allium cepa*, *Beta vulgaris* and *Lycopersicum esculentum*) showed a higher richness and the other five crops presented lower values (*Ocimum basilicum*, *Cynara scolymus*, *Petroselinum crispum*, *Cichorium intybus* and *Phaseolus vulgaris*) than expected by chance. The remnant species were into the confidence limits range (Table 3).

In summer, β diversity was higher in OF (β=2.53) than in CF (β=0.37). In CF this index fell into the confidence limits range (percentile 5^{th} = 0.32; 95^{th} =0.57). Meanwhile in the OF β diversity was higher than the upper confidence limit (percentile 95^{th} =2.29).

Discussion

The results of this study indicate that compared to the conventional farm, the organic farm evaluated had: 1) a higher associated plant diversity at the γ and β level; also plant diversity at α level was higher than expected by chance in several important crops plots. 2) a higher number of cultivated monospecific plots and a higher number of cultivated taxa.

The higher plant species diversity at farm level (γ diversity) found in this diversified organic system agrees with the results in Bengtsson et al. (2005), Roschewitz et al. (2005) and Manhoudt et al. (2007). This relationship was two-fold in spring and three-fold in summer than those found in the conventional farm, similar to that cited by Hole et al. (2005).

In the organic farm ten crops presented a higher or a lower median richness than expected by chance, indicating a higher spatial and seasonal heterogeneity (more crop species and smaller size plots, and periodic crop rotations). This was also shown at β level by a higher β diversity which was higher than expected by random compared to the conventional farm. The establishment of rare species in the organic farm increased all diversity levels. In contrast, richness at α and β level did not differ from the random model in conventional farm suggesting homogenization of floristic composition and habitat at both scales. This can be a consequence of management type characterized by a lower number of crops, small numbers of plots of larger size, less frequent rotation and intensive farming including agrochemical use. Despite the mean richness per crop (α) is similar in both farms, floristic homogenization results in a lower γ diversity of the conventional farm and conventional management limits spontaneous plants to a more reduced, homogeneously distributed group. In addition to management style, crop structure and landscape might influence associated plant diversity. When the same crop species (in this study: *Zea mays*, *Cynara scolymus* and *Phaseolus vulgaris*) show a different value of median richness under both farming styles, management and landscape effects might be the main causes of associated diversity differences as the structure of the crops do not differ between management styles. Moreover, market characteristics (HOLE et al., 2005) and farmer's cultural and ethical considerations (SHEPHERD et. al., 2003) may influence organic management techniques and consequently cultivated and associated diversity. In the organic farm evaluated in this study, market influence was evidenced by a multi-species demand related to a direct, commercialized producer- consumer pathway via door to door delivery or in local small markets. The second was evidenced in farmer conviction and involvement with production of healthy organic products.

Differences between both management styles were observed in the floristic composition as well

Table 3: Median sample richness per crop and total richness per crop in organic and conventional farm. Median richness obtained through randomization (percentile 50th) is shown with lower (5th percentile) and upper (percentile 95th) confidence limits. Observed median richness laying out of confidence limits are indicated by an asterisk (*). Total richness is the number of associated species registered in the set of sampling units of each crop.

Crop	Median Richness				Total Richness
	Obtained			Observed	
	5th	50th	95th		
Organic faro					
Allium cepa L.	6	10	15	17 *	27
Allium fistulosum L.	6	10	13	8	22
Allium porrum L.	6.5	10	14.5	8	17
Beta vulgaris L.	7	10	13	16 *	35
Beta vulgaris L. var.cicla (L.)	6.5	10.5	14	14.5 *	22
Brassica napus L.	6.5	10	14	11	20
Brassica oleracea L.	7	10	13	12	22
Brassica oleracea L. var. Italica	6	10	15	10	13
Capsicum annum L.	8	10	13	8	20
Cichorium intybus L.	6.5	10	14.5	6 *	11
Cucumis sativus L.	6	10	15	6	9
Cucurbita sp.	6	9.5	15	8	11
Cynara scolymus L.	6	10	15	5 *	8
Daucus carota L.	7	11	13	9.5	17
Eruca sativa Mill.	6	10	15	10	14
Foeniculum dulce D.C.	0	10	14	10.5	15
Lactuca sativa L.	6.5	9.5	14	8.5	12
Lycopersicum esculentum Mill.	6	10	15	17 *	23
Ocimum basilicum L.	6	9.5	15	5 *	6
Origanum vulgare L	6	10	15	8	12
Petroselinum crispum (Miller) A. W. Hill	6.5	10	14	5.5 *	17
Phaseolus vulgaris L	6	10	15	3 *	6
Raphanus sativus L.	6.5	9.5	14	6.5	14
Solanum melongena L.	6	10	15	15	18
Zea mays L.	7.5	9.5	12.5	14 *	33
Conventional faro					
Cynara scolymus L.	8.5	9	10.5	9.25	11
Phaseolus vulgaris L.	6.25	9.75	11.5	6.25	19
Zea mays L.	8	9	12	12	14

as in its origin and functional characteristics (except morphotype).

The higher plant richness observed in the organic farm was associated with exclusive species and families. The presence of exclusive or rare species agrees with results from Europe, where more rare species were found in farms under organic management than in conventional ones (HOLE et. al., 2005). The higher species richness found in the organic farm was also associated with an important number of utilitarian, perennials and natives species. Fifty spontaneous species (30 exclusives) in the organic farm compared to 20 species (common to both farms) in the conventional farm have ornamental, medicinal or fodder value. One of the exclusive families found in the organic farms has been cited as a reservoir of natural enemies (Fabaceae) (ALTIERI, 1999). The higher proportion of annual than perennial species found in both systems agrees with results from Suárez et al. (2001) and Poggio et al. (2004). The dominance of annual plants has been associated with disturbed habitats where soils are ploughed (SUÁREZ et al. 2001) and/or in high intensive management systems. A higher percentage annual species was observed in the conventional farm. Ghersa and Martinez-Ghersa (2000) reported that the use of broad-spectrum action herbicides favours the presence of annual species more than perennials and biennials. A higher proportion of perennial species in organic farm compared to conventional farms has been related to the presence of perennial crops in the rotations (VAN ELSEN, 2000). However, in our study, these species were found both in annual short cycle crops and in biennial crops in the organic farm, suggesting a weak association with crop characteristics. Perennial species are generally found in intermediate stages of ecological succession, in low disturbance conditions (GRIME, 1979). This suggests that this organic system had characteristics of less disturbed systems compared to the conventional farm, as ecological succession reaches a later stage (more perennial species) than in conventional ones. Disturbance type and degree might cause different effects, being important to the relative floristic and habitat heterogeneity or homogeneity observed in the farms.

The observed trend of increase in cultivated and associated diversity with the increase in habitat heterogeneity and decrease of farming intensity in the studied farms agrees with the results of Hole et al. (2005) and Benton et al. (2003). Therefore, the organic farm allows "*in situ*" conservation of a higher number of species. Its importance rests in species conservation itself and their associated ecological roles especially for low input agroecosystems.

In a pampasic landscape dominated by agriculture and cattle raising, biodiversity dynamics depends on the degree to which farms differ from each other. For example,
the total number of spontaneous species found in the horticultural systems described in this study (66 taxa in 16 ha) is high when compared to grain crops from large rural properties devoted to one or a few extensively cultivated species. De La Fuente et al. (1999) reported 60 sps in 60 farms totalling 6000 ha, and Poggio et al. (2004) determined 96 species in 74 farms covering 2200 ha. These results suggest that the horticultural systems of La Plata, when managed with high crop diversity, as in the organic farm, can hold an important associated floristic diversity. However, if the actual trend in this area continues towards a high input horticulture restricted to a few high benefit crops, an increase in homogenization of habitats will provide a serious challenge in the conservation of biota.

This paper shows the importance to design and manage agroecosystems with a high-cultivated diversity to enhance associated plant diversity, which is an important component of agrobiodiversity.

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