6
Traditional Agroforestry in West Java: The *Pekarangan* (Homegarden) and *Kebun-Talun* (Annual-Perennial Rotation) Cropping Systems

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Indonesia is an archipelago of some 13,000 islands, a total land area of approximately two million km². The total population is about 200 million and is increasing at 2.32 percent per year. The population is not evenly distributed among the islands, Java and Madura having 64 percent of the population on only 6.95 percent of the country's total land area. The population density in Java averages 700 inhabitants per km², with an average household farm size less than 0.5 ha.

A shortage of food has become an increasingly serious problem in recent years, and both expansion and intensification of land use, particularly rice production, will be necessary to overcome it. Since most of the lowland agricultural areas are already under intensive farming, expansion is impossible, and an inward expansion by fragmentation of existing farms is necessary. The average farm size continues to decline, and the number of landless laborers and rural poor continues to increase, even though the majority of the population on Java still obtain their livelihood from farming (Soemarwoto 1980).

Upland farming has become increasingly important as a source of food and income in recent years as landless farmers have moved onto lands such as steep slopes or forest reserves that were previously considered too poor for cultivation. Without proper agricultural and soil management practices, however, serious soil erosion and deterioration of water resources may occur when upland areas are put into intensive agricultural production (Soemarwoto 1980). There is therefore a need to devise and put into practice upland farming systems that can provide sustained yields without causing environmental degradation.

An appropriate upland farming system should satisfy the following criteria:

- Ecologically, the system should protect the soil from erosion, and it should provide sustained yields without causing environmental degradation.
- Economically, it should increase the carrying capacity of the ecosystem and should give a long-term livelihood to the people.
- Psychologically and politically, the people should be able to relate to it. Peasant farmers operate on the basis of traditional knowledge and personal experience. Improved versions of traditional farming systems have better prospects for adoption than totally new cropping systems (Valdes et al. 1980).

THE ROLE OF KEBUN-TALUN AND HOMEGARDENS IN THE JAVANESE LANDSCAPE

There are already traditional agroforestry systems in Java that have fulfilled these needs for centuries by combining agricultural crops with tree crops or forest plants (Bene et al. 1977, Wiersum 1982). The two most common agricultural systems in West Java, aside from rice fields, are both agroforestry systems:

1. *Kebun-talun* (rotation system between mixed garden and tree plantation)—A traditional system that increases overall production and serves multiple functions by *sequentially* combining agricultural crops with tree crops (Soemarwoto 1984); and
2. *Pekarangan* (homegarden intercropping system)—A traditional system located in the village that provides both subsistence and commercial products and serves multiple functions by simultaneously combining agricultural crops with tree crops and animals (Soemarwoto and Soemarwoto 1985).

The *kebun-talun* and *pekarangan* systems are products of centuries of trial and error that have adapted them to the environmental, social, cultural, and economic realities of village life while fulfilling a variety of subsistence needs. It is important to understand traditional systems of land management, such as *kebun-talun* and *pekarangan*, and how they function in order to draw upon the best in the traditional systems when modifying or improving Javanese agriculture.

Kebun-Talun

The *kebun-talun* system usually consists of three stages—*kebun*, *kebun campuran*, and *talun* (Figure 6.1)—each stage serving a different function. *Kebun* is the first stage, usually planted with a mixture of annual crops. This stage has a high economic value since most of the crops are sold for cash. After two years, tree seedlings have begun to grow into the field, and there is less space for annual crops. The *kebun* gradually evolves into a

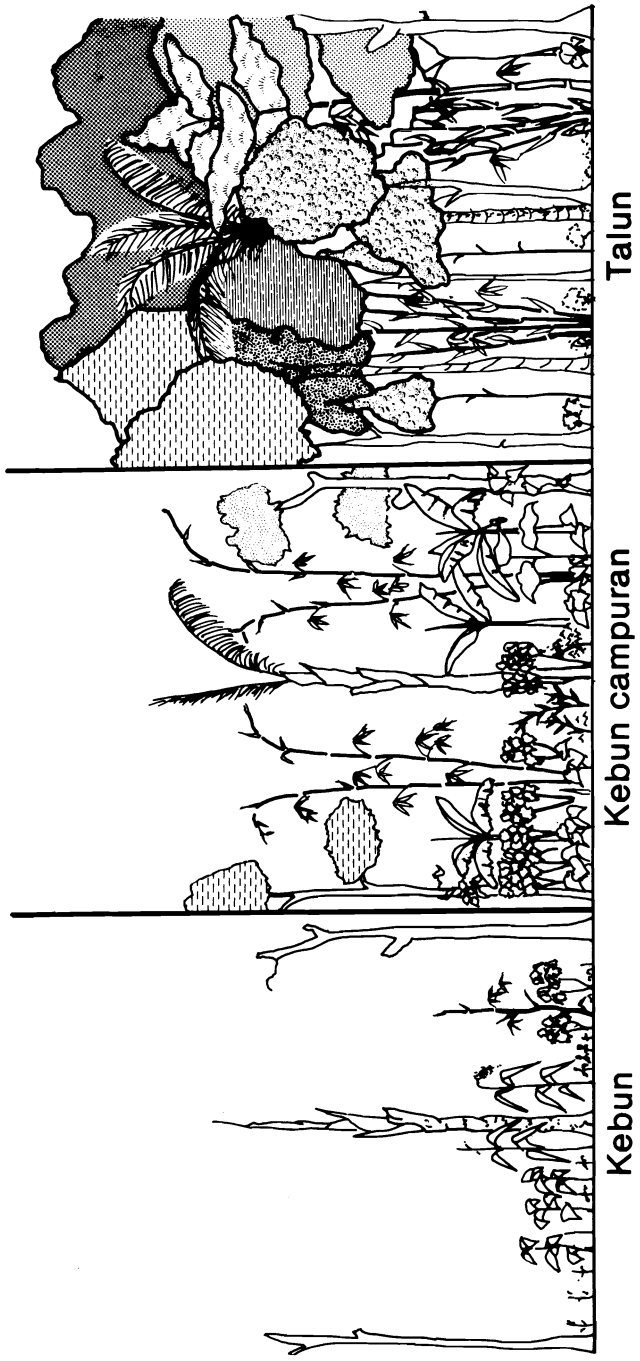


Figure 6.1. Successional Stages of the *Kebun-Talun* System

Source: Isnawan 1980.

kebun-campuran, where annuals are mixed with half-grown perennials. The economic value of this stage is not as high, but it has a high biophysical value as it promotes soil and water conservation. After harvesting the annuals, the field usually is abandoned for two to three years to become dominated by perennials. This stage is known as *talun*, and this stage has both economic and biophysical values.

In areas where irrigation is available, most of a family's carbohydrate is produced in *sawah* (rice paddy). In other areas, where irrigation is not in practice, farmers clear forest to cultivate field crops *(kebun)* or *huma* (dryland rice cultivation) as the first stage of shifting cultivation. The *kebun* or *huma* may be followed by a forest fallow, but the *kebun-talun* system replaces the secondary forest fallow with a tree plantation *(talun)* that resembles a forest. The *talun* has evolved as shifting cultivators selected the forest plants in their fallow, including new species introduced from elsewhere. Thus, a new and adaptive shifting cultivation system has formed by selecting particular tree species for the "fallow" and shortening its duration.

Homegarden (Pekarangan)

The *pekarangan* (Figure 6.2) is a mixture of annual crops, perennial crops, and animals (including insects and wild animals) on the land surrounding a house. It is an integrated system with boundaries and serves a variety of economic, biophysical, and sociocultural functions for the owner. The homegarden system originated in Central Java and spread to West Java in the middle of the eighteenth century (Terra 1953). A *kebun-talun* is converted into a homegarden when a house is built upon it. Instead of clearing the trees to cultivate field crops as in *kebun-talun*, the homegarden trees are kept as a permanent source of shade for the house and the area around it, and field crops in the homegarden are planted continuously beneath the trees. Some differences between *kebun-talun* and homegardens are summarized in Table 6.1.

Figure 6.3 shows a typical land-use sequence in Java. After clearing the forest, the land can be planted to *huma* (dryland rice) or *sawah* (wet rice paddy), depending on whether irrigation water is available. Alternatively, the land can be developed directly into *kebun* by planting a mixture of annual crops. In some areas *kebun* is developed after harvesting the *huma* by following the dryland rice with annual field crops. If the *kebun* has tree crops or bamboo, it becomes *kebun campuran* (mixed garden), which will be dominated after several years by perennials and become *talun* (perennial crop garden). *Pekarangan* (homegarden) can be developed by building a house on the *kebun*, *kebun campuran*, or *talun*.

About 20 percent of the total land area of 4.4 million ha in West Java is used for homegardens including housing compounds, while 16 percent is used for *kebun-talun* (Table 6.2). This proportion varies from place to place according to climate, topography, soil, economic activity, and culture. For example, in Legokkole hamlet, West Java, 59 percent of the total land area is used for *kebun-talun* and only 9 percent is used for homegardens.

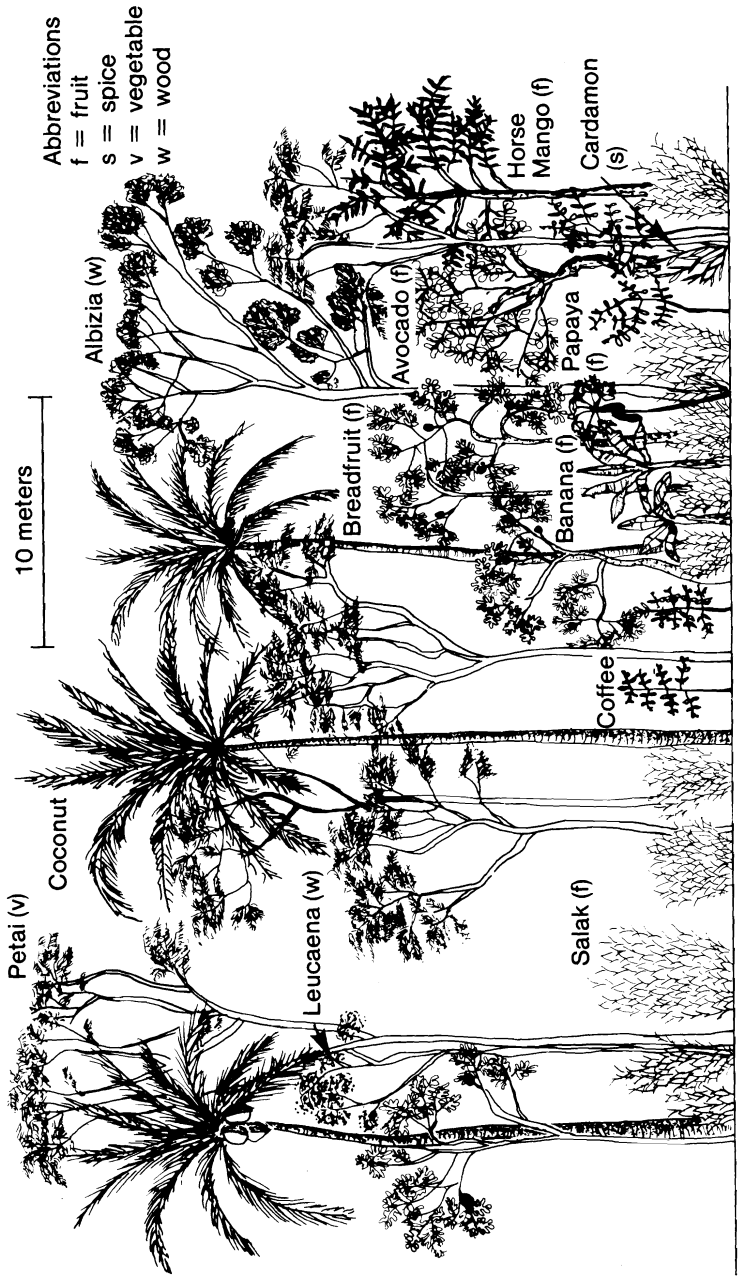


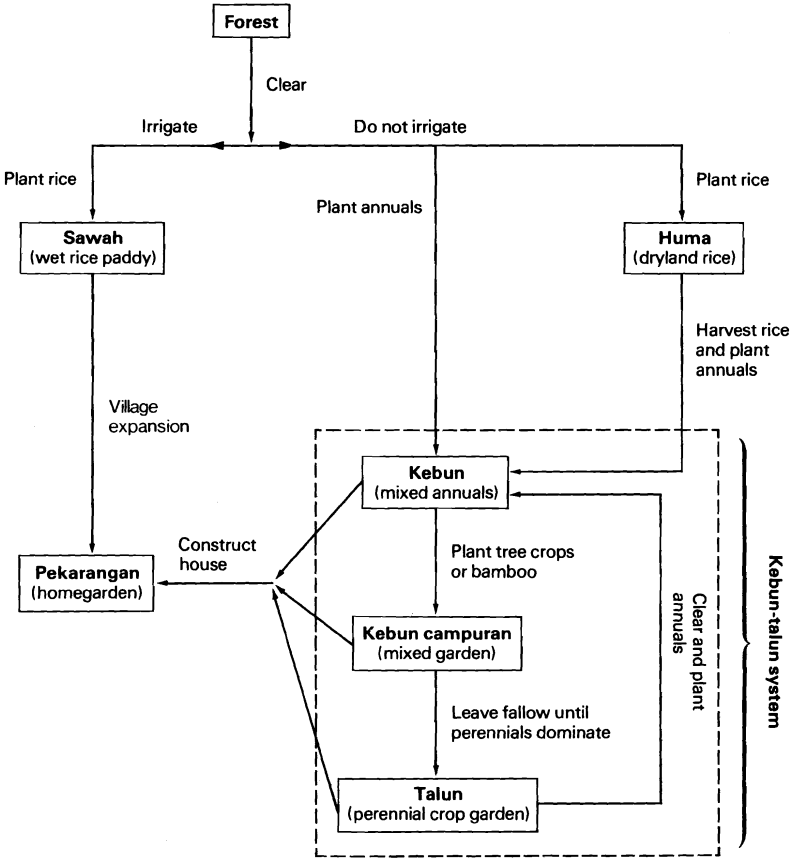
Figure 6.2. Profile Diagram of a Typical Homegarden

Source: Iskandar 1980.

Table 6.1. A Comparison Between *Kebun-Talun* and *Pekarangan*

Kebun-Talun	*Pekarangan* (Homegarden)
Usually with rotation	Without rotation
Absence of houses	Presence of houses
Usually outside the village	Inside the village
High maintenance (in terms of labor and fertilizer at the *kebun* stage)	Low maintenance
Larger size	Smaller size
More commercial	Less commercial (to a certain extent depends on size, distance from markets, and external market demand)
Diversity is often less than home-garden because commercial crops are emphasized	High diversity
Usually on slopes	Usually on flat land
Animals are indirectly involved	Animals are always an integral part of the system
Regular harvest on an annual cycle	Irregular (but year-round) harvest

Figure 6.3. Land Uses Leading to *Pekarangan, Kebun,* and *Talun* After Clearing Forest



Kebun-talun in this area is primarily for producing cash crops, building materials and materials for home industry, while food needs are met primarily by rice production from lowland areas (Table 6.3). Nonetheless, homegardens are psychologically significant in this area. Most people have homegardens, and they tend to look down on those who do not. When asked about their strategy for dealing with crises such as natural disasters or economic instabilities, the people say that if land has to be sold, the homegarden is the last land they would sell.

CROPPING STRUCTURE

Both homegardens and *kebun-talun* have a high plant diversity. Hadikusumah (1982) found 112 species of plants in *kebun-talun* and 127 species of plants in homegardens (Table 6.4). The appendix in Chapter 14 lists more than 235 plant species that occur in the homegardens and *kebun-talun* of West Java. The percentage representation of the main functional groups of plants is similar in both systems, except that ornamental plants are more significant in homegardens while trees for building materials and firewood are more significant in the *kebun-talun* system. A high diversity of crops provides for a variety of family needs while making maximum use of the limited space available. This is summarized by the saying *pepek teng karangan*, which indicates that agriculture is a consequence of thinking how to complete the land on which people settle and how to satisfy their needs (Abdoellah 1980).

The high diversity of plants in homegardens and *kebun-talun* forms a complex horizontal structure, while a mixture of annuals and perennials of different heights forms a vertical structure. The mix of crops and levels of production are a consequence of biophysical, socioeconomic, and cultural factors (Terra 1958, Danoesastro 1976). The most extensive areas of homegardens and *kebun-talun* in Java and the most intensive cultivation occur below 800 m altitude, where the dry season is short or absent (Terra 1958, Danoesastro 1976). Choice of crop species is determined primarily by mean temperatures and the seasonal distribution of rainfall, while crop growth is rather independent of total rainfall (Danoesastro 1976). Farmers can adjust the planting time of annual field crops to accommodate their growth requirements, whereas tree crops must be compatible with the range of climatic variation throughout the year.

Suitable conditions for plant growth, such as favorable soil conditions and climate, do not always ensure the development of homegardens or *kebun-talun* in that area. For example, Terra (1953) found these systems were absent from the wet regions of Sumatra, Kalimantan, Sulawesi, and Halmahera, where conditions are favorable for mixed gardening. He concluded the patriarchal social structure of the local people was responsible, there being a matriarchal social structure in typical mixed-gardening regions such as Central Java.

Table 6.2. Land Use in West Java, 1980

Land Use	Area (ha)	Percent
Rice field	1,168,691	26.5
Plantation	670,979	15.2
Forest	968,166	21.9
Rainfed agriculture (*pekarangan, talun, kebun*)	1,609,567	36.4
Total	4,417,403	

Source: West Java provincial government documents, Bandung.

Table 6.3. Land Use in Legokkole Hamlet, Sadu Village, West Java, Indonesia, 1980

Land Use	Percent of Households	Average Size Ha/Household	Percent Area
Homegarden	90.9	0.02	8.7
Rice field	55.0	0.09	32.6
Kebun-talun	67.2	0.13	58.8

Source: Iskandar et al. (1982).

Table 6.4. Distribution of Plant Species in the Homegarden and *Kebun-Talun* in Legokkole Hamlet, Sadu Village, West Java, Indonesia

	Location			
	Kebun-Talun		Homegarden	
Main Function of Plants	No. of Species	Percent	No. of Species	Percent
Ornamentals	8	7.1	47	37.0
Medicinals	5	4.5	8	6.3
Spices	5	4.5	6	4.7
Vegetables	15	13.4	18	14.2
Cash crops	7	6.3	6	4.7
Fruits	20	17.9	22	17.3
Additional food crops	5	4.5	8	6.3
Building materials and fuelwood	47	42.0	12	9.4
Total	112		127	

Source: Modified from Hadikusumah (1982).

Homegardens

A typical homegarden has a similar vertical structure from year to year, though there may be some seasonal variation. The lowest story (less than 1 m in height) is dominated by starchy food plants, vegetables, and spices (e.g., sweet potatoes, taro, *Xanthosoma*, chili peppers, eggplant, and *Languas*). The next layer (1–2 m in height) also is dominated by starchy food plants (e.g., *ganyong [Canna edulis]*, *Xanthosoma*, cassava, and *gembili [Dioscorea esculenta]*). Cassava and *ganyong* are the most common plants in the homegardens described in Table 6.5. Both of these plants have a high calorie content and are important as rice substitutes.

The next story (2–5 m) is dominated by bananas, papayas, and other fruit trees. The 5- to 10-m layer also is dominated by fruit trees (e.g., soursop, jackfruit, *pisitan [Lansium domesticum]*, guava, and mountain apple) or other cash crops such as cloves. The top layer (10 m or more) is dominated by coconut trees and other trees (e.g., *Albizia*) for building materials and firewood. The overall effect is a vertical structure similar to a natural forest (Figure 6.2), a structure that appears to optimize the use of space and sunlight energy. Table 6.6 shows how light is intercepted by the different strata and the resulting levels of photosynthetic activity. Figure 6.4 shows the net biomass production in different strata.

Certain groups of plants tend to be found together. For example, in the Bantarkalong area (Abdoellah 1980), wherever *gadung (Dioscorea hispida)* is found in the homegarden, it is probable that *petai (Parkia speciosa)*, *rambutan (Nephelium lappaceum)*, and possibly guava and *suweg (Amorphophalus campanulatus)* will be there as well. An important plant association consists of *rambutan*, *kelor (Moringa pterygosperma)*, rose, *mangkokan (Nothopanax scutellarium)*, *gadung*, and pomelo. Each of the plants in this association provides the farmer with something useful. *Rambutan* fruit is sold and eaten; roses are grown for their esthetic value; *mangkokan* is grown as an esthetic plant and is used occasionally for hedges and hair tonic; *kelor* is used as a vegetable and is believed to be a magical plant that can exorcise the devil and remove the strength of undefeated people. *Gadung*, besides its function as a food, can be used as a weather indicator because the rainy season can be expected to begin a short time after its leaves start to grow. Pomelo has a similar function. When its fruits start to grow, the season of annual plant cultivation begins. These traditional weather and planting-time indicators are still being used today, and many farmers believe agricultural failures are due mainly to improper planting times. They say, "Apa guna gawe, yen ora guna mangsa, sanajan gelema menggawe yen ora ngerti mangsa yakin rugi," which means, "Although we like to work, if we do not follow the proper starting time, all will give disadvantages."

The structure of homegardens and *kebun-talun* can be affected by population density, the socioeconomic status of the household, and the proportion of land suitable for rice paddy. For example, the Sundanese households in a village in West Java appeared to have a greater number of ornamental and vegetable plants in their homegardens than the Javanese

Table 6.5. Crop Abundance in Homegardens in Bantarkalong, West Java

Plant Category	Name	Abundance Index
Ornamentals	*Randa midang*	1.4
Starchy food crops	*Ganyong*	13.1
	Taro	2.5
	Sweet potato	3.4
	Cassava	13.9
Fruits	Banana	5.4
	Jackfruit	1.0
	Papaya	1.1
	Mango	1.1
Vegetables	Spinach	1.8
	Wing bean	1.0
Spices	Chili pepper	1.7
Medicinals	*Dadap*	1.0
Cash crops	Coconut	2.6
	Coffee	1.3
Others	*Laban*	1.1
	Bamboo	1.9

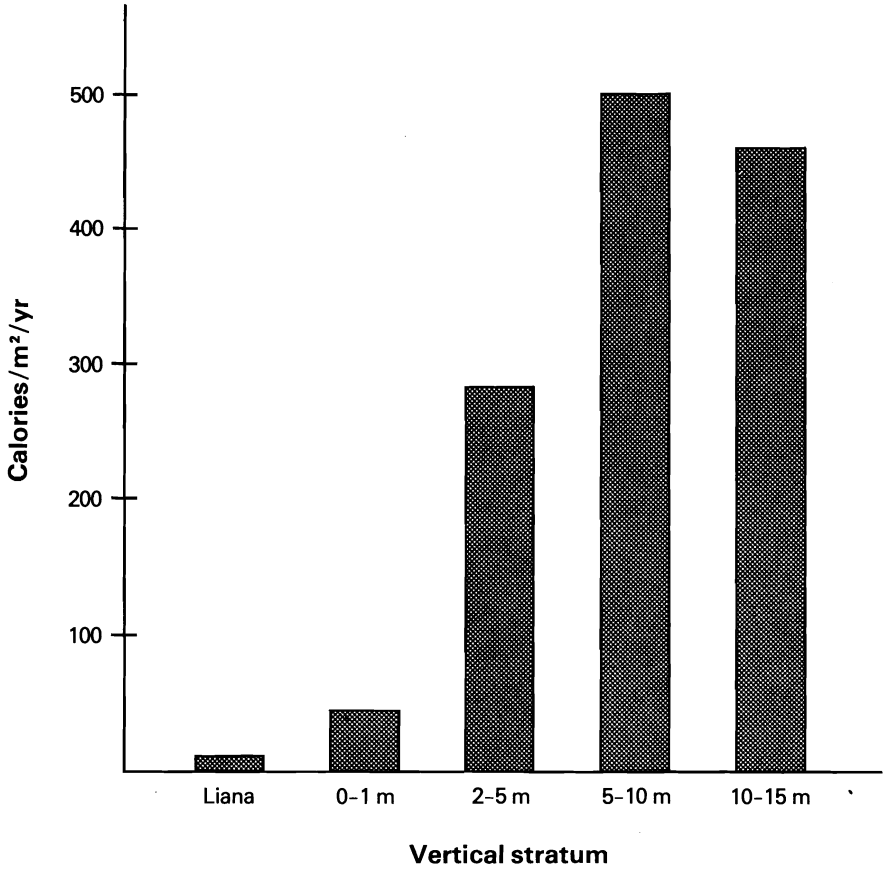
Source: Abdoellah (1980).

Table 6.6. Relative Light Interception and Photosynthetic Rate of Plant Layers at Different Heights in a Homegarden in Cihampelas, West Java

Stratum	Light Interception (%)	Photosynthetic Rate (mg CO_2 dm^{-2} hr^{-1})
Top layer	20	15.9–28.0
Second layer	64	12.9–24.8
Third layer	10	12.0–23.6
Bottom layer	6	7.0–39.8

Source: Christanty (1981).

Figure 6.4. Vertical Stratification of Net Primary Production in a Homegarden in Cihampelas, West Java



Source: Christanty 1980, 1981.

Table 6.7. Number of Species and Plants in 36 Javanese Homegardens and 37 Sundanese Homegardens in Bantarkalong, West Java

	Species				Plants			
	Sundanese		Javanese		Sundanese		Javanese	
Plant Category	No.	%	No.	%	No.	%	No.	%
Ornamental	67	29.4	41	20.9	3,090	8.2	2,170	5.5
Starchy food	14	6.1	13	6.6	19,455	51.6	23,409	58.8
Fruit	28	12.3	28	14.3	4,811	12.8	4,994	12.6
Vegetables	29	12.7	32	16.3	5,424	14.4	3,190	8.0
Spice	6	2.6	7	3.6	1,299	3.5	557	1.4
Medicinal	21	9.2	19	9.7	586	1.6	685	1.7
Industrial	10	4.4	6	3.1	2,034	5.4	2,099	5.3
Others	53	23.3	50	25.5	991	2.6	2,700	6.8

households (Table 6.7). Stoler (1981) found a relationship between the significance of homegardens for household food production and the size of rice paddy owned by the families in Kaliloro, Central Java. Tubers (e.g., cassava) for home consumption accounted for 21 percent of the total homegarden product consumed by households owning less than 0.1 ha of rice paddy land, whereas only 4 percent of the homegarden production was consumed by households owning more than 0.2 ha of rice fields. Danoesastro (1976) observed that homegardens in rice-paddy areas (i.e., areas where more than 40 percent of the total land is used for rice paddy) are usually dominated by perennials; in areas that do not have much rice paddy, perennials are found mostly in the *kebun-talun*, and homegardens are dominated by annual crops. Karyono (1981) observed that homegardens in rice-paddy areas normally are dominated by fruit plants, while in areas without rice paddies the homegardens are dominated by other food crops.

The crop diversity (i.e., the number of different species) in homegardens is associated with a number of factors:

- *Altitude*—There is a greater diversity in lowland areas than in upland areas (Karyono et al. 1977).
- *Homegarden size*—The larger the homegarden, the greater the number of plant species (Karyono et al. 1977, Stoler 1981, Abdoellah 1980).
- *Cash crops*—The number of vertical layers and the number of crop species are less when cash crops predominate.
- *Labor*—When labor is scarce, people plant more perennials and fewer annuals and crop diversity is lower (Stoler 1981).
- *Population density*—At high population densities there is a tendency to grow cash crops, so the diversity of plants in the garden is reduced. However, sometimes the land is used more intensively for subsistence purposes, and the diversity of plants increases (Penny and Singarimbun 1973).
- *Employment*—When people do not have good outside jobs, they may concentrate their labor on their homegardens, and the crop diversity increases (Penny and Singarimbum 1973).
- *Economic status*—Poor people plant many kinds of subsistence plants in their homegardens, especially fruits and vegetables. Rich people have a tendency to plant more ornamental plants, as well as more cash crops (e.g., cloves) that have higher economic value (Achmad et al. 1978).

Abdoellah (1980) observed that the crop diversity of homegardens in Bantarkalong Village (West Java) was not significantly correlated with a household's educational level nor the size of its rice field and *kebun* holdings.

Figure 6.5 shows a typical homegarden layout. Although a homegarden may present the appearance of a haphazard assemblage of trees, shrubs, herbs, climbers, and creeping plants, there are actually systematic processes behind the selection of planting sites for each crop. Farmers try to optimize the use of space in their homegardens by planting as many crops as they

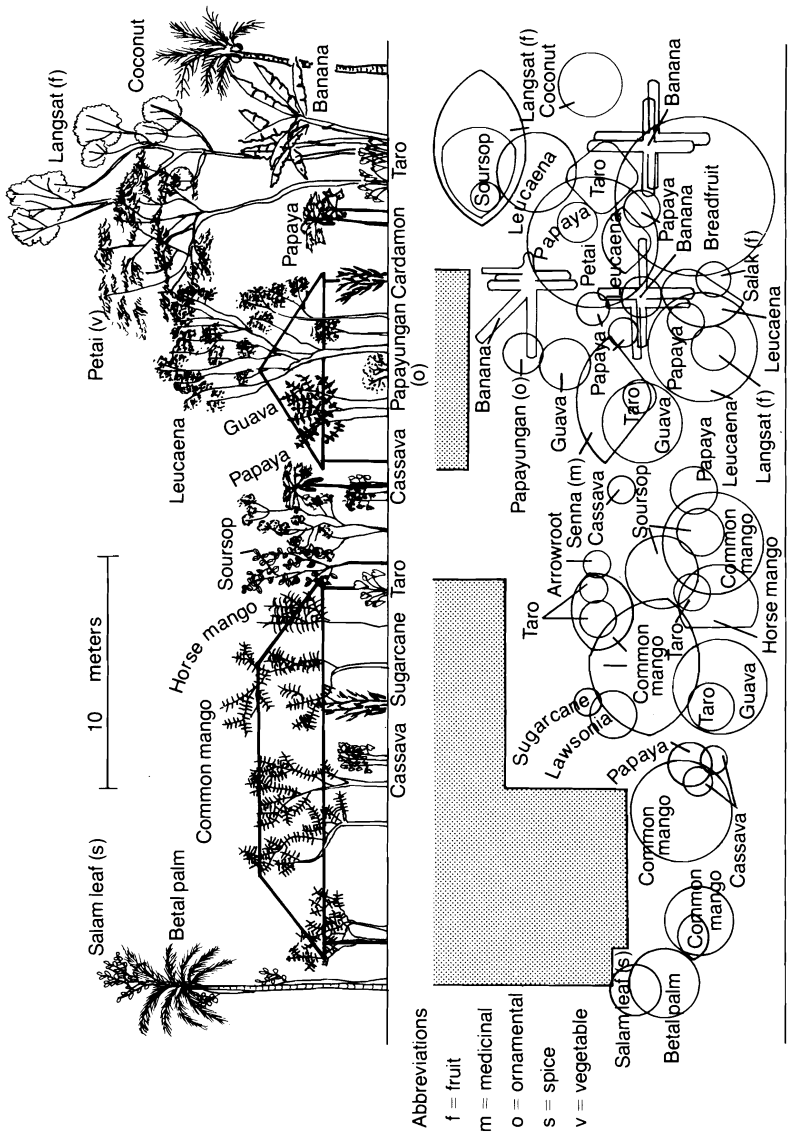


Figure 6.5. Layout of a Typical Homegarden

Source: Iskandar 1980.

can in the space available, locating each crop according to its light, water, and fertility requirements. The following factors determine the spatial arrangement of crops in a homegarden (Christanty et al. 1978, Achmad et al. 1978):

- Light requirements,
- Water requirements,
- Fertility requirements,
- Efficiency of space utilization,
- Esthetic considerations,
- Practical considerations, and
- Security and crop protection.

Homegardens have definite planting patterns in the front, back, and sides of the house. Ornamental plants are more frequently planted in front of the house, and valuable crops (e.g., cloves, oranges, and mangoes) are planted in the front yard where the owners can see them. Starchy crops, cash crops, medicinal plants, and others are found more frequently in front of the house and behind it rather than on the side. Coffee is usually planted in the side and backyard areas as a living hedge, while the front yard hedge is composed of ornamental plants. Vegetables usually are grown in the front and side yards where there is sufficient light because tall trees rarely are planted in those areas. Taro, chayote, and select vegetables and spices are planted close to the latrine and fishpond in the backyard or side yard. The spaces close to livestock pens, fish ponds, and *jarian* (the garbage dump) are known as fertile sites and are used to grow crops with high nutrient requirements (e.g., banana, mango, jackfruit, and other fruit trees). Plants used for daily cooking (e.g., chili peppers, *Languas*, lemon grass, and tomatoes) are planted close to the kitchen for convenience. Trees with large crowns (e.g., *jambu semarang [Syzygium javanicum]*) are planted in the *buruan* (part of the front yard that is kept clean) to provide shade for children to play.

The back of the house is referred to as "supados singkur," which means "to be unseen by other people." Coconuts, fruit trees, and other tall trees for building materials and firewood usually are grown in this part of the yard, away from the house, so the house will not be damaged if a tree should fall during a storm. Some plants (e.g., mangoes) propagate themselves *(janteun ku anjeun)* through seed dispersal by birds or mammals or by people throwing the seeds away after eating. Because those plants are left wherever they spring up, there is no distinct spatial arrangement.

Homegardens have a seasonal rhythm. Annual plants (e.g., eggplant) are grown throughout the year, but it is usually necessary to water by hand in the dry season. This means dry-season annuals must be located near wells, fish ponds, or open sewage ditches. Some perennials (e.g., coconuts, bananas, and jackfruit) bear fruit throughout the year, while other perennials have restricted fruiting seasons. For example, *duku (Lansium domesticum)*

fruits in December–January, *jambu semarang* (*Syzygium javanicum*) fruits in April–June, mango in September–November, and *durian* in October–February. This pattern of harvesting provides a continuous supply of food for daily subsistence needs, minimizes risks of failure, and increases a household's financial stability by spreading cash income over the year.

Kebun-Talun

The vertical structure of *kebun-talun* is different at each successional stage: *kebun*, *kebun campuran*, and *talun* (Figure 6.1). There are three vertical layers during the *kebun* stage, when annual crops predominate. The lowest layer consists of creeping plants (e.g., peanuts, soybeans, cucumbers, and melons) that occupy the ground below a 30-cm height. The interval from 50 cm to 1 m is occupied by vegetables (e.g., chili peppers and eggplant). The upper layer is occupied by maize, tobacco, cassava, or leguminous vines (e.g., wing bean or long bean) supported by bamboo poles.

The vertical stratification in the *kebun campuran* stage is more complex because of a mixture of annuals and perennials. At this stage, shade-tolerant plants (e.g., taro) occupy the space below 1-m height, while cassava forms a second layer from 1- to 2-m height. The third layer is occupied by bananas, and trees use the space above 5-m height. It is typical to have scattered trees, banana patches, and a dense, shrubby, shade-tolerant understory.

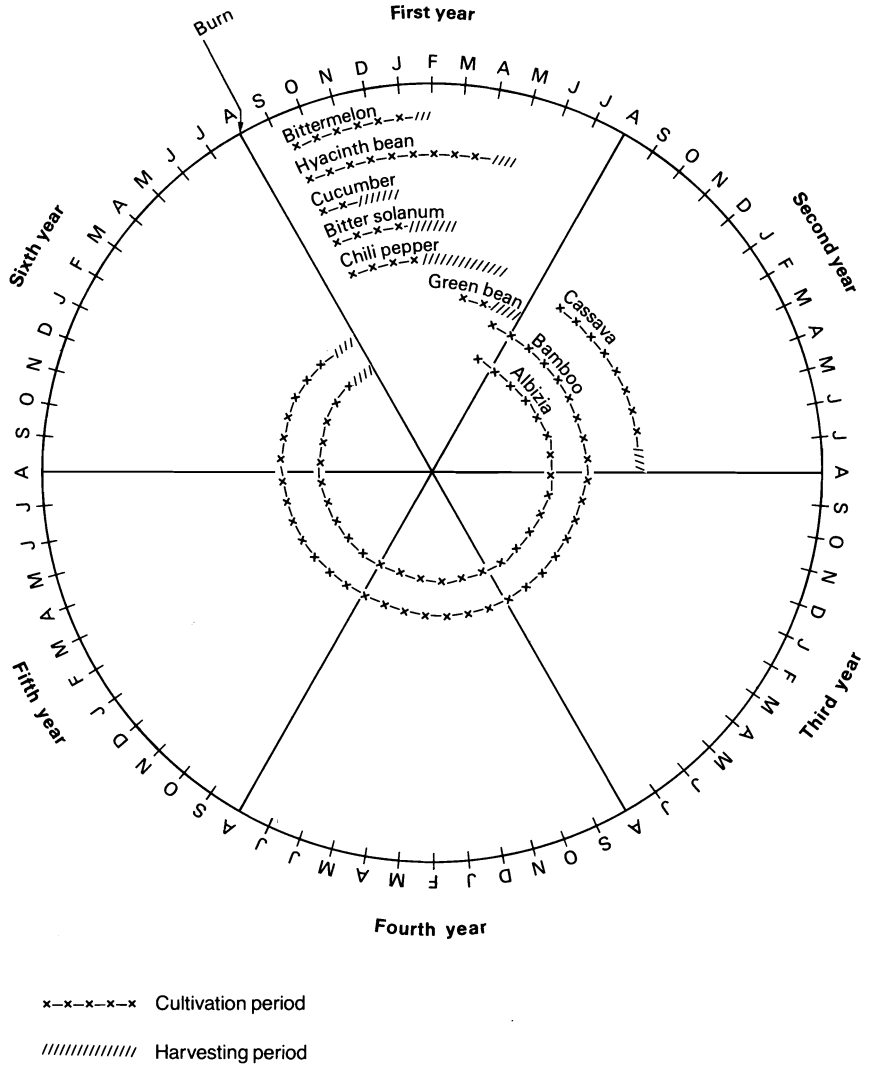
The *talun* stage usually is dominated by a mixture of perennial trees and bamboo forming three vertical layers. The shorter trees use space not occupied by taller trees. The *talun* stage can take a variety of forms, such as woodlots (firewood and building materials), bamboo, and mixed perennials (e.g., fruit trees). Mixtures of these basic forms also are common.

The management practices for each of these forms are different. If trees in the woodlots are of different ages, harvesting is by selective cutting, and some crops can be interplanted in the more open spaces during the rainy season. If the trees are homogeneous in age, however, it is common to harvest by clear-cutting. The land can then be field-cropped for one or two years before the new seedlings grow and provide shade.

Bamboo *talun* is dominated by bamboo but may also have trees such as *Albizia* or fruit trees scattered in the field. Harvesting is usually by clearing, followed by burning leaves and branches in piles, and using the ash as fertilizer for the annual cropping period. The bamboo starts suckering at the end of the first year after cutting and completely shades out annual crops by the end of two to three years. At this point the field is usually abandoned for two to three years, during which time the bamboo becomes mature and ready for the next harvest.

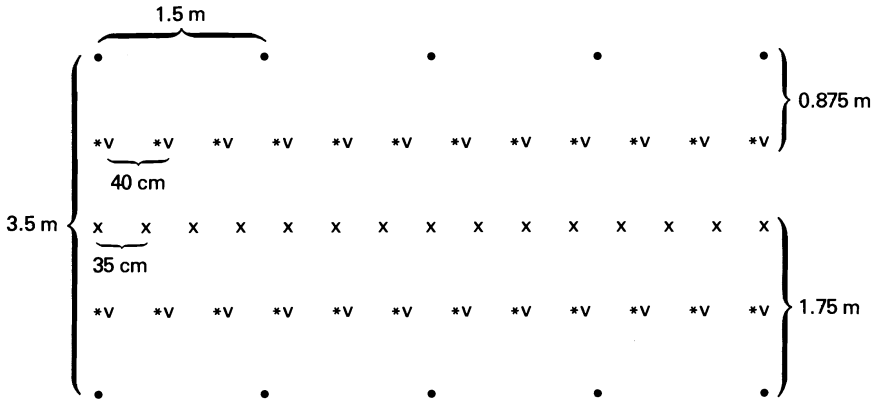
Mixed-perennial *talun* is dominated by perennials, mostly fruit trees, coconuts, and other cash crops. There is sometimes pruning and thinning to reduce competition for light, and some annuals can grow underneath if the tree density is not too high, but the main products usually come from the trees. Although fruit-tree *talun* requires intensive care, the diversity of fruit trees makes the care worthwhile by ensuring income throughout the year.

Figure 6.6. Cyclical Calendar for an Example of the *Kebun-Talun* System



The temporal arrangement of *kebun-talun* is characterized by a cyclical rotation over time, from *talun* to *kebun* to *kebun campuran* and back to *talun* (Figure 6.6). The rotation of a bamboo *talun* is started by clearing the bamboo and *Albizia* in mid-August to set up the *kebun* field crops. Crops usually are grown in rows along contour lines during the *kebun* stage, with different crops grown in alternate rows (Figure 6.7). The *kebun campuran* stage is characterized by row cropping of cassava with 0.75-by-

Figure 6.7. Spatial Arrangement of Crops in a *Kebun* at Legokkole Hamlet, Sadu Village, West Java



- • Hyacinth bean
- x Bittermelon
- * Vegetables (chili pepper, bitter solanum, eggplant, etc.)
- v Cucumber

Source: Adapted from Hadikusumah 1982.

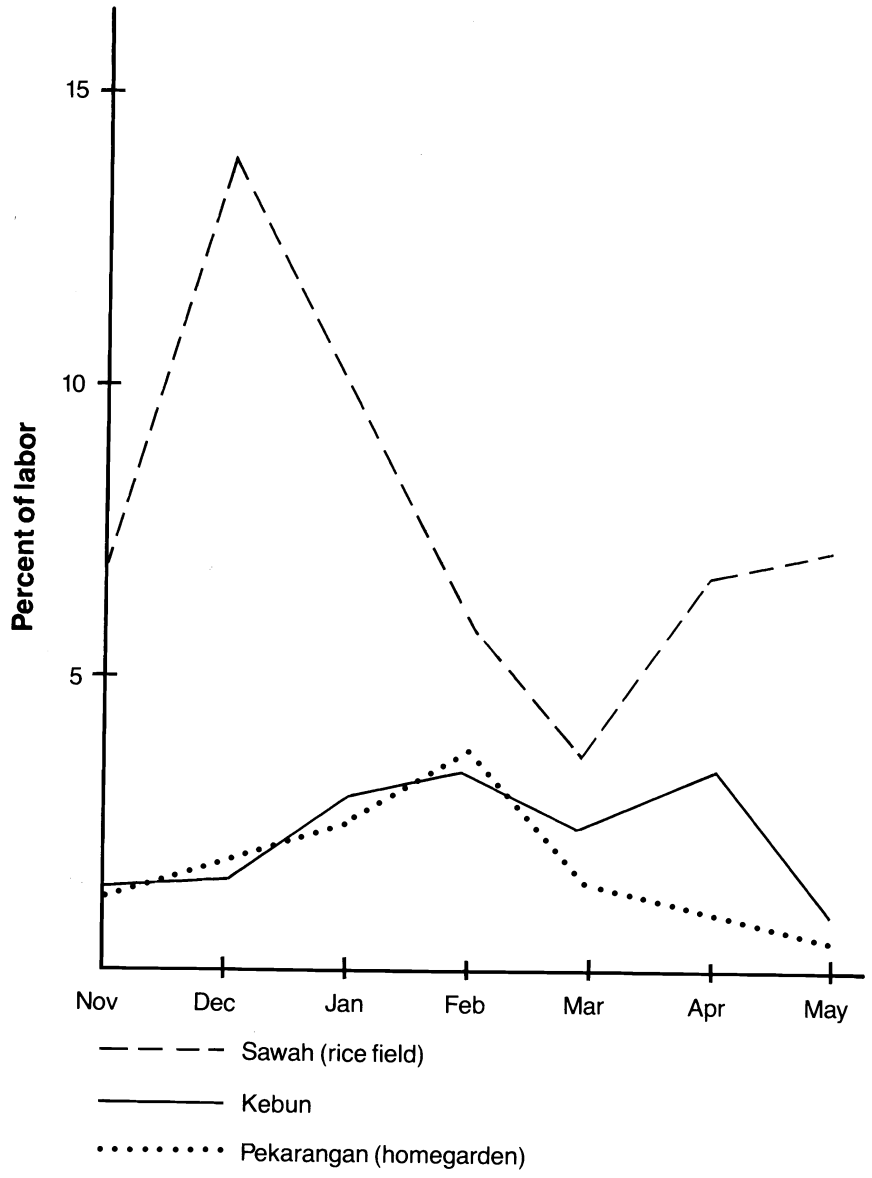
0.75-m spacing, mixed with young bamboo having 15-cm spacing between clusters. The field is then abandoned for two to three years so the bamboo (sometimes intercropped with *Albizia*) takes over.

LABOR INPUT

Homegardens

Most farmers put the majority of their efforts into their rice fields. Rice field work is *padamelan anu bangga* (heavy work that consumes a large amount of time), while homegarden work is described as *padamelan anu tanggel* (work that requires a small amount of time and is not heavy). Farmers work in the homegarden during their leisure time after work in the rice field and *kebun* is completed, so the seasonal pattern of labor in the homegarden, *kebun*, and rice field complement one another (Figure 6.8). Rice field work reaches its peak in December (*nyawah ageung*, main planting season) and May (*nyawah alit*, secondary planting season); homegarden work is greatest in January and February; peak work in the *kebun* is in February and April.

Figure 6.8. An Example of the Seasonal Pattern of Labor in Homegarden, *Kebun*, and Rice Field



Source: Achmad et al. 1978.

Kebun-Talun

In contrast to the irregular work schedule for the homegarden, there is a definite seasonal schedule of work in the *kebun* (Figure 6.6). The annual calendar can be divided into three stages: clearing, cropping, and harvesting. Clearing normally starts before the rainy season, at the beginning of August. The first activity is weeding and collecting litter and weeds in piles, usually done by women and children. At the end of the first week, farmers till the soil by hoe, cut the *talun* ten days later, and leave the slash to dry. Litter, leaves, and small branches are burned in piles at the end of August, while stems of bamboo and woody plants like *Albizia* are removed from the field for sale. Tilling, cutting, and burning are done by men.

Following the example in Figure 6.6, cropping is started by planting bittermelon seeds at the beginning of September, just after the first rain. Ash from the burn and manure from the homegarden are used to fertilize around the seeds. Seedbeds are made for vegetables three days later, and holes for planting hyacinth beans are prepared two weeks after planting the bittermelons. Two or three seeds are planted in each hole and the hole is covered with compost from the homegarden. At about the same time, cassava may be planted along the edges of the *kebun* to serve as a kind of hedge.

Bittermelons and hyacinth beans are planted in rows. About two days after planting the hyacinth beans, shallow furrows for cucumbers are made between the rows. Vegetable seedlings from the seedbeds are transplanted near the cucumbers at the end of September (the *tumpangdaun* stage) when the cucumbers have developed two leaves. All crops are then fertilized with urea and compost. Women do most of the cultivation, though men usually help by making holes, seedbeds, and shallow furrows. Women and children weed at the beginning of October.

Both men and women harvest in the *kebun*. The first harvest starts with cucumber at the end of October, about forty days after planting. Harvesting continues every five days for up to two months. There is not much activity in November and December besides cucumber harvesting, which does not require much labor. Most of the labor during this period is focused on rice fields. There is another weeding at the end of December, before harvesting vegetables and bittermelon, to clear paths between the rows. Harvesting then starts at the beginning of January. Bittermelon is harvested continuously for about three weeks. Bitter solanum is harvested weekly, and chili peppers are harvested every two weeks for four months. Hyacinth bean, the main crop of the *kebun* stage, is harvested in mid-April, about seven months after planting. The land can be tilled again and used to grow green beans if there is enough rain after harvesting the hyacinth beans. Green beans take about fifty days to mature and are harvested at the end of May. Cassava is harvested nine to ten months after planting, about the same time the green beans are harvested. Both men and women harvest.

The land is left idle for one to two months after harvesting at the end of May or early June. It is tilled again at the beginning of August in

Table 6.8. Calorie and Protein Yields/m^2/Year from Homegardens in Cipetir, West Java

Categories of People	Yields		Average Homegarden Size
	Kcal/m^2/Year	Protein/m^2/Year	
Well off	863	15.6 g	1,279 m^2
Poor	584	7.1 g	1,202 m^2
Very poor	1,004	13.2 g	920 m^2

Source: Abdoellah et al. (1981).

Table 6.9. Percentage of Calories and Protein Intake in Cipetir, West Java

Sources of Calories and Protein	Poor People		Well-Off People	
	Calories	Protein	Calories	Protein
Homegarden	2.6	2.7	2.8	3.4
Kebun	0.5	1.3	5.2	5.6
Fish pond	–	–	0.3	2.1
Rice field	22.2	17.7	77.1	65.3
Purchases	42.2	48.0	14.6	21.8
Gifts	1.1	1.5	–	1.8
Gathering	31.5	29.0	–	–

Source: Abdoellah et al. (1981).

preparation for the second year of crops. Cassava is usually the main crop in the second year and is planted at the beginning of September. The bamboo is sprouting strongly by the second year, and perennial seedlings also are moving up, so the *kebun* gradually changes to *kebun campuran* consisting of cassava and young bamboo or *Albizia*. The cassava is ready for harvest after nine to ten months, when the bamboo and other perennials are intercepting most of the light, limiting the possibility for growing further field crops. After the cassava harvest the fields are usually abandoned for three to four years until the perennials are ready to be harvested. Almost no labor input is needed during this period.

FOOD AND INCOME PRODUCTION

Homegarden

Homegardens can be a substantial source of protein and carbohydrates, though the significance of homegardens is less in some villages than in others (Tables 6.8 and 6.9). Homegardens may supply as little as 1 percent of the total calories or as much as 18 percent of the calories and 14 percent

of the protein (Ochse and Terra 1937). Since malnutrition and vitamin deficiencies can be a major problem in Javanese villages (Sajogyo 1973, Isnawan 1980, Abdoellah et al. 1980, 1981, 1982), the homegarden has an important role as a source of protein and of vitamins such as A and C. There is always some crop in the homegarden that can be harvested on a small scale to satisfy daily needs—coconuts, yams, taro, a handful of cassava leaves, sweet potato leaves, chili peppers, spinach, or bitter solanum. An assured food supply of this sort is particularly important to people who do not have much money.

Karyono (1981) has found that homegardens in non-rice-field areas can assume part of the rice field function by production of starchy root crops. Many species of tubers (e.g., cassava, taro, sweet potato, and yam) have a high carbohydrate content and therefore can be used as a staple to supplement or substitute for rice, especially during *paceklik* (a food shortage before harvest or after the rice harvest has failed due to drought). Chapter 14 presents a detailed description of the complementary roles of homegardens, *kebun*, and rice fields for nutrition.

The income from homegardens comes from selling fruit and other cash crops (e.g., limes, *rambutan*, jackfruit, *durian*, cloves, and coffee) to local brokers or merchants. Homegarden income increases in November, December, and January and decreases in March, April, and May (Figure 6.9).

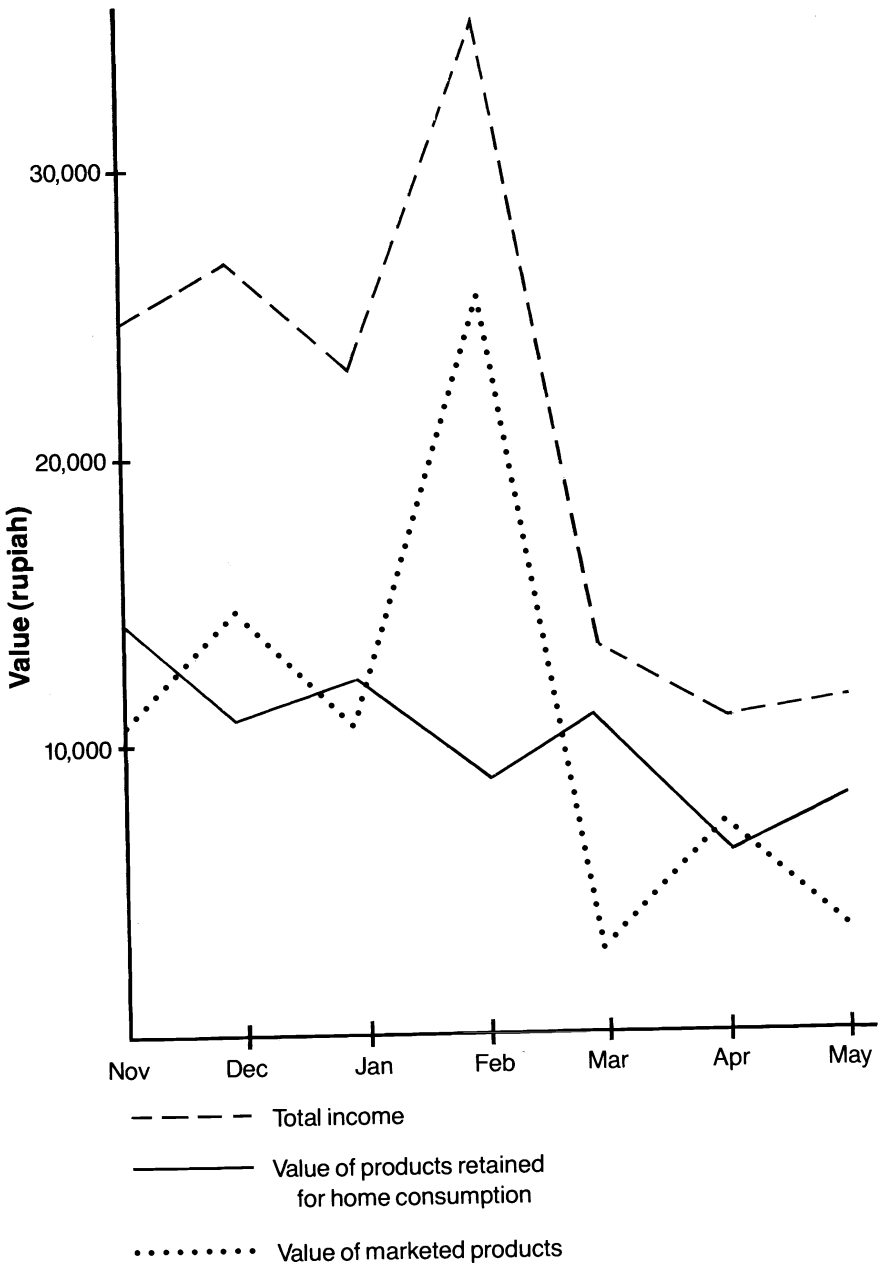
There is a tendency for the income from homegardens owned by poor people to be lower than the income from homegardens owned by wealthier people. This is because wealthier people have the means to cultivate fruit trees and cash crops with a high economic value. However, the homegarden income of poor people is a larger percentage of their total income (Table 6.10).

Village people rarely sell their agricultural products directly to market because if they did they would eliminate the livelihood of village middlemen whom they consider to be their brothers. There is also a practical reason. Although they receive more cash if they sell directly to the market, it does not cover the cost of transportation to market unless the market is nearby.

CONSERVATION FUNCTION

A dense cover of tree and crop foliage reduces the impact of rain and sun on the soil. Research on *kebun campuran*, *talun*, and forest in the Jatiluhur area (Citarum watershed, West Java) has shown that tall trees lacking an understory do not protect the soil from erosion. Only land uses with a cover of litter or vegetation close to the ground provide such protection (Handoyono et al. 1979). The importance of trees for soil protection lies in the litter they produce. If there is a significant accumulation of litter, it covers the soil surface, protects the soil from the impact of raindrops, and helps to maintain the pores and channels into which rainfall infiltrates (Bennet 1939, Wiersum et al. 1979). A mixture of trees and field crops also provides a density of roots at the soil surface that holds soil particles and

Figure 6.9. An Example of the Seasonal Pattern of Income from a Homegarden



Source: Achmad et al. 1978.

Table 6.10. Income from Homegardens (Rp/capita/year) in Babakan, Cihampelas Village, West Java

	Poor People	Well-Off People
Average total income	38,089	106,912
Average income from homegarden	8,979	9,648
Percentage of total income from homegarden	23.6	9.0

Source: Adapted from Achmad et al. (1980).

Note: One U.S. dollar = approximately 630 Rp.

encourages the development of an erosion-resistant soil crumb structure. The dense root structure of a mixture of trees and field crops also uses a maximum of soil moisture, thereby minimizing periods when the soil is saturated with water and unable to absorb water during storms—a situation that can lead to severe runoff and gully erosion (Donahue 1976). Sarief et al. (1981) found that homegardens and *talun* have low levels of erosion, even on land that is highly susceptible to erosion, while the erosion in *kebun campuran* is somewhat higher, and the *kebun* stage has the highest levels of erosion.

The high diversity of plants in homegardens and *kebun-talun* is a potential genetic resource of considerable importance, as the numerous varieties may be drawn upon for future breeding programs to increase the quality and quantity of agricultural production (Soemarwoto 1980, Karyono 1981). The high diversity of plants also provides habitat for wild animals. *Kebun-talun* in Cihampelas Village (West Java) has a higher bird diversity than homegardens or rice fields (Iskandar 1979). Although homegardens have a similar structure to *kebun-talun*, human disturbance in homegardens is greater. Children shoot birds with slingshots or blowpipes and take eggs and young birds from nests on homegarden trees, and this can decrease the number of bird species. Farmers protect their rice fields by killing or chasing away bird pests.

STRATEGIES FOR THE FUTURE

Both homegarden and *kebun-talun* systems are dynamic ecosystems that respond continuously to natural and human-induced changes in the environment. They are changing through the impact of the following factors:

- Population growth,
- External market demands,
- Introduction of new hybrids and other agricultural technologies, and
- Efforts to increase the standard of living.

Population growth causes fragmentation of landholdings to the point where many households do not have sufficient land to support themselves

and are forced to switch to off-farm employment, though this is difficult without the necessary skills. Intensification of agriculture is needed to increase production, but this may lead to a decrease in the *talun* phase of the *kebun-talun* system, a reduction in the diversity of homegarden plants, and a decline in soil fertility unless fertilizer applications are increased.

Because of an increase in the demand for cash crops, there is a tendency to use "improved varieties" and switch to monoculture production. More farmers are concentrating on economically valuable crops such as cloves or oranges while eliminating other crop species from their homegardens and *kebun-talun* to provide space for the valuable crops. The gross income may be higher; but cloves need high fertilizer and pesticide inputs, and oranges need intensive pest and disease control because they are susceptible to virus infection. The result is higher production costs and higher risks, particularly if the more intensive input requirements are not met. Eliminating crop species from the gardens reduces plant diversity and diminishes the reserve of genetic resources.

New varieties of fruit trees are being promoted to replace traditional varieties, but they can have a disruptive effect on the overall function of the garden. An example is the new hybrid variety of coconut, *kelapa genjah*, which has a higher production potential and a shorter trunk than the traditional coconut. When this coconut is introduced, it replaces the traditional coconut, whose crowns make up a major portion of the top layer of the homegarden. The new, shorter coconut is in the middle layer, which is already occupied by fruit trees (e.g., mangoes, *durian*, *rambutan*, *duku*, soursops, and bananas), resulting in overcrowding and the need to remove some trees. Moreover, the denser canopy in the middle layer reduces the penetration of sunlight to the lower layer, affecting photosynthetic activity and the growth of subsistence plants such as vegetables, tubers, and spices.

Development is meant to improve quality of life, but it tends to emphasize material improvements that move from a simple subsistence life-style to a higher level of consumption (Soemarwoto 1980). Villages need more cash as transportation and electricity reach them and as television, motorcycles, and other consumer goods become available. Farmers tend to switch to cash-crop gardens or orchards to obtain a higher income, but there are numerous risks that accompany such a change. While improving the yields of homegardens and *kebun-talun* is a worthwhile objective, it is important to realize that homegardens and *kebun-talun* serve multiple functions. Development should be based not only on economic potential but also on other considerations such as socioculture and conservation functions.

The development and improvement of the homegarden and *kebun-talun* should be based on a program of intensification, diversification, and plant breeding along the following lines:

- Development should maintain a balanced integration of rice fields, homegardens, *kebun-talun*, and other appropriate farming systems;

- Multiple functions of the farming systems should be considered before encouraging changes;
- Development of a farming system should be accompanied by the development of related technologies such as processing of products, better marketing, and capital management;
- Improvement of the quality of human resources is an essential part of development; and
- The traditional knowledge and ecological wisdom of the people should not be neglected, since careful combination with modern science and technology could improve the prospects for success of new systems.

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