

## Conversion of traditional village gardens and new economic strategies of rural households in the area of Bogor, Indonesia

G. MICHON<sup>1</sup> and F. MARY<sup>2</sup>

<sup>1</sup> ORSTOM/BIOTROP, P.O. Box 17, Bogor, Indonesia; <sup>2</sup> CNEARC, Av. d'agropolis, 34000 Montpellier, France

**Key words:** homegardens, forest gardens, Java, Indonesia, household economy

**Abstract.** Multistoried village gardens in the vicinity of Bogor (West Java, Indonesia) have long been essential multi-purpose production systems for low-income households. However they are being subjected to important conversion processes linked to socio-economic changes presently found in overcrowded semi-urban zones. Determining factors in their development are a high population increase and the rise of a market economy. Some gardens tend to specialize in commercial growing of fruits or of export crops, others are colonized by houses and associated home-gardens. Traditional gardens gradually lose their earlier ecological and economic features but also become a major asset for the modernization of village economy and society. In addition they bring socio-professional changes to villagers and play a determining role in the search for a new balance in the relationship between cities and villages.

### Introduction

Home-gardens and related systems of village tree-gardens on the island of Java, Indonesia, are some of the best examples of indigenous gardening in the tropics [Christanty, 1990; Price, 1982; Soemarwotto and Soemarwotto, 1981; Terra, 1953]. Like home-gardens in other rural societies in the tropical world [Budowski, 1990; Christanty, 1990; Ninez, 1984; Okigbo, 1990; Thaman, 1990], they have survived as an original small-scale production system, combining numerous ecological, economic and social functions. Traditional agriculture and peasant societies in Java are presently facing real problems: high population density and increased scarcity of agricultural land, urbanization pressures, conflicts between commercial agriculture and traditional food production systems, development of a market economy and the low economic profits of small-scale agriculture. These threaten the very existence of home-gardens.

In many parts of rural Java home-gardens are still an important household asset [Christanty, 1990; Mary, 1986; Soemarwotto and Soemarwotto, 1981; Stoler, 1978] but in semi-urban areas, they have to adapt to extreme socio-economic pressures. There, as a low-income, domestically-oriented production system, home-gardening may not survive. What can be the future of tree-gardens in villages faced with extreme population density, in societies

which lose their traditions and become more and more dependent on city jobs and markets?

An analysis of present trends in village-gardens from the vicinity of Bogor and Jakarta (West Java, Indonesia) may offer some insight. In this area, conflict between city and village, between traditional food production and modern commercial agriculture, and between agricultural land and dwelling space, is highly developed. Most of the reported conversions have occurred between 1982 and 1985, with minimal qualitative changes from 1985 to 1991—1992. From 1991 totally new and unexpected factors occurred, such as the total disorganization of the clove market and the related total drop in prices, the important valuation of land in the surroundings of Cibitung due to holiday resort development projects, the conversion of the dirt road into a good tar road, the development of a golf resort in the highlands of Cibitung. These factors entailed important changes in the dynamics of Cibitung itself, which are presently under study. However, the conclusions of this study are still representative of what globally happens in rural villages of the surroundings of Bogor.

### **1. Cibitung: the general background**

Cibitung is a village of about 300 families, located 60 km south of Jakarta, the capital city of Indonesia, and 15 km from Bogor. Until 1990, it had no electricity and was linked to surrounding villages by a dirt road, hardly suitable for motor vehicles during the rainy season.

Bogor is an important market and urban center with 350,000 inhabitants, and its surrounding countryside is one of the main fruit- and vegetable-growing areas for Jakarta markets. In villages located within the sphere of influence of the city, the evolution of agricultural systems is tied closely to the development of city markets. The increasing number of villagers depending, at least part-time, on urban labour for daily survival vitally affects the socio-professional organization of village society. Moreover, rural villages tend to absorb the surplus of urban population. Rural population densities are between 1,000 and 2,500 p/km<sup>2</sup>. In Cibitung it is more than 1,500 p/km<sup>2</sup>.

Whereas most of the villages located near Bogor increasingly resemble urban forms, Cibitung remains fairly agricultural: village economy depends primarily on the production, processing and marketing of agricultural produce, and 80% of the active population in the village depend on the agricultural sector, including primary and secondary production (Table 1). However, the organization of farming systems as well as household economy is increasingly tied to the market economy: subsistence agriculture has largely given way to commercial agriculture, and families rely partly on the market for their food supply.

Cibitung lands cover 40 ha of fertile volcanic soils, distributed between 30

ha of open-fields (2/3 of which have been terraced and irrigated for rice cultivation) and a block of 10 ha of village settlements and associated homegardens, which constitutes a well-defined woodland unit. Traditional subsistence rice-growing has been replaced by commercial cropping of cassava which is processed locally into tapioca for the international export market. Cassava fields presently cover 60% of the open-field lands. Moreover, commercial growing of papaya and vegetables, which developed 15 years ago, is still expanding, and presently occupies 14% of the open-fields. Land still used for irrigated rice-growing comprises less than 26% of the field area, and usually bears one rice crop (during the rainy season) and one vegetable crop (during the dry season) a year. Commercial production of fruits and vegetables is well developed in the village gardens.

Traditional rules and social organization of the village society are being affected by these economic and socio-professional changes. A fully expanding land market, distinct from traditional laws on land tenure, will soon overturn the whole traditional hierarchy of Cibitung's society. Up to the seventies, 68% of the villagers had no access to land property, while 10% of them, representing respected landholding families who held religious and administrative power, owned 80% of the agricultural land. With the recent re-allocation of land through market channels, new classes of landowner are developing. The nuclear family is now the main unit of production and consumption; it also tends to control economic and socio-professional strategies linked to agriculture, which is a radical departure in this society where communal traditions linked to irrigated rice-cropping have dominated for so long. Lastly, agricultural labour is supplanting the traditional mutual-aid system: it presently affects, at least temporarily, about 30% of the active population (Table 1).

## 2. Garden types in Cibitung

Up to the beginning of this century, the arrangement of the village of Cibitung was typical of the traditional Sundanese<sup>1</sup> lowland villages described by Terra [1953]. It consisted of a group of houses adjacent to a large communal garden which was dominated by high multi-purpose trees and various species of fruit and more or less resembled a forest. Gradually, new houses were built in this original forest-garden, and the communally-owned garden land was divided into private plots surrounding new houses, thus introducing great changes in the structure and functions of garden vegetation. At the present time, patches of the original forest-garden still make up 40% of the garden area inside the village boundaries, but, though not fenced-in, they are always privately owned and they often include houses, which relates them to homegardens (Fig. 1).

Table 1. Distribution of workers and of income in Cibitung.

Activity	Manpower (% of the workers)	Income (% of total income)
<i>Open field agriculture</i>	45.9	39.1
Farmers	26.9	30.6
Wage-earners	19	8.5
<i>Cassava processing</i>	7.5	4.6
Factory boss	0.7	1
Wage-earners	6.8	3.6
<i>Tree gardens</i>	26.8	32.1
Producers	17	16.4
Tree-climbers	1	0.6
Traders	8.8	15.1
<i>Other activity in the village</i>	12.6	12.9
Shopkeepers	6.5	5.6
Craftsmen	6.1	7.3
<i>Urban Jobs</i>	8.5	11.2
Shopkeepers and traders	4.1	6.2
Wage-earners	4.4	5

### 2.1. Traditional gardens: biological and ecological features

Floristic composition and structural vegetation patterns in the traditional gardens share features typical of a forest ecosystem.

More than 150 plant species among the 250 species listed for the garden ecosystem in Cibitung are characteristic of traditional gardens, and most of them are native to the local forest ecosystem. The dominant plant type are fruit trees, ancestors of which are tree species of the upper strata of the natural forest's canopy: *Durio* (Bombacaceae), *Parkia* and *Pithecellobium* (Mimosaceae), *Mangifera* (Anacardiaceae), *Nephelium* (Sapindaceae), *Eugenia* (Myrtaceae), *Baccaurea* (Euphorbiaceae), *Garcinia* (Clusiaceae). Traditional gardens also shelter bamboos (6 species) and palms (5 species), as well as many herb and shrub species typical of a shaded forest undergrowth: Araceae, Gesneriaceae, Marantaceae, Urticaceae.

Common garden plots, 300 to 500 m<sup>2</sup> in area, may contain more than 50 different tree and herb species. Floristic richness is great since most tree species are represented by several varieties and cultivars, derived from the original species through both natural breeding and careful selection of interesting types.

Structural patterns of garden vegetation are similar to those observed in natural forests (Figs. 2a and 2b). Mean densities of the tree stand are around

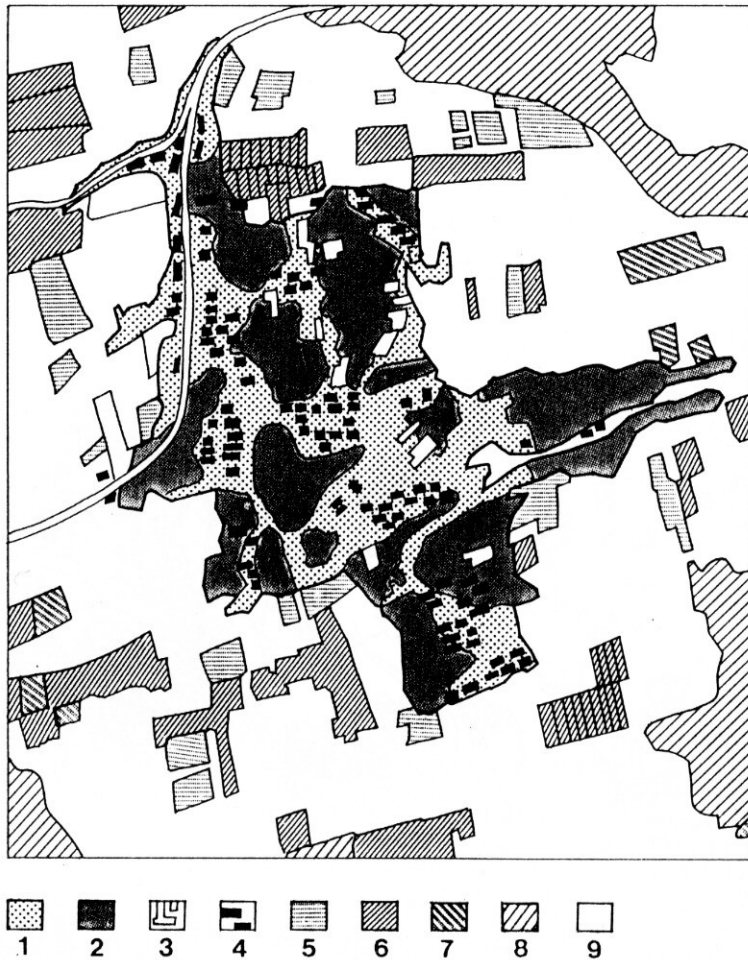


Fig. 1. Aerial map of the village with settlement areas, garden types and surrounding open-fields. (1) transformed gardens; (2) traditional gardens; (3) (inside village boundaries) tree gardens; (4) dense settlement areas; (5) pepaya fields; (6) irrigated rice fields planted with rice; (7) vegetable fields; (8) other villages; (9) (outside village boundaries) irrigated ricefields planted with cassava.

800 mature individuals per ha, and 900 young trees above one meter high. Global tree crown cover (the sum of surfaces of tree crown projections) makes up 200% of the plot surface which means that trees largely overlap each other (Fig. 7): the vertical arrangement of garden's vegetation is 'layered'. Mature, productive trees occupy the space on several superimposed ensembles:

- a tall ensemble of emergent fruit trees (*Durio zibethinus*, *Parkia speciosa*, *Mangifera odorata*, *M. foetida*, *M. caesia*) reaching 35 m high, with a tree cover of 75%,
- a canopy ensemble, which is the major tree ensemble, with a tree cover around 100%, consisting of fruit species (*Nephelium* spp., *Baccaurea* spp., *Lansium* spp., *Eugenia* spp., *Garcinia* spp.) and vegetable species (*Gnetum gnemon*, *Pithecellobium lobatum*), between 15 and 25 m high,



Fig. 2a. Traditional garden in Cibitung: behind the house, the ancient 'fruit forest'.

*Antidesma bunius* 17; *Artocarpus heterophyllus* 36; *Averrhoa bilimbi* 41; *Baccaurea racemosa* 4, 34, 48; *Bouea macrophylla* 3, 12, 35, 45, 51, 52; *Coffea robusta* 25; *Durio zibethinus* 6, 42, 55; *Eugenia malaccensis* 40; *Eugenia polycephala* 30, 31, 32; *Gnetum gnemon* 7, 11, 53; *Lansium domesticum* 1, 2, 10, 15, 27, 44, 47, 50, 56, 57, 58; *Mangifera caesia* 14, 37; *Nephelium lappaceum* 30, 39; *Pangium edule* 54; *Parkia speciosa* 43; *Pithecellobium lobatum* 38; *Salacca edulis* 48; *Sandoricum koetjape* 59.



Fig. 2b. Traditional garden in Cibitung: around the house, a homegarden dominated by trees. *Arenga pinnata* 5; *Artocarpus heterophyllus* 25; *Baccaurea racemosa* 6, 10; *Coffea robusta* 25; *Colocasia indica* (c); *Durio zibethinus* 11, 23; *Eugenia polycephala* 1, 7, 9, 16, 17, 19; *Gnetum gnemon* 13; *Mangifera foetida* 12; *Mangifera indica* 14, 15; *Mangifera odorata* 21; *Lansium domesticum* 4, 9, 12, 22, 26, 27; *Musa paradisiaca* (b).

- one or two discontinued under-canopy ensembles with palms (*Arenga pinnata*, *Areca catechu*, *Salacca edulis*) and small trees (*Bouea macrophylla*, *Averrhoa belimbi*, *A. carambola*, *Flacourtia* spp., *Phyllanthus acidus*),
- an herbaceous ensemble colonized by shade-tolerant herb and shrub species, which shelters seedlings and saplings of the upper strata trees.

For about 20 years, increasing needs in dwelling space and in land for highly intensified agriculture have caused important and rapid changes in traditional gardens. These have gradually lost their original forest features and been converted into either simplified homegardens or specialized orchards.

## 2.2. Conversion of tradition gardens: extension of dwelling space

The rate of population growth in this area has reached 5% per year during the last decades. Increasing demands for building land from villagers is one of the major reasons for garden conversion. New houses encroach more frequently on garden land than on rice-fields: 20% of the garden land purchased in Cibitung since 1965, but only 8% of the purchased rice-field land, has been converted into building land.

Where possible, free land surrounding a new house is converted into a home-garden (Fig. 3): the frontyard is used for ornamental species and for short-cycle, heliophilous species (banana and papaya trees, cassava, taro, legume vines) which are grown in small, enclosed plots. Big trees from the previous garden stand are cut down and replaced by sun-tolerant tree species with commercial value, such as clove or nutmeg, jackfruit, improved varieties



Fig. 3. Conversion of homegardens in dense settlements: smaller tree species and vegetable beds.

*Artocarpus altilis* 12; *Carica pepaya* p; *Coffea robusta* 4; *Cordyline fruticosa* C; *Eugenia caryophyllata* 7, 19; *Gliricidia sepium* 1; *Gnetum gnemon* 9; *Leucaena leucocephala* 2; *Nephelium lappaceum* 3; *Nephelium mutabile* 14, 15; *Mangifera caesia* 5; *Parkia speciosa* 10.  
(A, B, C): *Pandanus odoratus*, *Colocasia*, *Momordica charantia*, *Capsicum annum*, *Zingiber officinale*, *Musa paradisiaca*, *Cordyline fruticosa*, *Psidium guajava*, *Eugenia aquea*, *Musa paradisiaca*, *Capsicum frutescens*, *Eugenia caryophyllata*, *Ficus virens*.



of mango, rambutan or guajava. In many places however, space between houses is so confined that even frontyard garden do not exist. Most villagers just have a fence of medicinal or ornamental plants, or one clove tree.

### 2.3. Conversion of traditional gardens: extension of commercial tree-cropping

Garden conversion is also induced by the increasing priority of cash-generating activities in the agricultural economy. Traditional gardening appears more and more obsolete with too little economic profit, and gardens are now being converted into mixed plantations, dominated by new commercial tree crops.

#### 2.3.1 The transformation processes

Garden conversion often implies drastic modification of the traditional vegetation ensembles. However, some examples occur of integrated intensification processes: conversion there focuses on the development of the undergrowth ensemble (which is obviously under-exploited in traditional gardens) without any alteration of the upper ensembles (Fig. 4). Shade-tolerant crops with commercial value are usually limited, but several traditional plant species of shaded undergrowth appear to hold economic interest for Bogor markets. Some farmers have successfully developed commercial cultivation of certain Araceae species (*Xanthosoma* or *Amorphophallus* for their starchy tubers, *Alocasia* for leaves and petiol eaten as a green vegetable, *Arum*, *Aglaonema*, *Caladium* as commercial ornamentals), or of a Marantaceae species (*Halopogon blumei*), leaves of which are sold as packing material in village and city markets.

In semi-shaded places, development of the undergrowth ensemble can occur through intensive cultivation of coffee (*Coffea canephora*, var. *robusta*) or of traditional varieties of pineapple.

However, most of the intensification processes rely on the introduction of true light-demanding tree species, namely clove and nutmeg for export markets, grafted varieties of *Durio*, *Mangifera* and *Nephelium* for city markets, or exotic, fast-growing wood species: *Albizia falcataria* (Mimosaceae), *Maesopsis emenii* (Rhamnaceae), *Melia azederach* (Meliaceae), for regional and national markets. In order to create suitable niches for these species, farmers have to carry out important thinning in the traditional canopy ensembles.

Usually, 40 to 80% of the original tree stand is removed. As far as possible clearing is selective, and affects primarily minor fruit species (*Eugenia*, *Baccaurea*, *Pithecellobium*) and poorly-producing trees. Vigorous valued species are preserved (Fig. 5).

The transformation process is influenced by ancient techniques of shifting cultivation. Valuable wood is collected whereas branches and grasses are burned on the plot. Immediately after burning, short-cycle crops are established (banana and papaya for the city market, chili, cassava, vines and taro

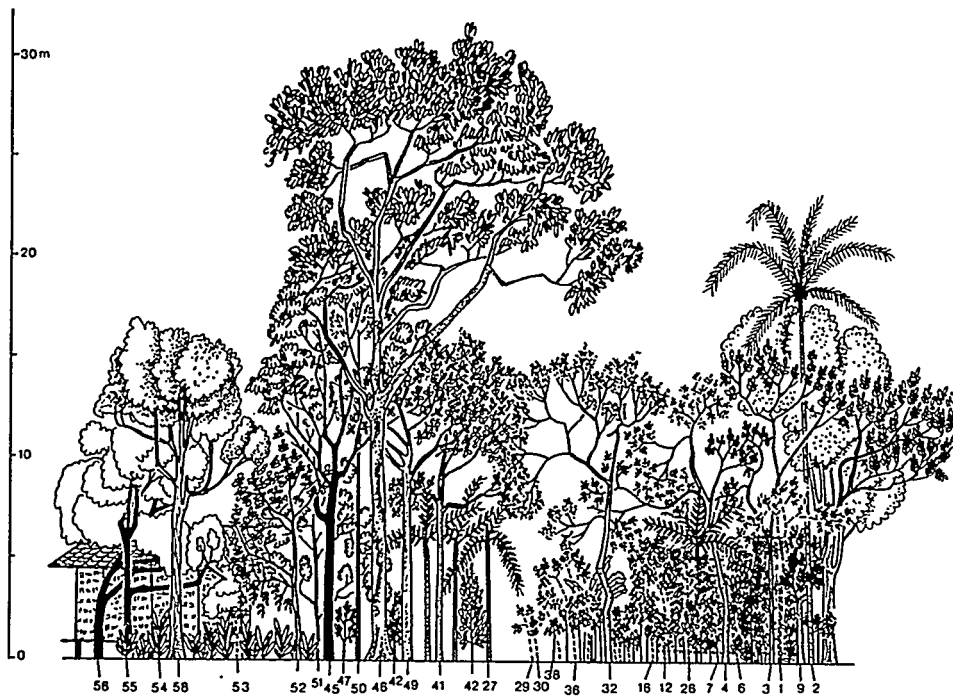


Fig. 4. Transforming traditional gardens: the intensification process, with shade-tolerant plants in the undergrowth.

*Baccaurea racemosa* 51; *Artocarpus heterophyllus* 9, 54; *Bouea macrophylla* 56; *Coffea robusta* 16; *Durio zibethinus* 26, 46, 47, 50; *Cocos nucifera* 2; *Halopegia blumei* 58; *Lansium domesticum* 55, 58; *Lansium domesticum* var. 1, 3; *Mangifera foetida* 29, 41, 49; *Nephelium lappaceum* 6, 16, 27, 52; *Myristica fragrans* 42; *Melia azederach* 32; *Persea americana* 53; *Pithecellobium lobatum* 4; *Tamarindus indica* 45.

for home consumption and village market, or coffee for home consumption and national market). Seedlings of commercial tree species are planted in between. This establishment process creates favourable growth conditions for the young trees: seedlings of commercial species benefit from the care (fertilizing and clearing) given to vegetable crops, whereas trees preserved from the former garden structure maintain a relatively humid microclimate on the plot and protect young seedlings against direct exposure to sunlight or heavy rains. It also secures immediate economic development: the mature preserved trees continue to yield fruits and wood for consumption or sale whereas the short-cycle crops soon provide additional income. The association with short-cycle crops is renewed regularly and maintained until the new commercial stand starts to produce (for about 4 years).

### 2.3.2. New garden types: commercial mixed-gardens

Seventeen of the 37 gardens plots purchased (for conversion or house



Fig. 5. The common conversion process: selective 'slash and burn' and replanting.

*Artocarpus heterophyllus* 7; *Baccaurea racemosa* 26; *Bouea macrophylla* 16; *Cocos nucifera* 4; *Durio zibethinus* 14, 27, 28, 29; *Eugenia polycephala* 8, 11, 13; *Eugenia caryophyllata* 1; *Garcinia mangostana* 22, 23; *Gnetum gnemon* 15, 21; *Lansium domesticum* 12, 17, 18, 19, 24, 25; *Mangifera caesia* 10; *Mangifera foetida* 2, 9; *Parkia speciosa* 5, 20 and *Capsicum annum*, *Myristica fragrans*, *Coffea canephora*, *Musa paradisiaca*, *Carica pepaya*, *Colocasia esculenta*.

building) within the last 15 years have been converted into a mixed-garden combining fruit trees and a nutmeg/clove stand (Fig. 6). The ensemble of emergent trees is commonly dominated by *Durio zibethinus* and *Parkia speciosa*, with a tree crown cover of 20 to 50% (Fig. 7). The main vegetation ensemble is a rather low canopy (between 5 and 15 m high) dominated by clove and nutmeg trees with improved varieties of *Mangifera indica* and *Nephelium lappaceum*. Its tree crown cover ranges between 50 and 75% (Fig. 7), so that the undergrowth is rather sunny. It is colonized by common heliophilous grass species (Poaceae, Melastomaceae, Asteraceae, Malvaceae) and is frequently used as a 'fodder ensemble' for village cattle: either sheep are allowed to graze freely in the mixed-garden or grasses are cut regularly and given to penned livestock.

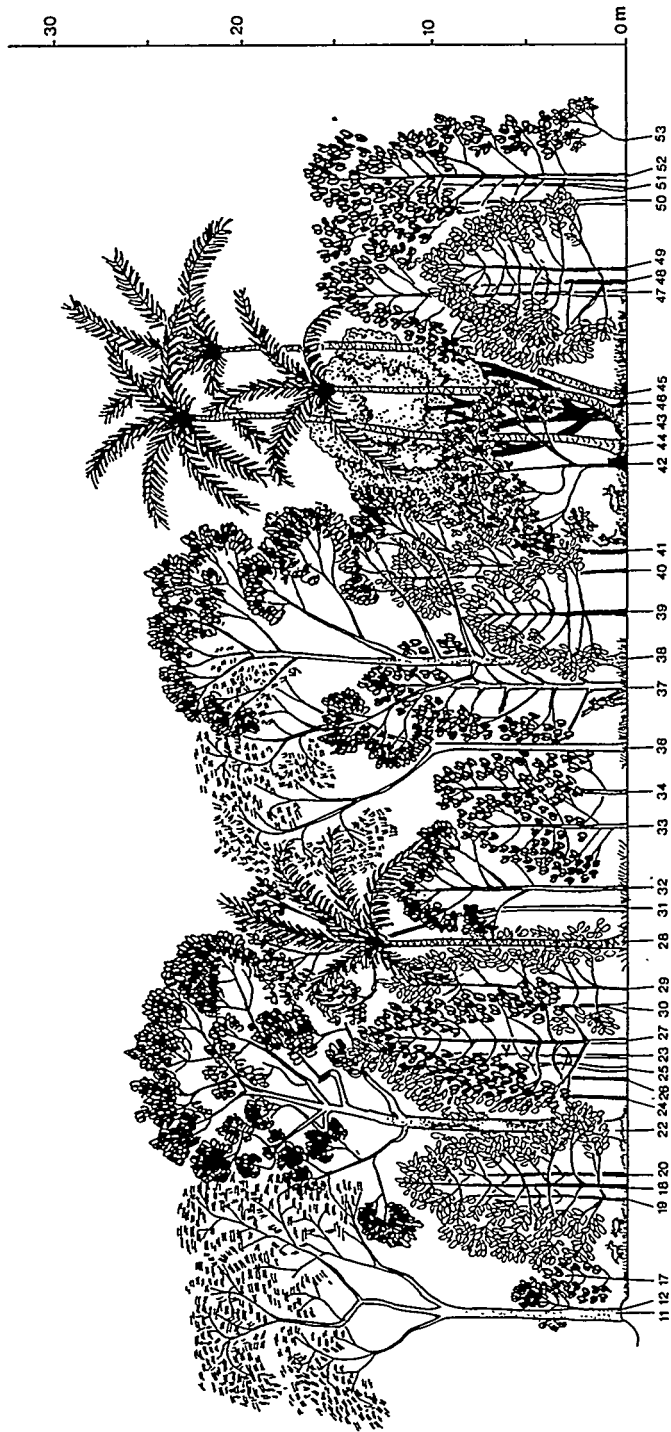


Fig. 6. New commercial mixed-garden: nutmeg and clove with fruit trees. *Baccaurea racemosa* 30; *Cocos nucifera* 28, 43, 44, 45; *Durio zibethinus* 12, 22, 36; *Eugenia caryophyllata* 17, 27, 33, 34, 37, 47, 50, 51, 52; *Mangifera indica* 21, 25; *Myrsitica fragrans* 18, 19, 20, 23, 26, 29, 39, 40, 41, 48, 49; *Parkia speciosa* 11; *Nephtelium lappaceum* 31, 42, 53.

Several other new gardens specialize in a mixed production of fruits and industrial light-wood for city markets. The fast-growing wood species mentioned above form a high canopy culminating at 25 to 30 m high, under which grafted varieties of fruit species may produce fully.

Some monospecific clove gardens have also developed, either on garden land or in open-fields. Cassava and taro may be interplanted occasionally with clove trees. New garden types are beginning to develop which specialize in orchid-growing for Jakarta markets.

#### 2.4. *Evolution in floristic and structural patterns: their biological meaning*

Traditional gardens have been established and managed by farmers for more than two centuries. Most fruit-tree species presently cultivated in traditional gardens have been taken from the original forest ecosystem, but for centuries new varieties have been developed and carefully reproduced through human and natural selection. Traditional gardens presently harbour a large collection of fruit-tree varieties, ranging from the wild type to improved cultivars, which represents a genetic reserve of extreme importance. Moreover, with their floristic richness and complex structure, they are the very last traces of the original lowland forest formerly prevailing throughout the area. Indeed, they still shelter self-established forest species, chiefly treelets, herbs and lianas or epiphytes, some of them being utilized by man, and therefore act as the last genetic reserve for certain original plant resources, native of the lowland forests of the area.

Traditional gardens also shelter some wildlife: birds, bats, insects, squirrels and civets, which are only a pale shadow of the original range once found in the area but play an essential role in biological processes such as pollination, natural hybridation and fruit dispersal.

The scattered conversion processes lead to the expansion of new structures in the village ecosystem. Similarity between garden and forest is lost and this biological simplification leads to important changes in garden ecology (Fig. 7).

As far as floristic composition is concerned, a drastic decrease in the number of forest species is observed. The direct elimination of minor tree species, along with the reduction of dark niches essential for the survival and reproduction of forest trees, shrubs and grasses, leads to an obvious genetic erosion. A whole forest heritage, which has been an essential asset in the success of traditional horticulture in Java, is being lost. Not only original cultivars of fruit species but also herbs and shrubs, used as nutritious greens or as valuable medicines, are bound for rapid extinction in the village. The consequences for future fruit-breeding as well as for the immediate maintenance of the sanitary and nutritional levels of villagers are serious. However, free land comprising banks of deep rivers and channels inside and around the village, also shelter most of these minor species; they could be saved more systematically as a valuable *in situ* reserve for vanishing species in the garden ecosystem.

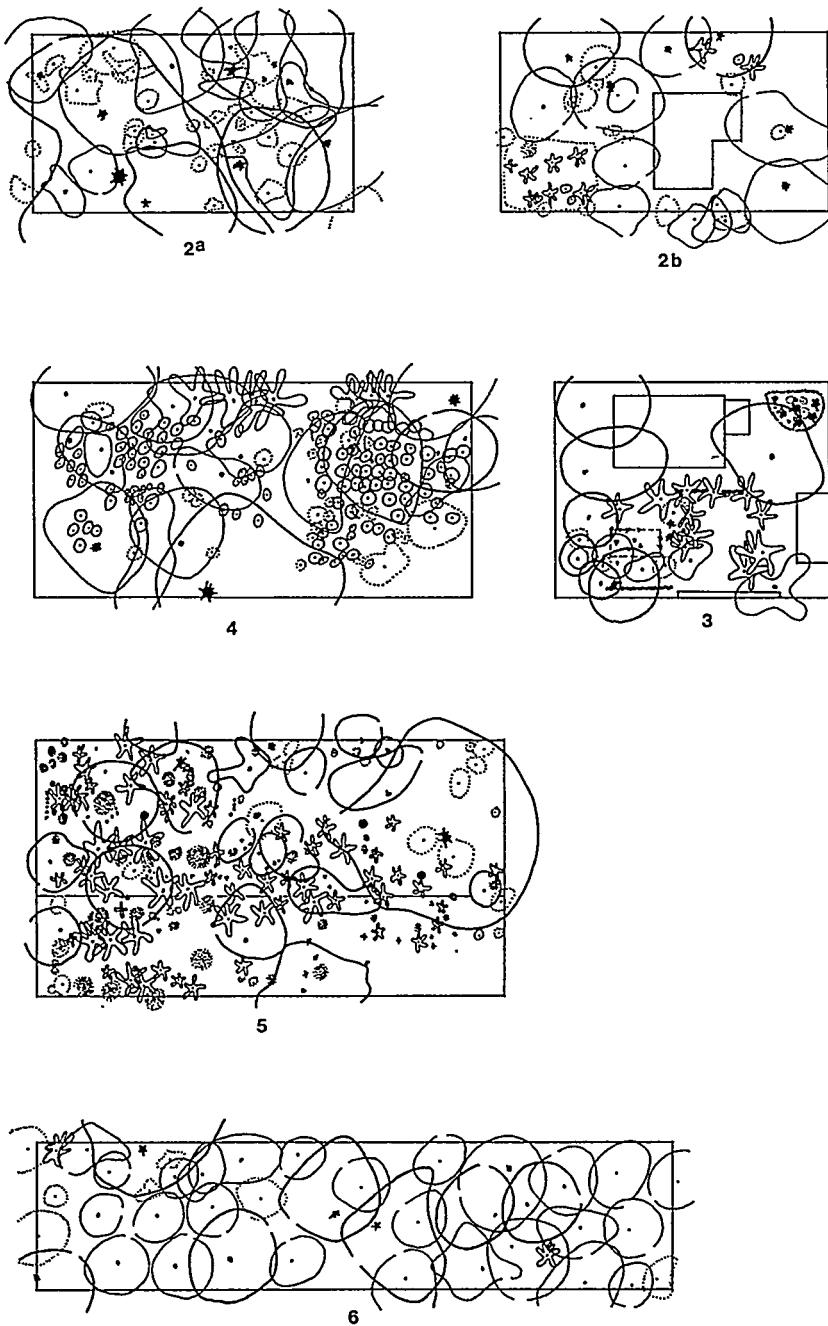


Fig. 7. Evolution of crown projection and plant coverage from (2a) traditional fruit forest, (2b) traditional home garden, to (3) new homegardens in dense settlements, (4) intensified homegardens, (5) converted gardens and (6) new commercial gardens.

The richness of plant associations inside garden plots also decreases (a maximum of 15 different species, including grassy weeds, are associated in converted gardens), and this impoverishment intensifies as intraspecific variability is reduced through systematic promotion of high-yielding varieties. A loss of biological diversity as well as biological weakening of introduced species is also observed: conversion promotes large populations of even-aged trees, and hardiness and adaptation to local ecological conditions are lost along with commercial selection. This may have direct consequences on the overall biological stability of gardens. Such homogeneous stands of high-yielding species are exposed to pests attacks while the increased scarcity of forest niches valued by insect predators or of insect repellent plants may intensify insect damage on garden and field crops.

### 3. Management practices in traditional and converted gardens

#### 3.1. *management of traditional gardens*

Traditional gardens produce and reproduce mainly on their own and require minimal human care. Natural processes of biomass production and regeneration prevail; management practices remain simple, occasional, and hardly interfere with the natural processes. The farmer merely channels production processes to his benefit (fruit or wood production) and orients reproduction processes to the benefit of selected species. Management of traditional gardens do not imply any global treatment of the vegetation. It consists of punctual operations affecting individual trees and seedlings: pruning of trees to increase fruit production, selection of saplings, light thinning of canopy trees or selective clearing of the undergrowth to stimulate growth of the valuable species.

Commercial species, fruits of which are exported to the city market, are reproduced through careful planting techniques (seed selection, cuttings or air-layering). However, most species reproduce through seeds of fallen fruits. Self-established seedlings are selected and protected from year to year and gradually constitute a pool of uneven-aged trees. This stock of growing trees (representing more than 50% of the total tree population over 1 m high) is used as a reserve of *in-situ* replacement trees and is a major asset in the maintenance of continuous production levels in the garden plot. As in a forest ecosystem, replacement trees can wait for years in the undergrowth until an opening in the canopy (through the death of a tree or induced thinning) allows them to develop to mature stage.

Biomass exportations due to man remain at low levels in relation to the total standing biomass. There is no use of chemical fertilizers, but regeneration of soil fertility is easily maintained through litter degradation (fallen leaves, branchlets, fruit pericarps) and regular soil enrichment punctually occurs with kitchen garbage and chicken or sheep faeces.

### 3.2. *Evolution of management practices in converted gardens*

If compared with traditional gardens, converted gardens appear as artificial tree structures established for a forced and selective biomass production. Success of this production system implies important and regular technical control over production and reproduction processes.

Sustained production levels are maintained by regular inputs of chemical or organic fertilizers. However because of the imbalance between high rates of exported biomass (fruits, grasses, wood) and cycled biomass (leaf litter only), and owing to the economic problems inherent in fertilizer use, maintenance of soil fertility in the long term may be in danger.

The traditional strategy of tree-by-tree replacement is still observed for fruit species and, to a lesser extent, for wood species but it does not occur for export tree crops which are mass-treated like any commercial field crop (i.e. with global stand elimination and massive replanting). Continuity of production levels over time is no longer ensured, which may have important economic implication for households.

## 4. Economic use of gardens

### 4.1. *Multi-purpose dimension of garden production*

Traditionally, gardens are designed to provide all the products necessary for daily life, except for the staple food. This is achieved through both the floristic richness of the garden's vegetation and various purposes of most garden species.

#### 4.1.1. *Fruit production*

No less than 70 fruit tree species are found in the gardens. Among them are the famous asian fruits like durian, mangosteen, rambutan, langsat, but also a huge variety of lesser known fruits ranging from fresh, juicy fruits (36 species and many varieties) which are important sources of vitamins and minerals for the villagers, to seeds and pods (*Pithecellobium*, *Parkia*, *Leucaena*, *Pangium*, *Gnetum*, *Tamarindus*) which supply both proteins and fats. Most species are seasonal, and the main fruiting season occurs between November and April. During this period, the diet of all villagers changes considerably, and this is reflected by a much healthier look of children as well as adults.

In modernized gardens, traditional varieties and species of fruits are lost. This, together with the strong market orientation of fruit production, leads to obvious changes in the level of fruit and vitamin consumption by most of the villagers.

#### 4.1.2. *Vegetable production*

Pure vegetable and starchy species (taro, cassava, legume vines, cucumbers



and allies) are not common in traditional gardens: preferably they are grown in open-fields often in association with papaya. Traditionally most of the vegetable consumption is of wild species: young leaves and shoots of undergrowth shrub and grass species (fern species, *Ficus* spp., some Euphorbiaceae like *Sauropus androgynus*, *Glochidion borneense*, *Phyllanthus niruri*, *Claoxylon indicum*, *Bridelia monoica*, some Labiaceae, Asteraceae and Verbenaceae) make up at least 70% of the vegetable supply in the daily diet of villagers. Many fruit tree species also provide additional 'greens', consumed either raw or boiled: young leaves of *Mangifera caesia* and *M. foetida*, leaves and inflorescences of *Gnetum gnemon*, stamens of durian flowers, flower buds of some varieties of banana trees. Shoots of some bamboo species (*Dendrocalamus asper*, *Gigantochloa apus*, *G. ater*, *G. verticillata*) are also regularly consumed.

New trends in vegetable production in home-gardens are apparent. In new settlement areas these often include edges or protected beds of vegetable species (legume vines as *Cajanus cajan*, *Dolichos lablab*, *Vigna unguiculata*, *Psophocarpus tetragonolobus* for pods and leaves, tomatoes and varied egg-plants or allies, some Cucurbitaceae like *Cucumis sativus*, *Cucurbita moschata*, *Momordica charantia*, *Sechium edule* for boiled fruit). New mixed-gardens also integrate some intercropping of vegetables, mainly chilis, taro, and varieties of sweet cassava grown for leaves, usually for village or city markets.

#### 4.1.3. *Animal production*

Fish breeding is the main form of animal production. Many gardens, specially those located near houses, include a small fishpond which is used for both fish-breeding and toilet or bathroom. Fish is reserved for home consumption. Some larger ponds have been established near the village channels, specializing in commercial fish-breeding for Bogor market.

Poultry is the common animal component of the gardens, whereas sheep and goat breeding, derived from traditional gardening, is much developing. Livestock in Cibitung amounts to 500 heads, and 50% of families in the village own some animals. These are usually kept permanently in bamboo shelters located near the house and fed with fresh grass collected from the garden's undergrowth, supplemented by cassava leaves.

By-products of animal production (cattle manure and mud of fishponds) constitute an important fertilizer, used mainly for commercial crops in either gardens or open-fields.

#### 4.1.4. *Wood and other material*

Traditionally villagers in Bogor area do not grow trees for wood: bamboo constitutes the main building material. Whole culms provide frames for houses and animal shelters, pillars for bridges, pipes for the irrigation networks in the rice-fields as well as in the village; splitted and plaited culms are used for flooring and walling purposes.

Additional building material is supplied by hard-producing fruit trees: *Mangifera* and *Baccaurea* yield a hard and durable wood for houses piles, durian wood can be cut up in boards and used for various purposes, that of jackfruit makes the best handles for agricultural tools.

Lastly, gardens provide firewood from old trees and dead branches. However, gardens presently supply less than 30% of the fuel consumed in the village. This has to be supplemented by dried stems of cassava and people rely more on oil stoves.

Gardens also provide a wide variety of medicinal plants commonly used in the village.

#### 4.2. *Commercial gardening*

Garden conversion is accompanied by specialization in economic uses. Except in newly established home-gardens the proportion of produce allocated to home-consumption is usually reduced while commercial production is promoted. Present commercial orientation has two complementary aspects: fruit production, aimed at a local, fully expanding market, and production of export crops, aimed at a profitable but highly unpredictable market. This commercial orientation has led to a significant increase of household income: for 53% of the village families, their garden supplies between 15 and 25% of their total annual income (including that from other agricultural activities as well as all forms of wages).

##### 4.2.1. *Development of commercial fruit production*

Development of fresh fruit production was initiated about 20 years ago, with the rise in demand in Bogor and Jakarta for fresh agricultural products. Within the last 20 years, fruit prices have soared 15 times faster than rice price, and they have increased ten-fold since 1976. Durian and *petay* are the main commercial fruits: 70 to 90% of the total production is marketed and provides more than 65% of the total income supplied by gardens for the whole village. Of other fruits such as mangosteen, rambuttan, *duku* and mangoes, between 40 to 80% of the yearly production is marketed.

The fruit trade is handled completely by the villagers. Marketing channels from producer to consumer comprise only one or two middlemen, who are salesman from the village, sometimes themselves fruit-producers. This marketing system, in which villagers play an important part in the negotiations of market prices also allows a better development of prices for the producers. Profit margins for the trader vary between 10 and 25% in Bogor markets, and between 15 and 100% on Sunday markets visited by Jakarta people.

As clove production is losing its interest (see below), development of fruit production intensifies, and specially that of durian for which prices are increasing from a fruiting season to another and reached between 5 and 7 US\$ per fruit in Jakarta in 1992.

#### 4.2.2. *Export crop production*

Export crop production concerns mainly clove, nutmeg and coffee. Whereas coffee has been grown in the village for a long time, cultivation of nutmeg, and particularly of clove, has really spread from 1975 to 1985.

Coffee is usually grown on a small scale on the edges of traditional gardens or of home-gardens, mainly for home consumption or for sale in village shops. It is also grown as a transitional crop, during the process of garden conversion, for regional trade.

Commercial production of clove spread like a disease in Cibitung and surrounding villages from 1976. In 1974, clove production started to be subsidized by the government in order to boost national production,<sup>2</sup> prices have been artificially raised 10 times between 1974 and 1976, and 10 times again between 1976 and 1980, where it reached the maximal price of 10 to 12 US\$ per kg. In spite of regular price drops from 1980, in spite of the sometimes dramatic disease which appeared in the area since 1985, production of clove has been, for the last 15 years, the main target of most garden conversions, whereas clove trees were also planted on a small scale in traditional gardens or in home-gardens. Until recent years, even poor farmers could expect to make quick profits from clove, and clove trees have even been established in the confined space between houses in dense settlements. However, drastic changes concerning clove market have occurred recently, and clove planting is no more profitable.

#### 4.3. *Household economic strategies in gardening*

##### 4.3.1. *Traditional management of garden produce*

Traditionally, gardens are managed so as to protect the economic independence of families. As an essential complement to rice-growing, gardens provide, all year round, basic complementary food and material products. Moreover, and this is an essential asset of traditional tree-cropping in Indonesia, the garden still acts as a 'forest substitute', allowing some gathering activities opened to everyone in the village. This aspect is not simply frivolous. It must be considered of meaningful importance for low-income households since it provides irreplaceable additional products, such as wild vegetables, medicinal plants and light material, for daily life.

Traditional gardening is conceived of as a low-risk agricultural strategy and gardens act as a security investment for daily life. The variety of garden plants, the multi-purpose dimension of many species, and the related multiple-production function of the garden as a whole reduces the economic risks of total failure while ensuring a certain continuity in garden production. All year round there is something to be harvested, consumed or sold from the garden, which is vital since, for most households, economic strategy is on a day-to-day basis, and their savings capacity (in food or in money) is very low. The proportion of garden produce sold in the market varies according to house-

hold needs and availability of food and capital, and garden income is usually allocated to common expenses. In case of an unexpected expense, a commodity such as bamboo can be sold.

#### 4.3.2. *New economic strategies linked to commercial gardening*

With garden conversion, the multi-purpose dimension of gardens is lost. Converted gardens do not supply either basic complementary products or those minor 'forest' products mentioned above. Daily complementary food and material have now to be purchased from village salesmen or from Bogor. The basic economic independence of families is reduced drastically.

Presently, gardening and associated activities are strategies for raising income and for capitalization. With the success of commercial tree growing, gardening can easily raise high returns on minimal investments in money, time and labour. Moreover, garden management, which requires only part-time work, can easily be associated with another economic activity (agricultural or urban labour, or private business), the profits from which cover the basic expenses of the household.

Income provided by fruit or clove production is both important and seasonal. Once a year, the farmer has a large capital sum in hand, which is of essential importance in a society where household economic strategies have rarely succeeded in developing a policy of money savings. Moreover, standing production can be sold to traders several months before harvest, thus providing large amounts of money off-season. This annual income may be partly allotted to common expenses, but as daily expenses are generally met from some other economic activity, preferably it is saved for further investments (see Section 5).

For the poor who do not own garden land, keeping livestock under a 'sharecropping' arrangement provides good way to raise some income. The tenant is charged to look after and feed the animals and in return he receives half of their off-spring. Keeping several animals under such agreements require minimal investments in time and labour, but do not involve any capital, since animals are fed on grass collected from rice-field banks or in the gardens. The sale of the new-born animals creates an initial capital sum (Section 5).

However, specialization leading towards commercial production and the related loss of economic diversity entails an important increase in economic risks. For most fruit species, production is rather unpredictable from one year to another, and the annual income may vary greatly. However, risks are spread somewhat since commercial fruit production relies on several different species. Export crop productions are both seasonal and highly speculative, so that profits can suddenly drop (or increase). Moreover, farmers cannot exert any control over prices, except by storing a part of the harvest in case of a price fall. The best example is clove, prices of which soared significantly from 1974 to 1980, and then dropped, from more than US\$ 10 kg in 1980 to less than 10 cts kg in 1992.

#### 4.4. *New economic assets of gardens*

Gardens presently play an important role in the development of monetary flow between villagers: garden land, trees and tree produce become exchangeable assets and can serve as a base for monetary transactions. This affects both traditional and converted gardens.

##### 4.4.1. *Monetary dealings concerning trees*

Trees can be 'pawned' through special agreements called *gadai*. 'Pawnbrokers' (any villager with funds available can become a pawnbroker) provide loans of several hundred US\$ for one tree for an undetermined period (at least one fruiting season). Fruit production serves as yearly interest for the creditor, who for the whole period of pawning can use the tree for his own convenience, except for selling or felling it. The agreement ends as soon as the owner refunds all the money to the creditor. Usually, the sum of money involved in the *gadai* agreement amounts to the value of one fruit crop, which is important, and it is unfair to the owner if the agreement lasts for more than one year. Usually, villagers who use their personal funds in a *gadai* agreement make a good profit. The *gadai* strategy is essential in the new processes of capitalization (see Section 5).

##### 4.4.2. *Garden conversion and the development of a land market*

Traditionally, gardens (land and trees) are considered a family patrimony. In Cibitung, use and inheritance of a garden plot from one generation to another used to be ruled by traditional laws on land tenure which are based on kinship rights and Islamic laws of succession. Gardens were managed in the long term as inalienable property: villagers who inherited a piece of garden land had rights to harvest and use or sell the produce, but not to sell trees or land.

A shift in the status of garden land has been observed for several years. The success of new economic strategies in gardening that accompanied garden conversion, induced an increasing demand for trees and garden land which presently hold a trade value as both capital and production assets.

Demand for garden land comes from medium-class families (landowners, wage-earners, shopkeepers) who have started to raise surplus funds and wish to invest in commercial agriculture (see Section 5). For those families, purchasing a piece of garden land is easier than acquiring an open-field plot. It is almost impossible to get a field for less than US\$ 1,000, whereas a small parcel of garden land can be acquired for US\$ 400. This increasing demand is met both by medium-class families who have to face unexpected expenses and landlords who, pushed by needs of money for important investments (see Section 5), gradually sell their gardens in small parcels.

Transfer of a garden parcel often goes along with conversion: 90% of the parcels purchased during the last 20 years are pieces of traditional gardens and 45% have been converted into commercial mixed-gardens, whereas only

15% have been modified to allow house building. Increasingly, development of the land market acts as a speeding-up process for garden conversion.

Moreover, trees can now be owned individually. With the continuous parcelling of garden plots created by the inheritance system, the point is being reached where small garden plots cannot be further sub-divided, and an inheritance may consist of only individual trees. As landed properties, trees can then be sold independently of the land on which they grow. Access to private ownership of individual trees through purchase, which is much easier than access to garden land, is an important present trend.

## **5. Gardening and the present changes in the socio-economic and socio-professional organization of village society**

Changes of garden status and gardening strategies have direct consequences on the development of Cibitung social and economic organization. Garden conversion, which is determined by national economic changes is a major determining factor in reshaping the hierarchy and rules of village society.

Increasing population pressure and the rapid development of market economy are the two combined factors that bring socio-professional changes to most villagers. As agriculture can no longer provide food and jobs for all villagers, many have to depend more and more on urban labour, or to turn to other non-agricultural activities: fisheries, animal husbandry, trade, craft, all of which require available funds for initial investment.

Commercial gardening plays a double role in the socio-economic and socio-professional conversion processes in Cibitung's society. The development of commercial horticultural production creates new job opportunities for the villagers, and management of commercial gardening, which creates new opportunities for successful monetary strategies, allows valuable socio-professional improvement in peasant life.

### *5.1. Vanishing social functions of gardens*

Traditionally, garden plots are never enclosed. Everyone is allowed to pass by, village children have free access to non-commercial fruit trees and landless persons are invited to collect minor products not needed by the owner. This has two important implications. Firstly, there is a re-allocation of garden produce, which is vital considering the disparity of landed property distribution among villagers. Such additional products as deadwood, wild vegetables, some fruits, grasses, are shared out to the poor, and in return it increases the landlord's prestige. Secondly, there is free access of living space for all villagers, which previously was essential since most of the garden area was owned by a few landlords.

Most unconverted gardens have kept this original quality, inherited from the times of 'communal' forest space, open to everyone for living and

occasional gathering. However, garden conversion is accompanied by a strengthening of the notion of private property. Converted plots tend to be fenced-in, specially clove gardens which are protected by barbed wire. This drastically reduces the space available for daily life and for free movement of villagers.

Lastly, re-allocation of garden land through the market and development of new economic criteria of success in gardening have important consequences on the social hierarchy. Traditional power used to be held by religious leaders and landlords, but this may be modified with the emergence of a new class of economically and financially powerful villagers.

## 5.2. *Commercial gardening and the development of primary and secondary horticultural production*

The use, transformation and marketing of garden produce have developed different sectors of activity in the village.

Bamboo processing has long constituted an important handicraft activity in the village, and several families have full-time employment, splitting and plaiting culms for house walls and floors. Several sawyers and carpenters work in the village and get most of their work from local wood producers.

Fruit production provides various forms of temporary employment. Since fruit producers themselves do not generally dispose of their garden produce, they have to rely on hired labour for activities involved with the harvest (tree climbers), transport (*pikulan*, who convey fruits in bamboo baskets to the Bogor markets) and marketing of their fruits. With the recent development of intensive fruit production for city markets, activities associated with the fruit business have contributed greatly to providing employments for young villagers. The associated activities of fruit production, from their harvest to sale in Bogor markets, presently employ more than 30% of the active population in Cibitung. This is very important as the agricultural sector supplies fewer jobs since cassava has been substituted for rice in open fields.

Development of commercial tree cropping in the Bogor area has resulted in an increased demand for seedlings of commercial species. As a sideline of gardening, some villagers started developing nursery enterprises, mainly for seedlings of clove, exotic wood species, and durian, in small, enclosed parcels in their garden.

## 5.3. *Garden conversion and socio-professional effect*

### 5.3.1. *Socio-professional changes resulting from garden conversion*

All the landowning groups could benefit from the improvement in clove and fruit prices but some social groups have exploited the financial opportunities given by commercial fruit-growing and garden conversion, more readily than others.

The few landlords in Cibitung have benefited doubly from the garden

conversion process. Most have divided their traditional garden into small plots and sold part of it keeping the rest for themselves. These parcels they have gradually converted, and through successful management of the profits from converted gardens and sales of garden land, some owners realized real professional improvement within 10 years. Large-scale fish breeding in the village, trade business in Bogor, have flourished through a series of investments. Today these businesses of these landlords have become their main economic activity (in terms of time allotted to work and of obtained profits), whereas gardening is carried out as a sideline aimed at providing additional annual income to be saved or re-invested.

For those who own only a small piece of garden, profits from garden conversion are not sufficient to allow important investments. Money is usually saved as a capital investment for their children. Investments allotted to garden conversion allow socio-professional improvement of the next generation.

### 5.3.2. *Garden conversion and the development of the poor: livestock, trees and access to land ownership*

The losers in this process are those who have little or no access to land-ownership, who did not receive any original capital. The poorest landowners, the agricultural wage-labourers, and their children, who comprise the bulk of the population, usually have no savings capacity. It is impossible for them to plan any money investment, even a short-term one.

However, some shrewd young people, sons of temporary wage-labourers in cassava fields, who had neither family patrimony nor particular funds, have achieved astonishing socio-professional success within 10 years. Livestock, trees and gardens are the keys of their success. They first obtained funds from keeping livestock, generally sheep, on a sharecropping agreement. After several years of this animal husbandry, sufficient funds can be secured to invest in a small-scale fruit business.

Yearly profits from the sale of a lamb can also be invested in the money market. The cash value of the sale of 2 or 3 lambs is equivalent to the loan value linked to the pawning of a valuable fruit tree: thus, selling 2 lambs allows providing a loan of US\$ 30 to 50 to a garden owner, for a *gadai* agreement, which can bring control of one durian or one clove tree, crops of which first refund the initial investment, and then supply new funds. Profits thus provided by successive crops and by the final re-imbursment of the loan by the tree owner are important and can be invested in tree (or garden land) purchase.

This process of progressive fund-raising and investments require a judicious management of profits, which is a new way of thinking in Cibitung's society. It has led to some spectacular bankruptcies, but also to some real successes, as seen in the following example:

Mr X, son of a landless farmer, began by keeping 3 goats under a sharecropping agreement in 1972. In 1973, profits provided by the sale of the



offspring (US\$ 70) were loaned to a garden-owner through a *gadai* agreement: Mr X assumed the control of one durian tree. Funds obtained the first year from the sale of the durian crop allowed him through another *gadai* agreement control of a *petay* tree. Between 1974 and 1978, other *gadai* agreements were concluded and Mr X assumed control of 8 trees (4 of which were clove trees). At the same time, additional profits were used for wedding expenses (US\$ 90), house building (US\$ 500), and for investments in the fruit business (US\$ 40). In 1979, Mr X could buy a durian tree (US\$ 350), and in 1980, with the final re-imbusement of 4 *gadai* contracts, he bought a piece of garden land (US\$ 800). From 1980 to 1983, he concluded other *gadai* agreements with garden owners, which allowed him to buy a small shop in the village (US\$ 490), to enlarge his house, and to buy 3 goats. Within 10 years, Mr X, starting from nothing, became a garden-owner and succeeded in developing complementary activities: garden conversion, fruit business, shopkeeping and cattle breeding.

## 6. The role of garden conversion in the new balance between villages and city

In this area of West Java, where many unavoidable problems due to urban expansion (in terms of population pressure and market organization) threaten the balance of traditional agriculture and of rural society itself, the definition of new types of relations between city and village seems possible through the development of tree gardens.

Population increase in the area and expansion of the city result in greater demand for building-land from city-dwellers wishing to live in the countryside. However, the revival of garden land as valuable agricultural land, which is evident in the intensified market in land between villagers themselves, should be able to restrain, at least for some years, the process of appropriation of village land by non-village residents.

Garden conversion itself induces a new balance in the relationship between city and villages. In offering fresh fruits and vegetables of high quality, garden conversion stimulates a demand from urban markets, which consequently leads to the development of associated activities in the village. The city is more and more dependent on fruit-producing villages, but still cannot expect to exert any control over these villages. Peasants have to follow demand in adopting new varieties or abandoning several, less appreciated, species, but, because of the organization of trade channels, they still control prices. Some traders specialize in sales at Sunday markets, which are visited mainly by Jakarta residents and are much more profitable, maintaining a policy of high prices.

Lastly, through gardening and related activities, most villagers can escape from complete integration into the city through urban labour. Less than 10% of the active population in the village depend totally on urban jobs, and only

4.5% are wage-earners in the city. Moreover, gardening, which does not require full-time work, can be associated with another economic activity (in village or city enterprises): 35% of the villagers have two separate jobs, which secure both higher income and valuable liberty.

## Conclusion

Agriculture in the area of West Java has long reached its limits of expansion, and now struggles to find new strategies for intensification. Open-field culture, which was transformed several decades ago with the replacement of subsistence rice-growing by commercial cassava cultivation, no longer offers new jobs or profit opportunities. Village tree-gardens presently appear to be the very last place for further agricultural intensification: through gardening, farmers can still find agricultural answers to problems hanging over the rural economy.

Garden conversion plays a fundamental role in the adaptation of village society to a modern economy in the context of high population pressure. The development of commercial tree-cropping gives rise to and supports meaningful socio-economic changes at the village and household levels.

Fruit-growing, which was up to the present time related to a subsistence economy and treated as a gathering activity, is presently managed as a proper agricultural activity related to the production economy. Through garden conversion, the potential productivity margin (in terms of income per ha) of garden land is consequently increased, which is essential since availability of land is the main limiting factor in agriculture in the whole island of Java. Gardening tends to be more valued than open-field agriculture, and the sudden development of a garden land market reflects the priority being given to tree-growing. Garden landowners will soon become powerful in the village economy, and consequently, will play an important part in the organization of village society.

Socio-professional changes which accompany garden conversion have already changed the traditional structure of Cibitung society. Garden conversion and the associated importance given to capital and saving result in the development of non-agricultural activities. Profits obtained through gardening allow diversification of economic enterprises in household strategies. A new socio-economic class arises, which appears to become rapidly dominant. It is composed of people with two professional roles, relying on both agricultural and commercial activities, who are able to make quick profits.

The success of this socio-professional transformation seems relatively independent of earlier social conditions, as it involves landlords as well as children of the lower social classes. However, a significant part of the village population, mostly from the ranks of agricultural wage-earners and poor farmers, are still unaffected by these processes of capital and socio-profes-

sional change. The less endowed and the less inventive do not seem change, and many are forced to look for a better life in Bogor or in Jakarta.

Tree gardens in this area, commonly assimilated to age-old models of low-income agricultural strategy, have withstood the test of modernization.

In most of the conversion strategies presently observed, gardens largely lose their original features: biological diversity and the related multipurpose dimension in household economy. However, in no way does garden modernization proceed uniformly. The establishment of monocrop gardens remains an exception in the conversion process, while different types of tree-associations, several plantation models (and related economic options) are promoted. As in traditional gardens but to a lesser extent, the new village gardens still constitute a diversified world which cannot be given over to a single crop or a single economic policy. Formerly, village gardens were an essential complement to openfield culture and gardening assumed a meaningful role in the balance of economic strategies by poor families. At present, gardens either support or supplement non-agricultural activities, and gardening remains more than ever at the very heart of the economic strategies of all village social classes.

### Acknowledgement

Warm thanks are due to Sue Kenyon who kindly checked the quality of the English of the manuscript.

### Notes

<sup>1</sup> Sundanese people traditionally occupied the whole Province of West Java.

<sup>2</sup> Clove is intensively used in Indonesia for manufacturing *kreték* cigarettes.

### References

- Bahri S (1984) *Plantes utiles de sous-bois: une perspective en agroforesterie* DEA Univ Montpellier, France
- Budowski G (1990) Home-gardens in tropical America: a review. In: Landauer K and Brazil M, eds, *Tropical Homegardens*, pp 3–8. The United Nations University, Tokyo, Japan
- Christanty L (1990) Home-gardens in tropical Asia: a special reference to Indonesia. In: Landauer, K and Brazil, M, eds, *Tropical Homegardens*, pp 9–20. The United Nations University, Tokyo, Japan
- Mary F (1986) *Agroforêts et sociétés: étude comparée de trois systèmes agroforestiers indonésiens*. Th Dr Ir ENSA Montpellier, France, 2 vols
- Mary F (1987) *Agroforêts et Sociétés: analyse socio-économique de systèmes agroforestiers indonésiens*. INRA-ENSA, Série Notes et Documents no 81. ENSA, Montpellier
- Michon G (1985) *De l'homme de la forêt au paysan de l'arbre: agroforesteries indonésiennes*. PhD thesis Univ Montpellier, France

- Ninez V (1984) Household Gardens: Theoretical Considerations on an Old Survival Strategy. 'Potatoes in Food Systems Research Series', report no 1, Int Potato Center, Lima
- Okigbo BN (1990) Home-gardens in tropical Africa. In: Landauer K and Brazil M, eds, Tropical Homegardens, pp 21—40. The United Nations University, Tokyo, Japan
- Price N (1982) The Tropical Mixed-Garden: An Agroforestry Component of the Small Farm. CATIE, Turrialba, Costa Rica
- Soemarwotto O and Soemarwotto I (1981) Home-gardens in Indonesia. Paper presented at the IV Int Congr for Pacific Science, Singapore, Sept 1981
- Stoler A (1989) Garden use and household economy in rural Java. *Bull of Indonesian Economic Studies* XIV(2): 85—101
- Terra GJA (1953) Mixed-garden horticulture in Java. *Malayan Journal of Tropical Geography* I: 33—44
- Thaman RR (1990) Mixed home-gardening in the Pacific Islands: present status and future prospects. In: Landauer K and Brazil M, eds, Tropical Homegardens, pp 41—65. The United Nations University, Tokyo, Japan