Origin and evolution of rural homegardens in Ethiopia

ZEMEDE ASFAW

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Small-scale traditional agricultural ecosystems, commonly known as homegardens, were studied in the semi-arid central and the humid southwestern parts of Ethiopia. Hundred homegardens, with fifty in each of the two areas, but otherwise randomly sampled, were scored as being in pioneer, intermediate or climax stages. In the southwest, the percentage of climax gardens was 11% above country average, while in central Ethiopia it was 10% below average; the opposite was the case with intermediate gardens; the percentage of pioneer gardens was nearly the same in the two areas. Qualitative information recorded from observation of gardens at different stages was used to discuss general trends in the development of homegardens. In central Ethiopia homegardens are generally established outside agricultural land, often on stony or rocky ground earmarked for living quarters, while in the southwest homegardens are usually established in forest clearings where useful forest plants are deliberately retained *in situ*. Microhabitats diversify as the homegardens mature, vertical and horizontal patterns develop, and the diversity of cultivated species increases, as well as the range of variation in horticultural, physiognomic and phenological features. The vertical structure and complex intercropping is more developed in homegardens of the southwest, while there is more emphasis on the horizontal structure of the homegardens of central Ethiopia. Homegardens in southwestern Ethiopia utilise many species of the natural ecosystem and recruit promising new crops through an open-door strategy, which facilitates geneflow between spontaneous and homegarden populations of crop species, as well as with their wild relatives. Conservation can learn a lesson from traditional management of rural homegardens in southwest Ethiopia, but these homegardens will no doubt be poorer if the surrounding natural forest continues to disappear.

Zemede Asfaw, Department of Biology, Addis Ababa University, P. O. Box 3434, Addis Ababa, Ethiopia. E-mail: nat.heb@telecom.net.et

Introduction

The term homegarden is applied to a variety of small-scale farming premises attached to the living quarters. Homegardens mainly serve family needs for food, medicine and other products of domestic importance (Brownrigg 1985; Soleri & Cleveland 1989; Christanty 1990). Homegardens are known by various vernacular designations in different cultures, *viz.* backyards, compound farms, kitchen gardens, homestead farms, or mixed gardens. Homegardens constitute part of the traditional farming systems, and are charged with crop production, while they also help conserving agrobotanical biodiversity on-farm (Brownrigg 1985; Soleri & Cleveland 1989; Christanty 1990; Fer-

nandes & Nair 1990; Marten 1990; Okigbo 1990; Wojtkowski 1993; Nguyen 1995, Power & Flecker 1996; Gesseler *et al.* 1996, 1997; Godbole 1998; Wang 1998). In a broader context, homegardens are systems that include the people on the farm and the domestic animals, together with the plants maintained in the small space around the homestead. Planting patterns in homegardens often include patches, rows, or complex intercropping, or may be according to a seemingly random design. Homegardens make up a complex agro-ecosystem that simultaneously functions as a vegetable garden, an orchard, a medicinal plant garden, a spice lot, a bee yard, a garbage disposal corner, a compost heap, and much more. Homegardens serve critical functions in fulfilling community needs, which may range from basic food security to general nutrition, primary healthcare, income generation and other specialised functions, while ensuring conservation of agrobiodiversity and sustenance of a healthy environment around the living quarters.

The history of homegardening discloses that it has been an integral component of human subsistence strategies since the Neolithic Age (Soleri & Cleveland 1989). The earliest records of homegardens are from the third millennium BC in the Near East, where the homegardens we know about seem largely to have been associated with temples, palaces and elite residences (Brownrigg 1985). At present homegardens are widespread in the tropical and subtropical regions of Asia (Christanty 1990; Marten 1990; Nguyen 1995; Godbole 1998; Wang 1998), Africa (Okigbo 1990) and Central and South America (Padoch & Jong 1991; Esquivel & Hammer 1992; Hammer *et al.* 1992; Caballero 1992). In ecological terms, homegardens can be viewed as managed ecosystems with a dynamic interplay between the biotic, abiotic and socio-cultural factors (Power & Flecker 1996; Gesseler *et al.* 1997).

In Ethiopia, the antiquity of homegardens is still undocumented due to absence of palaeoethnobotanical studies, but the long history and present significance of homegardens is fully acknowledged (Westphal 1975; Okigbo 1990; Zemede Asfaw & Ayele Nigatu 1995). The frequency of homegardens, and the intensity with which they are cultivated, varies from region to region. Homegardens are well developed in the south and the south-west, where vegeculture abounds, and the eastern part of the country where diverse cropping patterns are known, but homegardens are rudimentary in the north, which is dominated by cereal culture (Zemede Asfaw 1997). Many indigenous crops of Ethiopia are cultivated in homegardens, and for some species there are both cultivated forms in the home gardens and spontaneous populations that occur wild in the natural ecosystems. Considering the long history of agriculture in Ethiopia (Harlan 1969; Westphal 1975; De Wet 1979; Brandt 1984) and the presence of ancient crops in homegardens, it can with reasonable safety be speculated that gardening was among the earliest forms of farming practised in Ethiopia.

The last couple of decades have witnessed an increasing world-wide interest in homegardens, exposing their potentials for sustained subsistence farming (Benneh 1974; Torquebiau 1992) and biodiversity conservation (Brownrigg 1985; Caballero 1992; Okigbo 1994; Godbole 1998). Homegardens contribute to diversification of the agrobiodiversity in terms of genera, species, cultivars, and ecological specialisation, which under traditional management may show regular progression towards climax structures of intensive land utilisation in space and time (Rico-Gray *et al* 1990; Wojtkowski 1993). Homegardens have preserved local knowledge of plants and skills of their cultivation and utilisation, and traditional homegardens offer opportunities for ethnobotanical and agroethnobotanical studies. Though homegardens

have been characterised in many agroecosystems of the world, the dynamic processes during their growth to maturity still await elucidation on a broader scale. Limited studies have focused on the evolution of homegardens, but it has been supposed that they arose from shifting cultivation to overcome resource constraints and to ascertain rights to land resources (Fernandes & Nair 1990; Jose & Shanmugaratnam 1993). Very little is yet known about Ethiopian homegardens, but some information can be gathered from the work of Okigbo (1990), Zemede Asfaw & Ayele Nigatu (1995), Zemede Asfaw (1997), and Zemede Asfaw & Zerihun Woldu (1997). To date, the aspects of origin and evolution have never been investigated, though from earlier observations some clues can be found on the ecological succession and the biotic, abiotic and socio-cultural factors that governs it. This paper is focused on the origin and evolution of rural homegardens in two agroecologic zones in central and southwest Ethiopia.

The study area

An initial survey of homegardens in Ethiopia (Zemede Asfaw 1997) and a study that focussed at homegarden crop associations (Zemede Asfaw & Zerihun Woldu 1997) have highlighted the poor knowledge of homegarden inception and evolution in rural Ethiopia. Consequently, two agroecologically and culturally different zones, in the semi-arid Central Rift Valley and in the humid southwest respectively, were identified and data pertaining to origin and evolution collected. Data collection and observation was undertaken during fieldwork in 1996-1998, undertaken to study land resources in the Central Ethiopian Rift Valley (Zemede Asfaw 1999), and during an ethnobotanical study (1998) conducted in southern and western Ethiopia. The former study site is located in the area of the Ziway-Shala basin at approximately 8° N and 39° E. This area is relatively dry, and the crops are mostly annuals, but some woody and perennial herbaceous species occur, including *Citrus spp., Rhamnus prinoides, Catha edulis, Coffea arabica, Ensete ventricosum*, and *Brassica carinata.*

The second study site is located in the Kefa-Sheka zone in the area adjoining Bonga town at approximately 7°03' N and 36° E. This area is located in the high rainfall zone of Ethiopia, with natural multiple canopy rain forest containing spontaneously growing forest coffee (*Coffea arabica)* (see Friis 1979) and other plants also in cultivation, including *Rhamnus prinoides, Aframomum corrorima*, and *Ensete ventricosum.*

Methods

With the progress of the documentation of the Flora of Ethiopia, which has simplified determination of plants and made it easier to trace basic literature, it is becoming more and more feasible to take up the study of ethnobotany, agroethnobotany, indigenous food plants and their use in homegardens. During the work described in this paper, voucher specimens of taxa for which identification in the field was not certain were secured and deposited at the National Herbarium (ETH); the same applies for those species of which the available herbarium collections were felt to be insufficient. The initial study was a survey of homegardens, the results of which has already been published (Zemede Asfaw & Ayele Nigatu 1995; Zemede Asfaw 1997). These initial studies were followed by a study of homegarden crop associations (Zemede Asfaw & Zerihun Woldu 1997). The present study focuses on origin and evolution of homegardens in the two study areas in central and southwestern Ethiopia. However, the observations that led to this paper were also of a more opportunistic nature, undertaken over a prolonged time. Fifty rural homegardens have been randomly sampled in each region and scored as representing

the pioneer, the intermediate and the climax stage. The scoring was made on the basis of visual assessment, taking into account soil related factors, crop diversity, proportion of annual and perennial species, age classes of the dominant perennial species, the overall horticultural mix as well as the diversification of vertical and horizontal structures. Crop arrangement inside the garden was observed during transect walks from the house to the rear end of the garden: the species in each major zone were identified and mapped, together with the horizontal crop layout. Qualitative descriptions were provided to illustrate the ongoing changes and to paint a general picture of the pioneer, intermediate and climax homegardens of the two sites. Since the variation within each stage is wide, the description was of necessity general, and emphasis was given to the climax stage, in which the differences between the agrobotanical features of homegardens of the two study areas come out most clearly.

Results

Ethiopian homegardens have diverse structures, showing variation with the agroecology and general cultural diversity of the people. Collectively, the homegardens maintain a large assemblage of useful plants. The homegardens of some rural families, apparently crop conservators, were found to maintain an amazing number of crop diversity, a feature that has also been observed elsewhere in the world (Altieri & Merrick 1987). During the survey work of Ethiopian homegardens (Zemede Asfaw & Ayele Nigatu 1995; Zemede Asfaw 1997) a list of 172 species of useful plants maintained in Ethiopian homegardens was compiled. About 74% of these species were grouped as food crops, the remaining 26% as non-food crops. A recent ethnobotanical survey in southern and western Ethiopia showed that about 90% of the crops cultivated by each of the eleven ethnic groups surveyed were recorded from homegardens, and that about 60% of the crops cultivated by these people at present are only grown in homegardens (Zemede Asfaw 1998). The plants could be allocated to a wide range of horticultural groups, including food, medicinal herbs, spices, ornamentals and many other categories and subcategories. Mostly, the families assess the agricultural output of their homegardens by the degree of continuous availability of diverse fresh products with a significant nutritional complement (Zemede Asfaw & Zerihun Woldu 1997). Homegradens should therefore to a high degree be evaluated on their role for food security, although they of course have many other roles.

Of 100 rural homegardens observed with the intention of elucidating their developmental stages, 75 were scored as climax while 20 were intermediate and 5 were pioneer types that were just initiated. In the site in central Ethiopia, 64% of the gardens scored were at the climax stage, 30% at the intermediate and 6% at the pioneer stage. In the southwest, 86% was at the climax, 10% at the intermediate and 4% at the pioneer stage. Thus, there were relatively more mature gardens in the southwest than in central Ethiopia, relatively more intermediate gardens in central Ethiopia. This observation can be related to other observations, namely that in the two areas, homegardens are brought to life under different inception patterns, and that they progress to different climax stages. Since each garden has its unique features with regard origin, dynamics and content, the descriptions has essentially to focus on the main aspects rather than on specifics.

Inception and maturity of homegardens in central Ethiopia

In central Ethiopia, farmers build their living houses outside the farming area, usually on an outcrop mainly used for grazing of farm animals, and the place is frequently covered with

bushes and grasses when the new homestead is going to be established. The families begin by carving out the area needed for the house somewhere in the centre of the identified site. The animal stall is constructed at a suitable place, often where it is practical to accumulate manure that will be used to fertilise the cropping area. The usual practice is, however, from time to time to shift the location of the stall to a new site in the neighbourhood of the house, and to convert the old site of the stall to a cropping site that would become a new main garden area. Elders may identify these future cropping-sites during the initial planning phase, before the construction work on houses and stalls begins. The fertility of the garden soil gradually builds up, and some weedy and ruderal plant species become established in the garden, following the moving in of humans and domestic animals. The most common colonising herbs, some of which may be utilised for domestic purposes, include *Amaranthus spp., Solanum nigrum, Lycopersicon esculentum, Physalis peruviana, P. micrantha, Avena sp., Nicotiana tabacum, Cucurbita spp., Lagenaria siceraria, Commelina spp.* and several others. Some indigenous invasive species (*e.g. Lippia adoensis, Ocimum lamiifolium, Rosa abyssinica, Rubus spp.* and *Carissa edulis*) are tolerated along the garden fences and around unworked spots, and may be part of the fencing. The *in situ* garden species usually establish on the rubbish heaps and on places where the domestic animals rest. The pioneering conventional garden crops usually include spices, for example garlic, basil, peppers, and shallot, and vegetables, for example tomato, kale, cabbage, cucurbits, and white potato, as well as ornamentals that are gradually being planted by members of the family. The potential space of the garden is gradually being claimed while soil conditions improve. Land preparation, organisation of nursery beds and special plots for different horticultural purposes continues in new areas, while older parts of the garden are planted with intermixed cropping. Once deliberate planting starts, family members bring seeds and seedlings from abandoned houses in the village, from neighbours, or from the market, and piece by piece the family stocks their garden with an increasing number of taxa, increase the density of plants and the number of horticultural categories that give different products. As is clear from this description, relatively young gardens contain few species, many of which are annual herbs and juvenile perennials, while seasoned gardens contain more diversity and a higher proportion of perennial species and seasoned specimens of shrubs or trees.

Farmers sometimes opt for faster garden establishment by ploughing or hand digging the new ground in order to cultivate one or several crops of legumes (*e.g. Pisum sativum*, and *Vicia faba*) or cereals (*e.g. Hordeum vulgare, Eragrostis tef*). If this is done for the first season, the soil is rendered suitable for planting the regular garden crops in the following season. Sometimes homegardens are short-lived, as in central Ethiopia where they are partly meant for improving the future farm soil. The practice not only involves periodic shifting of the stalls and the garden plots, it also means shifting the entire living quarters together with the homegarden to less fertile sections of the farm and using the more fertile garden site for cultivation of the major field crops. In this process, the house is moved to a less fertile spot and gardening is started afresh. Such itinerant homegardens will usually have a limited total number of species and fewer perennial elements.

Inception and maturity of homegardens in southwestern Ethiopia

In the high-forest areas of southwestern Ethiopia, homegardens originate amidst the forest. Suitable sites are initially prospected and approved by knowledgeable elders on visual inspection of the sites and with due consideration to cultural traditions. Through

selective clearing of the forest, the useful elements, which include *Coffea arabica, Rhamnus prinoides, Aframomum corrorima, Piper capense* and *Passiflora edulis,* and a range of shade trees with other uses (*e.g. Cordia africana, Millettia ferruginea* and *Erythrina brucei*) are protected *in situ* inside the developing garden and/or as live fence plants. After clearing, the house is constructed at a suitable site within the cleared area, and members of the family prepare the land, taking good care of the useful forest plants left behind. Step by step the introduction of the usual garden crops proceeds, either from old houses, neighbours or the market, and a homegarden begins to mature.

The local people around Bonga asserted that the standing coffee crop in that general area has largely been claimed from spontaneous stands of coffee in the forest through such selective clearing. The same is the case with the cultivated false cardamom (*Aframomum*) and *Rhamnus*. The people also explained that wild enset is not claimed from the forest because of the local belief that wild enset (locally known as the devil's kotcho) is the devil's crop and not for human consumption. However, bananas from wild enset may occasionally be eaten, but only in limited amounts, and wild enset plants may be used as fodder, and the leaves provide wrapping and roofing material, the plants may be used for a number of other purposes. It was observed that wild enset in this part of Ethiopia mainly grows in association with river valleys, in places not suitable for housing sites, which may also partly account for these plants not being claimed in the establishment of new gardens as the other forest-growing crop species.

Patterns of homegarden evolution

General trend of the changes

Some of the main changes reflecting the growing complexity of Ethiopian homegardens can be related to the general patterns and processes of vegetation changes (Burrows 1990). Mature homegardens share to varying degrees the characteristics of climax ecosystems, such as relative stability, self-sustainability and ability to maintain productivity from inputs of solar energy. For that reason they are regarded by different authors as man-made ecosystems that mimic the natural tropical forests (Power & Flecker 1996; Jose & Shanmugaratnam 1993).

As homegardens grow to maturity, the following main changes are usually observed:

1. Improvement in soil conditions
2. Better suitability for a variety of different horticultural and physiognomic classes (plants for food, medicine, fragrance, fodder, construction material, implements, crafts, ornamentals and other use-values)
3. Increase in the number of crop species or cultivars
4. Higher frequency of perennial species
5. Increasing structural complexity in the homegarden (more patches, horizons and layers, diversification in growth forms; this and the following two points lead to higher intensity of land use)
6. Increasing complexity of intercropping
7. More patches of mixed stands of physiognomic and phenologic classes
8. Higher share in relation to total crop production on the farmstead, and higher share in the cash generation of the family.

A well-developed homegarden with diverse horticultural classes and high species diversity indicates that the family has higher levels of agricultural activities and more functional roles in the local community. This results in environmental, social and economic benefits for the family. It is a general feature throughout the tropics that homegardens originate, develop gradually and undergo subtle changes towards maturity and relative stability at their climax stages (Fernandes & Nair 1990; Jose &

Shanmugaratnam 1993). When finally terminated by human action, homegardens leave traces for years even after the homes are abandoned and the houses collapsed or removed from the site. This is seen in some parts of southern Ethiopia where the patchy wild enset stands appear to be indicators of abandoned homegardens of varying age. However, as mentioned above, around Bonga wild enset is found on hilly sides of streams, and it is unlikely that these were from ancient homegardens since families never build homes on riverbanks.

Specific aspects of homegarden evolution

In the semi-arid central Ethiopia, the setting up of a stable homegarden takes longer time, as the land needs repeated working and fertilising. Some of the crops require supplementary irrigation either for raising seedlings or for establishing transplants. More species need protection from the sun and moisture stress. In these areas homegardens with more perennial species are often those that are close to streams. Homegardens in the semi-arid zone start from an initial monolayered structure, mostly mixtures of annual herbs and a few juvenile perennials, and only gradually they progress to the emergence of distinct horizontal patches and in rare cases to multilayered structures. Compared to younger stages, climax homegardens in this area have a higher proportion of perennial species and seasoned shrubs or trees. With ecological changes in the area, and the receding of natural vegetation from the inhabited areas, the role of the homegarden as a place for maintaining medicinal and other useful plants increases. This results in the acceptance around the living quarters of such weedy medicinal herbs or spicy plants that would elsewhere be collected from nature. Experimental planting of wild collected seedlings of useful plants, and raising of the same from seeds, increases with advancing land degradation. It is common for farmers to collect *Rhamnus prinoides* seedlings from spontaneous stands in nearby montane forests and transplant them in homegardens. Sometimes coffee seedlings germinated from bird droppings in the vegetation of riverbanks are uprooted and transferred to nursery beds in homegardens for later transplanting.

In the humid southwestern zone, homegardens grow to climax within a relatively short period. This happens because of the good soil condition, the favourable environment with high rainfall and the *in situ* crops retained from the original natural forest. Young and seasoned homegardens have mixtures of crops of different ages, but the density of crops, the horticultural mix, the complexity of garden structure and the diversity of species increase with age. The main garden crop of the area, enset (*Ensete ventricosum*), soon emerges as a dominant element in the homegardens. Other common species include *Colocasia esculenta, Xanthosoma sagittifolium, Dioscorea alata, D. bulbifera, Musa paradisiaca, Cyphomandra betacea, Coccinia abyssinica, Passiflora edulis, Sechium edule, Ipomoea batatas, Saccharum officinarum, Zea mays, Sorghum bicolor* (sugary sorghum) and many species of *Cucurbita*, leafy vegetables, spices, medicinal herbs and others (see Table 1 below). The cropping layout gradually develops some pattern and will remain unaltered so long as owners maintain the home sites, which they can do for generations in this area.

Normal harvesting and replanting will ensure that the vertical and the horizontal structure of the climax homegarden remain unmodified. The system survives as a kind of traditional agroforestry system. Continued harvesting of enset for food does not change the structure to any noticeable degree because of renewed planting, which is well staggered in time and ensures presence of many stages of the plant within the same garden. The frequency of useful trees in the homegarden

Table 1. Horizontal layout of crops in a typical climax homegarden in the vicinity of Bonga town, southwest Ethiopia. The crops (a total of 48 species) have been recorded in different rings (from A (species from the ring with smallest diameter nearest to the home) to D (species from the ring with the largest diameter furthest from the home)). Species may occur in more than one ring.

A (9 species)	B (20 species)	C (23 species)	D (4 species)
Ocimum basilicum	*Artemisia afra*	*Dioscorea bulbifera*	*Ensete ventricosum*
Thymus sp.	*Ruta chalepensis*	*Dioscorea alata*	*Musa paradisiaca*
Allium sativum	*Brassica spp.*	*Sechium edule*	*Citrus sinensis*
Foeniculum vulgare	*Nicotiana tabacum*	*Cucurbita pepo*	*Ricinus communis*
Solanum tuberosum	*Cymbopogon citratus*	*Lagenaria siceraria*	
Iresine herbstii	*Rumex bequaerti*	*Brassica oleracea*	
Euphorbia pulcherrima	*Phaseolus vulgare*	*Saccharum officinarum*	
Canna indica	*Allium sativum*	*Nicotiana tabacum*	
Ruta chalepensis	*Capsicum sp.*	*Capsicum annuum*	
	Allium cepa	*Aframomum corrorima*	
	Zingiber officinale	*Coccinia abyssinica*	
	Foeniculum vulgare	*Canavalia ensiformis*	
	Lippia adoensis	*Coffea arabica*	
	Curcuma domestica	*Citrus aurantifolia*	
	Aframomum corrorima	*Citrus aurantium*	
	Lycopersicon esculentum	*Citrus sinensis*	
	Solanum tuberosum	*Colocasia esculenta*	
	Iresine herbstii	*Xanthosoma sagittifolium*	
	Euphorbia pulcherrima	*Manihot esculenta*	
	Canna indica	*Carica papaya*	
		Cyphomandra betacea	
		Ensete ventricosum	
		Sorghum bicolor	

reduces as people start utilising them for wood and other uses than fruit picking, but when a critical level of utilisation is reached the owners normally start encouraging spontaneous seedlings or planting those trees that they expect they will need in the future. The people have mimicked nature and increased the capacity of the homegarden to produce the optimal amount of the materials that they needed for everyday life. Here, crop production is directly linked with diversity as the people cultivate a very diverse assemblage of crops. Continuation of this tradition will have a good future for the biodiversity of food and agriculture.

The planting pattern secures that the size of the plants, on the average, successively increase with distance from the house and the diversity of taxa is highest relatively near to the homes (but not immediately around the house), and is re-

Table 2. Species both cultivated in homegardens and wild in natural ecosystems around Bonga or naturalized (*=a new record for the flora region). The probable place of domestication is indicated according to Hill (1972), Kunkel (1983), and Hancock (1992).

Species	Family	Probable place of domestication	Place of occurrence (other than homegarden)	Remarks
Aframomum corrorima	Zingiberaceae	Ethiopia	Forest	Native
Amaranthus caudatus, A. cruentus, A. hybridus	Amaranthaceae	South /Central America	Weedy	Naturalised
Anethum graveolens	Apiaceae	Mediterranean/Eurasia	Disturbed sites	Naturalised
Arundinaria alpina	Poaceae	Africa	Forest	Native
Arundo donax	Poaceae	Mediterranean/Eurasia	Forest	Naturalised
Coccinia abyssinica	Cucurbitaceae	Ethiopia	Forest	Native
Coffea arabica	Rubiaceae	Ethiopia	Forest	Native
Colocasia esculenta	Araceae	Southeast Asia	Escape from cultivation	Naturalised
Echinops kebericho	Asteraceae	Ethiopia	Wild habitats elsewhere	Native
Ensete ventricosum	Musaceae	Ethiopia	Forest	Native
Foeniculum vulgare	Apiaceae	Mediterranean	Montane grasslands	Naturalised
Lycopersicon esculentum	Solanaceae	Central/South America	Rubbish/refuse spots	Naturalised
Ocimum lamiifolium	Lamiaceae	Ethiopia	Forest margins	Native
Passiflora edulis	Passifloraceae	South/Central America	Forests and margins	Naturalised
Physalis peruviana	Solanaceae	South America	Disturbed sites	Naturalised
Piper capense	Piperaceae	Southern Africa	Forest	Native
Psidium guajava	Myrtaceae	Tropical America	Secondary bushland	Naturalised
Rhamnus prinoides	Rhamnaceae	Ethiopia	Forests	Native
Ricinus communis	Euphorbiaceae	Ethiopia-Egypt	Disturbed sites	Native
Solanum dasyphyllum	Solanaceae	Tropical Africa	Disturbed sites	Native
*Xanthosoma sagittifolium**	Araceae	Tropical America	Escape from cultivation	Naturalising

duced further away. Through cross-sectional transects taken from the back of the houses of climax homegardens in the southwest, 48 species were recorded. The gardens were sectioned into four semi-concentric rings (circular zones). In the four rings, indicated in Table 1 as Columns A, B, C, and D, 9, 20, 23, and 4 species were recorded, respectively. In each ring, some characteristic crop combinations are maintained. Zones close to the living houses contain higher number of species used as spices, medicinal plants and vegetables (Table 1, Column A). This first circle is worked upon, harvested and restocked mainly by the women of the house, and mainly by that part of the adult generation to which the mothers belong, who thus show their gender roles in homegarden management together with a host of other collective responsibilities. Many species that are grown in the first ring are represented by only a few individuals, sometimes only a single bush (*e.g. Ruta chalepensis, Cymbopogon citratus,* and *Foeniculum vulgare).* These plants are only needed in small quantities. Plants of fragrance and ornamental value

are also grown just around the house in the first ring, and only in small numbers. Further away from the houses, the circumference of the garden increases while the number of species reduces and the number of individuals of a species increases, the plants being grown in large plots of one or two species. Hence, species number per unit area decreases from A to D, while the number of individuals of a species reduces in the reverse direction. The crop diversity in southwest Ethiopia follows similar pattern as reported for the general cultivated landscapes of tropical Africa (Okigbo 1994), that is that diversity is highest near and around the homes.

The homegarden may contain both native and exotic species, as is true elsewhere (Harlan 1969; Macioti 1992; Hancock 1992). Many of the native crops are known to have rich genepools in Ethiopia. Some native species, and some that have naturalised in forests and forest margins, are found both in homegardens and the wild in the southwestern study site. Table 2 gives a partial list of such crops, their probable status in Ethiopia, and the putative centres of domestication. It can be seen that some crops having been domesticated within Ethiopia, in the rest of Africa and outside the continent both occur in homegardens and in wild habitats. Species with spontaneous populations in southwestern Ethiopia include *Coffea arabica* (see Friis 1979), *Ensete ventricosum, Aframomum corrorima, Coccinia abyssinica, Piper capense, Rhamnus prinoides* and others. Another group of species is not indigenous, but have naturalised populations at forest margins or in suitable places with secondary growth and in otherwise disturbed sites, *e.g. Colocasia esculenta, Amaranthus spp.*, and others. The interface between homegardens and natural forests must be studied in order to learn about the gene pools and population genetic structure of such species. Natural or human interaction between homegarden and spontaneous populations may result in cross-fertilisation and seed dispersal, and ultimate gene-flow in either direction. Since the homes in a village are usually contiguous and since in many instances natural forests are not far from homegardens, it is probably plausible to invoke the metapopulation concept (Hanski & Simberloff 1997) in the interpretation of such species that are both wild and domestic.

Discussion

Since Ethiopian homegardens have been places where plants from the natural ecosystems and plants introduced from abroad are grown together, the crops demonstrate different degrees of domestication. The farming system has intensified by adopting the strategy of mixing compatible crops, the application of organic manuring, and intensified labour input, all organised in space and time. The dynamic processes are propelled by the combined effects of biotic, abiotic and socio-cultural factors that govern the overall changes in plant assemblages of the garden (Rico-Gray *et al.* 1990; Zemede Asfaw & Zerihun Woldu 1997). However, not all homegardens are intensively cultivated, and in fact many are under-utilised. The homegarden agrosystem is yet to develop to its full potentials, and domestication is still on the move with regard to some indigenous species which apparently fairly recently have been introduced into cultivation (*e.g. Echinops kebericho, Solanum dasyphyllum*).

Traditional tropical African agriculture is characterised by co-existence of forests with crops. The area around homes is planted with crops without removing all the trees, and therefore with minimum environmental interference. As time has gone by, and some areas have become more densely populated, more trees have been cut down, and more land converted to crop fields. The typical crop fields in Ethiopia dotted with trees on margins or in little used parts of the farmland are reminiscent of

this past environment. Forest trees that have positive associations with garden crops are retained, and may have significant use values to the community. One of the virtues of traditional rural homegardens is that it delays the process of deforestation and land degradation, partially preserving a range of forest species.

Soil conditions of homegardens may continue to improve with time, and manuring, crop rotation, recycling of crop residue, domestic wastes and litter from trees all contribute towards improving soil conditions. Even when there is no significant crop rotation involving leguminous crops and trees, soil fertility may improve because of inflow of domestic wastes in the agrosystem. Much organic material originating in crop fields, forests, grasslands and markets finally end up in the garden soils through decomposition and mineralisation. Mineral recycling in homegardens is shown to be particularly high in the cultivation of *Ensete ventricosum* (Asnaketch Woldetensae 1997).

Through years of experimentation, the owners of Ethiopian homegardens have developed a general garden design with considerable diversity and flexibility that allows them to fit in and produce a wide range of crops of their own choice. As archetype agricultural "engineers" and "breeders", farmers have managed to select crops that are co-adapted and give aggregated benefits, including multipurpose trees for adding soil fertility, serving as shade and material for construction, crafts and household and farm implements. These "engineers" and "breeders" have designed the homegardens to allow optimal harvest of solar energy through the strategy of manipulating physiognomic forms, phenological classes and other growth forms for a rich niche diversification. A plethora of indigenous agricultural knowledge survives in the practices around the homegarden, and this is being increasingly called upon to establish and strength the scientific basic of *in situ* conservation of the agricultural biodiversity (Mooney 1992). The homegarden is a living archive of agroethnobotanic knowledge and natural cultural history. Considering only dietary criteria, each well managed rural homegarden vows a nutritional calculus in its making, as it maintains crops that are sources of starch, legumes, oils, leaves and other categories proportionately mixed to best serve its primary home use function (Marten 1990; Zemede Asfaw & Zerihun Woldu 1997). This is a cultural heritage passed from generation to generation through action and word of mouth. While there is a general pattern, as described above, each garden is unique in its design and crop mix.

Traditional rural homegardens are meant for bio-production, but as already pointed out above they also maintain agrobiodiversity *in situ* in association with the wild flora (Power & Flecker 1996; Gesseler *et al.* 1996, 1997; Godbole 1998). Among the main determinants of the evolution of homegardens given by these authors are ecological factors (soil, altitude, water, *etc*), personal factors (preferences, interest, knowledge, *etc.*), socio-cultural and economic factors (household-needs, gender interests, preferences of social groups, market conditions, general wealth status, *etc.*) and political factors (land-use systems, general marketing and conservation policies, and agricultural support systems). The view of Harlan (1975) that differences between wild, tolerated, encouraged and cultivated plants are less clear in the tropics is well illustrated in the homegardens of southwest Ethiopia. Plants are transplanted from the wild, brought into the garden and escape again and escape again into the naturalized state. The movement of useful plants from the wild condition to the cultivated and back again can be easily observed. The indigenous management system of Ethiopian homegardens employs time and space based multiple strategies to maintain the biological and environmental heterogeneity and meet economic, social, cultural and ecological needs, as has

been described for traditional crop fields (Melaku Werede 1992).

People have responded to scarcity of arable land created by population growth by intensification of homegardens, and studies undertaken elsewhere have shown that homegardens have reached high levels of development in terms of plant diversity, labour input and income derived in regions where the human population density has reached high levels, 750 persons per square kilometre in Java for example (Padoch & Jong 1991). In parts of Ethiopia, intensification of homegardening has helped to avert some of the adverse effect of high human population density. Changes in homegardens are brought about by a number of natural and human factors, including the deliberate activities of the plot managers, non-intentional human actions, accidental occurrences, predictable successional changes and combinations. Where the intensification of Ethiopian agriculture has gone to the limits, homegardens have already become regular places for obtaining woody materials like the indigenous mountain bamboo (*Arundinaria alpina*), a common element in homegardens of southern and southwestern Ethiopia, where it is needed for construction purposes.

The strategy of the homegarden owners to adopt plant material from wild habitats, sometimes referred to as an "open-door strategy", provides opportunities for embracing novel plants of alleged use from any source (this may be from the wild flora or improved types from elsewhere). In the past this has contributed significantly to the increase of the agrobiodiversity and helped to maintain it on a high level. There is no reason to assume that this rich tradition can not continue, and Ethiopian homegardens should be able to persist through further intensification in a continuing tradition, even though modern agriculture has not as yet developed a positive attitude towards it. In fact, most attempts of organised modernisation have so far not succeded in changing this highly polycultural system to a monoculture.

Along with the growing socio-economic challenges to develop homegardens, halting the ecological degradation of the environment to maintain the rich reservoir of biodiversity is an important and promising issue (Nations 1988). In addition to its regular provision of household necessities, the homegarden preserves relics of the natural ecosystem and of a rich cultural heritage. The challenge is to understand and adapt the indigenous practices and knowledge systems so as to enhance sustainable gardening with the desired input from modern agriculture (Boef *et al.* 1996).

Conclusion

Globally, there has been a growing interest in homegardens during the last couple of decades, both with regard to the taxonomy of the species cultivated and in the possibility for further development of the techniques. The completion of the work on the Ethiopian flora is crucial for the study of Ethiopian homegardens, agroethnobotany and ethnobotany. The ecological significance of the traditional rural homegardens, especially those complicated ones of the Bonga area, demonstrate how important such studies are, if the homegardens of tropical environments are to continue to play significant roles in the provision of food, medicine, fodder, construction materials, firewood and other necessities mainly for home use.

One way to combat the ecological crisis of Ethiopia is to study the traditional homegarden agrosystem, and to develop it further. Completely new, but probably technically feasible possibilities are for example incorporation of biogas generation, the development of fishponds and mushroom cultivation. By such initiatives, the traditional Ethiopian homegarden can be developed into a self-contained future agroforestry complex with multiple functions

expanding into the realms of energy and home industry. This would lead to a polyfunctional production system, which would be in keeping with the mainstream of homegarden evolution, as we have seen it up to now. The future development of homegardens promises to be a dialectic link between bio-production and bio-conservation if we develop it according to the principles practised since long time ago. However, the positive effects of homegardens have developed in balance with a healthy environment. Maintenance of a healthy ecological balance between homegardens and the natural forests is therefore in the best interest of homegarden perpetuation and development. The challenge of the future will be how to obtain such a balance. We do not yet know, but I fully agree with the statement of Jose & Shanmugaratnam (1993) that a good strategy is to direct the development of homegardens, rather than to try and control it in minute detail.

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