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AN EVALUATION OF THE STRUCTURE AND FUNCTION OF TROPICAL HOMEGARDENS

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SUMMARY

Homegardens represent land-use systems 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. Known by different names in various places, these agroforestry systems are common in all ecological regions of the tropics and subtropics, especially in humid lowlands with high population density.

An analysis of the structural and functional aspects of 10 selected homegarden systems from different ecological and geographical regions shows that the average size of the homegarden units is less than 0.5 ha; yet they are composed of a larger number of woody and herbaceous species, carefully structured to form 3-5 vertical canopy strata, and each component having a specific place as well as function.

Food production is the primary function of most homegardens, a vast majority of them being subsistence production systems. While there is a remarkable similarity among the different homegardens with respect to the type and nature of the herbaceous crops, the nature of woody perennials vary depending on the environmental and ecological factors. In general, most woody components produce fruits or other types of food in addition to other outputs such as fuelwood, timber, etc. These various food products provide a substantial proportion of nutritive and calorific requirements of the local diet. Moreover, the species diversity and varying production cycles of the different components ensure a continuous production throughout the year from the homegarden unit.

Little or no research has been done to improve the homegarden systems. Structural complexity, species diversity, multiple output nature, tremendous variability from farm to farm etc. are some of the main characteristics that make the homegardens extremely difficult models to work with according to the currently available research procedures.

1. Introduction

Quite a lot has been written about the so-called "homegardens". Most of these are qualitative descriptions of traditional land use practices around homesteads. Numerous terms have been used by various authors to denote these practices. These include, for example, mixed-garden horticulture (Terra, 1954), mixed garden or house garden (Stoler, 1975), home-garden (Ramsay and Wiersum, 1976), Javanese homegarden (Soemarwoto et al., 1976), compound farm (Lagemann, 1977), kitchen garden (Brierley, 1985), household garden (Vasey, 1985), and so on. Various forms of Javanese homegardens dominate in most of the writings on the topic so that the Javanese words "pekarangan" and "Talun-kebun" are often used interchangeably with the word homegarden.

While it is true that the Javanese homegardens provide an excellent example to show the diversity and complexity of the structure and function of tropical homegardens, it is important to point out that there are also several other types of homegardens in other geographical locations too, each with its own characteristic features. In fact, homegardens can be found in almost all tropical and sub-tropical ecozones where subsistence land-use systems predominate.

The global inventory of agroforestry systems being undertaken by ICRAF since 1982 (Agroforestry Systems, (3), 269-272, 1982) has gathered and synthesized quite a substantial body of information on several types of traditional land-use systems that can collectively be called "homegardens". This paper aims at evaluating the structure and function of some of these selected traditional homegardens from different geographical regions, highlighting their special characteristics, similaries and merits.

2. Homegardens as an Agroforestry System

The definition of agroforestry as adopted by ICRAF, and now being almost unanimously accepted is as follows:

> Agroforestry is a collective name for land-use systems and technologies where woody perennials are deliberately used on the same land-management units as agricultural crops and/or animals, in either a spatial arrangement or a temporal sequence, there being both ecological and economical interactions between the different components (Lundgren and Raintree, 1983).

This definition implies that:

(i) agroforestry normally involves two or more species of plants (or plant and animals), at least one of which is a woody perennial (trees, shrubs, palms, bamboos, etc.);

(ii) an agroforestry system always has two or more outputs;

(iii) the cycle of an agroforestry system is always more than one year; and

(iv) even the most simple agroforestry system is more complex, ecologically (structurally and functionally) and economically, than a monocropping system.

Although the word 'homegarden' has been used rather loosely to describe such diverse practices as growing vegetables behind houses to complex multistoreyed systems, the word is used here to refer to "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". It can therefore be seen that the homegardens display many agroforestry concepts: the intimate mix of diversified agricultural crops and multipurpose trees fulfils most of the fundamental needs of the local populations and their multistoreyed configuration and high species diversity avoid the environmental deterioration commonly associated with monocultural production systems. Moreover, they have been producing sustained yields for centuries in a most resource-efficient way. Thus homegardens are economically efficient, ecologically sound and biologically sustainable agroforestry systems. According to the classification of agroforestry systems based on the nature and type of components (Nair, 1985), most homegardens are agrosilvopastoral systems consisting of herbaceious crops, woody perennials and animals; some are agrisilvicultural systems consisting of the first two groups of these components only.

3. Brief Description of Selected Tropical Homegardens

From the computerised data base (system register) of the earlier-mentioned AF Systems Inventory of ICRAF, we have selected 10 homegarden types representing diverse ecological and geographical regions for comparative evaluation. Data sheet of one of them is attached as Annexure I as an illustrative example (data sheets in respect of the rest of the systems mentioned here can be made available against specific requests: contact P.K.R. Nair, ICRAF).

The biophysical and socio-economic aspects of the selected homegardens are summarized in Table 1 and their major components as well as literature references in Table 2. Homegardens are found in

TABLE 1 BIOPHYSICAL AND SOCIO-ECONOMIC ASPECTS OF SELECTED TROPICAL HOME GARDENS

REGION	LOCAL NAME OF SYSTEM	LOCATION	POPULATION DENSITY (km^{-2})	ECOZONE	RAINFALL RANGE (mm)	ALTITUDE RANGE (m)	MEAN MANAGEMENT UNITS (ha)	RANGE OF MANAGEMENT UNITS (ha)	MARKET ORIENTATION
S.E. Asia	Pekarangan	Java, Indonesia	700	Humid lowlands		0-600	0.6	0.01-3.0	Subsistence/ Commercial (50:50)
	Home Gardens	Philippines	400	Subhumid to humid; mostly lowlands	1000-3000	0-1500	0.05	0.01-1.0	Subsistence with subsidiary commercial
Pacific	Home Gardens	South Pacific Islands	40	Humid lowlands	2000-2500	0-100	No Data	No data	Subsistence with subsidiary commercial
S. Asia	Kandy Gardens	Sri Lanka	500	Humid; medium altitude	2000-2500	400-1000	1.0	0.4-2.2	Commercial with subsidiary subsistence
	Compound Gardens	Kerala (S.W. Coast of India)	500	Humid lowlands to mid-altitudes	2000-2500	0-1000	0.5	0.1-4.0	Subsistence to commercial
Africa	Compound farms	S.E. Nigeria	500	Humid lowlands	2000-4000	0-300	0.5	0.2-3.0	Subsistence with subsid. commercial
	Chagga Home Gardens	Mt. Kilimanjaro N. Tanzania	500	Highlands	1000-1700	900-1900	0.68	0.2-1.2	Commercial with subsid. subsistence
	Ka/Fuyo Gardens	Mounde Region, Bourkina Faeso	50	Semi-arid to sub-humid lowlands	700-900	200-500	0.50	0.1-0.8	Subsistence
American Tropics	Huertos Familiares (Kitchen Gardens)	Tabasco, Mexico	(variable)	Humid lowlands	1500-5000	0-500	0.50	0.1-1.0	Subsistence
	Kitchen Gardens	Grenada, W. Indies	300	Humid lowlands	1500-4000	0-300	0.15	0.01-0.5	Subsistence subsid. commercial

TABLE 2 MAJOR COMPONENTS OF SELECTED TROPICAL HOME GARDENS

SYSTEM NAME	PLANT COMPONENTS						LIVESTOCK TYPES AND IMPORTANCE	MAJOR REFERENCES
	*Common no. of woody species reported		Herbaceous species reported		Major cash crops	Usual no. of vertical canopy strata		
	Total	Food-producing	Number	Major food crops				
Pekarangan (Java)	152	48	39	Upland rice, maize, vegetables, coconuts, fruit trees	Fruits and vegetables	5	Poultry, fish, goats sheep, cows, water buffalo - meat and manure	Soemarwoto et al. (1976) Stoler (1975) Michon et al (1983)
Home Gardens (Philippines)	34	28	40	Sweet potatoes, coconut, banana	Tomatoes, egg plant, squash peas, mango	4	Pountry, pigs meat	Sommers (1978)
Home Garden (Pacific)	53	35	19	Coconut, colocasia, yams, arrowroot	Coconut	4	No data	Barrau (1961)
Kandy Gardens (Sri Lanka)	18	15	11		Cloves, pepper, tea, coconuts	3	Poultry	McConnel et al. (1973)
Compound Gardens (S.W. India)	25	8	12	Tuber crops, upland rice, banana, vegetables	Coconut, arecanut, cacao, pepper, cashew, spices	4	Poultry (meat, eggs) cattle (milk)	Nair (1979)
Compound farms (S.E. Nigeria)	64	62	73	Yam, cocoyam, banana	Cola, oil palm	4	Goats, sheep, poutry, Tsetse constraint	Okafor and Fernandes, (1985)
Chagga homegardens (N. Tanzania)	53	13	58	Banana, beans, colocasium, xanthosoma, yams	Coffee (arabica) Cardamom	5	Cattle, goats, pigs, poultry for meat, milk and manure	Fernandes et al. (1984)
Ka/Puyo gardens (Bourkina Fasso)	7	5	7	Maize and red sorghum	Tobacco	2	Goats, sheep, poultry for manure and rituals	Savonnet (1959)
Huertas familiares (S.E. Mexico)	28	24	45	Maize, beans	Cacao	4	Pigs and poultry meat and manure	Gliessman et al (1981)
Kitchen gardens (Grenada)	24	21	37	Colocasia, Xanthosoma, yams, maize, pigeon peas	Banana, cocoa and nutmeg.	4	Poultry, pigs, sheep and goats for meat and cash	Brierley (1985)

* The numbers vary widely

most ecological regions of the tropics and subtropics, but a majority of them are in the lowland humid tropics. Similarly, except in the case of the Ka/Fuyo gardens of semi-arid Burkina Faso, and the homegardens in the Pacific islands, the population density is generally high in all selected homegarden areas. The Tables also show that in most cases, the average size of a homegarden (management unit) is much less than a hectare, indicating the subsistence nature of the practice. All homegardens contain some sort of food crops and many of the trees also produce fruits or other forms of food. This shows that the most important function of the homegardens is food production (see Section 5). However, there are also several secondary outputs from the homegarden. For example, in a recent study from Java, it was found (K.F. Wiersum: personal communication) that the homegardens provided 15-20% of the total fuelwood requirements of the local households. Indeed, it is only natural that a mixed stand of a large number of multipurpose species provide a variety of products. Environmental protection is also achieved through a multistoreyed plant configuration but it is often an effect of the homegarden system, and seldom a motivation for adopting the practices.

4. Structure of Homegardens

In spite of the very small average size of the management units, homegardens are characterized by a high species diversity and usully 3-4 vertical canopy strata (Table 2), thus indicating the intimacy of plant associations. Schematic presentations of canopy configurations of four common homegardens, redrawn from other reports, are presented as Fig. 1-4. Some woody and herbaceous species that are most commonly found and therefore characteristic of the systems, are also indicated in the drawings.

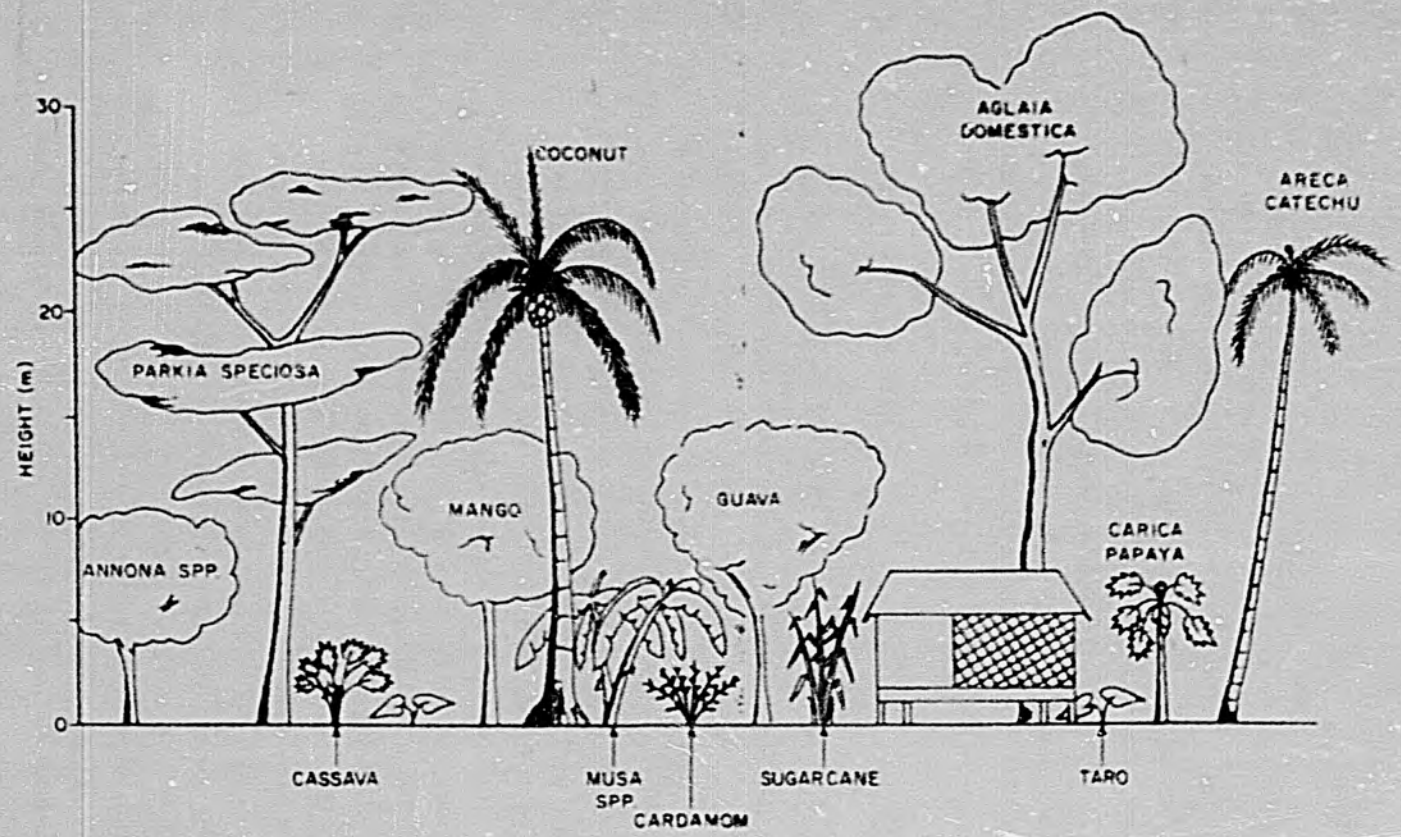


Fig. 1: Schematic representation of the structural composition of a Javanese homegarden (Pekarangan). Redrawn from Michon (1983).

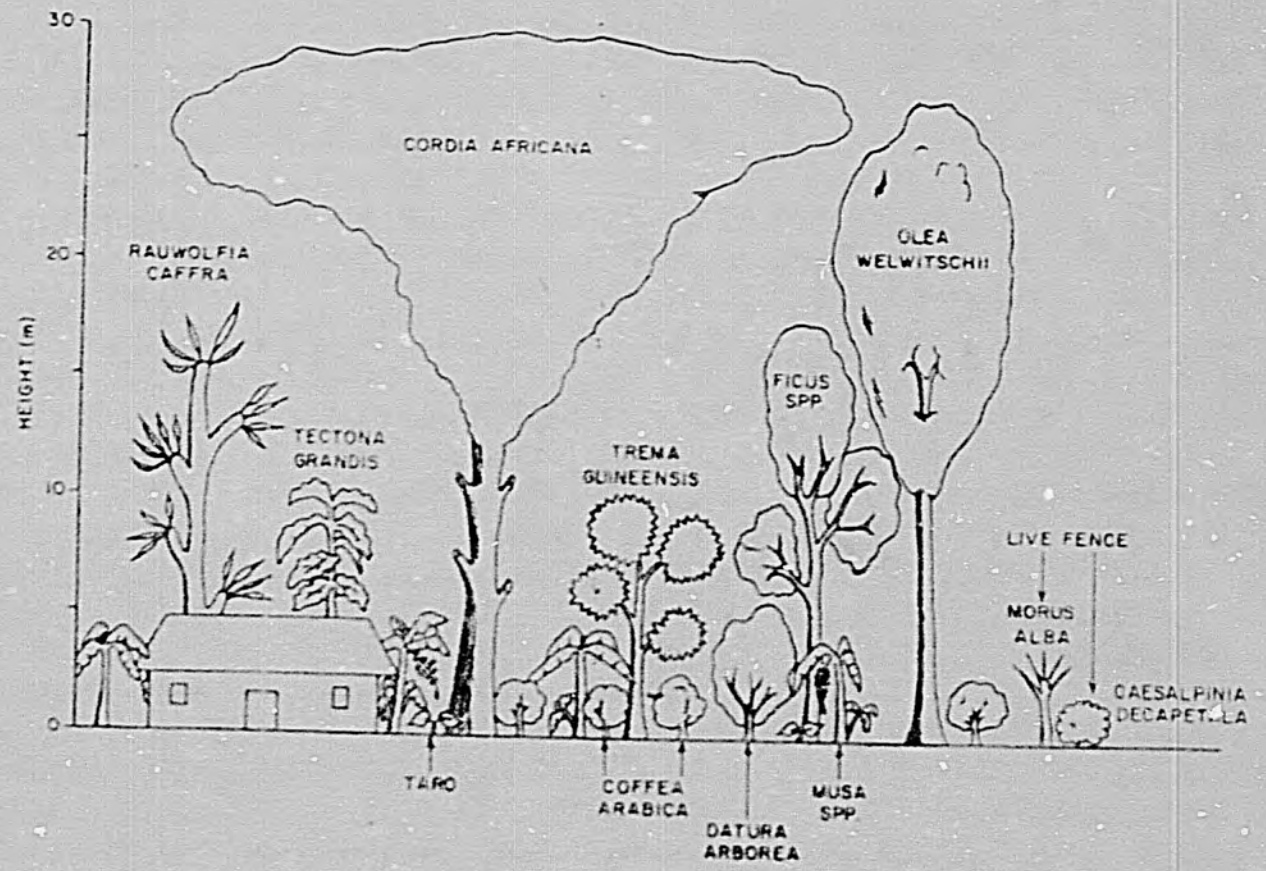


Fig. 2: Schematic representation of the structural composition of a Chagga homegarden in N.E. Tanzania. Redrawn from Fernandes *et al.* (1984)

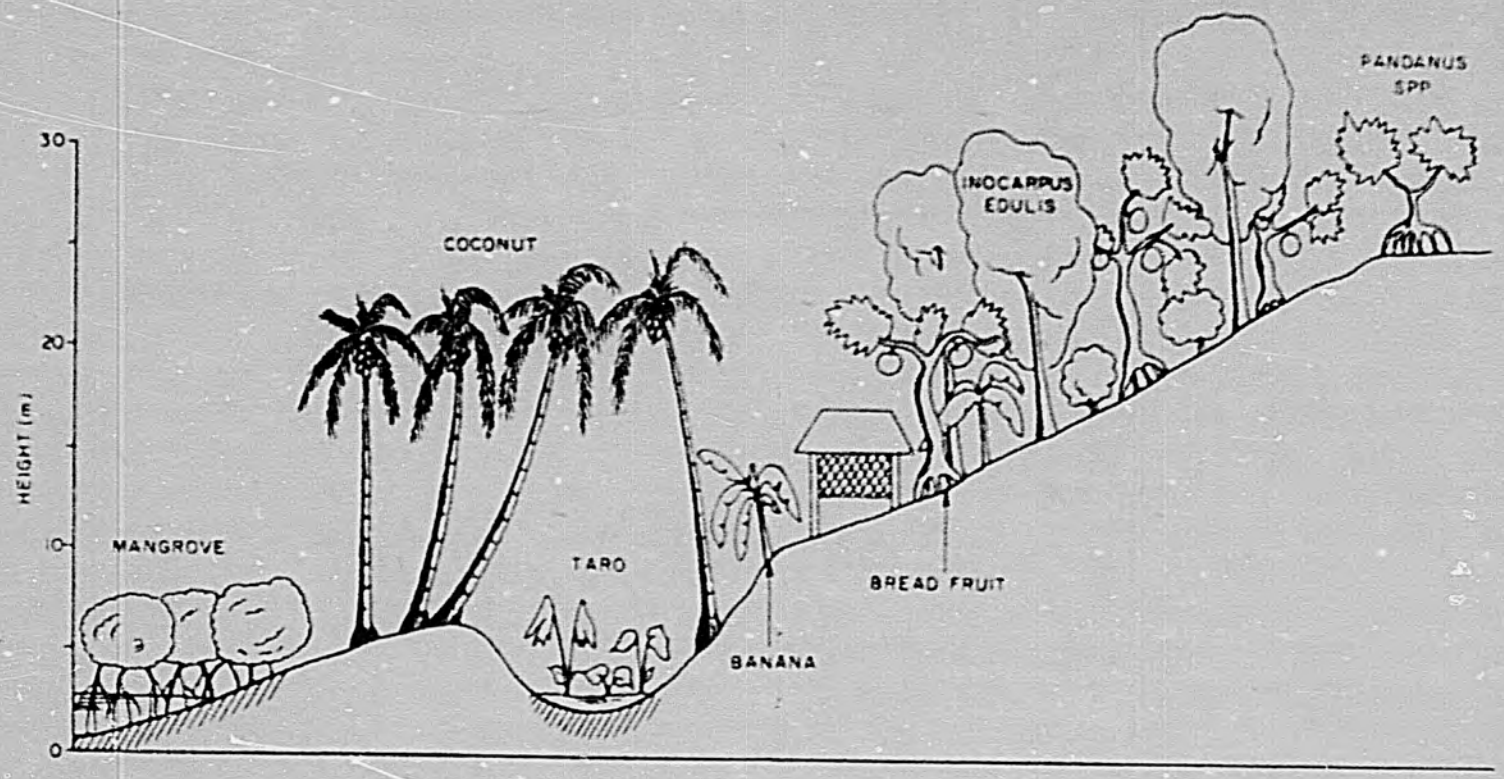
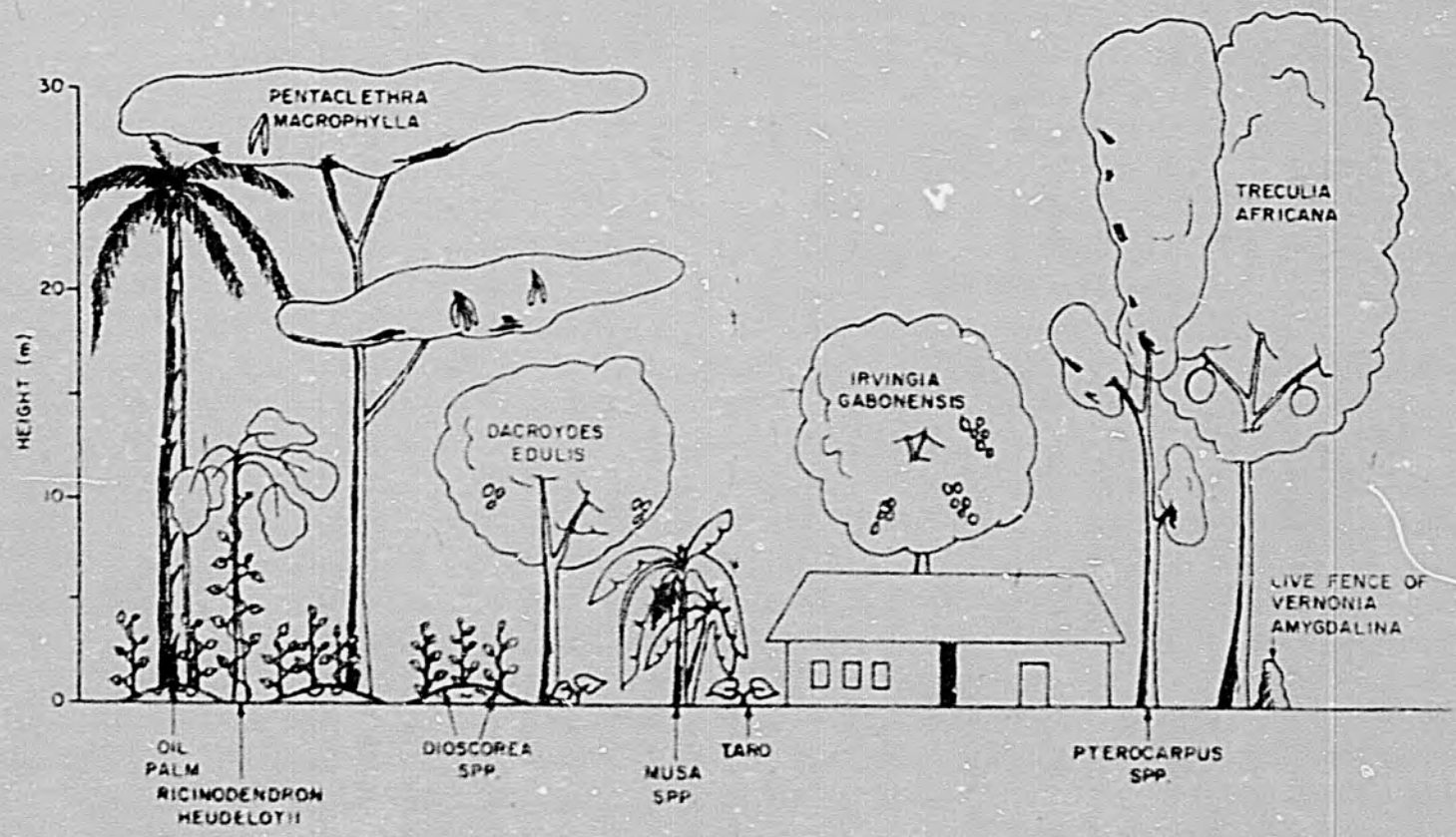


Fig. 3: Schematic representation of the structural composition of a homegarden in the Pacific Islands. Redrawn from Barrau (1961).



F g. 4: Schematic representation of the structural composition of a compound farm in S.E. Nigeria. Redrawn from Okafor and Fernandes (1986)

The layered canopy configurations and compatible species admixture are the most conspicuous characteristics of all homegardens. Contrary to the apparent appearance of random arrangement of species, the gardens are usually carefully structured systems with every component having a specific place as well as function. The Javanese pekarangan is a clean and carefully tended system just surrounding the house, where the plants of different heights and architectural types, though not planted in any apparently orderly manner, perfectly occupy the available space both horizontally and vertically (Wiersum, 1982; Soemarwoto et al., 1984). Michon (1983) reported from an analysis of the structure of pekarangan in Citarum watershed in West Java a five-layered canopy structure, where the lower layer of less than 1 m contained 14% of the total volume of canopies, second layer of 1-2 m - 9%; 2-5 m - 25%, 5-10 m -36% and more than 10 m 16%. The Pacific island homegardens present a more clearly-defined spatial arrangement of species following the orientation and relief characteristics of the watershed. The West African compound farms (Okafor and Fernandes, 1986) are characterized by a four-layer canopy dominated by a large number of indigenous tall-growing fruit trees, and an architectural analysis of the canopy will reveal a relatively higher percentage of canopy distribution in the upper strata. The Chagga homegardens (Fernandes, et al. 1984) are essentially a commercial system based on arabica coffee and banana, so that the coffee/banana layers which constitute the second and third canopy strata from the ground seem to take dominance in terms of total volume over the others.

In general terms, all homegardens consist of a herbaceous layer near the ground, a tree layer at upper levels and an intermediate layer in between. The lower layer can usually be partitioned into two, the lower most being at less than 1.0 m in height, dominated by different vegetables and medicinal plants, and the second layer of 1.0 - 3.0 m height being composed of food plants such as cassava, banana, papaya, yams and so on. The upper tree layer can also be divided into two, consisting of emergent, fully-grown timber and fruit trees occupying the upper most layer of over 25 m height, and medium-sized trees of 10-20 m occupying the next lower layer. The intermediate layer of 5-10 m height is dominated by various fruit trees, some of which are still growing taller. This layered structure is never static; the pool of replacement species make the producing structure always dynamic, the overall structure and functions yet being maintained.

Practically very little has been reported about the rooting patterns and configurations in the multispecies homegardens. From a planted multistorey crop combination involving coconut, cacao, black pepper and pineapple, Nair (1979) found that the horizontal and vertical distributions of the root systems involved little or no overlapping. In homegardens, a dynamic equilibrium can be expected to be operational with respect to organic matter and plant nutrients on the garden floor because of continuous addition of leaf litter and its constant removal through decomposition. Consequently accumulation of absorbing roots of all species is to be expected at or near the soil surface. However, at lower depths in the soil, the root distribution of various species is likely to be such that there will be defined vertical rooting configuration roughly proportional to the canopy layers. However this remains a point, and an important one too, for further investigation.

5. Species Composition viz-a-vis Food Production from Homegardens

The magnitude and rate of output of products as well as the ease and rhythm of maintenance of the homegarden systems depend upon their species composition. Although the choice of species is determined to a large extent by environmental and socio-economic factors as well as dietary habits and market demands of the locality, there is a remarkable similarity with respect to species composition among different homegardens in various places. Table 3 lists the various species found commonly in the 10 selected homegardens.

The most remarkable similarity among the different homegardens from diverse ecological and socio-economic background is with respect to the species composition of the herbaceous components. This is so because, as mentioned earlier, food production is the predominant role of most species, especially the herbaceous ones, in almost all these systems. Tuber crops such as taro, cassava, yams, sweet potato, etc. can replace the basic staples of cereals on the one hand, and can be grown with relatively less care as understorey species in partial shade and yet be expected to yield reasonable levels of carbohydrate-rich produce on the other.

A conspicuous character of the tree crop components of the homegardens is the predominance of fruit trees, and other food-producing trees. Apart from providing a steady supply of various types of edible products, these fruit-and-food trees also combine well -- biologically and environmentally -- with other components of the system (Nair, 1984). While the fruit trees such as guava, rambutan, mango, mangosteen and so on along with other food

Table 3 Woody Perennials

	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPP	NIGERIA	SRILANKA	TANZANIA	INDIA
Acacia albida	•									
Achvranthes aspera									•	
Acioa barterii							•			
Adansonia digitata	•									
Adhatoda vasica										•
Agauria salicifolia									•	
Ailanthus triphysa										•
Alangium chinense									•	
Albizia petersiana									•	
Albizia schimperiana									•	
Albizia spp.							•			
Aleurites moluccana			•		•					
Anacardium occidentale		•	•	•	•	•				•
Annona cherimola					•					
Annona muricata		•	•	•	•		•		•	
Annona reticulata		•	•		•	•				
Annona squamosa		•		•	•	•				
Anthonontha macrophylla							•			
Antidesea bunius			•							
Antidesma sp.					•					
Areca catechu						•		•		•
Artocarpus altilis		•			•	•		•		•
Artocarpus chaplenden			•							
Artocarpus communis				•						
Artocarpus heterophyllus						•		•	•	•
Artocarpus hirsuta										•
Artocarpus incisa							•			•

Woody Perennials	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPP	NIGERIA	SRILANK	TANZANIA	INDIA
Artocarpus integra			•		•					
Artocarpus rigida			•							
Averrhoa bilimbi			•			•				•
Averrhoa carambola			•		•	•				
Azadirachta indica							•			
Baccaurea dulcis			•							
Baccaurea motleyana			•							
Baccaurea racemosa			•							
Bambusa spp.										•
Baphia nitida							•			
Barringtonia edulis					•					
Berlinia grandiflora							•			
Bersama abyssinica									•	
Bixa orellana				•						
Bombax malabaricum										•
Bouea macrophylla			•							
Brachystegia eurycoma							•			
Bridelia micrantha									•	
Butyrospermum parkii	•									
Byrsonima crassifolia				•						
Caesalpinia decapetala									•	
Cajanus cajan		•		•		•				
Calpurnia aurea									•	
Camellia sinensis								•		
Canarium dustum						•				
Canarium spp.			•							
Carica papaya		•	•	•		•	•	•	•	•

Woody Perennials	BURKINA	SRENADA	JAVA	MEXICO	PACIFIC	PHILPP	NIGERIA	SRILANK	TANZAN	INDIA
Carvota urens								•		
Cassia alata							•			
Cassia didmvobotrya									•	
Cassia floribunda									•	
Ceiba pentandra	•						•			
Chlorophora excelsa							•		•	
Chrysophyllum albidum		•					•			
Chrysophyllum cainito				•		•				
Cinamomum zeylanicum		•						•		
Citrus aurantifolia		•	•				•			
Citrus aurantium				•						
Citrus grandis				•		•		•		
Citrus limon			•	•		•		•	•	
Citrus maxima			•							
Citrus medica		•								
Citrus microcarpa						•				
Citrus nobus						•				
Citrus paradisi		•						•		
Citrus reticulata		•	•				•			
Citrus sinensis		•					•		•	
Citrus spp.										•
Coccoloba uvifera					•					
Cocos nucifera		•		•	•	•		•		•
Coffea arabica				•		•			•	
Coffea liberica							•			
Coffea robusta								•		
Cola acuminata							•			

Woody Perennials	BURKINA	SRENADA	JAVA	MEXICO	PACIFIC	PHILPP	NIGERIA	SERLANK	TANZAN	INDIA
Cola lepidota							•			
Cola milleni							•			
Cola nitida							•			
Cola pachycarpa							•			
Colocarpum sapotosum				•						
Cosmiphora zimmermannii									•	
Cordia abyssinica									•	
Cordia subcordata					•					
Crataeva speciosa					•					
Crescentia cujete							•			
Croton macrostachys									•	
Cussonia holstii									•	
Cynometra cauliflora			•							
Dacryodes edulis							•			
Datura arborea									•	
Dialium guineense							•			
Dialium indum			•							
Diospyros discolor			•			•				
Diospyros mespiliformis									•	
Dracena afromontana									•	
Dracena arborea							•			
Dracena vanni							•			
Dracontomelon vitiense					•					
Durio zibethinus			•					•		
Ehretia cymosa									•	
Elaeis guineensis							•			
Elaeocarpus serratus										•

Woody Perennials	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPP	NIGERIA	SRILANK	TANZAN	INDIA
Elettaria cardamomum									•	
Emblica officinalis										•
Eriobotyra japonica									•	
Erythrina abyssinica									•	
Erythrina indica										•
Eucalyptus camaldulensis									•	
Eucalyptus citriodora									•	
Eucalyptus grandis									•	
Eucalyptus robusta									•	
Eucalyptus saligna									•	
Euclea divinorum									•	
Eugenia aquea			•							
Eugenia javanica			•							
Eugenia malaccensis			•		•					
Eugenia polycephala			•							
Eugenia sp.							•			
Ficus exasperata									•	
Ficus gnaphalocarpa	•									
Ficus natalensis									•	
Ficus spp.							•			
Ficus vallis-choudae									•	
Flacourtia indica			•							
Flacourtia inermis			•							
Flacourtia rukam			•							
Fortunella japonica					•					
Garcinia cola							•			
Garcinia dulcis			•							

Woody Perennials	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPP	NIGERIA	SRILANK	IAWZAN	INDIA
Garcinia eangostana			•					•		
Gliricidia sepium										•
Gnetum africanum							•			
Gnetum gnemon			•							
Grevillea robusta									•	
Grewia pooulifolia					•					
Hevea brasiliensis				•				•		
Holsundia opposita									•	
Iboza riparia									•	
Inga jinicuil				•						
Inocarpus edulis			•		•					
Irvingia gabonensis var excelsa							•			
Irvingia gabonensis var gabonensis							•			
Jacaranda acutifolia									•	
Jatropha curcas							•		•	
Jatropha gossypiifolia							•			
Kigelia africana							•		•	
Lansium domesticum			•			•				
Lantana camara									•	
Leucaena leucocephala				•						
Litchi chinensis						•				
Lucuma nervosa						•				
Macaranga peltata										•
Mangifera caesia			•							
Mangifera indica		•		•		•	•	•	•	•
Mangifera odorata			•							
Manilkara achras		•	•	•		•				•

Wood/ Perennials	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPPINES	NIGERIA	SRILANKA	TANZANIA	INDIA
Margaritaria discoidea									•	
Marilkara kauki			•							
Markhamia platycalyx									•	
Monodora myristica							•			
Morinda citrifolia					•					
Moringa oleifera					•	•				•
Morus alba			•						•	
Musanga cecropicides							•			
Mutingia calabura				•	•					
Myrica salicifolia									•	
Myristica fragrans		•						•		
Napoleona imperialis							•			
Nephelium lappaceum			•					•		
Nephelium longana			•							
Nephelium mutabile			•							
Newbouldia laevis							•			
Newtonia buchananii									•	
Nicotiana tabacum										
Olea capensis									•	
Pandanus tectorius					•					
Pangium edule			•							
Parkia biglobosa	•									
Parkia speciosa			•							
Passiflora quadrangularis			•							
Passiflora laurifolia			•							
Pennisetum acidula					•					
Pentaclethra macrophylla							•			

Woody Perennials	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPP	NIGERIA	SRILANK	TANZAN	INDIA
Persea americana		•		•		•	•	•	•	
Persea gratissima			•							
Phyllanthus acidus			•							
Pisonia dioica		•		•						
Piper betle					•					
Piper methysticum					•					
Piper nigrum								•		•
Pithecellobium dulce			•			•				
Pithecellobium lobatum			•							
Poneria pinnata					•					
Psidium guajava		•	•	•	•	•	•		•	•
Pterocarpus osun							•			
Pterocarpus santalinoides							•			
Pterocarpus soyauxii							•			
Punica granatum			•					•		•
Raphia sp.							•			
Rauwolfia caffra									•	
Ricinidendron heudelotii							•			
Rothmania spp.							•			
Rubus steudneri									•	
Salacia edulis			•							
Sandoricum koetjape			•			•				
Sorindeia madagascariensis									•	
Spathodea campanulata							•			
Spondias cytherea			•							
Spondias dulcis		•			•					
Spondias mombin							•			

Woody Perennials	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPPINES	NIGERIA	SRI LANKA	TANZANIA	INDIA
Spondias purpurea				•						
Spondias sp.										•
Synadenium volkensii										
Syzigium aromaticum		•						•		
Syzigium cumini						•	•			•
Syzigium jambos					•					
Syzygium aromaticum										•
Tabernaemontana usambarensis									•	
Talisia olivaeformis				•						
Tamarindus indica	•	•	•		•	•				•
Telfaria pedata									•	
Tephrosia vexillata									•	
Terminalia catappa					•					
Tetracarpidium conophorum							•			
Theobroma bicolor				•						
Theobroma cacao		•		•		•	•	•		
Treculia africana							•			
Trema orientalis									•	
Trichilia emetica									•	
Turrisea robusta									•	
Uvarria sp.									•	
Vanqueria madagascariensis									•	
Vernonia subuligera									•	

Table 3 cont'd

Herbaceous Plants	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILPP	NIGERIA	SRILANK	TANZAN	INDIA
Abelmoschus indica			•							
Acalypha indica			•							
Alium cepa		•								
Allium cepa				•		•		•	•	•
Allium sativum				•		•		•		
Alocasia macrorhiza			•							
Alocasia macrorrhiza					•					
Aloe volkensii									•	
Amaranthus dubius									•	
Amaranthus hybridus							•			
Amaranthus spp.			•							
Amaranthus viridis							•			
Ananas comosus								•		
Ananas comosus		•		•		•	•			•
Arachis hypogaea						•	•	•		
Basella alba						•				
Benincasa hispida			•			•				
Brachiaria miliformis								•		
Brasica oleiacea		•								
Brassica chinensis						•				
Brassica oleracea				•					•	•
Canavalia ensiformis			•	•						
Capsicum								•		
Capsicum annuum			•	•		•				
Capsicum frutescens			•			•	•		•	•
Capsicum sp.		•								
Celosia spp.			•							

Herbaceous Plants	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPPINES	NIGERIA	SRI LANKA	TANZANIA	INDIA
Cissus discolor			•							
Citrullus vulgaris				•						
Clerodendron serratum			•							
Cnidoscolus chayamansa				•						
Coleus aromaticus			•							
Colocasia esculenta		•	•	•	•	•		•	•	
Colocasia sp.	•									
Commelina latifolia									•	
Corchorus olitorius						•	•			
Coriandum sativum				•						
Cosmos spp.			•							
Crotolaria mayshrensis				•						
Cryptosperma chamissonis					•					
Cucumis melo		•		•						
Cucumis sativus				•						
Cucurbita maxima						•				
Cucurbita moschata			•							
Cucurbita pepo				•			•			
Cucuma longa							•	•		
Cymbopogon citratus				•						
Daucus carota		•								
Dicliptera chinensis			•							
Dioscorea bulbifera									•	
Dioscorea alata				•	•	•	•		•	
Dioscorea bulbifera					•		•			
Dioscorea cayenensis							•			
Dioscorea dumetorum							•			

Herbaceous Plants	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPP	NIGERIA	SRILANK	TANZAN	INDIA
Dioscorea esculenta					•		•			
Dioscorea flabellifolia					•					
Dioscorea hispida					•					
Dioscorea nummularia					•					
Dioscorea pentaphylla					•					
Dioscorea rotundata							•			
Dioscorea spp.		•						•		
Dolichos lablab			•			•				
Eleusine coracana								•		
Eleusive africana									•	
Eleusive coracana									•	
Eleusive indica									•	
Eryngium sp.				•						
Galinsoga parviflora									•	
Glycine max								•		
Helichrysum spp.									•	
Hibiscus abelmoschus		•								
Hibiscus cetveldianus			•							
Hibiscus esculentus						•	•			•
Hibiscus manihot					•					
Hibiscus sabdariffa			•	•		•				
Impatiens kilimanjari									•	
Ipomea batatas		•		•	•	•	•		•	
Ipomea reptans			•							
Jatropha curcas			•							
Justicia insularis							•			
Lactuca sativa		•								

Herbaceous Plants	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPP	NIGERIA	SRILANK	TANZAN	INDIA
Lagenaria leucantha			•							
Lagenaria spiceraria						•				
Lufa acutanqula			•							
Lufa cylindrica			•							
Luffa cylindria						•				
Lycoperscicon esculentum									•	
Lycopersicon esculentum		•		•		•	•			•
Manihot esculenta		•		•	•	•	•		•	•
Momordica charantia			•			•				
Mucuna urens							•			
Musa nana					•				•	
Musa paradisiaca					•		•		•	
Musa sapientum					•		•			
Musa spp.	•	•		•		•		•		•
Musa troglodytarum					•					
Myristica fragrans										•
Nicotiana tabacum	•									
Ocimum basilicum				•			•			
Ocimum gratissimum							•			
Ocimum suave									•	
Oryza sativa							•	•		
Pachyrrhizus erosus						•				
Passiflora edulis				•				•	•	
Pennisetum purpureum							•			
Phaseolus aureus						•				
Phaseolus lunatus			•			•	•			
Phaseolus vulgaris	•	•		•				•	•	•

Herbaceous Plants	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPP	NIGERIA	SRILANKA	TANZANIA	INDIA
Pisum sativum									+	
Psophocarpus tetragolobus								+		
Psophocarpus tetragonolobus			+			+				
Raphanus sativus				+		+				
Ricinus comeunis			+				+		+	
Saccharum edule		+			+					
Saccharum officianarum							+			
Saccharum officinarum									+	
Sechium edule			+	+						
Senecio kilimandsharica									+	
Sesamum indicum							+			
Sesamum orientale				+						
Solanum incanum									+	
Solanum macrocarpon							+			
Solanum melongena						+				+
Solanum nigrum			+			+			+	
Solanum sp.							+			
Solanum torvum			+							
Sorghum sp.	+									
Sorghum vulgare							+			
Sphenostylis stenocarpa							+			
Tacca leartopetaloides					+					
Telfarium triangulare							+			
Trichosanthus anguina			+							
Triosacum laxum									+	
Vernonia amygdalina							+			
Vetiveria zizanoides									+	

Herbaceous Plants	BURKINA	GRENADA	JAVA	MEXICO	PACIFIC	PHILIPP	NIGERIA	SRILANK	TANZAN	INDIA
Vigna radiata								•		
Vigna sinensis				•		•				
Vigna unguiculata		•					•	•	•	
Ianthosoma sagittifolium		•		•	•		•	•		
Ianthosoma sp.	•									
Ianthosoma violaceium					•					
Zea mays	•	•		•		•	•	•	•	
Zingiber officinale			•					•		•
Zingiber officinale							•			

producing trees such as Moringa sp. and Sesbania grandiflora dominate the Asian homegardens, indigenous trees that produce leafy vegetables (Pterocarpus spp.), fruit for cooking (Dacroydes edulis), condiment (Pentaclethra macrophylla), and so on, dominate the West African compound farms. These various food crops from the home gardens may provide a substantial proportion of the calorific and nutritive requirement of the local diet. For example, Terra (1953) and Stoller (1975) reported that the Javanese homegardens provided more than 40 per cent of the whole calorific requirement of the local farming communities. Similarly, from a survey of 40 households of the Philippines homegardens, Sommers (1978) found that nearly all the households could meet the recommended daily requirement for Vitamin A, Vitamin C, iron and calcium; over half could obtain a sizeable contribution towards their thiamine, riboflavin and niacin requirements and one in four households could meet their protein and energy requirements, with the outputs and resources from the homegardens. Okafor (1981) reported from an analysis of the edible parts (fruits, seeds, nuts) of some trees in the compound farms in southeastern Nigeria, most of them contained substantial quantities of fat and protein. He found that seeds of Irvingia gabonensis, nuts of Tetracarpidium conophorum and fruit pulp of Dacroydes edulis are rich (44-72%) in fat, whereas nuts of T. conophorum and Pentaclethra macrophyllla contain high quantities (15-47%) of protein. Food production is, thus, the primary function and role of most, if not all, of the homegardens. The Chagga homegardens where arabica coffee is the most dominant crop is perhaps the only exception. Even in that case, the system evolved as a subsistence food production system and it remained so until coffee was introduced as a commercial component by the European settlers around the year 1890. However the system has not lost its food-production objective because the farmers maintain a sort of careful balance between coffee and food crops (banana, vegetables, and tubers) and switch over from one to the other depending upon the market price of coffee and demand for food.

Another aspect of the important role of food production in homegardens is the maintenance of almost continuous production throughout the year from the Unit. The combination of crops with different production cycles and rhythms is such that such an uninterupted supply of food products is maintained. Depending upon the climate and other environmental characters, there may be some peak and slack seasons for harvesting the various products, but in a general sense, there is something to harvest daily from most homegardens. Most of this production is for home consumption, but any marketable surplus can provide a safeguard against failure of, as well as, a security for the interval between the harvests of other agricultural crops of the homegardens (rice in Java and Sri Lanka, coffee and maize in Tanzania, coconut and rice in S.W. India and so on). All these harvesting and other upkeep operations require only a relatively small amount of working time of the members of the family.

6. Research on Homegarden Systems

Almost all the homegarden system have evolved over time under the influence of resource constraints (population pressure and consequent reduction in available land, capital and labour) or physical limitations (remoteness of the area forcing the inhabitants to produce most of their basic needs by themselves, lack of adequate market outlets compelling the farmers to produce something of everything they can use but not sell). Scientific attention has seldom been given to improve these traditional systems. Scientists who are not familiar with the system do not realize the importance and potential contribution of these systems in the framework of agricultural or agroforestry development. Some others, who are under the influence of the traditional outlook of monocultural systems of agriculture or forestry consider the homegardens to be very specialized systems adapted to subsistence land use, or structurally too complex to be suitable as a model to work with. The group of

scientists who have persona experience with such systems recognize the importance of detailed investigations and appreciate the value of the systems and the wealth of information they can provide in understanding the behaviour of plants grown in intimate proximity. Some initiatives have been reported from a few places mainly as a result of the enthusiasm of this last category of scientists: for example, the mixed garden trials in Sri Lanka (Bavappa and Jacob, 1982; improvement and distribution of indigenous tree species for compound farms in Nigeria (J. Okafor, pers. communication). However, such efforts are usually ad hoc and sporadic in nature and therefore they lack the much-needed coordination and continued fellow-up.

Homegardens are very complex systems with very sophisticated structure and a large number of components. Researchers are, by and large, specialists in a discipline or a commodity. Farmers who practise homegarden 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 specialized entity in itself. These contradictions and conditions are the main impediments to any concerted actions on coordinated research on homegardens. Yet these important systems, that have hitherto been ignored by the scientific and development community deserve more serious attention. A large number of research topics can quickly be listed, but that will be of little value unless there is a strong will and persuasion on the part of the policy makers to support and motivate research efforts of deserving magnitude on these traditional systems.

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AGROFORESTRY SYSTEM DESCRIPTION

CODE NUMBER:0017/ECMF

SOURCE:Okafor, J. C. and Fernandes, E. C. M. (1985) [site specific].

SYSTEM NAME:Compound farms (homegardens): multistoried agroforestry system in the humid zone of S. E. Nigeria.

EXTENT OF SYSTEM:To be assessed

MEAN MANAGEMENT UNIT:0.4 Ha

RANGE OF MANAGEMENT UNIT:0.2 - 2.0 Ha

COMPONENTS OF ASSOCIATION:Natural woody vegetation, Field crops (perennial, seasonal) and livestock.

AGROFORESTRY PRACTICES:mp trees on cropland/mp trees around homesteads/fodder t rees/fuelwood trees/lots/ trees sheltering crops/ trees sheltering animals/ trees sheltering homesteads/live fen ces/tree garden/apiculture with trees/soil conservation

GEOGRAPHICAL LOCATION

AFSI REGION:Africa (E. C & W)

COUNTRY: Nigeria

PROVINCE: Anambra state, south eastern Nigeria

AREA:Enugu

LATITUDE: 06.4 N

LONGITUDE:007.5 E

ALTITUDE: 300 m

BIOPHYSICAL DATA

KOPPEN CLASS:Humid tropics, permanent

MEAN ANNUAL RAINFALL:1500 - 1600 mm

MEAN ANNUAL TEMPERATURE:No data

LANDFORM: Flat/gently sloping

DRAINAGE: Well drained

SOIL TYPES:

SOIL NAME:Orthic ferralsols

RAINFALL REGIME:Unimodal, high sun

GENERALIZED CLIMATE:Humid tropics

NATURAL VEGETATION TYPE:Rainforest (now derived savanna)

PRIMARY LAND USE KEYWORDS:Rotational (shifting cultivation)

DERIVED LAND USE KEYWORDS:Complex cropping (mixed)

SOCIAL ECONOMIC DATA

MARKET ORIENTATION:Subsistence with subsid commercial

NUMBER OF PEOPLE INVOLVED:No data

POPULATION DENSITY:> 500 per Sq.Km

ETHNIC GROUP:Ibo

DOMINANT RELIGION:Christianity

LAND AVAILABILITY:Scarce

LAND TENURE TYPE:Freehold

MARKET FACILITIES:Excellent

CREDIT FACILITIES:Good

INFRASTRUCTURE:Excellent

COOPERATIVES:Present

CAPITAL INTENSITY:Low

LABOUR INTENSITY:High

MECHANIZATION LEVEL:Hoe & spade

INPUT INTENSITY:Low

SYSTEM OUTPUTS:Yams, cocco yam,maize,beans,vegetables,fruits

MAJOR INPUTS:

LAND OPERATION:Landholders

STATUS:Locally evolved/established

INCENTIVES TO PARTICIPATE:

COMPONENT ARRANGEMENT

DOMINANT FEATURE:Space

ARRANGEMENT OF WOODY PERENNIAL-HERB SPECIES IN TIME:Interpolated

HORIZONTAL ARRANGEMENT OF WOODY PERENNIAL-HERB SPECIES:Mixed, dense

VERTICAL ARRANGEMENT OF WOODY PERENNIAL-HERB SPECIES:More than three layers

ARRANGEMENT OF WOODY-WOODY SPECIES IN TIME:Overlapping

HORIZONTAL ARRANGEMENT OF WOODY-WOODY SPECIES:Mixed

VERTICAL ARRANGEMENT OF WOODY-WOODY SPECIES:More than three layers

HERB-HERB ARRANGEMENT IN TIME:Overlapping

HERB-HERB HORIZONTAL ARRANGEMENT:Mixed

HERB-HERB VERTICAL ARRANGEMENT:More than three layers

WOODY-ANIMAL ARRANGEMENT DOMINANT FEATURE:Space

WOODY-ANIMAL ARRANGEMENT IN TIME:Interpolated

LOCATION OF WOODY SPECIES:Inside animal management unit

HORIZONTAL ARRANGEMENT OF WOODY SPECIES:Mixed

VERTICAL ARRANGEMENT OF WOODY SPECIES:More than three layers

ANIMAL FEED METHOD:Grazing, zero-grazing

SPECIES DETAILs

TYPE	COMMON NAME	SCIENTIFIC NAME	USES/FUNCTIONS
Natural woody vegetation	Oil palm	*Elaeis guineensis*	/food oil/beverage/building material/
Natural woody vegetation	African pear	*Dacryodes edulis*	building material/food fruit/feed leaves/feed s eds/
Natural woody vegetation	African mango	*Irvingia gabonensis v. gabonen*	feed seeds/food fruit/food oil/beverage/
Natural woody vegetation	African mango	*Irvingia gabonensis v. excelsa*	beverage/food oil/food condiment/
Natural woody vegetation	African breadfruit	*Treculia africana*	food condiment/food seeds/fuelwood/poles/pulp/w ndbreak/
Natural woody vegetation	Oil bean tree	*Pentaclethra macrophylla*	windbreak/food condiment/feed leaves/fuelwood/li ve support/soil conservation/
Natural woody vegetation	Star apple	*Chrysophyllum albidum*	soil conservation/food fruit/tool & utensils/rit ual/
Natural woody vegetation		*Ricinodendron heudelotii*	ritual/live support/feed leaves/

Natural woody vegetation		*Tetracarpidium conophorum*	feed leaves/food nuts/
Natural woody vegetation	Hog plum	*Spondias mombin*	food fruit/feed leaves/boundary marker/
Natural woody vegetation	—	*Newbouldia laevi*	crop shade/ritual/boundary marker/
Natural woody vegetation		*Pterocarpus milbraedii*	food vegetable/dye/
Natural woody vegetation		*Pterocarpus santalinoides*	food vegetable/
Natural woody vegetation		*Pterocarpus soyauxii*	food vegetable/dye/
Natural woody vegetation		*Pterocarpus osun*	food vegetable/dye/
Natural woody vegetation	Bitter cola	*Garcinia cola*	food nut/
Natural woody vegetation		*Erythrophleum suaveolens*	soil conservation/fish poison/
Natural woody vegetation	Raphia palm	*Raphia hookerii*	beverage/thatching/
Natural woody vegetation	African nutmeg	*Monodora myristica*	food spices/ornamental/
Natural woody vegetation		*Saba florida*	food fruit/food condiment/
Natural woody vegetation		*Afzelia africana*	feed leaves/food condiment/
Natural woody vegetation		*Uraria chanae*	food nuts/feed leaves/
Natural woody vegetation		*Xylopia parviflora*	food spices/
Natural woody vegetation		*Vitex doniana*	food fruit/food vegetable/
Natural woody vegetation		*Artocarpus communis*	food fruit/
Natural woody vegetation	Velvet tamarind	*Dialium guineense*	food fruit/timber/feed leaves/tools & utensils/charcoal/
Natural woody vegetation		*Parkia biglobosa*	food fruit/food condiment/
Natural woody vegetation		*Afzelia bella v. bella*	food vegetable/feed leaves/
Natural woody vegetation		*Acioa barterii*	feed leaves/tools & utensils/live support/soil conservation/live fence/
Natural woody vegetation		*Basquea angolensis*	food nuts/feed leaves/
Natural woody vegetation		*Desmodium velutinum*	food vegetable/feed leaves/
Natural woody vegetation		*Vernonia amygdalina*	food vegetable/live fence/
Natural woody vegetation	Cola nut	*Cola acuminata*	food nut/ritual/
Natural woody vegetation		*Canarium schweinfurthii*	food fruit/veneer/
Natural woody vegetation	Calabash tree	*Crescentia cujete*	tools & utensils/ornamental/
Field crop (perennial)	Papaw	*Carica papaya*	food fruit/
Field crop (perennial)	Plantain	*Musa paradisiaca*	food fruit/
Field crop (seasonal)		*Amaranthus spp.*	food vegetable/

Field crop (seasonal)		*Solanum aserolum*	food fruit/food vegetable/
Field crop (seasonal)		*Corchorus olitorius*	food vegetable/
Field crop (semi-perennial)	Cassava	*Manihot utilissima*	food roots/
Field crop (seasonal)	Yam	*Dioscorea rotundata*	food root/
Field crop (seasonal)	Yam	*Dioscorea alata*	food root/
Field crop (seasonal)	Yam	*Dioscorea bulbifera*	food root/
Field crop (semi-perennial)	Castor bush	*Ricinus communis*	food condiment/
Field crop (seasonal)	Maize	*Zea mays*	food seeds/
Field crop (seasonal)		*Capsicum spp.*	food vegetable/food condiment/
Field crop (seasonal)	Pumpkin	*Cucurbitta spp.*	food vegetable/
Field crop (seasonal)	Tomatto	*Lycopersicon esculentum*	food fruit/
Field crop (seasonal)		*Basella alba*	food condiment/
Field crop (seasonal)	Cocoyam	*Xanthosoma sagittifolium*	food root/
Field crop (seasonal)		*Phaseolus vulgaris*	food seed/
Field crop (seasonal)	Yam	*Dioscorea dumetorum*	food root/
Field crop (seasonal)	Cowpea	*Vigna unguiculata*	food seed/
Field crop (seasonal)	Groundnut	*Arachis hypogaea*	food nut/
Field crop (seasonal)	Bambara nut	*Voandzeia subterranea*	food nut/
Natural woody vegetation	Mango	*Mangifera indica*	food fruit/

EVALUATION

CONSTRAINTS: (1) Land is in very short supply and this results in fragmentation of management units. (2) Livestock could play a major role in enhancing productivity and recycling of nutrients but are present only in limited numbers due to tsetse presence. (3) Newly acquired wealth (during the oil boom) has resulted in some farmers clearing the compound farms with bulldozers and engaging in high input monocropping. Soil compaction by heavy machinery and mismanagement soon results in soil degradation.

POTENTIAL: The system can be improved by (1) Incorporating improved varieties of indigeneous food/fruit trees currently being developed by FIDB. (2) Increased use of trypano-tolerant livestock for meat, milk and manure.

RESEARCH NEEDS: (1) Continued development of the multipurpose food tree germplasm currently being undertaken by the FIDB. (2)

Tree-crop combinations to optimise light utilisation while minimising competition for nutrients and water.

MERITS: (1) Multistoried intercropping provides excellent soil protection from the high intensity rainfall. (2) Continuous production of a diverse range of food and other products minimises risk, increases labour efficiency and reduces post-harvest crop losses.

EXTRAPOLABILITY: The system has great potential for extrapolation to other areas of the african humid tropics. The numerous woody and herbaceous species could be of immense value in the homegarden systems found in S. E. Asia and American tropics.

LAND USE PROBLEMS: (1) High erosivity of rainfall. (2) Light can become limiting in some seasons due to intense and prolonged cloud cover. (3) Trypanosomiasis

SYSTEM HISTORY/BACKGROUND: System believed to be in existence for at least 10 centuries.

ADDITIONAL INFORMATION: The system involves the use of numerous indigenous food/fruit trees intercropped with food and other herbaceous species in a complex multistoried configuration. Associated with the compound farm are other outlying fields which are used to supplement the production of the compound farms. In general, the compound farm has the highest intensity of food species and this intensity decreases as the outlying fields get further away from the house.

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