Overview of Research in Home Garden Systems

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Introduction

Home Gardens can be defined as the land surrounding a house on which a mixture of annual and perennial plants are grown, together with or without animals, and largely managed by the household members for their own use or commercial purposes. Brownrigg (1985) defines the term as '*a supplementary food production system by and for members of a group of people with rights to the land, who eat meals together regularly*'. Fernandes and Nair (1986) state that the term Home Garden can mean anything from growing vegetables behind houses to complex multistoried systems. They defined the term as '*land-use practices involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and, invariably, livestock, within the compounds of individual houses, the whole crop-tree-animal unit being intensively managed by family labour*'.

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Home Gardens are an ancient and widespread agroforestry system. While the focus on the system as a development strategy is relatively recent, its existence as a traditional land-use practice spans centuries, even millennia in some cases (Lai 1989). According to Hutterer (1984), the system may have developed in prehistoric times when hunters and gatherers deliberately or accidentally dispersed seeds of highly-valued fruit trees in the vicinity of their camp sites. Brownrigg (1985), in his literature review (cited in Soemarwoto 1987), mentioned that Home Gardens in the Near East were documented in paintings, papyrus illustration and texts dating to the third millennium BC. The systems have survived throughout the centuries as the result of long-term adaptation of cultivated plants and cultural techniques to local ecological conditions; and they have in many cases reached a noticeable degree of harmonisation with the natural environment (Michon 1983). Farmers who practice the systems are guided, perhaps in the absence of a unified set of expert recommendations, by their own perceptions and convictions about species' selection, admixture and management, so that each farm unit is a specialised entity in itself (Fernandes and Nair 1986).

Home Gardens are fundamental to peasants' lives because they are not only units of production but are also part of the habitation unit of the peasant family (Buylla Roces et al. 1989). Although there are many variations in Home Garden design and pattern, the basic features remain the same (Christanty 1985). A Home Garden usually contains a house, a bare space and a cultivated space.

Usually the cultivated space (the garden) surrounds the house, in front of the house as a frontyard or behind the house as a backyard. The bare space is used for various social and ceremonial activities. Intensive uses of cultivated space, the multiple functions of farmyard plantings, and predominance of root, tuber and tree crops are some of the characteristic traits of traditional Home Gardens in many parts of the world (Ninez 1987). The gardens often feature low-capital input and simple technology and are intensively managed by family labour. Yields are generally low but stable and sustainable (Fernandes and Nair 1986; Ninez 1987; Soemarwoto 1987). Personal preferences and attitudes, socioeconomic status and culture often reflect the appearance, structure and function of the Home Gardens (Christanty 1985).

Various authors have used numerous terms to denote these practices. These include, for example, mixed-garden horticulture (Terra 1954), mixed garden or house garden (Stoler 1978), Home Garden (Millat-e-Mustafa 1996), Javanese Home Garden (Soemarwoto et al. 1985), compound farm (Lagemann 1977; Okafor and Fernandes 1987), kitchen garden (Brierley 1985), household garden (Vasey 1985), tropical mixed garden (Price 1982), quintal (Posey 1985), *calmil* (Palerm 1967), *pekarangan* (Soemarwoto et al. 1985), *kandyan* garden (Jacob and Alles 1987), and homestead agroforestry (Leuschner and Khaleque 1987).

Home Garden characterisation

Despite their potentials, Home Gardens are often ignored as an important part of traditional farming systems by scientists and development agents, largely because of their small size and apparent insignificance (Bunderson et al. 1990). They are often viewed as an example of primitive, underdeveloped agriculture compared to modern high-yielding technological agrosystems (Michon et al. 1983). Many studies have reported the existence of Home Gardens in various regions of the world (Table 1), but very few studies have adequately analysed the structure, species' composition, diversity and management aspects of Home Gardens (Tables 2 and 3).

Home Garden structure

The vertical stratification of vegetation within Home Gardens has been long recognised as a characteristic feature although the variation of height within any one stratum has led to some arguments as to the distinctness of the various strata recognised by various authors. Barrau (1961), Michon (1983), Altieri and Farrell (1984), Fernandes et al. (1984), Okafor and Fernandes (1987), Oduol and Aluma (1990), Millat-e-Mustafa (1996) give schematic presentations of vertical structures from various geographical regions and observe that the canopies of most Home Gardens consist of between two and six strata. Millat-e-Mustafa (1996) provides a general summary of strata.

<1 m	Vegetables, spices, tubers, roots, pineapple
1-3 m	Food plants, e.g., lemon, banana, papaya, guava
3-5 m	Saplings of fruit/timber trees all growing taller
5-7 m	Fruit/timber trees, some growing taller
7-9 m	A few fruit/timber trees
>9 m	Timber trees, bamboo

Table 1: Literature on the Qualitative Description of Home Gardens from R&D across the World

Country	Specific home gardens	References
a) Asia and the Pacific region		
Bangladesh	Bangladesh home gardens	Chowdhury 1993
	Bangladesh home gardens	Hocking and Islam 1994
	Bangladesh home gardens	Leuschner and Khaleque 1987
India	Kerala home gardens	Nair and Sreedharan 1986
	Kerala home gardens	Salam and Sreekumar 1991
Indonesia	Javanese home gardens	Abdoellah and Marten 1986
	Javanese home gardens	Ahmad et al. 1980
	Javanese home gardens	Christanty et al. 1986
	Javanese home gardens	Raintree 1978
	Pekarangan	Soemarwoto and Soemarwoto 1984
	Javanese home gardens	Soemarwoto et al. 1985
Sri Lanka	Sri Lankan home gardens	Wickramasinghe 1992
Regional Home gardens	South East Asia	Anderson 1979
	Asia	Ninez 1987
	Indian Subcontinent	Singh 1987
	Tropical	Soemarwoto 1987
	Asia and the Pacific	Tejwani and Lai 1992
	Tropical	Torquebiau 1992
	Tropical	Wojtkowski 1993
b) American region		
Regional	Tropical American home gardens	Budowski 1985
Home gardens	American home gardens	Ninez 1987
c) African region		
Swaziland	Swazi home gardens	Allen 1990
Tanzania	Tanzanian home gardens	Rugalema et al. 1994
Zimbabwe	Zimbabwe home gardens	Campbell et al. 1991
Regional Home gardens	Sub-Sahara	Cook and Grut 1989
	Africa	Mergen 1987
	Africa	Ninez 1987
	Tropical Africa	Okigbo 1987

He stresses that these strata are dynamic and there is constant recruitment from one stratum to another. Soemarwoto (1987) first analysed strata in Javanese Home Gardens as above, then gave the percentages of numbers of species and numbers of plants contained in each layer, showing that these were highest in the lowest layer and lowest in the upper layer, thus adding an element to the picture of vegetation distribution over the garden as a whole.

Table 2: Literature from around the World on the Structure of Home Gardens

Country	Horizontal structure	Vertical structure	References
a) Asia and the Pacific region			
India	RA	4 strata	Jose and Shanmugaratnam 1993
	HA	*	Kumar et al. 1994
		4 strata	Nair 1979
	RA		Nair and Krishnankutty 1984
Indonesia	HA		Christanty 1985
		4 strata	Christanty et al. 1986
		4 strata	Jensen 1993
	RA		Mergen 1987
		3-5 strata, species richness and density higher in lower stratum	Michon 1983
	HA	3-5 strata	Soemarwoto 1987
Nepal	HA		Tuladhar 1990
Pacific		4 strata	Barrau 1961
Philippines		4 strata	Sommers 1978
Sri Lanka	HA		Jacob and Alles 1987
		3 strata	McConnell and Dharmapala 1973
	HA		Nanayakkara 1990
		4 strata, vertical dominance of species on the basis of RIV	Perera and Rajapakse 1991
b) American region			
Grenada		4 strata	Brierley 1985
Mexico		4 strata	Gliessman et al. 1981
c) African region			
Nigeria	HA	4 strata	Okafor and Fernandes 1987
		4 strata	Okigbo 1987
Tanzania		4 strata	Alriksson and Ohlsson 1990
	HA	4 strata	Fernandes et al. 1984
Uganda	HA	4 strata	Oduol and Aluma 1990

* Blank cell indicates no information is available.
RA = Regular arrangement, HA = Haphazard and irregular arrangement

Table 3: Literature from around the World on Home Garden Floristics

Country	Total species	Species' composition	Species' similarity	Species' diversity	References
a) Asia and the Pacific region					
	52	*			Abedin and Quddus 1990
	21	+			Akhtar et al. 1989
	28	+			Alam et al. 1990
		+			Dasgupta et al. 1990
Bangladesh	20	+			Islam and Ahmed 1987
		+			Islam et al. 1990
	28	+			Kar et al. 1990
		+			Khaleque 1987
		+			Khan et al. 1990
	34	+			Miah et al. 1990
	92	+	60-76%		Millat-e-Mustafa 1996
	52	+			Momin et al. 1990
China	300				Shengji 1985
Fiji	61				Thaman 1990
India	127		28.57 -81.08 %	H' = 1.13-3.02, E = 0.37-0.54	Kumar et al. 1994
	30				Nair and Sreedharan 1986
	36				Babu et al. 1992
	196			H' = 2.79	Abdoellah and Isnawan 1980
				H' = 3.71	Christanty 1985
	60				Jensen 1993
Indonesia	607			H' = 2.73-2.99	Karyono et al. 1978
	191				Mergen 1987
	500	+			Michon 1983
	600				Soemarwoto 1987
	180				Sollart 1986
Nepal	129				Thapa 1994
Philippines	74	+			Sommers 1978
	41				UNICEF 1982
PNG	114				Thaman 1990
Sri Lanka	65				Perera and Rajapaksa 1991
	170				Southern 1994
Thailand	100				Kamtuo et al. 1985
Tonga	65				Thaman 1990
b) American region					
Grenada	31	+		H' = 0.24	Brierley 1985
Martinique	67				Kimber 1966
	338				Buylla Roces et al. 1989
Mexico		+			Gliessman et al. 1981
	135		49-59%	H' = 1.6	Rico-Gray et al. 1990
Peru	29				Padoch and Jong 1987
	168				Padoch and Jong 1991
c) African region					
Nigeria	60				Bittenbender 1985
		+			Okafor and Fernandes 1987
Tanzania	111				Oktingati et al. 1984

* Blank cell indicates no information is available.
\+ indicates more food and fruit producing species.

Many authors (Table 2) from tropical regions describe Home Gardens on first sight as haphazard, random, even anarchic and, rather poetically, 'order in disorder'. Within Kandy Home Gardens of Sri Lanka, Jacob and Alles (1987) and Nanayakkara (1990) failed to find any spatial pattern of species' distribution. A similar observation is also made by Tuladhar (1990) for the Home Gardens of Nepal and Kumar et al. (1994) for the Kerala Home Gardens of India.

The opposite view is also expressed by a number of authors for the horizontal arrangement of plants in tropical Home Gardens. Fernandes and Nair (1986) claim that the Pacific Home Gardens present a more clearly defined spatial arrangement of plants following the orientation and relief characteristics of the watershed and each species perfectly occupies the available space in the Home Gardens. According to Nair and Krishnankutty (1984), a certain general pattern in arrangement of plants seems to exist in the Home Gardens of Kerala. However, Christanty et al. (1986), Ahmad et al. (1980), Sommers (1978) and Wickramasinghe (1992) mention that the spatial arrangement of plants in a Home Garden is always determined by various factors such as light, water and fertility requirements, security and crop protection, health, aesthetics and efficiency of space utilisation.

Home Garden floristic diversity

Diversity is defined as 'many different species and their intensity of interactions occurring in a small space at one time' (Harmer 1991) and indeed this definition neatly encapsulates the concept of diversity in Home Gardens, since there is a great variety of interactions taking place vertically, horizontally and temporally within one garden often of less than one hectare. There are different degrees of diversity, here involving a spectrum ranging from 29 species to 191 species in one garden (see below), but basically diversity begins to exist when there is more than one crop included in a small area. Diversity can be measured in as much as individual species can be counted but this must be in relation to the scale of the garden. Home Gardens are almost universally reported as being on average less than one hectare (e.g., FAO 1986; Altieri and Farrell 1984) as in Chilean gardens; Nair and Sreedharan (1986) observed gardens in Kandy 0.4 - 2.0 ha in size; and some gardens noted in Bangladesh can be as small as 0.02 ha (Millat-e-Mustafa, 1996).

Diversity is well documented in the literature with exhaustive lists of species found. Almost every author who covers a Home Garden from a particular country gives a list of the species found in the garden. Some are short and general whereas others provide long lists of every species identified. There is even an entire article devoted to the plant species in Chagga Home Gardens (Oktingati et al. 1984). The range of species reported goes from 29 'useful' species in one garden in Peruvian Amazon (Padoch and Jong 1987) to more than 600 species found in both seasons in gardens ranging from the highlands to the lowlands of Java (Soemarwoto 1987). There are a variety of methods for cataloguing plant species. Some authors take individual gardens, e.g., Chambers et al. (1989) counted 70 species in one garden in Bangladesh. Mergen (1987) goes further—having reported 191 species in one garden in Java (the upper limit for number of species in one garden found in the literature), he then categorises the species, e.g., 37 species of fruit trees, 21 herb species, etc. Other authors look at a village as a whole, e.g. in Mexico, 338 species were found in gardens in one village (Buylla Roces et al. 1989) and, in Java, over 500 species were encountered in a village by Michon (1983). Oktingati et al. (1984) surveyed 30 farms where they noted 111 different species. Millat-e-Mustafa (1996) recorded 92 perennial species in the set of 80 Home Gardens surveyed in four physiographic regions (20 from each region) of Bangladesh.

Home Gardens are a highly efficient form of land use, incorporating a variety of crops with different growth habits. Although there is little quantitative information regarding species' composition in the Home Gardens (Table 3), the studies of Barrau (1961) in the Pacific, McConnell and Dharmapala (1973) in Sri Lanka, Sommers (1978) in the Philippines, Michon et al. (1983) in Java, and Boonkird et al. (1984) in Thailand have acknowledged the predominance of fruit and food-producing species in the Home Gardens of the respective countries. Food production is thus the primary function and role of most Home Gardens.

Factors affecting diversity

A variety of factors affecting diversity are reported. Mergen (1987) cites personal choice of the farmer but more often external forces come into play. Soemarwoto (1987) has a concise catalogue of factors—better financial position leading to fewer food crops and more ornamentals, scarcity of labour prompting farmers to grow more labour-saving perennials and the proximity of markets, influencing farmers to include cash crops in their gardens. In the Home Gardens of Kerala, cocoa and coconuts have become dominant (Nair and Sreedharan 1986) while Chagga farmers juggle with coffee and food crops depending on market demand and the need for food (Fernandes and Nair 1986). Soemarwoto also mentions population pressure, which decreases the size of landholdings, subsequently, although cropping intensity increases, the price is usually the sacrifice of species' diversity. Other authors agree: e.g., in Java, gradually more annual crops are included until, under pressure of providing immediate food for the family, only staple crops such as cassava dominate (Wiersum, 1982). A similar situation has turned previously species-rich Nigerian Home Gardens into virtual monocultures (Mergen 1987).

The management skills of farmers world-wide, acquired empirically over generations, in dealing with the diversity of their gardens are constantly emphasised, e.g., Michon et al. (1983) claim that Javanese farmers have such a thorough knowledge of ecology that they can often choose the correct 'niche' for each plant depending on the gradient of light and humidity, and this seems to correspond to its ecological niche in the natural forest. Experimentation to increase diversity is also widely recorded. In the Andes, Ninez (1987) reports on gardens being used as informal experimentation stations for new varieties and exotic species. Chambers et al. (1989) and Fujisaka and Wollenberg (1991) found that, particularly in newly-established gardens in Kenya and the Philippines, farmers chose gardens for testing and observing new cultivars and species' combinations and for domesticating wild plants.

Importance of diversity

Authors agree on the wide range of uses for products from gardens. The multipurpose tree crops can provide shade (e.g., for coffee and for sitting under), living fences, fodder and mulch, bee forage, fuelwood, fruit, timber and poles. Other components provide food both for home consumption and for sale if a surplus remains, protection against pests, cash crops, medicines, spices, mushrooms, fibres for ropes and mats, and even simply for ornamentation. In some gardens, e.g., in Kandy, seemingly useless species are retained, but information on these is minimal. One of the most striking features of Home Gardens, observed on all three continents (e.g., Michon (1983) in Java; Okafor and Fernandes (1987) in Nigeria; Buylla Roces et al. (1989) in Mexico; and Millat-e-Mustafa (1996) in Bangladesh) is that, due to such great diversity of species and their varied biological cycles, having the effect of staggering production of food crops, small daily harvests can be made year round for immediate home consumption.

The diversity of plants reduces soil erosion. Young (1989) devised two categories of vegetation in relation to soil erosion by rain—trees as barriers and as cover—remarking that trees alone, as barriers, only slightly reduce erosion, but in Home Gardens it is the ground surface litter cover which is crucial. Soemarwoto (1987) takes a different angle and divides erosion into two categories—splash and surface erosion—and goes into precise details of leaf driptips and droplet size in relation to splash erosion, whilst agreeing with Young about the vital necessity of ground cover. Other authors, however, do not go into such detail.

Most sources recognise that the species' diversity of Home Gardens represents a valuable genetic resource. Two aspects of this are examined: Ninez (1987) sees this as a way of preserving species uneconomical in field production and notes that, in Peru, landraces of vanishing cultivars are found solely in Andean gardens, whereas both Fernandes and Nair (1986) and Michon et al. (1983) view Home Gardens as a valuable gene pool for breeding and improvement programmes since selection processes, both natural and human, have occurred over the years. However, Soemarwoto (1987) regrets the genetic erosion resulting from commercialisation in areas of Java—75 varieties of mango were reported in one area in the 1920s but nowadays in many places, to supply urban markets, there is only one variety.

Diversity is seen by many authors (Fernandes et al. 1984; Mergen 1987; FAO 1989; Millat-e-Mustafa 1996) as a safeguard against pest and disease. '*The advantage of a species-rich polyculture is undoubtedly that the risk of losses is spread among many species*' (Soemarwoto 1987). Altieri et al. (1987) give evidence from trials performed in Mexico that polyculture can foster improved biological control of pests and that a diversity of species can harbour both pests and their natural enemies. They state that further research is warranted in this area, but few sources mention the presence of beneficial insect predators. The sources are stronger on reporting local strategies to combat pests and diseases. The Kayapo Indians of Brazil manipulate fire which eradicates certain insects but encourages ants which in turn repel other pests (Mergen 1987). In Kerala, coconut root wilt has swept through gardens, thus farmers have resorted to greater diversity of intercrops to sustain production levels (Nair and Sreedharan 1986). There is an example of farmers using one species to protect another in Chile where an otherwise useless species is retained to keep chickens healthy.

Animal diversity

In addition to the variety of nutrition derived from food crops, diets are further augmented by animal products. Brownrigg's literature review (1985) indicated that animals were found in virtually all types of Home Garden. Other examples of Home Gardens with animals are the Chagga gardens in Tanzania (Fernandes et al., 1984), the Home Gardens in Ghana (Asare et al. 1985), Grenada (Brierley 1985), Indonesia (Soemarwoto et al. 1985), India (Nair and Sreedharan 1986) and Bangladesh (Leuschner and Khaleque 1987). Most of the literature mentions animals—poultry, pigs, rabbits, cows, sheep, goats, buffalo, fish and bees, even butterflies and crocodiles in Papua New Guinea (Bourke 1984), and Michon et al. (1986) report the importance of wild fauna in pollination and seed dispersal in Sumatran gardens. However, far less attention is paid to animal than to plant species. Reasons for the lack of animals are also noted: in Java there are no pigs on religious grounds (Soemarwoto 1987) whereas in Nigeria the keeping of some livestock is almost ruled out by the presence of tsetse flies (Okafor and Fernandes 1987).

Home Garden production

Production is the prime reason for the existence of Home Gardens, but the continuing capacity to produce depends on the sustainability of the gardens. Although, as noted above, Home Gardens are ecologically stable and continuously provide a variety of produce, yet authors usually comment on the low productivity. Capital inputs are low (Soemarwoto 1987) with the exception of the family labour inputs, which Cook and Grut (1989) find to be particularly high where soil moisture and fertility have to be maintained by continuous additions of water and organic matter.

Figures to quantify production in Home Gardens are scanty. Soemarwoto (1987), Ninez (1987), Stoler (1978) and Nair and Sreedharan (1986) provide figures for income derived from gardens, and Fernandes et al. (1984) quote amounts of produce (beans, coffee and bananas) harvested from Chagga gardens, but admit that fruit, vegetable and herb production remains unquantified. Ninez (1987) explains that this is because the production is usually for immediate family consumption therefore goes unassessed in official statistics. Farmers are usually aware that crops are not producing at maximum capacity but total production is greater and more diverse, with risks minimised and greater long-term sustainability ensured (Altieri and Farrell 1984).

Nutrient cycling and recycling in Home Gardens

Mergen (1987) suggests that Home Gardens can produce everything necessary without straining the carrying capacity of the land. It is precisely the combination of elements which forms the nutrient cycle that is so crucial to the sustainability of the system. Michon et al. (1983) provide an excellent summary of the processes involved which are sufficient to maintain soil fertility, dividing them into two—matter and water cycling, and recycling of waste products. Wiersum (1982) observed that gardens are usually dominated by perennial crops therefore a high ratio of the nutrients are stored in the vegetation rather than the soil leading to nutrient cycling via the litter, and a relatively small hazard from leaching and erosion. Litter and fallen trees are frequently cited as contributing to nutrient cycling (e.g., Buylla Roces et al., 1989; Ninez, 1987) and in many gardens legumes are planted for their nitrogen-fixing properties (e.g., Balasubramanian and Egli (1986) in Rwanda; and Nair and Sreedharan (1986) in Kerala). Nair and Sreedharan (1986) report that gardens of Kerala cause substantial improvements in the physical and biological characteristics of the soil. This may be true in the case of nitrogen fixation but they offer no evidence of quantification to back up their claims. Young (1989) is more cautious and argues on the basis of research that at the moment there is only limited evidence to suggest that agroforestry systems can maintain soil organic matter.

Most sources report the cycling process of waste garden products and fodder being fed to animals whose manure is then used to fertilize the crops. Green maturing and mulching is also widely practised. The role of animals as recycling agents is depicted in the literature as being as important as their role as producers. In Chagga gardens, livestock are stall fed with fodder from the garden and with kitchen waste, and the manure spread over the gardens (Fernandes et al. 1984) whereas in Mexico pigs and chickens wander freely (Buylla Roces et al. 1989). Mulch is universally used. In many sources bananas are noted for their high organic matter and the excellent mulching effect of their refuse (e.g.. Watson [1982] in Nigeria) and in Chile guano, ash and straw is used (Altieri and Farrell 1984). In Bangladesh, Leuschner and Khaleque (1987) observe that because of the scarcity of fuelwood, all house, garden and animal residues are used for cooking, but surprisingly omit to comment on the effect of this on the system. Soemarwoto (1987) laments the advent of chemical fertilizers into Javanese systems—composting is now deemed cumbersome—resulting in the recycling systems beginning a decline which in the long run will affect soil structure and fertility.

Much has been written about nutrient cycling and recycling but almost nothing is said about the role of roots, apart from nitrogen fixation. Fernandes and Nair (1986) admit little is known about the function of roots but presume they do not overlap greatly and that dynamic equilibrium occurs below as well as above ground. Michon (1983) briefly mentions the advantages of diversified root systems. Wiersum's theory (1982) that mineral uptake occurs through deeply rooted perennials from deeper soil layers is dismissed as unproven by Young (1989). This lack of attention is surprising in the light of Young's observations that tree roots play a central role in maintaining soil organic matter and physical properties and are the below ground equivalent of litter.

Interactions among Home Garden components

Interactions among components are frequently mentioned as a typical feature of Home Gardens but rarely analysed in detail. Complexity is stressed and perhaps this is the underlying reason why analysis is scarce. Nair and Sreedharan (1986) describe Kerala Home Gardens species by species, noting interactions between individuals: this is useful but diverts attention from the holistic nature of the garden as one interaction system. Fernandes and Nair (1986) admit there is no available data on interactions between components in Chagga gardens. The most impressive accounts of interactions come from Michon et al. (1983) who preface their exposition '*if an analysis of the gardens is to be successful, it must use a global approach*'. Gardens are likened to natural forest ecosystems with their interrelated dynamic processes. An architectural analysis is used to focus on relations between different elements, and plants are classified as having potential, actual and decaying production. Light availability and human factors often dictate diversity, and a chablis, produced by the removal of a large tree, begins a cycle of regeneration and succession in which a range of plant species takes part. The process differs from natural forests chiefly in that the dynamics are speeded up by the farmers. Thus, although the producing landscape is unsettled over time, its structure and function remain stable.

Indigenous management techniques

The management of the traditional Home Garden systems has evolved as a response to many factors, cultural, economic, and environmental as well as personal preferences (Southern 1994). Since farmers live in intimate contact with their Home Garden production systems, it is reasonable to assume that they have detailed knowledge of the components that they manage in their Home Gardens, and the interactions between them and the local environment. Farmers' indigenous knowledge is often characterised as highly specific and context-bound, with knowledge emerging simply from localised, practical experience (Scoones and Thompson 1994). Local communities in many areas benefit from generations of experience of the management of complex land-use systems that take advantage of the benefits of stability and sustainability associated with complexity. They continuously conduct their own trials, particularly adopt and adapt technologies to their specific circumstances and spread innovations through their networks (Cornwall et al. 1994). Their experimentation is quicker and more able to accommodate changing circumstances and diversity than those of research scientists.

Many authors acknowledge the management skills of farmers in dealing with the complex Home Gardens that they have acquired empirically over generations. For example, Michon et al. (1983) claim that Javanese farmers have such a thorough knowledge of ecology that they can often choose the correct niche for each plant depending on the gradient of light and humidity, and this seems to correspond to its ecological niche in the natural forest. In fact, the diversified structure of the Home Garden provides knowledge of a broad range of plant species and systems to the farmers. Farmers utilise this knowledge to manage plant species with different means of propagation, life form and origins with a variety of uses. However, literature provides little basis for the management of Home Gardens across the world. Management activities for Home Gardens available from the literature include planting materials used to regenerate the Home Garden plants; cultural operations such as weeding and pruning; watering and fertilizing; labour forces required for Home Garden management; and the constraints of the present management systems.

Planting materials used for regeneration

Seeds, seedlings and vegetative propagules are all used by farmers to regenerate their Home Garden plants in Bangladesh (Millat-e-Mustafa 1996). Indeed fruit trees may spring up wherever people eat fruits and leave the seeds behind. Farmers also scatter the seeds or nuts in suitable places. Sometimes bats, squirrels or birds also act as vectors. Seedlings of valuable species are also used to propagate plants whenever available. Fernandes et al. (1984) in Chagga Home Gardens and Millat-e-Mustafa (1996) in Bangladeshi Home Gardens report that farmers also encourage naturally arriving seedlings of valuable species to grow.

Farmers collect their planting materials from different sources. Millat-e-Mustafa (1996) reports that the farmers of Bangladesh obtain different planting materials from their own Home Gardens, relatives and neighbours, markets and occasionally from government nurseries. Wickramasinghe (1992) reports that in Sri Lanka most planting materials are obtained freely from neighbours, and that farmers also occasionally buy seedlings of valuable species from the market.

Cultural operations

Removal and/or partly uprooting of undesirable species from the Home Gardens through weeding is a common cultural practice reported by Sollart (1986) and Bompard et al. (1980) from Javanese Home Gardens, and Millat-e-Mustafa (1996) from Bangladesh Home Garden. The practice of farmers in west Java of partly uprooting weeds under trees and leaving them to decompose illustrates how weeding is an integral part of skilful management of traditional systems: the soil is covered, nutrients recycled and unnecessary work avoided (Bompard et al. 1980). Weeding may follow a schedule or be done from time to time as required. Sollart (1986) mentions that the farmers of Javanese Home Gardens weed when time is available but they do it at least once every two months.

Pruning is another important cultural operation practised by the farmers for various reasons. Millat-e-Mustafa (1996) mention that, in Bangladesh, farmers prune trees to increase fruit and timber production, to facilitate harvesting of fruits, to avoid conflicts with the neighbours due to excessive lateral growth of plants, and to provide light to the more valuable understorey plants.

Several authors (Bompard et al. [1980] from Java; Fernandes et al. [1984] from Chagga Home Gardens; Nair and Sreedharan [1986] and Dadhwal et al. [1989] from India; Hossain et al. [1988], Alam et al. [1990], Miah et al. [1990] and Millat-e-Mustafa [1996] from Bangladesh; and Thaman [1990] from the Pacific) report that farmers generally use farmyard manure and organic manure/compost for the soil fertility management of their Home Gardens and application of chemical fertilizer is very rare and limited to valuable species only during early stages of development and/or during fruiting. Irrigation is carried out on a very limited scale for high-valued trees during the dry season and/or early stage of establishment of seedlings in different agroecological zones of Bangladesh (Hossain et al. 1988; Alam et al. 1990; Miah et al. 1990).

Labour Requirements for Home Garden Management

Several authors mentioned the low-labour demand for Home Gardens from different countries, e.g., half hour to two hours daily in 500m^2 Home Gardens of the Philippines (Sommers 1978). A similar range is reported in Indonesia (Haryadi (1975) cited in Christanty (1985)); 50 minutes per day in 200m^2 Home Gardens in Lima (Ninez 1985); 35-45 days of family labour per year during the year for Home Gardens' establishment and 17-22 days during subsequent years in Mexico (Buylla Roces et al. 1989).

Several authors (e.g., Stoler 1978; Ahmad et al. 1980; Hossain et al. 1988; Millat-e-Mustafa 1996) mention that there is a clear sharing of tasks between women and men for the management of Home Gardens. According to Stoler (1978), Home Garden cultivation occupies only eight per cent of the total working time of men and an insignificant amount of time for women, but Ahmad et al. (1980) found that in west Java women spent 9.4 per cent of their productive activities in the Home Garden while men spent only 2.3 per cent of their productive activities. In Bangladesh farmers spent only from 4.8–12.2 per cent of their total labour in Home Garden management; up to as much as 64 per cent of the total labour requirements for the Home Garden are met by hired labour, the larger the farm, the greater the use of such hired labour (Millat-e-Mustafa 1996).

Constraints of the present management system

Many sources (e.g., Liyanage et al. 1984; Hossain et al. 1988; Alam et al. 1990; Miah et al. 1990; Millat-e-Mustafa 1996) mentioned a number of constraints faced by the farmers in managing their Home Gardens. Some of the common constraints are lack of funds, land, planting materials, technical know-how, and natural calamities such as drought and floods. Almost all Home Gardens face at least three of the constraints mentioned above.

Sustainability of Home Gardens

Young (1989) provides a simple definition of sustainability: '**production + conservation = sustainability**' elaborating later '*sustainable land use is that which maintains an acceptable level of production and at the same time conserves the basic resources on which production depends, so enabling production to be maintained*'. This definition perfectly brings out the cyclic nature of sustainability that is so vital to the continuous functioning of Home Gardens.

Sustainability is a relatively new subject and has only recently become a focus of attention (Young 1989), thus, although many authors believe it is a feature of Home Gardens and diversity is a key contributing factor, there is even less quantification in the documentation of sustainability than there is for diversity (perhaps diversity is easier to quantify). The basis for the arguments of many authors that Home Gardens are sustainable often rests on the fact that the gardens have been functioning efficiently for years, even centuries (e.g., Jacob and Alles [1987] in Sri Lanka; and Okafor and Fernandes [1987] in Nigeria). Fernandes et al. (1984) note that in the Chagga gardens stability has existed for centuries and, although the recent cash crop element fails every three or four years, the system as a whole has never failed.

Several authors (e.g., Michon et al. 1983; Soemarwoto 1987) compare the structure of Home Gardens to that of natural forests and here, particularly, a link between diversity and sustainability is believed to exist, since natural tropical forests, which often have a great variety of species, seem to be extremely sustainable ecosystems.

What authors often fail to emphasise when celebrating the sustainability of Home Gardens, is that many are situated on fertile soils which are relatively easy to maintain and need little improvement, e.g., the volcanic soils of Java noted by

Wiersum (1982) and the deep alluvial soils high in organic matter in Chile (Altieri and Farrell 1984). Mention is usually only made of soils when they are poor. Wiersum continues, saying that, in Java, gardens hardly ever exist on tertiary soils. This observation is backed up by African examples; e.g., in Rwanda, competing species cause farmers' management problems in areas of poor soils, and in some places a continuous decline in soil fertility has been detected (Balasubramanian and Egli, 1986).

With these examples in mind, caution should be exercised in overgeneralising about the extrapolation of the Home Garden system to poor soils, e.g., Jacob and Alles (1987) believe there are good possibilities for making marginal lands in Sri Lanka more productive by means of the Home Garden system only on the basis of their observations of existing Home Gardens.

New gardens

Several articles deal with newly-established gardens. Boonkird et al. (1984) describe attempts to rehabilitate degraded lands in Thailand by granting shifting cultivators land for permanent gardens. However, only the briefest mention is made of difficulties encountered in establishment on poor soils or of previously mobile peoples creating a complex garden system—as Michon et al. (1983) suggest '*such systems demand a very refined knowledge in their establishment as well as in their management*'.

However, in a similar situation in the Philippines, Fujisaka and Wollenberg (1991) stress that farmers on new lands experienced considerable difficulties and passed through several experimental stages before settling for a Home Garden-type agroforestry solution. This article provides a comprehensive view of the trials involved in rehabilitating land.

Nair and Sreedharan (1986) report on the immediate success of a three-tier multicropped garden established on undeveloped arid land, and, on this basis, the authors recommend that this be used as a model for future development. On the evidence of the Philippines' example and a catalogue of failures recorded in Kerkhof's account (1990) of African projects, Nair and Sreedharan's results seem suspiciously straightforward since their statement is not backed up with sufficient evidence of other trials or research.

Changes and threats

Home Gardens have remained sustainable through the ability of farmers to adapt to new circumstances, and the fact that species alter without affecting the overall structure and productivity. But nowadays, with the increasing pressure to include cash crops in gardens, there is doubt whether the system is sufficiently flexible to accommodate these changes. One of the most useful accounts of change is Soemarwoto's article (1987) in which his stated objective is not only to describe the system but also to examine its potential for future development. He mentions current improvements but then lists a range of threats that result. These threats are nearly all connected with loss of species' diversity. He warns against concentrating only on the tangible economic and nutritional aspects at the expense of intangible ecological and social values. As a result, versatility is limited, genetic erosion sets in, losses to pests and diseases increase and soil erosion becomes a problem, exacerbated by a decline in mulching in response to the availability of chemical fertilizers.

Many sources (e.g., FAO 1986; Foley and Barnard 1984; Singh 1987) agree with this diagnosis and have similar examples of sustainability sacrificed to productivity. As an extreme example, in Nigeria, Okafor and Fernandes (1987) report that recent wealth acquired from the oil boom has led to some farmers clearing their gardens with bulldozers and substituting high-input monocropping. The result has been soil degradation, leading to lower yields than before. However, some systems have been adapted: e.g., in Kerala the large-scale introduction of cocoa to gardens in the 1970s was often replaced by fodder grasses, bananas and tuber crops when cocoa prices later dropped (Chacko 1991).

Wiersum (1982) emphasises the rapid changes occurring nowadays to which the previously flexible systems are failing to adjust. The main threat is from the pressures of population and modern agriculture. Increases in population have led to diminishing crop diversity as farmers' struggle to grow enough staple food crops, though they know diversity confers more advantages. At the same time agricultural development workers, often backed by the government or NGOs, are imposing their single component approach on many farmers and pressurising them to change over to monocropping. In Africa migration poses a major threat, e.g., in Uganda (Oduol and Aluma 1990) and the Chagga gardens (Fernandes et al. 1984). Young people are migrating so there will be no one left to inherit the traditional skills necessary to keep the complex Home Gardens operating.

Too often the crucial relationship between structure and function is ignored. However, both Soemarwoto (1987) and Michon et al. (1983) mention it: Soemarwoto explains that manipulation of structure can lead to unforeseen loss of valuable functions, and Michon et al. (1983) caution against the careless establishment of new dynamics in crop succession since this can lead to a failure of the whole system. Soemarwoto concludes that nowadays sustainability is being jeopardised, in turn putting future productivity at risk.

Conclusion

In the last decade, because of the resurgence of interest in small-scale farming, many authors have 'jumped on to the Home Gardens' bandwagon'. A wide range of literature has resulted. There are many articles that have taken one region, provided a description—often long and detailed, and useful as far as it goes, with lists, tables and diagrams of species—and then briefly concluded that gardens are good but need improvement. Some less useful articles have already been mentioned. Coverage of African gardens is disappointing (e.g., Oduol and Aluma [1990] on Ugandan gardens; and Fernandes et al. [1984] on the Chagga Home Gardens) as is Jacob's and Alles' (1987) article describing Kandyan gardens. Altieri and Farrell (1984) state at the beginning of their article that their scope is limited to description and therefore wisely do not attempt a discussion of more complex issues. Quantitative data are rare, though some sources, e.g., Soemarwoto (1987) do provide statistics. Discussion of interaction is also scanty.

In fact, overall, actual documented experimentation with quantitative data is scanty and most articles seem to reach their conclusion by observation followed by inference based on current theories (Forrester 1992). There may be several reasons for this: perhaps with little previous work done there are no examples to follow, perhaps it is because of the complexity of the systems or because there is inadequate appreciation among scientists of their importance and potential, or perhaps because agricultural researchers tend to be specialists, focusing on precise elements, thus missing the essence of Home Gardens.

Home Gardens are widespread throughout the tropical and subtropical world but are in general very thinly covered, particularly those in Indochina, the Pacific, and South and Central America. Indonesia dominates in the literature and has also produced some of the most impressive articles, all mentioned above. Apart from Soemarwoto's excellent account (1987), there are three other general articles, by Ninez (1987), Fernandes and Nair (1986) and Mergen (1987), which all provide a useful overview of gardens round the world. Ninez gives a broad view of tropical and temperate gardens, Fernandes and Nair (1986) examine diversity thoroughly with lists, tables and diagrams, and Mergen (1987), having summarised systems from different regions, stresses the importance of complex interactions and recommends a multidisciplinary approach to further research, emphasising indigenous knowledge.

However, whereas Ninez only describes her article as a 'framework', Fernandes and Nair claim to examine sustainability but can do no more than repeat the fact that Home Gardens have been producing sustained yields for centuries and draw the conclusion '*thus they are ecologically sound and biologically sustainable*'. This is typical of the majority of accounts that generally do not add anything new on sustainability; e.g., the summary of sustainability of Fernandes et al. (1984) is '*the system still appears to be working well with the majority of farmers*'. Many authors automatically conclude that diversity leads to an increase in sustainability, but this is almost never substantiated with scientific research, and, in the light of research such as that of Goodman (1975) casting doubt on the hypothesis that a greater number of interacting species provides a more stable balance in nature, it certainly should be. Soemarwoto (1987) admits that the ecological functions of Home Gardens have generally been taken for granted and, even after examining the evidence, recognises that he can say no more than '*it seems reasonable to conclude that Home Gardens are a sustainable production system*'.

Most authors see a promising future for Home Gardens — with reservations. On the evidence from natural forests and Home Gardens through history, it does seem likely that diversity contributes to sustainability. However, while research is required to establish this more precisely, more urgent research is needed into finding ways to increase production while maintaining diversity and long-term sustainability, perhaps in part by rehabilitating the traditional knowledge underlying the success of gardens up to now (Michon et al. 1983). Ninez (1987) holds that Home Gardens represent one of the last frontiers for increasing food production, and urges '*let the persistence of families all over the globe in growing their own food speak for itself*'.

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