



Home gardens in the maintenance of biological diversity

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Abstract:

Home garden is an integrated system which comprises different things in its small area that produces a variety of foods and agricultural products including staple crops, vegetables, fruits, medicinal plants and so on. In this context, the role of home garden as repositories of biological diversity is acknowledged. Home gardens, whether found in rural or urban areas, are characterized by a structural complexity and multi-functionality which enables the provision of different benefits to ecosystems and people. High levels of inter- and intra-specific plant genetic diversity are preserved in home gardens. Home gardens are important social and cultural spaces where knowledge related to agricultural practice is transmitted and through which households may improve their income and livelihood. The biological and cultural significance of agrobiodiversity in home gardens are highlighted with the future constraints and opportunities in home garden research in the prospect of defining and promoting their role in conservation of agricultural biodiversity and cultural heritage.

Keywords: Home garden; maintenance; biodiversity; food security; conservation.



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1.0 Introduction

Home garden is an integrated system which comprises different things in its small area that produces a variety of foods and agricultural products including staple crops, vegetables, fruits, medicinal plants and so on. The importance of home gardens in the production of food, medicine and other useful products for human beings is widely recognized (Polegri and Negri, 2010). Consequently, regular attempts to improve the productivity of this wide spread agro-ecosystem have usually been initiated with specific objectives in mind. The realization that home garden 'farming' system is also an important reservoir of unique genetic diversity has more recently led to initiatives to study this system more carefully in order to obtain a better understanding of the role of home gardens in the management and conservation of genetic diversity in situ. Biodiversity is the totality of genes, species and ecosystems of a region. Biological diversity for food and agriculture can be managed to maintain or enhance ecosystem functions to provide options for the optimization of agricultural production and contributing to the resilience of ecosystems for risk mitigation (Smith et al., 2006). Maintenance of genetic variation within agricultural crops provides a broad range of essential goods and services which support ecosystems functioning, resilience and productivity. Through a better understanding of the role of farmers and their families as the producers of garden products, it will be possible to improve the management of genetic diversity in home gardens, resulting in a better and more sustainable production combined with the maintenance of high level of genetic diversity. Targeted and well-planned intervention from the outside i.e. the introduction of new crops, improved varieties and/or of specific characteristics that are missing in a given home garden system can further strengthen the importance of this production system and allow a natural link between conservation and development. Home garden is an integrated system which comprises different things in its small area (the family house, a kitchen garden, a mixed garden etc). It produces a variety of foods and agricultural products including staple crops, vegetables, fruits, medicinal plants and so on. These products could be both for home consumption or use and for income. A garden is typically located on the land near a residence; it is the landscape around the home that makes the home look better and beautiful. There are numerous types of home gardens all serving particular functions. They include; vegetable gardens: It is the cultivation of different kinds of vegetables and fruits. It is one of the oldest varieties. Vegetable gardens are usually sectioned with a section for each vegetable or fruit. Herb gardens: This can be grown in a small spot as a window box. Growing of culinary herbs and spices gives the freshest ingredients. Different herbs are usually separated through the planting design. Rose gardens: It is mainly for the cultivation of flowers for income or beautification. Knot gardens: This type of garden has squares of flora or paving encased by dwarf box-hedgings. The knot garden looks to control nature into beautiful patterns. Oriental gardens: This type of garden incorporates the use of water and paths, rocks and sculptured bushes and trees to create a peaceful and tranquil garden. Wild gardens: It is a natural type of garden. Its natural style encourages the growth of natural plants and wild grasses.

Biological features of home gardens

Complexity and multi-functionality

Home gardens occur in regions with either high or low human population densities and are always located in proximity of human dwellings often delimited from their surrounding by hedges, fences, or other barriers. The more or less sharp separation, coupled with repeated tending from the household creates specialized edaphic, microclimate and biotic conditions which make home gardens markedly different from the surrounding landscape (Guarino and Hoogendijk, 2004). Traditional home gardens typically have a multilayered arrangement, resembling an agro-forestry system, which brings different plant species together in a temporal and spatial succession. This stratified and dynamic architecture more than the identity of a single species has been shown to make a home garden a sustainable and resilient ecosystem (Smith et al., 2006) in which different root structures utilize nutrients from various soil levels and both ground and aerial space are efficiently utilized (Eyzaguirre and Linares, 2004).

Inter-specific genetic diversity

Home gardens specific relevance for conservation purposes resides in their capacity to represent agro-biodiversity at multiple levels (Agbogidi, 2011a; Hodgkin, 2011) over small spaces. By harboring species with different life cycles and domesticated status (wild, semi-domesticated and domesticated), which require diversified cultivation practices and serve multiple purposes (food, fodder, medicine, fuel and fibre, ritual and ornamentals), home gardens become loving store houses for a variety of end products. Studies carried out in home gardens of various regions have recorded notable richness of species and varieties. In terms of composition, high diversity of species with an immediate use in the home is the most prominent feature of home gardens (Hoogerbrugge and Fresco, 1993). Predominance of fruit trees is common, particular when these are crucial for the diet of household members in terms of vitamins and fibres (Mitchell and Hanstad, 2004); other edible species, wild or domesticated are the next most represented category. Home gardens are often utilized as testing plots for new crops, as nurseries for plantlets later destined for planting in open fields and as sites for domestication of needy forms which may also be used directly within the household (Kulpa and Hanelt, 1981; Leiva et al., 2001).

Intra-specific plant genetic diversity

The predominant subsistence orientation of garden cultivation and the consequent greater flexibility in farming practices encourages the introduction and maintenance of wild species (Guijt et al., 1995), indigenous crops (Juma, 1989), and traditional varieties (Negri, 2003; Negri and Polegri, 2009). This results in significant intra-specific diversity (Eyzaguirre and Linares 2004), which not only increases a species' chance for adaptation and survival over time (Soule, 1987; Nunney and Campbell, 1993), but also provides crucial material for breeding (Tanksley and McCouch, 1997; Feuillet et



al., 2008) and for establishing complementing or restoring germplasm collections (Castineiras et al., 2007). The presence of crop wild relatives in particular allows gene exchange with the crops themselves: natural crosses between domesticated forms and their wild or weedy relatives still consistently occur in or around home gardens (Hammer et al., 1999) and wild germplasm has often been utilized by farmers to create and improve crops by experimenting in backyard gardens (Hughes et al., 2007).

Advantages of home gardens

(1) Beyond the reward of home grown produce, gardens provide health, environmental and enjoyment advantages for the gardener. It is also a way to save money and eat healthier foods. The benefits of a home garden make the physical exertion in costs of gardening worth the effort.

The major reason given for the increase in cultivation of home gardens is the provision of food and income. Another reason is the convenience of their location around the home.

(2) **Easy access:** A home garden gives instant access to fresh produce so that one is not forced to visit the market to find it. It makes one save time and money to go somewhere else to buy produce. It can also help to save money on the food itself.

(3) **Control:** Growing one's own food gives complete control over the chemicals and products used during the growing process. A home garden allows one to pick the produce when it is ripe. Unlike produce at the market that is often picked before it is fully ripe. Produce retains more nutrients when consumed shortly after harvesting, making home grown produce a healthier option.

(4) **Environmental impact:** A garden provides the opportunity to make a positive environmental impact. A composite pit allows one to recycle certain kitchen and yard waste products into a nutrient-rich additive for the garden. This reduces the waste produced and provides natural fertilizer for plants. Avoidance or limited chemical use reduces pollution and ground water contamination from gardening activities. Garden plants often help reduce erosion by holding the soil in place. Mulching around plants in home gardens further reduces erosion and runoff.

(5) **Enjoyment and family satisfaction:** Planting a garden provides enjoyment for many home owners. Watching your garden grow from bare ground to ripe produce or beautiful plants, offers a sense of satisfaction. Gardening also offers a form of moderate outdoor exercise.

2.0 Biodiversity

Biodiversity is the totality of genes, species and ecosystems of a region. Biological diversity is the variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels and is necessary to sustain key functions of the ecosystem. Biodiversity is defined, studied and managed at three levels which are the: ecosystem diversity, species diversity and genetic diversity. Each of these three is relevant to the study promotion of home gardens as loci for agro-biodiversity conservation and use. At the level of species diversity, quite a large number of studies already exist that describes the floristic richness of home garden systems and their contributions to cultural identity and to economy, nutrition and health at the household levels. Maintenance of genetic variation within agricultural crops provides a broad range of essential goods and services which support ecosystem functioning, resilience and productivity, and for this reason, it has become a core principle of sustainable agriculture and agro-ecology.

2.2 Home gardens and the maintenance of genetic diversity

Home gardens have characteristics that present particular challenges and opportunities for those interested in the maintenance of genetic diversity within production systems. They are complex, multi-storied environments with very high species diversity and a wide range of very varied ecological micro-niches (Agbogidi, 2011b).

2.2.1 Conservation and production

Crop diversity is maintained in home gardens when it meets producers' needs. It may be maintained over long periods and in this sense, it may be said to be conserved "in situ". However, conservation is rarely (if ever) the actual objective. Farmers who maintain diversity do so because they find it useful. Thus, any evaluation of in situ conservation of crop diversity in home gardens has to place the desired conservation objectives (the amount of diversity maintained, the duration of maintenance etc.) in the context of farmers' production objectives. Three groups of interacting factors affect the maintenance of crop genetic diversity in home gardens (Yongenous et al., 2006)

- The biological characteristics of the crops.
- The way in which farmers manage the production and reproduction of the material.
- The way in which environmental factors affect crop production.

In trying to determine how home gardens can best contribute to conservation, it is necessary to understand the ways in which environment, crop biology and farmer management are affecting the extent and distribution of genetic diversity. This involves determining what diversity is maintained by farmers, where and when it is maintained and how and by whom. It also involves exploring why farmers choose to maintain the cultivars they do, in the ways that they do.



2.2.2 The amount of genetic diversity

There is a range of different approaches to describing the amount of genetic diversity present in a crop in a home garden or group of home gardens. Whichever methods are used, the three most important features that are measured are the richness, evenness and distinctness of the characteristics. Richness is a measure of the number of different types, while evenness describes their distribution within and between the different populations (cultivars, home gardens area etc). Distinctness provides useful additional information on how different the types are and can be particularly important for accessing whether some populations or areas have unique types.

2.2.3 Distribution of diversity

In analyzing diversity, the way it is distributed between local cultivars, between cultivars on different gardens, between communities and areas, is as important as the simple description of the amount of diversity. The way in which diversity is partitioned within and between home gardens, communities or areas, provides necessary information for determining not only where diversity is maintained but also who maintains it and how. Preliminary evidence suggests that there are substantial differences in distribution of crops. Thus, home gardens can often maintain many more local cultivars of some crops than might be found in larger scale production systems (e.g. Capsicum) or can maintain specific types that are not grown on a larger scale.

2.2.4 Maintenance of diversity

From a conservation perspective, the population sizes of a local cultivar in a home garden are usually well below that which would be desirable. Two important interacting elements that need to be explored in the maintenance of diversity are: the way in which farmers maintain such small population and the genetic implications of the small populations themselves. Most farmers are likely to save their own seed or planting material over longer or shorter periods. Since populations are small, this is likely to be a fairly unstable process and seasons in which particular types can no longer be maintained are likely to occur quite frequently. However, there have certainly been situations where farmers have maintained special types for many decades and some of the crops are themselves very long lived. While short maintenance periods may appear to make the conservation of material very unstable, this may not be the case. It depends on the way farmers meet their needs for new or replacement materials and the extent to which communities or given regions maintain a common range of materials that are exchanged or passed on (Sordi et al., 2008).

2.3 Relationship between diversity and some socio-economic factors

In the study of home garden, it was found that there is a relationship between diversity found and certain socio-economic factors such as: greater diversity in home gardens owned by older farmers, in households where there is a larger number of family members, in gardens where the household's only income source is the home garden, in households where there are a larger number of family members, in the longest established home gardens, in larger home gardens, in home gardens where access is difficult, either due to the poor condition of the road or when transportation is lacking. In the home gardens studies, it was found that there seems to be no relationship between the diversity found and the following socio-economic factors: schooling, household type, land tenure situation home gardens production destiny and use.

2.4 Cultural and socio-economic features and their relationship with plant diversity

The contribution of cultural and socio-economic factors in generating and maintaining crop diversity in home gardens has received little attention (Perales and Brush, 2005); yet human cultures have profound influence on the diversity of the ecosystems they belong to (Schneider, 2004; Eyzaguirre, 2006) and it is often people's cultural and economic values which explain differences even among neighboring fields and gardens. By spending leisure time and work in home gardens, families and communities turn them into culturally constructed spaces (Eyzaguirre and Linares, 2004) where ethno botanical knowledge is actively preserved. Customs, tradition and aesthetic preferences are instrumental in determining the overall aspect of the garden (Birol et al., 2005; Smith et al., 2006). Different crops or varieties are maintained because of the significance of each in a family's traditions or preferences or because they fulfill aesthetic requirements. In high income societies, the majority of those involved in gardening activities are elderly household members, who often remain faithful to landraces they have inherited from prior generations. Households' socio-economic status and patterns are often reflected in the genetic diversity of garden crops and plants, although the exact nature of the relationship is highly variable. Nevertheless, development of niche markets may reverse trend and revitalize cultivation of traditional crops or varieties, which may be commercialized as traditional specialties and provide income opportunities to gardeners (Vasey, 1985; Hoogerbrugge and Fresco, 1993; Marsh, 1998; Sordi et al., 2008; Polegri and Negri, 2010).

2.5 Biodiversity conservation and development in home gardens

Home gardens are micro-environments containing high levels of species and genetic diversity within larger farming systems. These gardens are not only important sources of food, fodder, fuel, medicines, spices, construction materials and income in many countries around the world, but are also important for in situ conservation of a wide range of plant genetic resources. Home gardens are dynamic systems; their structure, composition and species and cultivar diversity are influenced by changes in the socio-economic circumstances and cultural values of the households that maintain these gardens. The conservation of agro biodiversity is inseparable from the sustainable use of plant genetic resources in agriculture. This agro-biodiversity conservation is both a goal and a means to secure the livelihoods and well-being of farming communities in poorer regions of the developing world. Home gardens are clear examples of diversity rich production systems that serve both a development and a conservation function.



2.6 Conservation value of home gardens

There are various ways that home gardens contribute to biodiversity at the ecosystem, species and genetic levels. At the ecosystem level, the home garden provides a complex micro-environment that links more complex natural ecosystems with agricultural systems. Home gardens are often the focal point of a household's social interactions within the family and with visitors. One of the important functions that home gardens perform is to keep knowledge of varieties and uses of diversity alive from generation to generation. In home gardens children and visitors can learn from the family experts on different types of diversity and its uses. These can be nutritional, commercial, aesthetic and spiritual. In several countries and ecosystems, the home garden was where germplasm from the wild was brought under cultivation. This complex ecosystem close to the house where plants can closely be observed and managed makes it a convenient site for traditional plant experimentation and domestication. Some home garden species that exists both in cultivated and uncultivated forms are also income earners. Ecosystem services that home gardens provide to the larger agricultural systems and the health and well-being of the household are often noted. The home gardens provide, protect and enriches environments for varieties that may be susceptible to biotic and abiotic stress in fields. Among the services they provide are soil enrichment, improved water retention, a habitat for pollinators.

- (1) Home gardens help ensure food security for rural people, in particular for poor farmers: Home gardens can be considered to be a buffer maintaining the sustainability of rural livelihoods (Eyzaguirre et al., 2001).
- (2) Home gardens assist in protecting the environment: A major part of vegetables and fruits circulating in local markets are produced in home gardens. Their produce is clean because there is almost no use of pesticides in gardening, thereby contributing to environmental protection as well as public health. Home gardens take on the character of the surrounding ecological system and provide a place where plants, animals, insects, micro-organisms and soil and air media mutually interact to maintain the agro-ecological balance; they effectively protect the soil from erosion.
- (3) **Home gardens prevent job deficits in rural areas:** Home gardens can provide year round work, using the farmers spare time but giving high value to a working day. Gardening is a recreational job, but can also generate high income. Gardening gives people jobs in rural areas while it allows them to leave the uncertainties of high-input agriculture.

Importance of home gardens as conservation units

- (1) Home gardens as a unit, contain the highest population of some under-utilized fruit species they are also conservation sites for these species. Examples: *Annona muricata* (sour sop), *Annona squamosa*. (Sweet sop), *Psidium guajava* (guava), *Persea americana* (avocado pear), *Mangifera indica* (mango).
- (2) Home gardens are in situ conservation sites for indigenous varieties of some of our crops. Examples: *Elaeis guineensis* (oil palm), *Cocos nucifera* (coconut), *Dioscorea* spp (yam).
- (3) Home gardens are sites for the domestication of wild varieties of some species. Examples: *Dioscorea* spp (yam), *Senna alata* (candle bush), *Senna occidentalis*.
- (4) Home gardens are trial sites for new variety of some crops and hence can be considered as entry point for new varieties of crops into our agricultural system. Example: different plantain cultivars such as double bunch, triple bunch, cooking banana etc.

3.3 Factors affecting the conservation of biodiversity in home gardens

In determining how home gardens can best contribute to conservation of agro-biodiversity, all factors affecting its distribution within and across gardens, its evolution and resilience over time need to be understood. For such purpose, one of the urgent issues facing research on garden based conservation is the "definition of minimum size of conservation units" which is needed to conserve viable populations of the target species. Once established, these conservation units can be used to monitor evolutionary changes in the genetic diversity they harbor, for example, by using molecular markers for measures of drift, selection and gene-flow. Such information is crucial to ensure long-term conservation of any crop (Tosti and Negri 2005; Tiranti and Negri, 2007) as well as of the many associated wild species (Goddard et al., 2009).

A home garden will seldom host more than a few hundred plants even of the most important crops and the population size is highly variable depending on the species (Hodgkin, 2001). Because of such variation in terms of inter-and intra-specific diversity, scientists generally agree that a representative conservation unit should include not one but a number of gardens in multiple agro-ecological zones, thus capturing a significant representation of the overall diversity for any given species (Brown and Marshall, 1995). Landraces in a given area consists of a series of sub-populations distributed across a number of gardens. Each subset interacts with others and this interaction contributes to shaping the overall diversity of the landrace (Louette, 2000; Tosti and Negri, 2005; Tiranti and Negri 2007; Negri et al., 2010). These small-scale evolutionary processes are influenced both by natural (breeding systems, pollination mechanisms, mutation rates) and human factors such as introduction or displacement of varieties (Brush, 2004) selection and seed exchange. Selection is probably the factor that most profoundly influences the evolution of agro-biodiversity, hence, its conservation, due to its effects on population structure (Brush, 2004). Farmers' selection is a dynamic practice which depends on many variables such as the field's size, the crop, the market's demand and may easily change depending on opportunities. On the small scale of the home garden, the extent and the effect of selection are not fully understood. Seed movement and gene-flow add up to the effects of selection in modifying garden crop diversity. More divergence may exist between neighboring home gardens whose owners do not exchange germplasm than between more distant home gardens whose owners



share their seeds (Guarino and Hoogendijk, 2004). Gene-flow involving wild relatives, landraces and modern varieties is facilitated by the limited spatial separation of individuals grown in gardens.

3.4 The future of garden-based conservation

Changes occurring under increasing demographic and economic pressures fuel concern for the future of traditional home gardens and the genetic reservoir they contain. The global trend toward large-scale agriculture determines a gradual simplification of the agricultural systems and landscapes in which crops are produced and an erosion of the sophisticated knowledge associated to farming practices (Anderson, 1993; Birol et al., 2005). Replacement of rural areas once used for the production of services (home gardens, wooded areas, living fences, pastures) by monocultures has caused a depletion of local species, primitive varieties and wild relatives (Negri, 2005). Modern varieties which replace local landraces in large scale industrialized agriculture represent undeniable advances in breeding offering higher yields under intensive growing conditions with optimal availability of water and other inputs. But in many agricultural contexts where such conditions are not met, for geographical or technical reasons, they still perform poorly compared to adapted landraces (Caccarelli, 1996). The later if they are retained at all, survive in low numbers in family farms and home gardens and there is concern that their potential is not fully realized (Newton et al., 2010). Nevertheless, there are newly emerging positive trends in home gardening, which encourage people to maintain biodiversity in rural and urban gardens. In developing countries the nutritional value of local, neglected horticultural species has been assessed and their cultivation in family gardens promoted to guarantee the intake of vitamins and micro-nutrients (Odhav et al., 2007) aiding in the control of HIV infections and other diseases (Callens and Gallagher, 2003). Establishment of food producing gardens often based on local seed systemization is becoming an important tool for making cities more sustainable while also providing marginal sectors of the population with working opportunities, healthier food and reinforcing their cultural identity (Van Veenhuizen, 2006; Seck, 2009).

In high-income countries the growing demand for healthier life styles and closer connection with nature has driven a renewed interest towards sustainable agricultural systems and “traditional” food products, capable of connecting consumers to the natural and cultural heritage of a community or a geographical region. In Italy, regional governing bodies have set up subsidies to encourage the cultivation of landraces among networks of “custodians” who have preserved them so far, often in their home gardens. In another case like the southern region of Nigeria, local landraces still found in home gardens have been granted official protection through inclusion of their products in the list of specialties of the region, as is the case for “cashew” *Anacardium occidentale*. Many urban citizens of the developed world have taken up some form of self-production of food in their terraces, roofs, gardens or courtyards as well as in communal areas shared among neighbors (Bhatt and Farah 2009; Bradley, 2009). Associations and NGOs play a leading role in promoting garden agro-biodiversity by carrying out general educational activities or actively supporting cultivation and exchange of heirloom varieties. Exploring the conservation potential of the many diversified home garden systems discloses opportunities for interdisciplinary studies involving botanists, ecologists, geneticists, anthropologists and sociologists. An improved understanding of the factors which encourage or enable diversity within the domain of home gardens would allow conservation scientists and communities to foster and maintain important knowledge and biological resources while also preserving the health of services these multifunctional, sustainable agro-ecosystems provide to nature and people.

CONCLUSION

Home gardens provide good ecological and social conditions for outstanding production and contributing to conservation of diversity and evolution of plant genetic resources. They are an important production system of food and other essential products. Home gardens provide a unique opportunity to clearly explain and demonstrate the importance of genetic diversity for crop improvement as well as the relevance of linking conservation with development. It also provides environments in which part of the genetic diversity for many crops species can be maintained. The contribution of home gardens to conservation is dynamic and ensures the maintenance of materials, which provide direct benefits to the owners and users of home garden products.

In conclusion, home gardens play a major role in the maintenance of biodiversity through the production of food, job opportunities, crop improvement, development, maintenance of the ecosystem and so on. Looking into consideration the many importance/advantages of home gardens and in order to be able to incorporate them as a complementary strategy, I would like to recommend that the cultivation of home gardens be encouraged in any way possible like reinforce socio-economic information to improve capacity of farmer communities to manage and maintain home garden diversity.

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