Biological Agriculture and Horticulture, 2003, Vol. 21, pp. 349–366
0144-8765/03 $10

Printed in Great Britain

Tradition, Dynamics and Sustainability of Plant Species Composition and Management in Homegardens on Organic and Non-Organic Small Scale Farms in Alpine Eastern Tyrol, Austria

Christian R. Vogl* and Brigitte Vogl-Lukasser

Institute for Organic Farming, University of Natural Resources and Applied Life Sciences Vienna, Gregor Mendel Strasse 33, 1180 Vienna, Austria

ABSTRACT

In Eastern Tyrol (Austria), homegardens are an integral part of the farming system. The aim of this paper is to present evidence for the development of gardening in the study area and to identify differences/similarities between gardens at organic and non-organic farms. In 1997 and 1998, in homegardens on 91 organic and 105 non-organic farms from 12 communities, occurrence and abundance of cultivated plant species were surveyed and interviews were carried out about garden history, management and plant use. For the factor organic/non-organic, differences between gardens were statistically tested. Garden management is similar in organic/non-organic gardens, except mixed cropping and the use of alternative remedies to combat diseases, both with significantly higher occurrence on organic farms. Popular innovations from organic farming did not have a strong and clearly visible impact on management of homegardens. The population of cultivated plant species, until the 1960s approx. 51; nowadays approx. 587 species in all gardens, and main use of garden produce has been in a process of change with an increase in importance of species used as food and for decoration, but with no significant differences concerning organic/non-organic. Women farmers gardening in Eastern Tyrol are highly sympathetic to the principles of organic farming, even on non-organic farms. Sustainability can be increased when methods from organic gardening are promoted and tested locally more effectively. Science and policy should recognize the work of women farmers who maintain homegardens with high agrobiodiversity as part of their culture.

*Corresponding author—christian.vogl@boku.ac.at

INTRODUCTION

In Austria, as in many other European countries, organic farming has been developed by farmers at mixed crop-livestock operations (Pirklhuber & Gründlinger, 1993; Vogl & Hess, 1999). Scientific research on organic farming in Austria has primarily been focused on these operations, especially on soil, plants and their interactions at arable plots (Lindenthal, 1993; Lindenthal *et al.,* 1995). Organic horticulture in Europe has been addressed in scientific literature only recently, and only for commercial horticulture, fruit culture or viticulture (Lindenthal *et al.,* 1995). Data on the role of small gardens adjacent to most farmers' living quarters (henceforth called 'homegardens') with respect to organic farming have not been published. Homegardens are small in area, not primarily market-oriented, and are usually managed by women. It may be that these factors are responsible for the fact that homegardens have been neglected (IPGRI, 2000) and that scientific research on farmers' homegardens, despite the recent increased popularity of gardening, has not been realized either in Austria or at the European level, with a few exceptions (Hauser, 1976; Brun-Hool, 1980; Lohmeyer, 1983; Poppendieck, 1992; Inhetveen, 1994; Agelet *et al.,* 2000; Vogl-Lukasser, 2000; Vogl-Lukasser & Vogl, 2002), and without focus on the organic operation.

The lack of scientific data on homegardens in temperate climates is surprising, because research on tropical home gardens is done intensively. Ethnobotanical research on gardens has been published about rural areas of Latin America, the Caribbean, the Pacific Islands, Asia, Africa or on urban gardens in different countries (Niñez, 1985; Landauer & Brazil, 1990; Rico-Gray *et al.,* 1990; Padoch & De Jong, 1991; Caballero, 1992; Esquivel & Hammer, 1992; Anderson, 1993; Salvador Flores, 1993; Hochegger, 1995; Hodel & Gessler, 1999; Vogl *et al.,* 2002).

In Eastern Tyrol, homegardens are an integral part of the farming system in the study area. Until the 1960s, alpine farming in Eastern Tyrol was primarily done for subsistence and based on cereal cultivation (e.g. *Secale cereale, Triticum aestivum*), field vegetables (e.g. *Pisum sativum, Vicia faba*), fibre crops (e.g. *Linum usitatissimum, Cannabis sativa* ssp. *sativa*) and fruit trees (e.g. *Malus domestica, Pyrus communis*). Small areas of hay meadows near the homestead, alpine hay meadows and alpine summer grazing grounds served as fodder for a small number of animals of different species (hens, pigs, goats, sheep, horses, cows) kept on the farms. Farming for subsistence was based on a few staple products that had to be stored properly in order to ensure the survival of humans and animals during the winter period. Work on the farm was done by hand. External inputs of synthetic fertilizer and pesticides, and commercially traded seeds were not used owing to limited mobility and the large distances between farms and cities. In addition, low farm incomes made the high costs of external inputs unaffordable (Vogl-Lukasser, 2000).

Farming systems in Eastern Tyrol have been going through a process of change in the last few decades, starting from the 1960s. The cultivation of fibre crops has completely disappeared while the decline in cereal cultivation has been constant. Field vegetables and fruit trees are still cultivated, but reduced in extent and importance. Instead of these activities, specialized cattle breeding and the production of milk gained importance, paralleled by an increase of area used as meadows and pastures for these animals. Reasons for this development were the favourable prices of high quality cattle breeds, as well as for their meat and milk and, simultaneously, the low prices paid for cereals. Today almost all of agricultural land is covered with meadows and pastures. Areas where machinery cannot be used is converted into forests (Vogl-Lukasser, 2000). In spite of all these changes, homegardens remain colourful landmarks in the study area. Studies on homegardens of other study areas has led to interesting results and new insights into the composition, management and importance of these agroecosystems for subsistence, for conservation of agrobiodiversity and for sustainable development (Niñez, 1985; Landauer & Brazil, 1990; Watson & Eyzaguirre, 2001). The questions here are, is this also true for the homegardens of Eastern Tyrol and what impact does organic gardening have on homegardens here? The aim of this paper is to present evidence for the characteristics of temperate homegardening on organic and non-organic farms. Therefore, the flora composition, management and purpose of homegardens on organic and non-organic farms in Eastern Tyrol is presented and the sustainability of temperate homegardening on farms in the study area is discussed.

MATERIALS AND METHODS

In 1997 and 1998, 196 homegardens on 196 farms from 12 communities in Eastern Tyrol were investigated. Of the 196 gardens studied, 91 were at certified organic farms (46.4% of the sample). Organic farms are farms certified by certification bodies according to EC-Regulation 2092/91. The terms homegarden or garden refer in this paper to the small, fenced plot close to the farmers' homestead, where annual, biennial and perennial cultivated species are grown in beds. The homegarden is one of the women's responsibilities, henceforth called here 'women farmers', at all farms studied. The term cultivated plants refers to domesticated plants and wild plants under incipient management (tolerated, encouraged or protected) in gardens (Bye, 1997). The term traditional refers to species and varieties that have survived for a long time in the region with direct agricultural use or as an element of the agroecosystem.

Annual precipitation in the district of Lienz (Eastern Tyrol) is 850–1150 mm and mean annual temperature is 4.8–6.9°C (Waschgler, 1993). In the study area, 1830 farms (> 2 ha) are managed including 574 farms certified organic (M. Diemling, personal communication, February 2003; see Vogl & Hess (1999) for

history and characteristics of organic farming in Austria). The farms surveyed are situated between 600 and 1641 m above sea level. The average area of agricultural land located near the homestead is 7 ha, and mainly consists of hay meadow. In addition to the managed homegardens, 47% of the surveyed farms have small plots (average size 0.01 ha) of field vegetables (mainly potatoes, *Solanum tuberosum*), grown on moderate slopes and 79% have orchards (apples, *Malus domestica;* pears, *Pyrus communis*). Most farmers own forests and alpine meadows at 1500 m above sea level and above, which are used as summer grazing grounds and for hay production. On average, each of the households observed keeps 12 dairy cows, two pigs, 12 hens and 30 sheep. Fifty percent of the farms studied are managed on a full-time basis; 50% are part-time farms. The ages of the respondents were between 25 and 85.

The occurrence and abundance of cultivated plant species, subspecies or varieties, all referred to henceforth as species were surveyed on each of three dates in spring, summer and autumn. Voucher specimens were taken (Martin, 1995; Alexiades & Sheldon, 1996) and species identified according to botanical references (Wehrhahn, 1937; Encke, 1961; Hegi, 1979; Holzner, 1981; Jäger *et al.,* 1991; Pahlow, 1993; Fischer, 1994; Fitschen, 1994; Royal Horticultural Society, 1997; Hanf, 1998; Royal Horticultural Society, 1998).

Structured interviews were carried out with each of the women responsible for these homegardens. Information was collected in these interviews about different ethnobotanical topics for each cultivated plant species and on characteristics describing the location and the management of the garden. Semi-structured interviews about the management of farms over the last 70 years with a special focus on homegardens were carried out with an additional sample of 27 elderly women. Results from these interviews serve as a historic baseline for the description of changes in floristic composition and management in recent years. Field research was supplemented with participant and non-participant observation, i.e. work with women farmers and the observation of their work (Bortz & Doring, 1995; Martin, 1995; Alexiades & Sheldon, 1996; Vogl *et al.,* 2003).

All raw data were stored in an Access database (Microsoft Office package) and analysed with SPSS (version 7.5.2) for Windows (SPSS, 1997). For the factor 'land use system' (organic; non-organic) a one-way ANOVA was done for occurrence and abundance data of plants and a chi-square test for ordinal (intensity of mixed cropping) and nominal (e.g. presence/absence of compost) data. The influence of the factor is reported as being significant at a level of $p < 0.05$ and as a tendency at a level of $p < 0.1$.

RESULTS

Recent appearance and management of gardens

The homegardens on organic and non-organic farms differ little in terms of

location and layout. They are generally found right next to the farmhouses and consist of a series of ordered and raised beds. Small paths that allow the gardener to reach every part of the bed for planting, watering, weeding and harvesting divide the approx. 1.5 m wide beds. The gardens are separated from the surrounding area by fences.

Homegardens do differ considerably in terms of area (Range: 12 m^2–220 m^2). The differences in size (mean: organic 63 m^2; non-organic 65 m^2) cannot be explained by the land use system ($p_{ANOVA} = 0.662$).

Work is done by hand, and all women use very simple tools like small hoes, rakes, spades, forks and watering cans. Some of them are made locally or maintained and repaired on the farm. Tools are built in a way to last a long time. Some are built from recycled material no longer being used on the farm; for example, greenhouses made from old windows. In only 2.6% of the gardens is motor driven technical equipment used to cultivate the soil (Table 1). Modern garden tools, such as the claw cultivator, which are promoted by local retailers and on TV are rarely found, in only 6.1% of the gardens, and, if owned, they are not regularly used on either organic or non-organic farms. Modern equipment such as rotary cultivators, tillers or flame weeders are not used at all. The only modern tool used by women farmers (in 53.6% of the gardens) is the sprinkler for irrigation, with no difference between land use systems (Table 1). Women emphasize that the use of sprinklers is not very popular and, if used at all, then only in summertime when labour demand for other duties at the farm is high. Most of the time women irrigate with watering cans or hosepipes because this saves water and allows the irrigation of each species according to its needs.

The fertility of the soil is maintained by the use of manure from the farm's own cattle, sheep, horses or hens. Manure that is used as fertilizer in gardens is at least 2–3 years old. Fertilization with manure is utilized in almost all (96.4%) of the gardens and differences between gardens cannot be explained by the land use system (Table 1). Organic waste from the garden or kitchen is usually thrown on the dunghill. In addition, separate 'formal' composting of organic waste is done in 26% of the gardens. Women farmers have started formal composting only recently. They explicitly stress that they do not know how to prepare compost correctly, that composting is not very popular because of the increase in weeds after the application of compost, whereas no problems occur when the 2–3 years old manure is used. The land use system does not influence women farmers' decision to use compost or not (Table 1).

Commercially available fertilizers are used in the gardens of six non-organic farms and four organic farms (Table 1). Green manure, or water extracts from plants or compost are not used at all. Amelioration with alternative soil additives such as lime, stone meal or turba is done in 26.5% of the gardens, independent of the land use system (Table 1).

Mulching is practised in 22.4% of the gardens in autumn to protect the soil and/or perennial plant species from strong frost in wintertime. It is also done to

TABLE 1

Selected practices in the management of homegardens and percentage of respondents of organic and non-organic farms who do use/not use these practices.

		Percentage of respondents			
Selected practices in the management of homegardens	Tradition	Organic & non-organic as % of n (n = 196)	Organic as % of n (n = 196)	Non-organic as % of n (n = 196)	Significance
Work by hand with simple tools	Yes	100.0	46.4	53.6	–
Use of technical motor driven equipment	No	2.6	1.0	1.5	n.s.
Use of modern garden tool	No	6.1	3.6	2.6	n.s.
Irrigation with sprinklers	No	53.6	23.5	30.1	n.s.
Manure of own farm	Yes	96.4	45.4	51.0	n.s.
Use of compost	No	26.0	11.2	14.8	n.s.
Use of commercially available fertilisers	No	5.1	2.0	3.1	n.s.
Use of green manure or plant dung compost extracts	No	0.0	0.0	0.0	–
Amelioration with alternative additives	Yes	26.5	14.3	12.2	n.s.
Mulching as winter protection	Yes	22.4	10.2	12.2	n.s.
Mulching as technique during cultivation period	No	0.0	0.0	0.0	–
Digging the garden with turning the top soil	Yes	100.0	46.4	53.6	–
Written production plan for crop rotation	No	0.0	0.0	0.0	–
Existence of mixed cropping in beds	No	49.0	29.1	19.9	sig.
Intensity of mixed cropping in beds[a]	No				sig.
1 = few		19.9	13.3	6.6	
2 = some		13.3	7.1	6.1	
3 = much		15.8	8.7	7.1	
0 = none		51	17.3	33.7	
Following of lunar rhythms in management	No	77.6	35.7	41.8	n.s.
Use of synthetic or biological, commercially available pesticides to combat diseases	No	3.6	1.5	2.0	n.s.
Use of synthetic or biological, commercially available pesticides to combat pests	No	8.7	3.1	5.6	n.s.
Use of alternative homemade remedies to combat diseases	No	8.7	6.6	2.0	sig.
Use of alternative homemade remedies to combat pests	No	8.2	3.1	5.1	n.s.
Weeding by hand	Yes	100.0	46.4	53.6	–
Use of herbicides to control weeds	No	0.0	0.0	0.0	–
		Number of plant species per garden (mean)			
Species with seeds/plantlets from predecessor, neighbour, own production or from the wild	Yes	19	18	19	n.s.
Species with seeds/plantlets from seed retailiers or shops	No	23	22	23	n.s.

Chi-square test for nominal and ordinal variables done with the actual numbers
One-way ANOVA, done with the actual numbers
[a]1: Only one bed and in this bed less than three species; 2: Less than 50% of the beds with annual or biennial species and in these beds more than three species; 3: Equal or more than 50% of the beds with annual or biennial species and in some beds more than five species.

suppress weeds in the pathways between the beds. Mulching during the vegetation period in beds is not done, this being so because women farmers report negative experiences with the subsequent increase in weeds germinating in the beds, a high abundance of slugs and the fact that mulching does not correspond to their sense of garden aesthetic. Organic or non-organic farming has no influence on the occurrence of mulching in the sample (Table 1).

In autumn after harvest or in early spring, all 196 women farmers dig the garden down to 30 cm in depth. During this digging, manure is set in and the topsoil is turned 180º with a special shovel or fork. The loosening of the topsoil without turning it over is done only when plant species are already planted (Table 1).

Although women farmers do rotate most plant species in the beds every year, they do not report taking into account special demands, for example of nutrients for subsequently grown species. They do not use any kind of written plan for managing the garden with regard to crop rotation (Table 1).

Perennial plants, with a primarily ornamental purpose, are generally grown side by side in small beds adjacent to the surrounding fence. The beds in the centre of the gardens (approx. 85% of the total home garden area) are dedicated to food crops, mostly to annual or biennial species. In these beds, species are usually not mixed, i.e. the area covered by each species is clearly separated from areas designated for other species. If women practise mixed cropping in beds (in 49% of the gardens), then this is with different intensity. The cultivation of onions (*Allium cepa*) and carrots (*Daucus carota*) together in the same bed is the most frequent combination of crops. The land use system does influence the occurrence of mixed cropping. More women farmers from organic farms than from non-organic farms do mixed cropping. Women farmers at organic farms also do mixed cropping at more beds with more species than gardeners from non-organic farms (Table 1).

In 77.6% of the gardens, women take into account lunar rhythms and other astrological information for some management practices. Women report that they do take one or the other rule into account, especially for activities like planting and sowing. There is no significant difference between women farmers on organic or non-organic farms (Table 1).

According to the women farmers, diseases and pests occurring in gardens never menace the whole inventory of cultivated plant species. If at all necessary, pests are eliminated by hand and the part of the plant or the whole plant attacked by diseases is also removed by hand. Combating diseases and pests with synthetic or biological, commercially available pesticides is done by equally few women farmers on organic and non-organic farms (Table 1). Only a few women use alternative plant protection against diseases and pests with homemade remedies, including teas of nettle (*Urtica dioica*), horsetail (*Equisetum* sp.), soft soap or lime. Such practices to control diseases are significantly more frequent in gardens on organic farms (Table 1).

The weeding process is done on all farms by hand with simple tools. During summer, women often complain that there is not enough time to weed due to their workload in other sectors of the farm. Nevertheless, herbicides are not used at all (Table 1).

Plants, seeds and plantlets come from predecessors, neighbours, the farmer's own production, and are gathered in the wild or bought from shops or retailers. The land use system does not influence a woman farmer's choice of whether to obtain seeds/plantlets from the market or from regional sources (Table 1).

Appearance and management of gardens in the last century

A comparison of the modern situation with the reports of the elderly women shows that there has been no notable break with tradition in terms of the position and appearance of the garden. The main part of management techniques, such as working by hand with simple tools or digging the garden by turning the topsoil, are done in just the same way as the eldest living generation in the study area did it when they managed the gardens (Table 1). Only some innovations show a further distribution throughout the region, including sprinklers and work according to lunar rhythms.

The elder women report that, in former times, gardens were smaller and women would only work in them if they had any time left over after performing all of their other duties on the farm. Labour intensive crops are not grown in fields any more. Much of the labour done by hand and previously required for the cultivation of cereals, field vegetables and fibre crops (*Linum usitatissimum* was very labour intensive!) is now dedicated to garden work, i.e. in general, women use more time for gardening.

Recent plant species composition

The population of cultivated plant species across all 196 homegardens is made up of 587 species; a total of 445 species in gardens on organic and 512 in gardens on non-organically managed farms. An average of 42 plant species (Range: 7–119) and 746 plant individuals (Range: 138–2248) are cultivated per homegarden. The differences in occurrence and in abundance of plant species between gardens on organic and non-organic farms are not statistically significant.

Floristic composition is highly variable. Only 13 species are found in more than 50% of the homegardens surveyed. 155 plant species can be found in only one of the 196 studied homegardens. The 12 most frequently cultivated plant species are grown in gardens on organic and non-organic farms (Table 2).

TABLE 2

Percentage of gardens, where the most frequently cultivated plant species are grown.

Scientific name	Percentage of gardens (n = 196 = 100%), where species is grown	
	Organic farms	Non-organic farms
Lactuca sativa var. *capitata*	45.9	53.1
Allium schoenoprasum ssp. *schoenoprasum*	45.4	51.0
Petroselinum crispum convar. *crispum*	34.2	43.9
Brassica oleracea var. *capitata alba*	32.7	36.2
Brassica oleracea var. *gongylodes*	32.7	34.2
Fragaria × *ananassa*	29.6	33.2
Raphanus sativus ssp. *sativus*	29.1	27.6
Daucus carota ssp. *sativus*	27.0	32.7
Calendula officinalis	26.5	30.1
Phlox paniculata	26.5	28.6
Brassica oleracea var. *botrytis*	26.0	28.6
Allium porrum var. *porrum*	25.5	29.6

Recent use of plant species

All women farmers grow plant species for family use. Garden produce is commercialized from only nine organic and nine non-organic farms. In contrast, 79.6% of the women report that the garden produce is also given away as a barter or gift. Therefore, the properties of plants respond to a wide array of local family and rural community needs.

The largest number of species can be allocated to the category decoration (436 ornamental plant species in 194 gardens). On average, 21 species used for decorative purposes are grown per garden (Range for n = 194: 4–84). A tendency in the differences between organic and non-organic gardens can be observed ($p_{ANOVA} = 0.073$ for occurrence and 0.062 for abundance) (Table 3). The area for ornamental plant species in the gardens covers approximately 15–20% of the total garden area. The abundance of ornamental species is 19% of the total abundance of all species in all 196 gardens (Table 3). Species from the decorative category are used to decorate the garden, cemetery, churches and chapels, and to make bouquets for the houses. One hundred women farmers report that “the pleasure of gardening” is a reason to manage a garden. This pleasure is, according to the women, closely related to the colourful appearance of ornamental plant species in gardens.

TABLE 3

Usage categories for the plant species grown in Eastern Tyrolean homegardens (n = 196) at organic and non-organic farms including occurrence (Occ.; Number of plant species), abundance (Abund.; Number of individual plants per species) and percentage of gardens for every usage category (Multipurpose use is possible and therefore the total of all categories 100%, > total of occurrence or > total of abundance).

	All gardens			Organic gardens			Non-organic gardens			Differences*	
	Occ.	Abund.	% of gardens	Occ.	Abund.	% of gardens	Occ.	Abund.	% of gardens	Occ.	Abund.
Species for decoration	436	27567	99.0	299	11027	45.9	378	16540	53.1	t	t
Food crops	147	114886	100.0	129	55232	46.4	122	59654	53.6	n.s	n.s
Vegetables	45	55989	99.0	40	27151	45.4	41	28838	53.6	n.s	n.s
Salads	35	43039	100.0	29	21288	46.4	32	21751	53.6	n.s	n.s
Spices	58	26222	100.0	48	12277	46.4	50	13945	53.6	n.s	n.s
Fruits	24	9065	84.2	22	4557	38.8	19	4508	45.4	n.s	n.s
Beverage	44	2118	54.1	41	1520	24.5	23	598	29.6	t	t
Medicinal purpose	82	3949	73.5	61	2017	34.2	44	1932	39.3	n.s.	n.s.
Species for customs	43	381	34.2	17	76	15.3	37	305	18.9	t	t
Scented plants	19	113	18.4	9	47	7.7	15	66	10.7	n.s.	n.s.
Fodder	37	2547	27.0	18	772	11.7	25	1774	15.8	n.s.	n.s.
Other uses	81	1390	42.3	48	711	17.3	51	679	25.0	–	–

*Differences in occurrence and abundance between gardens at organic and non-organic farms, which are statistically significant at a level of $p_{ANOVA} < 0.05$ are indicated as "sig.", at a level of $p_{ANOVA} \geq 0.05$ and < 0.1 are indicated as "t" and those > 0.1 as "n.s.".

One hundred and forty seven species are used for food. On average, every gardener grows 18 plant species to be used for food (Range: 4–57 species). No statistically significant differences were found in occurrence or abundance of species used for food between the homegardens on organic and non-organic farms (Table 3). Plant species used as food cover the major area of the home-gardens and are grown with a higher abundance than plant species used for decoration.

In the food category, herbs and spices dominate in species diversity (58 species) and vegetables dominate in abundance (55989 individuals) (Table 3). Seventy six percent of the women report that having home-grown food is the main motivation for managing a garden. They say it is important for them to know where produce comes from, how it has been grown and that it can be harvested rapidly according to demand. Vegetables and salads are used daily during the growing period and therefore grown in high abundance per garden in relation to other plants. No statistically significant differences were found in occurrence or abundance of species used as vegetable, salad, spice or fruit. A tendency in the differences for beverages can be observed ($p_{ANOVA} = 0.098$ for occurrence and 0.05 for abundance) (Table 3), because more women farmers at organic farms report the use of herbs (e.g. *Mentha* x *piperita, Melissa officinalis*) for the preparation of beverages for wintertime.

Species with medicinal purposes are grown in 73.5% of the gardens with a total of 82 species in the study area. On average, two medicinal plant species are grown per garden (Range: 1–34). Abundance is low in relation to plant species used for ornamental purposes or for food. Women report that, nowadays, medical supply for humans as well as for animals is always guaranteed and is affordable; therefore the dependency on their own formulas is no longer an issue. No statistically significant differences were found in occurrence or abundance of species used for medicinal purposes between the homegardens on organic and non-organic farms (Table 3). The preparation of teas used in the treatment of digestive trouble, colds and inflammations are some of the purposes reported for medicinal plants. Camomile (*Chamomilla recut ita*), sage (*Salvia officinalis*) and elderberry (*Sambucus nigra*) are the most common plant species grown and used for medicinal purposes. None of the women reported the production of medicinal plant species as a reason for managing a garden.

In 34% of the gardens, between one and ten species (43 species in total) are grown for use in certain customs, i.e. as species with special significance and symbolic value in religious events (e.g. *Rosmarinus officinalis, Paeonia officinalis* ssp. *officinalis, Salix* sp.). There is a tendency towards a difference between occurrence and abundance of these species in gardens of organic and non-organic farms ($p_{ANOVA} = 0.098$ for occurrence and 0.095 for abundance) (Table 3).

Scented plants, i.e. plants with a special scent and with an explicit use of this scent, are represented with 19 species with very few individual plants in 18.4% of the gardens. Between one and three species cultivated are used for scent in these gardens with no difference between organic and non-organic farms (Table 3).

Fodder species are those which are considered as greens for pigs, or as fodder for bees. Species used as fodder are not exclusively grown as fodder, except turnips (*Brassica napus* ssp. *rapifera, Beta vulgaris* var. *rapacea*). The majority are species for human consumption, where lower quality produce is given to the animals. No statistically significant differences were found in occurrence or abundance of species used as fodder between the homegardens on organic and non-organic farms (Table 3). Other uses such as shampoo, additives for the bath, dye plants for food, tools for the kitchen and toys were met occasionally but they are not common in the study area (Table 3).

Plant species composition and plant use in the last century

The floristic composition of the homegardens did not vary much across the region until the 1960s. According to the elder women, around 51 species were found across the region and the mean occurrence of species per homegarden did not exceed 10 species.

According to the elder women farmers, the most important species were herbal plant species used as spices (e.g. *Allium fistulosum, Levisticum officinale*) and for medicinal purposes (e.g. *Althaea officinalis, Artemisia absinthium*) at that time. The old term for home garden in the study area, Kräutlachgartl (garden of herbs), is a reference to this traditional purpose of the garden. At that time, several herbal plant species also played an important role in customs. In addition, species with symbolic value (e.g. *Lilium candidum, Paeonia officinalis* ssp. *officinalis*), scented plants (e.g. *Artemisia abrotanum, Rosa centifolia*) and species for ornamental purposes were grown in gardens. Lettuce (*Lactuca sativa* var. *capitata*) was the only vegetable, or rather salad, in gardens. Gardening, in the sense of the labour intensive cultivation of vegetables for subsistence, was not done in the home garden but at arable plots near the homestead. Produce of the homegarden was not brought to market, but only used at the farmstead.

DISCUSSION AND CONCLUSION

Management

With the data it can be seen that in Eastern Tyrol there is no difference between homegardens on organic farms and non-organic farms as far as management is concerned, with the exceptions of occurrence and intensity of mixed cropping

and the use of alternative remedies to combat diseases. The diachronic perspective in our results shows that the appearance and management of gardens has not changed much in recent decades. Tools for gardening used in the Middle Ages in Central Europe (Willerding, 1994, 1995) are almost identical to tools and practices currently used. Popular innovations like those in the 1960s and 1970s from the green revolution or those in the 1990s from organic farming did not have a strong and clearly visible impact on homegardens. Some techniques discussed intensively in organic gardening (Franck, 1991; Kreuter, 1997) were tested and are practised by some, but not introduced in general. In homegardening in the study area, as in homegardens of other countries (Fernandes & Nair, 1986; Landauer & Brazil, 1990; Torquebiau, 1992), traditions in management seem to be stronger than innovations in management, the latter not having been tested locally and not having been successfully adopted locally over a longer period of time. Over decades, homegardens have been a system of low external input and high self-sufficiency. This has been observed also by other authors (Siller-Griessmair & Kompatscher-Hoppe, 1989; Inhetveen, 1994). It is concluded that traditional gardening in Eastern Tyrol is highly compatible with the principles of organic farming as defined by Lindenthal *et al.* (1995), even on non-organic farms, but probably, sustainability can be increased in gardens on organic as well as on non-organic managed farms when methods from organic gardening are promoted and tested locally more intensely.

Floristic composition and plant use

The data show that in Eastern Tyrol there is no difference in the floristic composition and use of plants between homegardens on organic farms and non-organic farms. The commercialization of garden produce is not usual, and in general no ingredients for organically certified nor for non-organic products in Eastern-Tyrol come from homegardens. In contrast, much more of the produce is given away in barter, as a gift or used by the owners of the gardens. This is similar to the traditional way of using garden products as also mentioned by other authors (e.g. Hauser, 1976; Anderson, 1986; Inhetveen, 1994; Agelet *et al.,* 2000). The high idiosyncrasy of plant species (155 species in only one garden) shows that individual patterns of plant use exist, but at the same time one can speak of the culturally typical domain of garden plants for the study area (Table 2), whether they be on organic farms or not. This set of culturally typical plants is almost equal to the set of typical plants in other Central European countries (Titze, 1983). Some of these species have a long tradition in Central Europe; they were already grown in the time of Charlemagne (circa 800 AC) and were recommended for cultivation in the 19th century (Fischer-Benzon, 1894).

Lohmeyer (1983), Titze (1983) and Schulmeyer-Torres (1994) report changes in German gardens towards a high proportion of lawn, ornamental species and

coniferous species parallel to the increase in economic wealth of gardeners. As a consequence, gardens have changed in appearance and gardens are no longer important for subsistence. In contrast in Catalonia/Spain (Agelet *et al.,* 2000) and Switzerland (Hauser, 1976) homegardens have been and continue to be important for subsistence. An increase in importance, i.e. more useful species that are actually used frequently, can be observed in Eastern Tyrol. During the recent four decades, women farmers at organic and at non-organic farms actively enriched the diversity of plant species in their gardens.

Although the species diversity of medicinal plant species, plant species used in traditional customs and scented plant species have increased throughout the region from the last century to today, occurrence and abundance per garden is low now. In particular, plants with symbolic religious value are either no longer to be found in the region studied (e.g. *Lilium candidum*), or are only recognized as such by the older women (e.g. *Paeonia officinalis* ssp. *officinalis*). It is indeed true that a high diversity of plant species exists in homegardens; however, this very fact may hide the danger that some culturally and historically significant plants are disappearing completely. Public awareness of endangered cultivated plant species in Austria must, therefore, be heightened and an urgent assessment made in this regard.

Contributions of homegardens to the development of (organic) farming

In many alpine regions, land-use already shows "a devastating break-down" (Bätzing, 1996). Eastern Tyrol is no exception. As an example, the cultivation of field vegetables, cereals and fibre crops is in decline, as it is also in other regions (Netting, 1981; Penz, 1996; Cernusca *et al.,* 1999). Changes in management techniques and in the abandonment of several practices, e.g. use of high alpine meadows as pasture, causes losses in agrobiodiversity and may increase the risk of natural disasters (Penz, 1996).

As shown by the results on the management of homegardens in Eastern Tyrol, gardening is by no means in a devastating break down. The contrary is true for homegardens. Homegardens and their management are an ideal setting to study the dynamic development of local practices on the edge of nature and culture, i.e. the bio-cultural management of agrobiodiversity. It is remarkable that not only organically managed gardens, but also homegardens in general, serve as a refuge for agrobiodiversity. This differs from farming, where several authors confirm that, depending on the intensity of farming, organically managed plots show higher diversity of species than non-organic plots (e.g. Van Mansvelt *et al.,* 1998; Mander *et al.,* 1999; Van Elsen, 2000). This is due to the difference in management practice between organic and non-organic farms, and is something that cannot be confirmed for homegardens in the study area. Therefore, the bio-

cultural heritage of both organic and non-organic homegardens in Eastern Tyrol can be a source of the re-diversification of landscapes.

Neither policy, nor science nor the organic farming movement has recognized, recommended or supported by way of the transfer of knowledge or financial subsidies, women's agrobiological conservation work in home gardens in Eastern Tyrol. This activity can be characterized as women farmer's independent adaptive response to their emic perceptions of changing internal and external processes. According to Soemarwoto (1987) in the laboratory of adaptive response, women farmers manage home gardens as an area of experimentation and innovation. This is true for Eastern Tyrol too, and it is a process that takes its time, i.e. no hurry in the adoption of new practices can be observed. Science and policy should recognize the work of local people who still maintain agro-ecosystems with high agrobiodiversity as part of their culture, lifestyle or practice. This paper shows that women farmers play an important role in this process. Organic farmers who have shown that it is possible to protect and enhance agrobiodiversity (Lindenthal *et al.,* 1995; McNeely & Scherr, 2001) can benefit from these people. Therefore, in Eastern-Tyrol, women farmers from organic and non-organic farms are important partners for the development of sustainable agriculture, for the testing of newly arriving innovations and for in situ conservation of agrobiodiversity. The local knowledge of women farmers is probably not limited to the management of useful plants in homegardens, but to a wide array of elements in the agroecosystem that have key functions in the survival and the welfare of rural people. Ethnobiological studies need to focus on all plots in the mosaic managed by women farmers. Ethnobiological knowledge gained through such studies will not only be important for scientists, development planners and policy makers, but also for the organic farming movement in its challenge to develop strategies for a site-appropriate and a sustainable management of diverse and risk-prone environments.

ACKNOWLEDGEMENTS

We thank the women farmers who opened the gates of their gardens for us and provided information on their knowledge and experience on gardening with so much enthusiasm. We thank Javier Caballero, Botanical Garden, Autonomous University of Mexico, and Harald Bolhàr-Nordenkampf, Institute for Ecology and Conservation Biology, University of Vienna, whose professional engagement in garden research was a major motivation for us. Research has been made possible by funds from the Federal Ministry of Education, Science and Culture, the Federal Ministry of Agriculture, Forestry, Environment and Water Management, the Government of Tyrol (Project L 1044/96) and by the collaboration of women farmers in Eastern Tyrol. Thomas Lindenthal, Michael H. Lyman, Cristina Flitner and the anonymous reviewers provided valuable comments on the manuscript for this paper.

References

Agelet, A., Bonet, M.A. & Vallès, J. (2000). Homegardens and their role as a main source of medicinal plants in mountain regions of Catalonia (Iberian Peninsula). *Economic Botany*, **54**, 295–309.

Alexiades, M.N. & Sheldon, J.W. (1996). *Selected Guidelines for Ethnobotanical Research: A Field Manual.* The New York Botanical Garden Press; New York, U.S.A.

Anderson, E.N. (1993). Southeast Asian gardens: Nutrition, cash and ethnicity. *Biotica Nueva Epoca,* **1**, 1–11.

Anderson, J.N. (1986). House gardens—an appropriate village technology. In *Community Management* (D.C. Korten, ed.), pp. 105–112. Kumarian Press; Bloomfield, U.S.A.

Bätzing, W. (1996). *Landwirtschaft im Alpenraum-unverzichtbar aber zukunftslos? Eine alpenweite Bilanz der aktuellen Probleme und der möglichen Lösungen.* Blackwell Wissenschafts-Verlag; Berlin, Germany.

Bortz, J. & Döring, N. (1995). *Forschungsmethoden und Evaluation.* Springer; Berlin, Germany.

Brun-Hool, J. (1980). Zur Pflanzensoziologie schweizerischer Gärten. *Phytocoenologia*, **7**, 73–99.

Bye, R. (1997). The role of humans in the diversification of plants in Mexico. In *Biological Diversity of Mexico—Origins and Distribution* (T.P. Ramamoorthy, R. Bye, A. Lot, & J. Fa, eds.), pp. 707–731. Oxford University Press; Oxford, U.K.

Caballero, J. (1992). Maya homegardens: Past, present and future. *Ethnoecolgia*, **1**, 35–54.

Cernusca, A., Tappeiner, U. & Bayfield, N. (1999). *Land-Use Changes in European Mountain Ecosystems: Ecomont- Concept and Results.* Blackwell; Berlin, Germany.

Encke, F. (1961). *Paul Pareys Blumengärtnerei. Beschreibung, Kultur und Verwendung der gesamten gärtnerischen Schmuckpflanzen.* Paul Parey; Berlin, Germany.

Esquivel, M. & Hammer, K. (1992). The Cuban homegarden "Conuco": A perspective environment for evolution and in situ conservation of plant genetic resources. *Genetic Resources and Crop Evolution*, **39**, 9–22.

Fernandes, E.C.M. & Nair, P.K.R. (1986). *An Evaluation* of *the Structure and Function* of *Tropical Homegardens.* International Council for Research in Agroforestry (ICRAF); Nairobi, Kenya.

Fischer, M. (1994). *Exkursionsflora von Österreich.* Ulmer; Vienna, Austria.

Fischer-Benzon, R. (1894). *Altdeutsche Gartenflora. Untersuchungen über die Nutzpflanzen des deutschen Mittelalters, ihre Wanderung und ihre Vorgeschichte im klassischen Altertum.* Publ. not known; Kiel & Leipzig, Germany.

Fitschen, J. (1994). *Gehölzflora: Ein Buch zum Bestimmen der in Mitteleuropa wildwachsenden und angepflanzten Bäume und Sträucher.* Quelle und Meyer; Heidelberg, Germany.

Franck, G. (1991). *Gesunder Garten durch Mischkultur.* Südwest; Munich, Germany.

Hanf, M. (1998). *Farbatlas der Wildkräuter und Unkräuter.* Eugen Ulmer; Stuttgart, Germany.

Hauser, A. (1976). *Bauerngärten der Schweiz—Ursprung, Entwicklung und Bedeutung.* Artemis; Zurich, Switzerland.

Hegi, G. (1979). *lllustrierte Flora von Mitteleuropa.* Publ. not known; Munich, Germany.

Hochegger, K. (1995). *The Kandyan Forest Gardens, Gewatta, of Sri Lanka—Their Ecology, Economy and Culture.* Doctoral thesis. University for Natural Resources and Applied Life Sciences Vienna (BOKU); Vienna, Austria.

Hodel, U. & Gessler, M. (1999). *In Situ Conservation of Plant Genetic Resources in Home Gardens* of *Southern Vietnam.* International Plant Genetic Resources Institute (IPGRI); Rome, Italy.

Holzner, W. (1981). *Acker-Unkräuter. Bestimmung, Verbreitung, Biologie und Ökologie.* Leopold Stocker; Graz, Austria.

Inhetveen, H. (1994). Die Landfrau und ihr Garten. Zur Soziologie der Hortikultur. *Zeitschrift für Agrargeschichte und Agrarsoziologie,* **42**, 41–58.

IPGRI (2000). *Annual Report 1999.* International Plant Genetic Resources Institute; Rome, Italy.

Jäger, E., Schubert, R. & Werner, K. (1991). *Werner Rothmaler's Exkursionsflora von Deutschland —Atlas der Gefäßpflanzen.* Volk & Wissen; Berlin, Germany.

Kreuter, M.-L. (1997). *Der Bio-Garten: Der praktische Ratgeber für den naturgemäßen Anbau von Gemüse, Obst und Blumen.* BLV; Munich, Germany.

Landauer, K. & Brazil, M. (1990). *Tropical Home Gardens.* United Nations University Press; Tokyo, Japan.

Lindenthal, T. (1993): *Forschung Im Biologischen Landbau.* Federal Agency for the Environment; Vienna, Austria.

Lindenthal, T., Vogl, C.R. & Hess, J. (1995). *Forschung im Ökologischen Landbau- Integrale Schwerpunktthemen und Methodikkriterien.* Der Förderungsdienst, No. 2c., Vienna, Austria.

Lohmeyer, W. (1983). Liste der schon vor 1900 in Bauerngärten der Gebiete beiderseits des mittel- und südlichen Niederrheins kultivierten Pflanzen. In *Dörfliche Vegetation im Freilichtmuseum. Erhaltung gefährdeter dörflicher Pflanzengesellschaften und historischer Nutzpflanzenkulturen* (Stiftung zum Schutze gefährdeter Pflanzen, ed.), pp. 109–131; Stiftung zum Schutze gefährdeter Pflanzen; Bonn, Germany.

Mander, Ü., Mikk, M. & Külvik, M. (1999). Ecological and low intensity agriculture as contributors to landscape and biological diversity. *Landscape and Urban Planning*, **46**, 169–177.

Martin, G. (1995). *Ethnobotany.* Chapman & Hall; London, U.K.

McNeely, J.A. & Scherr, S.J. (2001). *Common Ground; Common Future—How Ecoagriculture Can Help Feed the World and Save Wild Biodiversity.* IUCN (International Union for Conservation of Nature and Natural Resources); Gland, Switzerland and Future Harvest; Washington, U.S.A.

Netting, R.M. (1981). *Balancing on an Alp—Ecological Change & Continuity in a Swiss Mountain Community.* Cambridge University Press; Cambridge, U.K.

Niñez, V.K. (1985). *Household Food Production—Comparative Perspectives.* International Potato Center (CIP); Lima, Peru.

Padoch, C. & De Jong, W. (1991). The house gardens of Santa Rosa: Diversity and variability in an Amazonian agricultural system. *Economic Botany*, **45**, 166–175.

Pahlow, M. (1993). *Das groβe Buch der Heilpflanzen.* Gräfe und Unzer; Munich, Germany.

Penz, H. (1996). Die Landwirtschaft in den Österreichischen Alpen. In *Landwirtschaft im Alpenraum-unverzichtbar aber zukunftslos? Eine alpenweite Bilanz der aktuellen Probleme und der möglichen Lösungen* (W. Bätzing, ed.), pp. 141–167, Blackwell Wissenschaftsverlag; Berlin, Germany.

Pirklhuber, W. & Gründlinger, C. (1993). *Der biologische Landbau in Österreich*. Federal Agency for the Environment; Vienna, Austria.

Poppendieck, H.-H. (1992). Der erste Museums-Bauerngarten. *Gartenkunst*, **4**, 79–101.

Rico-Gray, V., Garcia-Franco, J.G., Chemas, A., Puch, A. & Sima, P. (1990). Species composition, similarity, and structure of Mayan homegardens in Tixpeual and Tixcaltuyub, Yucatan, Mexico. *Economic Botany*, **44**, 470–487.

Royal Horticultural Society (1997). *Gartenhandbuch Stauden. Translated by R. Ferstl & H. Kuwer.* DuMont; Cologne, Germany.

Royal Horticultural Society (1998). *Sommerblumen: Einjährige und Zweijährige; mit mehr als 500 Beet- und Balkonpflanzen. Translated by H. Kuwer & R. Ferstl.* DuMont; Cologne, Germany.

Salvador Flores, J. (1993). Observaciones preliminares sobre los huertos familiares Mayas en la Ciudad de Mérida, Yucatán, México. *Biotica nueva época*, **1**, 13–18.

Schulmeyer-Torres, D. (1994). *Bauerngärten: Historische Entwicklung und Charakterisierung des aktuellen Artenbestandes der ländlichen Hausgärten in West-Miteleuropa anhand ökologischer und historisch-geographischer Merkmale-ein Beitrag zur Erforschung der Überreste des Bauerngartens.* Logos; Saarbrücken, Germany.

Siller-Griessmair, B. & Kompatscher-Hoppe, A. (1989). *Vielgeliebter Bauerngarten.* Verlagsanstalt Athesia; Bozen, Italy.

Soemarwoto, O. (1987). Homegardens: A traditional agroforestry system with a promising future. In *Agroforestry, a Decade of Development* (H.A. Steppler & P.K.R. Nair, eds.), pp. 157–170, ICRAF; Nairobi, Kenya.

SPSS (1997). *Statistical Package for Social Sciences—version 7.5.2 for Windows*. SPSS Inc; Chicago, U.S.A.

Titze, P. (1983). Das Pflanzenkleid des Dorfes—seine Gärten. In *Dorfokölogie* (Landschaftspflege, ed.), pp. 29–54, Laufener Seminarbeiträge; Laufen/Salzach, Austria.

Torquebiau, E. (1992). Are tropical agroforestry home gardens sustainable? *Agriculture, Ecosystems and Environment*, **41**, 189–207.

Van Elsen, T. (2000). Species diversity as a task for organic agriculture in Europe. *Agriculture, Ecosystems and Environment*, **77**,101–109.

Van Mansvelt, J.D., Stobbelaar, D.J. & Hendriks, K. (1998). Comparison of landscape features in organic and conventional farming systems. *Landscape and Urban Planning*, **41**, 209–227.

Vogl, C.R. & Hess, J. (1999). Organic farming in Austria. *American Journal for Alternative Agriculture*, **14**, 137–143.

Vogl, C.R., Vogl-Lukasser, B. & Caballero, J. (2002). Homegardens of Maya migrants in the district of Palenque (Chiapas/Mexico): Implications for sustainable rural development. In *Ethnobiology and Biocultural Diversity* (J.R. Stepp, F.S. Wyndham & R.K. Zarger, eds.), pp. 631–647. University of Georgia Press; Athens, U.S.A.

Vogl, C.R., Vogl-Lukasser, B. & Puri, R. (2003). Tools and methods for data collection in ethnobotanical studies of home gardens. *Field Methods*, Accepted.

Vogl-Lukasser, B. (2000). *Studien zur funktionalen Bedeutung bäuerlicher Hausgärten in Osttirol basierend auf Artenzusammensetzung und ethnobotanischen Analysen.* Doctoral thesis, University of Vienna; Vienna, Austria.

Vogl-Lukasser, B. & Vogl, C.R. (2002). Ethnobotany as an interdisciplinary tool for the study of the biocultural management of agrobiodiversity in homegardens of Alpine farmers in Eastern Tyrol. In *Interdisciplinary Mountain Research* (R. Bottarin & U. Tappeiner, eds.), pp. 264–273. Blackwell Science; London, U.K.

Waschgler, H. (1993). Landeskunde. In *Bezirkskunde Osttirol* (Katholischer Tiroler Lehrerverein, ed.), pp. 19–26, Oberdruck; Lienz, Austria.

Watson, J.W. & Eyzaguirre, P.B. (2001). Home gardens and in situ conservation of plant genetic resources in farming systems. In *Proceedings of the Second International Home Gardens Workshop.* International Plant Genetic Resources Institute (IPGRI); Rome, Italy.

Wehrhahn, H.R. (1937). *Was wächst und blüht in meinem Garten? Blütenstauden und Sommerblumen. Tabellen zum Bestimmen von über 500 wichtigen Gartenpflanzen mit Kultur- und Verwendungsangaben.* Francksche Verlagshandlung; Stuttgart, Germany.

Willerding, U. (1994). Zur frühen Geschichte des Gartenbaus in Mitteleuropa. In *Geschichte des Gartenbaus und der Gartenkunst* (Förderkreis Gartenbaumuseum Cyriaksburg e.V., eds.), pp. 127–148. Publ. not known; Erfurt, Germany.

Willerding, U. (1995). Garten und Pflanzen des Mittelalters. In *Der Garten von der Antike bis zum Mittelalter,* Vol. 57 (M. Carroll-Spillecke, ed.), pp. 249–284, Von Zabern; Mainz am Rhein, Germany.

(*Received 11 March 2003; accepted 7 September 2003*)