Alley Farming in the Humid and Subhumid Tropics

Proceedings of an international workshop held at Ibadan, Nigeria, 10–14 March 1986
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Alley Farming in the Humid and Subhumid Tropics

Proceedings of an international workshop held at Ibadan, Nigeria, 10–14 March 1986

Editors: B.T. Kang and L. Reynolds

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Abstract / Résumé / Resumen

Abstract — An urgent challenge facing scientists working on upland food-crop production in many parts of the humid and subhumid tropics is the need to find viable, sustainable, and environmentally sound alternatives to the ancient shifting cultivation and bush-fallow, slash-and-burn cultivation systems. As a food-cropping and livestock-production technology, alley farming requires a low level of inputs and helps conserve soil resources while sustaining long-term farm productivity. This publication presents the results of an international workshop on alley farming in the humid and subhumid tropics. Held in Ibadan, Nigeria, 10–14 March 1986, the workshop was attended by 100 participants from 21 countries. The theme of this workshop was the development of more productive, sustainable farming methods with low inputs in the humid and subhumid tropics using alley farming techniques. This book reviews the present state of alley farming research and its application, discusses the use of woody species in tropical farming systems, highlights training and research needs, and proposes the establishment of channels for collaborative research.

Résumé — Les scientifiques s'intéressant aux cultures vivrières en zones d'altitude dans de nombreuses régions des tropiques humides et sub-humides doivent répondre à un besoin urgent : trouver des solutions de rechange viables, soutenables et environnementalement saines aux anciennes méthodes de rotation des cultures et mise en jachère et de culture sur brûlis. A titre de technique de culture et d'élevage, l'agriculture en couloirs ne nécessite que peu d'intrants et contribue à conserver les sols, tout en favorisant la productivité agricole à long terme. Cette publication présente les résultats d'un atelier international sur l'agriculture en couloirs dans les tropiques humides et sub-humides qui s'est tenu à Ibadan, au Nigéria, du 10 au 14 mars 1986 et qui a réuni 100 participants de 21 pays. L'atelier portait sur la mise au point de méthodes culturales plus productives et plus durables ne nécessitant que peu d'intrants pour les régions des tropiques humides et sub-humides, grâce aux techniques de l'agriculture en couloirs. Le livre fait le point sur la recherche actuelle en matière d'agriculture en couloirs et ses applications, discute de l'utilisation des arbres dans les systèmes agricoles en milieu tropical, met en lumière les besoins en matière de formation et de recherche et propose l'établissement de canaux aux fins de la recherche en collaboration.

Resumen — Un reto urgente al que se enfrentan los científicos que realizan investigaciones sobre la explotación de cultivos de montaña en muchas zonas húmedas y subhúmedas de los trópicos, es la necesidad de encontrar alternativas viables, sustentables y correctas desde el punto de vista del medio ambiente, al antiguo método de cultivos migratorios y a los sistemas de cultivo en barbecho y de corte y quema. Como tecnología utilizada para cultivos alimentarios y la producción ganadera, la agricultura de pasillo o entresurcos necesita pocos medios y ayuda a conservar los recursos del suelo en tanto mantiene la productividad agrícola a largo plazo. Esta publicación presenta los resultados de un grupo de trabajo internacional sobre agricultura de pasillo o entresurco en las zonas húmedas y subhúmedas de los trópicos, celebrado en Ibadán, Nigeria, del 10 al 14 de marzo de 1986, y al que asistieron 100 participantes de 21 países. El tema de este grupo de trabajo fue el desarrollo de métodos de cultivo más productivos y sostenidos con pocos recursos en las zonas húmedas y subhúmedas de los trópicos, utilizando técnicas de agricultura de pasillo o entresurco. Este libro revisa la situación actual de la investigación sobre la agricultura de pasillo o de entresurco y su aplicación, discute el uso de especies maderables en sistemas de cultivo tropicales, subraya la necesidad de realizar investigaciones y dar cursos de capacitación y propone la creación de canales para la investigación conjunta.
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Role of multipurpose trees in compound farming in tropical Africa

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Abstract — The home garden is an integral component of traditional farming systems in the humid and subhumid areas of tropical Africa. It is usually the operational base for several field systems in African agriculture. Species diversity and the complexity of the system is highest in the tropical forest zone and lowest in the savanna areas. The home garden is of major importance in the life-support system of rural communities. It supplies many products and contributes considerably to maintaining environmental quality and soil conservation. Components of the home garden ensure the year-round availability of different foodstuffs. A regular supply is assured through frequent harvest; storage and preservation are not required. It is therefore recommended that in finding solutions to the African food crisis, research on home gardens should be given high priority. Studies should be done on species composition and structure, nutritional roles, economic relevance, and overall ethnobotanical importance. Only through an understanding of the importance and role of home gardens in farming systems can programs to improve them and efforts in germ-plasm preservation be successful.

Introduction

The home garden or compound farm may be regarded as "a system of agricultural production largely conducted by the household members at or near their residence" (Brownrigg 1985). Brownrigg (1985) also defines home garden 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." In this paper, a home garden in Africa is defined as a specialized agricultural production or farming system within the homestead area, usually surrounding the home of its operators. It usually constitutes one of a set of fields operated by a farmer or farm family. On these fields, one or more family members work all or part of the time to produce food and other products for subsistence, sale, or other purposes (Okigbo 1985).

The home garden is also called the backyard garden, kitchen garden, dooryard garden, compound farm, compound garden, or homestead garden. It varies considerably in size, shape, and intensity and complexity of cultivation. According to White and Gleave (1971), the compound kitchen garden is the most common permanent, traditional production system in tropical Africa. It is located close to the settlement and provides items frequently used in small quantities for relishes and
sauces. It also produces crops that require guarding, more fertile soils, or individual attention.

The home garden usually contains tree crops, shrubs, arable crops, vegetables, ornamentals, and multipurpose species. It is often integrated in varying degrees with animal production and supplements other field systems operated by the same farmer or the farmer’s family.

Plants featured in home gardens usually have several purposes. Multipurpose plants are plants that are kept and managed for economical or ecological reasons in any land-use system, especially agroforestry systems (Burley and von Carlowitz 1984). Multipurpose species may include herbs, lianas, shrubs, or trees. Most herbaceous species found in compound gardens have edible parts and are mainly used as food or condiments. This paper reviews the uses of the most common or frequently used ligneous species in the humid, subhumid and drier (savanna) areas of tropical Africa; most examples are taken from West Africa.

Evolution and development of home gardens

After several millennia of trial and error with plants and animals, agricultural production evolved into a slash-and-burn, shifting-cultivation system. This involved rearing animals and planting less weedy species such as cereals and other annual, largely herbaceous species. Agriculture was then migratory and farmers lived in temporary campsites. According to Burkill (1962), the most probable sequence of plant domestication involved cereals (probably the earliest to be domesticated); pulses or grain legumes; oil seeds; roots and tubers; herbaceous fruits; fibre and dye plants; and woody fruit trees and shrubs.

Burkill (1962) regarded perennials as the most intractable of plants, especially if they are tall trees. It is, therefore, likely that primitive nomads initially camped close to areas rich in trees and shrubs with edible fruits, nuts, seeds, and other plant parts, or in abandoned campsites with groves of edible trees and shrubs. These species must have been only seasonally exploited, when the edible parts were most abundant. Even if the seeds of these species were observed to germinate and produce seedlings, it is likely that nomads increased the frequency of camping near such groves or established protective sanctions over them. Progress in plant domestication resulted in the reliance on a few arable species as regular sources of food; a sedentary culture and permanent settlement evolved. The homestead garden or compound farm constitutes an agroecosystem formed at the site of a permanent settlement.

In contrast, Porteres (1962) maintains that after several centuries of hunting and gathering, and trial and error, two agricultural complexes evolved: one based on seeds and the other on vegetatively propagated plants. The seed-agricultural complex is characteristic of the savanna; it involves growing cereals and grain legumes in open fields. The vegeticultural complex, characteristic of the tropical forest zone, involves the growing of vegetatively propagated plants, roots and tubers, fruit trees, and vegetables in gardens rather than in open fields. Whichever hypothesis is applied to the origin of home gardens, it is speculated that they are of relatively recent origin with the domestication and growing of arable crops such as yams, sorghum, and vegetables.
The homestead and its associated garden is the operational base for all the other cropped and fallow fields at different distances from the home garden (Figs 1 and 2). According to Okigbo (1985), the development of the home garden as a regular feature of the traditional farming system is, by and large, a result of the following four factors:

- Labour is divided by sex. Women, along with other responsibilities, cook the soups and sauces with which the major starchy staples (often produced by the men or the farm family) are eaten. Thus, the women grow several condiment plants, spices, and vegetables in the home garden to ensure a regular, year-round supply of fresh materials close to the kitchen. This proximity to the kitchen facilitates the tending of the crops and eliminates or minimizes the need for storage.

- A sedentary culture ensures that homesteads are located in places where edible and equally useful perennial plant species are abundant. With frequent slashing, burning, and clearing of vegetation, the development of the home garden ensures that several semiwild and wild species of edible trees and

![Diagram of homestead and compounds](image)

**Fig. 1.** Homestead fields and compounds in traditional farming systems in the humid tropics of West Africa: a, compound farm inside outer walls; b, compound farm outside compound fence or wall; A1, A2, B1, B2, near fields; A3, A4, B3, B4, distant fields (source: Okigbo 1984).
shrubs that are gradually disappearing from fallow areas are grown and preserved close to residential areas.

- The home garden functions as an experimental area for interesting and useful plants collected during trips to neighbouring compounds, villages, towns, and far-away places.
- Home gardens provide rural farmers with the opportunity to realize the many uses of plants: food, feed, environmental protection, landscaping, or raw materials for crafts.

**Structure and complexity**

The diversity and complexity of home gardens depend on the climatic or ecological zones in which they exist. Species diversity is greatest in the humid tropics and lowest in the savanna areas (Table 1). This parallels the situation with natural vegetation. Human population density must be considered when examining species diversity. In the humid tropics, the structure of home gardens approaches that of a tropical rain forest in its multistoried structure and number of species. It is
Table 1. Number of food crops and useful plants encountered in home gardens in three ecological zones in Nigeria.

<table>
<thead>
<tr>
<th>Crop group</th>
<th>Humid tropics (oil palm bush)</th>
<th>Humid tropics (derived savanna transition zone)</th>
<th>Subhumid tropics (southern Guinea savanna)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MH</td>
<td>H</td>
<td></td>
</tr>
<tr>
<td>Cereals</td>
<td>0-4</td>
<td>2-3</td>
<td>0-3</td>
</tr>
<tr>
<td>Roots and tubers, plantain</td>
<td>3-8</td>
<td>7-10</td>
<td>1-12</td>
</tr>
<tr>
<td>Legumes and pulses</td>
<td>0-3</td>
<td>0-3</td>
<td>1-5</td>
</tr>
<tr>
<td>Leaf vegetables</td>
<td>2-8</td>
<td>10-11</td>
<td>3-7</td>
</tr>
<tr>
<td>Fruit vegetables</td>
<td>0-6</td>
<td>3-4</td>
<td>4-6</td>
</tr>
<tr>
<td>Fruits, nuts, and oil plants</td>
<td>2-15</td>
<td>5-12</td>
<td>1-14</td>
</tr>
<tr>
<td>Spices and condiments</td>
<td>0-9</td>
<td>1-7</td>
<td>0-3</td>
</tr>
<tr>
<td>Miscellaneous useful plants</td>
<td>1-29</td>
<td>4-18</td>
<td>0-7</td>
</tr>
</tbody>
</table>

Source: Okigbo and Greenland (1976); Diehl (1982).

MH, medium-high human population density; H, high human population density.

more or less a four-storied structure. The ground layer consists of crops such as sweet potato (*Ipomoea batatas*), early okra (*Abelmoschus esculentus*), melon (*Colocynthis vulgaris*), chili peppers (*Capsicum frutescens* and *C. annum*), meleguetta pepper (*Aframomum melegueta*), or cocoyams (*Xanthosoma sagittifolium* and *Colocasia esculenta*). The second layer consists of shrubs such as citrus (*Citrus* spp.), bananas and plantains (*Musa* spp.), late okra, the soursop (*Annona muricata*), horseradish (*Moringa oleifera, Dennettia tripetala*), papaya (*Carica papaya*), croton (*Cordia* spp.), *Afzelia bella* var. *bella*, *Newbouldia laevis*, the tree gourd (*Crescentia cujete*), the fever plant (*Ocimum viride*), pigeon pea (*Cajanus cajan*), or bitterleaf (*Vernonia amygdalina*). The third layer consists of taller trees such as the star apple (*Chrysophyllum albidum*), African pear (*Dacryodes edulis*), African breadfruit (*Treculia africana*), cola nut tree (*Cola* spp.), mango (*Mangifera indica*), oil palm (*Elaeis guineensis*), coconut palm (*Cocos nucifera*), guinea pepper (*Xylopia aethiopica*), oil bean (*Pentaclethra macrophylla*), or camwood tree (*Pterocarpus* spp.). The topmost or fourth layer contains trees that may also appear in the third layer: the African elemi (*Canarium schweinfurthii*), coconut palm, silk cotton (*Ceiba pentandra, Bombax buanopezene, Brachystegia* spp.), or the iroko tree (*Chiorophora excelsa*). As in the tropical rainforest, there are lianas and climbers that use these trees and shrubs for support: conophor (*Tetracarpedium conophorum*), rubber vine (*Landolphia owariensis*), Gongronema latifolium, dye plants (*Rothmannia* spp.), yams (*Dioscorea cayenensis, D. alata, D. dumetorum, and D. rotundata*), fluted pumpkin (*Telfairia occidentalis*), and arrow poison (*Strophanthus* spp.).

In southeastern Nigeria, the number of species in a home garden range from 18 to 62 (Lagemann 1977). Compound farm ecosystems of such structure and species diversity are also found in Zaire, the Kumasi area of Ghana, parts of the Republic of Congo, Uganda, and southern Cameroon.

In the Guinea and Sudan savanna areas of Nigeria, a more open, three-storied structure of less diversity may be encountered. In the Guinea savanna or "Middle Belt" of Nigeria, the ground or herb layer may consist of sweet potato, tobacco...
(Nicotiana tabacum), roselle (Hibiscus sabdariffa), bitter melon (Cucumis and Colocynthis spp.), or sesame (Sesamum indicum). The second layer may consist of shrubs such as henna (Lawsonia spp.), papaya, boundary plants of the Euphorbia spp. and Newbouldia leavis, citrus trees, the tree gourd, kenaf (Hibiscus cannabinus), or late okra. The tree layer is occupied by mango, African elemi, locust bean (Parkia clappertoniana), and date palm (Phoenix dactylifera).

In the Sudan savanna, the number of species in a home garden rarely exceeds 30. The dominant trees are the shea butter (Butyrospermum paradoxum), the baobab (Adansonia digitata), locust bean (Parkia bigloba), and the neem tree (Azadiracta spp.).

Uses of trees

Compound gardens contribute in many ways to the quality of life of small-scale farmers. Lagemann (1977) estimated earnings from compound gardens relative to returns from other farming systems in eastern Nigeria (Table 2). Some crops, like the colas, are of immense cultural and religious importance. Trees and shrubs in compound gardens are involved in nutrient recycling. There are more than 120 species of trees, shrubs, and lianas used in the humid tropics (Okafor 1981b). In surveys of home gardens in southeastern Nigeria, Walker (1985) reported 138 species; 35% were herbaceous, 65% were woody species.

Surveys in various parts of tropical Africa indicate that the ligneous trees, shrubs, and lianas in home gardens are used for food (vegetables, fruits, nuts, seeds, nectar, beverages, condiments); feed or fodder; medicine; furniture; structural materials (roofing, thatching, walling, beams, pillars); fuelwood; ornamentals; body decorations; hedging or fencing; fishing; musical instruments; ladders and climbing ropes; trellises and stakes; religious artefacts and traditional costumes, including

<table>
<thead>
<tr>
<th>Village b</th>
<th>Crops</th>
<th>Compounds</th>
<th>Outer fields</th>
<th>Fallow</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okwe (L)</td>
<td>Arable</td>
<td>NA</td>
<td>265</td>
<td>5</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td>Tree</td>
<td>NA</td>
<td>4</td>
<td>165</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>NA</td>
<td>269</td>
<td>170</td>
<td>439</td>
</tr>
<tr>
<td>Umuokile (M)</td>
<td>Arable</td>
<td>64</td>
<td>80</td>
<td>2</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>Tree</td>
<td>28</td>
<td>6</td>
<td>103</td>
<td>137</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>92</td>
<td>86</td>
<td>105</td>
<td>283</td>
</tr>
<tr>
<td>Owerre-Ebeiri (H)</td>
<td>Arable</td>
<td>70</td>
<td>44</td>
<td>2</td>
<td>116</td>
</tr>
<tr>
<td></td>
<td>Tree</td>
<td>29</td>
<td>26</td>
<td>43</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>99</td>
<td>70</td>
<td>45</td>
<td>214</td>
</tr>
</tbody>
</table>

Note: NA, not available.

a In September 1989, 7.3 Nigerian naira (NGN) = 1 United States dollar.

b L, low human population density; M, medium human population density; H, high human population density.
protective charms; handicrafts (baskets, mats, cordage); and farm implements (digging sticks, tool handles, cooking utensils, and containers). This paper will only consider the first two (human and animal feed).

**Human food**

Several ligneous species encountered in home or compound gardens are sources of food and flavouring substances. These include fruits, leaves, seeds, nuts, barks, and other plant parts. Fruit trees include mango, citrus, bananas and plantains, oil palm fruits, soursop and sweetsop, and African pear. Trees and shrubs producing edible nuts include the coconut and the oil palm. The liana conophor produces a seed that is high in protein and oil content. The bignoniaceus shrub produces bell-shaped flowers, the nectar of which is cherished by children. Both raffia palm and the oil palm are sources of palm wine, a popular alcoholic beverage that is high in B-complex vitamins. Several perennial shrubs and trees are good sources of leafy vegetables; some produce edible leaf flushes in the dry season (e.g., camwood, *Afzelia bella* var. *bella*, and horseradish).

**Animal feed**

Many trees and shrubs are specially grown in home gardens as browse or fodder plants although they have other uses. Several species of *Ficus* and *Ricinodendron heudelotii* are often grown for their leaves, which are fed to sheep and goats. The African breadfruit produces fruits that are cherished by goats after the seeds have been removed. Sheep and goats also relish the seeds of the African pear. Most trees and shrubs grown in home gardens yield by-products that are fed to penned animals.

**Potential of multipurpose trees and shrubs**

Until recently, the compound farm or home garden has been neglected as a target for improvement in agricultural research. This is in spite of the fact that it lends stability to the traditional farm environment and ensures the sustained production and income of the traditional low-resource farmer. Some of the trees and shrubs in home gardens fulfill strategic nutritional roles, in addition to contributing significantly to the farmer's income (Fig. 3), especially near urban centres, where the demand for fruits and nuts are high.

Home gardens also preserve the environment through soil conservation. In addition to being a rich reservoir of germ plasm of plants that may be valuable in industries based on renewable resources, they beautify the environment. There are many ways in which trees and shrubs in home gardens can be used to develop self-sustaining agricultural production systems, especially in the humid and subhumid tropics.

**Germ-plasm collection and preservation**

Many indigenous trees and shrubs of economic and nutritional importance (e.g., the African pear, *Dennethia tripetala*, conophor, the locust bean, shea butter, and the baobab) are found in home gardens or close to human habitation. Some of the
traits of these species are often either obscured by dominant genes under natural conditions or are not easily accessible for observation, detection, and isolation. Therefore, priority should be given to the study of economically important plants found in home gardens. Various specimens should be described and documented and germ plasm should be collected and conserved.

Recent studies of compound gardens in Imo and Anambra states have identified *Cola pachycarpa*, *C. lepidota*, *Coaila edulis*, *Lascanthera africana*, and *Tetracarpedium conophorum* as rare or endangered species (Walker 1985). Studies by Okafor (1975, 1981a, b) have shown that variation exists: two forms have been identified in *Irvingia gabonensis* (var. *gabonensis* and var. *excelsa*), and in African breadfruit (var. *africana* and var. *inversa*).

These studies demonstrated the differences in economic importance of the various types and confirmed that compound garden species are amenable to conventional methods of horticultural propagation. There is no doubt that usual plant breeding methods and biotechnologies such as tissue culture can be used to enhance their potential.

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**Fig. 3.** Home gardens provide food and income throughout the year. Broken lines represent minor harvest periods or food being consumed from storage. Solid lines represent major harvest periods.

Improved cropping patterns

Certain sustainable farming systems (e.g., crop/livestock integration, coconut/pasture, coconut/cocoa, plantain/cocoyam, coffee/banana, and kolanut (*Marantochloa*) are ecologically stable and economically viable, involving compatible species in a structure of two or more stories. Studying plant interactions in home gardens will promote the modeling and subsequent improvement of such mixtures. Home gardens could also be used to design improved agrosystems involving trees and shrubs with animals or low-growing perennials.

Widening the spectrum of horticultural crops

Okafor (1981a) has demonstrated the potential of selection and propagation in the management, breeding, and genetic improvement of several indigenous, ligneous species in home gardens. As with mangoes and cashew nuts, fruit trees such as the velvet bean can be improved and regularly cultivated. Some of the fruits can be used in jams or preserves.

In some parts of southeastern Nigeria, some species of the camwood tree are sources of dry-season, leaf vegetables that are as good as or better than *Amaranthus* spp. and *Celosia argenta*. Improved methods of pruning will ensure better accessibility to this crop.

Industrial crops

Some trees and shrubs found in home gardens could be improved and put to industrial use. The fruit and seeds of the African pear, African elemi, oil bean, conophor, and African breadfruit contain more than 10% ether-extractable fat. Arils of the velvet tamarind are known to be high in vitamin C. The industrial potential of these species should be more seriously investigated. Growing such crops in plantations would provide rural employment. Because they are renewable resources, this would also lessen the need for imported raw materials.

Horticulture and landscaping

Where homesteads are scattered, compound gardens form a unique landscape — a forest of selected useful species. In fact, in areas of high population density and no urbanization, as in parts of southeastern Nigeria, it is difficult to tell where one village ends and another begins. There are individual ligneous species in home gardens that, in addition to their traditional uses, are good ornamental plants.

Conclusions

Home or compound gardens should be given greater priority in efforts to improve traditional farming systems because they involve multipurpose species. It is only by studying their structure, nutritional importance, economic importance, ethnobotanical value, and various uses that component species can be improved and used more effectively. Such research should include gardens in urban areas;
efforts aimed at their improvement should also focus on the utilization of indigenous species. Wherever possible, more exotics could be officially introduced to increase species diversity. The highest priority should be given to improving home gardens and broadening the food base of both the rural and urban poor.

References


