The Javanese Homegarden

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ABSTRACT

On of the oldest forms of agroecosystems, the homegarden is present throughout the world. It is most highly developed on the island of Java, in Indonesia, where it typically has a very high diversity of useful plants and animals per unit area. This diversity and the intensive household care that is given to the homegarden result in a unique combination of high levels of productivity, stability, sustainability, and equitability. Compared with rice fields on Java, the homegarden has a greater diversity of production and frequently produces a higher net income. The harvest is more stable over time, the system is buffered against pests and diseases, and the effects of erosion are less severe. Also, the products of the home garden are more equitably shared among members of the household and village. In the future, the homegarden will be a viable alternative to monocropped field agriculture. It also is a highly valuable source of genetic diversity.

INTRODUCTION

Agroecosystem Analysis (AFA) is a form of farming systems research developed in Southeast Asia over the past twenty years (Conway, 1985, 1986, 1987; Conway and Barbier, 1990). The approach rests on certain key concepts---the agroecosysten, the agroecosystem hierarchy, the properties of agroecosystems, and the trade-offs between them. These concepts are used as a means of stimulating interdisciplinary research and action, particularly involving natural and social scientists. It differs from conventional Farming Systems Research (FSR) in a number of respects, but particularly in its capacity to extend analysis, using the same concepts and techniques, to systems in the agricultural hierarchy above and below the farm.

Agroecosystems are ecological systems transformed for the purpose of agriculture. For example, a homegarden is created out of a forest. Around the garden is a fence or hedge that defines the biophysical boundary. Inside the great diversity of the original wildlife is reduced to a restricted assemblage of crop plants (trees, shrubs, and herbs), livestock (cattle, goats, and chickens) and associated pests, diseases, and weeds. The basic, renewable ecological processes remain: competition between the plants, consumption of the plants by the livestock and by the pests, and predation of the pests by their natural enemies. But these ecological processes are now overlain and regulated by the agricultural processes of cultivation, subsidy (with fertilizers), control (of water, pests, and diseases), and harvesting. And, in turn, these agricultural processes are regulated by

economic and social decisions. Farmers cooperate or compete with one another and market, exchange, or consume their produce. The resulting system is as much a socioeconomic system as it is an ecological system and has a socioeconomic boundary, as well as a biophysical one, defined by the activities of the farm household. This new, complex, agro/socio/economic/ecological system, bounded in several dimensions, is an agroecosystem.

More formally, an agroecosystem is an ecological and socioeconomic system, comprising domesticated plants and/or animals and the people who husband them, intended for the purpose of producing food, fiber, or other agricultural products.

Several important consequences follow from defining agroecosystems in this way. First, this definition helps to foster a genuinely interdisciplinary approach to farming systems research. Despite a commitment to integrated analysis, biological and social scientists often work separately, at best coming together to write a final synthesis. Yet many, if not most, of the crucial questions for agricultural development lie not in one province or the other, but at their intersection.

Second, agroecosystems conceived in these terms readily fall into hierarchies. At the lowest level is the individual plant or animal, its immediate microenvironment, and the people who tend and harvest it (Figure 1). The next level is the crop or herd, contained within a field or paddock, or in a swidden, homegarden, or range. These systems, alone or in various combinations, make up the farming system. The hierarchy continues upwards in a similar fashion, each agroecosystem forming a component of the agroecosystem at the next level.

Third, agroecosystems can be characterized in terms of a set of four system properties: (1) *productivity*--the output of valued product per unit of resource input; (2) *stability*--the constancy of productivity in the face of small disturbing forces arising from the normal fluctuations and cycles in the surrounding environment; (3) *sustainability*--the ability of the agroecosystem to maintain productivity when subject to a major disturbing force; and (4) *equitability*--the evenness of distribution of the productivity of the agroecosystem among the human beneficiaries, i.e., the level of equity that is generated.

Fourth, significant trade-offs usually exist between agroecosystem properties. High productivity often occurs at the expense of sustainability, and too high an equitability may reduce productivity. Each agroecosystem is characterized by a unique combination of the properties, partly reflecting the relative values that the people in the agroecosystem place on them. They may value productivity more highly than sustainability or equitability more than productivity. The emphasis may also change with time as certain needs are met and others assume importance.

RICE FIELD AND HOMEGARDEN

In Indonesia, the growing population and desire for higher living standards have resulted in a development strategy that emphasizes rapid increases in agricultural productivity.

The strategy has focused on the productivity of the rice field, using modern high-yielding rice varieties and their associated inputs. By 1984 the country was self-sufficient in terms of rice production and had a small stored surplus. However, this success has not been without considerable environmental, social, and economic costs (Conway and McCauley, 1983; KEPAS, 1984). The high productivity has been at the expense of stability, sustainability, and equitability.

There have been growing pest and disease problems, caused by excessive pesticide use and by the widespread, asynchronous planting of a limited number of rice varieties. Over 80 percent of the 830,000 ha of rice in West Java are planted with a single variety, the high-yielding Cisadane (Wirawan, 1987). The most serious pest has been the rice brown planthopper (*Nilaparvata lugens*), which had devastating outbreaks in the mid-1970s and as recently as 1986-87 (Chang, 1984; Oka and Bahagiawati, 1984).

Modernization of the rice culture has reduced the demand for labor, especially female labor (Collier et al., 1982; Papanek, 1985). The traditional practice of rice harvesting by women using a small hand knife is now widely replaced by harvesting with a sickle, using contracted male laborers. Small rice mills have virtually eliminated the jobs of women, who used to pound the paddy, and the introduction of tractors has reduced labor demand overall (Collieretal., 1974; Timmer, 1974).

In addition to these effects at the farm and village level, there have been national costs that threaten the sustainability of the country's food production. The current subsidy for fertilizers is about 68 percent of world prices; for pesticides, more than 40 percent; for irrigation as much as 87 percent; and for credit, an implicit rate of 8 percent (World Bank, 1987). Such levels of subsidy are not sustainable. Already there are signs that total rice production has started to level off and that rice stocks are decreasing.

The almost exclusive emphasis on rice production has also been at the expense of the other Indonesian staples---maize, cassava, sago, and yams. Rice has been elevated in sociocultural value; other staples are increasingly regarded as fit only for the poor. Significantly, all nonrice foods, except wheat flour, show a negative income elasticity (Afiff et al., 1980; Mears and Sidik Moeljono, 1980; Brs, 1985). As a consequence, Indonesia is becoming increasingly "monophagous:" the ratio of consumption of rice to other staples climbed from 0.4 in the late 1960s to over 0.8 by the early 1980s (BPS, 1985). Such dependence on a single staple food carries with it the risks of serious socioeconomic and political problems should major crop failure occur.

However, the rice field is not the only site of food production in Indonesia. Traditionally, a significant proportion of each household's food is derived from the homegarden or *pekarangan*, the cultivated land on the site where the house is built (Figure 2). In contrast to that of the rice field, homegarden production is far more diverse and versatile and appears to be inherently more stable and sustainable. Also the rural poor are more likely to benefit from homegardens. In this paper we review what is known about the homegarden in lava and argue for it to be accorded a greater prominence in future development strategy in Indonesia and in other developing countries.

HOMEGARDEN RESEARCH

The origins of AEA lie in efforts to improve the analysis of natural ecosystems (Walker et al., 1978), but most of the concepts and techniques were developed at the University of Chiang Mai in Thailand beginning in 1978 (Gypmantasiri et al., 1980). These were refined and elaborated at the University of Khon Kaen, also in Thailand, by a group of university and government research workers in Indonesia (as part of the *Kelompok Penelitian Agro-ekosistem* (KEPAS)) and by the Southeast Asia Universities Agroecosystems Network (SUAN).

One of the founding members of SUAN was the Institute of Ecology at Padjadjaran University in Java. The institute was created in 1972 as the first environmental center in Indonesia with a mandate to work on the "ecology of development" as a scientific basis for an ecologically sensitive approach to development. From the beginning it has focused its research and development activities on the homegarden, in recognition of the importance of the system for the rural people of Java, its significance in highlighting the positive interactions between ecology and development, and the challenges it poses for interdisciplinary research.

The Citarum river basin, in which Bandung is located, was chosen as the main study site. It is densely populated, suffers from severe deforestation, soil erosion, and water pollution problems, and is the site of several important development projects. Sample sites were chosen at various altitudes in the basin from sea level to 3,000 m to investigate the effects of climate, distance from urban areas, and patterns of farming on the structure and functioning of homegardens. Sites were also chosen in the areas affected by the Saguling and Cirata dams, and comparative studies were undertaken of homegardens in central Java and outside Java in transmigration areas.

The multidisciplinary team has undertaken detailed surveys of gardens, involving measurements of structure and function. Yields, incomes, and other benefits have been assessed, and this quantitative data has been complemented by intensive interviews with homegarden cultivators.

HOMEGARDEN CHARACTERISTICS

History and Extent

Homegardens (kitchen, dooryard, or backyard gardens) are commonly found in many parts of Indonesia and throughout Southeast Asia, South Asia, Africa, Latin America and the Pacific Islands, as well as in temperate regions (Savonnet, 1959; Fernandes et al., 1984; Thaman, 1984; Brierley, 1985; Brownrigg, 1985; Sommers,1985; Fernandes and Nair, 1986; Soemarwoto, 1986). The first written record of the homegarden in Indonesia appeared in a Javanese charter of 860 A.D. (Terra, 1954). But the homegarden probably originated 10,000 years or more ago, when hunters and gatherers discarded domestic refuse, containing seeds and other propagules, in the vicinity of their dwellings and then

tended and protected the plants that appeared (Hutterer, 1984). It has been suggested that Central Java is the Indonesian center of origin of the homegarden in its present highly developed form (Terra, 1948, 1954). Because homegardens are cared for primarily by women, they are more likely to be developed among matriarchal societies, typical of Central Java thirty years ago. In Tegal on the northern coast, for example, a homegarden could not be sold without the consent of the wife. Similarly, well-developed homegardens are found in the matriarchal society of West Sumatra and among the Acehnese of North Sumatra but not among the patriarchal Batak people, also of North Sumatra (Penny and Ginting, 1984).

Homegardens vary in size from less than 100 to several thousand square meters. In the early 19th century, Sir Stamford Raffles recorded gardens covering about ten percent of the total area of a district in Java (Raffles, 1817). By 1903 the total area of homegardens in Java was 378,000 ha and this increased, probably as a result of population growth, to 1,417,000 ha in 1937 (Terra, 1953) and 1,612,568 ha in 1986 (BPS, 1987), representing, respectively, 14.0 percent, 18.1 percent, and 17.0 percent of the total agricultural land. Locally, the proportion of land in homegardens shows large variations (BPS, 1987). In the 1920s it was as high as 50 percent surrounding Jakarta (Ochse, 1928-29) and it still is over 30 percent around Jogjakarta (Karyono, 1981). The extent of the contribution of the homegarden to national agricultural production, however, is not known; the products are mostly consumed locally and hence rarely appear in the statistical record.

Diversity

Homegardens are typically populated by a wide variety of plants, varying from small herbs to tall trees. In a recent survey, 56 species were found in a single homegarden in a village near Bandung, West Java, and in a hamlet of 41 households there were 219 species in the dry season and 272 species in the wet season. In a wider sample of 351 homegardens in the same area, 501 species were recorded in the dry season and 560 in the wet season, with a cumulative total of 602 (Karyono, 1981).

Trees are a common component, so much so that to the traveller in the Javanese countryside the villages are not recognizable by the presence of houses but by the dense "forest" that conceals them. According to popular belief, the structure of the homegarden deliberately mimics the natural forest, but in Javanese culture forests have a low social value. Indeed, Javanese feel offended when their homegarden is compared to a forest. In the popular shadow plays, the *wayang*, forests are depicted as dangerous places where wild animals live and evil spirits reign. Hence forest clearing (*babad alas*) is looked on as a noble deed and can only be done by men who have spiritual powers. Today the term babad alas is used in everyday life for the initial activities of praiseworthy projects, such as the creation of a university. The forest structure of a homegarden is, more plausibly, a result of convergent evolution, both natural and artificial selection favoring diversity.

Many species are represented by several strains, some only partly domesticated. In one river basin in West Java 34 banana varieties were recorded (Abdoellah, 1977). The fruit of some bananas (e.g., *ambon* and *susu*) are eaten as dessert, or steamed for snacks, and

others are supplementary staples (e.g., *kepok* and *tanduk*). Other varieties are grown for their wrapping leaves (e.g., *batu*). But farmers also clearly recognize the long-term importance of this genetic diversity: When asked why an unused tree is found in a garden, they typically respond by saying that they might need it sometime in the future. Homegardens are also a good habitat for small wild animals such as birds, reptiles, and amphibians. In a hamlet in West Java, 78 species of birds belonging to 38 families were found, including 13 species that are legally protected (Institute of Ecology, 1979). Nevertheless, the importance of the homegarden as a genetic resource has not been widely recognized to date and little inventory work has been done.

As altitude increases the homegardens become smaller, with greater density of plants and plant species and lower diversity (Figure 3). At lower altitudes coconuts and fruit trees predominate, whereas higher up the gardens are mostly devoted to vegetables. Detailed analysis of homegardens reveals well-defined plant associations that reflect a variety of complementary functions and whose design and composition are under the influence of climatic, edaphic, and economic factors, as well as cultural and traditional ones (Abdoellah, 1977; Karyono, 1981). Cultural influences can be very important: At the border between Central Java and West Java, where the Javanese and the Sundanese meet, the plant associations of the homegardens of the former are more complex than those of the latter (Abdoellah, 1980). There are also significant differences in the plant categories. Javanese families grow more medicinal plants, whereas the Sundanese grow more vegetables. The Javanese consume considerable quantities of extracts from medicinal plants (the *jamu*) to treat and protect against a variety of diseases and as a way of keeping fit. They are especially important during and after pregnancy. By contrast, the Sundanese are fond of eating raw vegetables and, because they also like neat gardens, they grow relatively more vegetables and ornamentals.

Agroecosystem properties---productivity, stability, sustainability, and equitability---are functions of the structure, processes, and history of the agroecosystem. In particular, they are related to its diversity. It has been argued that diversity in natural ecosystems is a product of environmental stability (May, 1972). To some degree this also applies to agroecosystems. The high diversity of plants in homegardens in the tropics is fostered by year-round climatic conditions that generally are favorable for plant growth. In this respect homegardens are diverse in much the same way as are the tropical rainforests. However, homegarden diversity arises primarily as a conscious response to socioeconomic forces. One of the interpretations, but not the literal meaning, of *pekarangan* is *pepek ing karang*, which means a complete design. By daily use of family labor close to home and by recycling household waste, homegarden owners can satisfy a wide range of domestic needs less expensively and more easily than through local markets. This, however, requires use of the usually limited amounts of land around dwellings. The density and diversity of crops per unit area, therefore, are high. It is the combination of diversity and intensive family care that is responsible for the high levels of stability, sustainability, and equitability.

PRODUCTIVITY

The only estimate for standing biomass of a homegarden is 2.5 kg/m2 from the Saguling area, West Java (Ratnawati, 1986). However, data are available for yields of harvested products. In general, the yield (in terms of gross income) of homegardens is lower than that of rice fields. However, because the costs of production are low, net income per unit area is relatively high. It can even exceed that of the rice field (Table 1). In one village of Central Java the rice field, which averaged 0.23 ha per farmer and was cultivated twice a year, contributed only 35 percent to the net income of the household, whereas the homegarden, which averaged 0.10 ha per farmer, made up 49 percent of the net household income (Penny and Ginting, 1984). Part of the productivity difference lies in relative labor requirements. One study reported labor input in homegarden, rice field, and dry field as, respectively, 7 percent, 59 percent and 34 percent of total labor input (Ochse and Terra, 1937). The low input level for homegardens reflects their proximity to living quarters, low incidence of pests and diseases, recycling of wastes, and low rates of erosion, which obviate measures to maintain soil fertility.

In areas far from towns, homegardens function primarily as subsistence systems and may produce over 15 percent of the total food requirement. Where homegardens generate income, most is derived from perennials. Income generation is a major function in the areas surrounding Jakarta, in the main fruit production centers, and in tourist areas. In such situations, income from homegardens is usually higher than from rice fields. For example, income from homegardens is 20 times higher in the tourist area of Lembang, West Java (Soemarwoto and Christanty, 1985).

In West Java fish production in homegarden ponds is common, with an income about 2 to 2.5 times that of rice fields in the same area. Other homegarden livestock are chickens, goats, and sheep, which are let loose by day to forage in the homegarden and market places. At night they are penned and often given additional feed, which is gathered from the garden, rice dikes, or river banks. In and nearby cities, orchids are grown using chicken manure as fertilizer. Many households also keep songbirds, such as the *perkutut* (*Geopelia strata*), in cages hung on tall bamboo poles. Top-quality birds that have won national song contests fetch very high market prices.

Most of the value of the homegarden to the rural household, however, lies not so much in net income generated but in the range of production and its contribution to the overall livelihood of the household (Table 2). Often it furnishes important supplements to the rice staple. In some circumstances, such as the heavily eroded areas of Gunung Kidul, Central Java, the homegardens have taken over much of the function of the crop fields and nearly 80 percent of the plants are vegetables and other food species. Virtually all species in the homegarden have a multiple use. Young coconut fruits are a popular drink and are believed to have medicinal effects, the milk of mature fruits is used directly in cooking and as a source of cooking oil, the fruits and young yellow leaves are used in wedding ceremonies to bring good luck, inflorescences are tapped for the production of sugar, the fiber and the shell of the fruits and the dry leaves are used as fuel, the trunk is often used as building material, and a dwarf yellow variety is a popular ornamental plant with supposedly mystical powers. Many plants in the homegarden that appear to be

weeds to an outsider are used for fodder, compost, medicine, etc. Ten species of very common weeds have medicinal value (Sangat, 1988).

Productivity also may be measured in nutritional terms (Table 3). Studies have shown a close relationship between well-developed homegardens and high nutritional status of household (Ochse, 1937). In Kutowinangun, 18 percent of the calories and 14 percent of the proteins consumed were derived from homegarden products (Ochse and Terra, 1934). Consumption increases With the amount produced (Danoesastro, 1980). The poorer households consume proportionately less and sell more than better-off households (Penny and Ginting, 1984).

The homegarden is also an important source of fuelwood, particularly for poor households, supplying from 40 to 80 percent of the rural need (Wiersum, 1977). Plants are rarely grown only for this purpose. Instead the dead wood of trees and shrubs, large dry coconut leaves, coconut shell and fiber, dry cassava stems, and other agricultural residues are gathered as fuel.

In addition to subsistence food and income, the homegarden also fulfills certain social and cultural needs. It is a symbol of status---people who build their house in someone else's homegarden are considered of lower social rank.

Homegardens also serve as a focus for social intercourse. The buruan, in front of the house, is kept clear of leaf litter as a place for children to play and for adults to gather for sport or to exchange views and news of the day. Homegardens are typically open, although they often have a fence that has no gate and does not completely enclose the garden. People can enter freely or pass through---there is no concept of trespassing. Indeed, an owner of a completely fenced homegarden is considered conceited. However, near and in cities this characteristic is disappearing. The gardens of the middle and upper classes in these areas are becoming more closed and people require permission to enter.

Homegardens also have an important aesthetic function that is served by the planting of ornamental plants, mostly in the front of the garden. This is most apparent in the cities, where plants that are grown for other purposes nevertheless are planted in an aesthetically pleasing manner.

STABILITY

Stability has two important components. The first is the constancy of useful production from season to season; the second is constancy from year to year. For homegardens, both may be compared with that of rice fields and other monocrop cultivations.

When water is readily available, for example, in regions with a long wet season or where the homegarden is located near a well, fish pond, or open sewer, annual crops can be grown the year round. Some fruit trees, such as coconuts, papaya, sawo (*Manilkara achras*), and pineapple, produce fruit all year; others, such as mango, rambutan (*Nepheleum lappaceum*), durian (*Durio zibethinus*), and duku (*Lansium domesticum*), are

strongly seasonal. Typically, subsistence plants are harvested daily according to need (e.g., a few tubers of yam, some chili peppers, one or two leaves of lemon grass, and a basket of cassava leaves may be picked.) Throughout the year there is a constant supply of produce of one kind or another, justifying the appellation of "living granary" (*lumbung hidup*) for the homegarden. By contrast, the harvest from rice fields is highly seasonal, and the period between the rice harvests is a time of low food supply and hardship, locally known as the *paceklik*. Such seasonality of rural poverty is common in less developed countries (Chambers et al., 1981). When the rice is being harvested the homegarden harvest is low, mostly consisting of vegetables and some secondary staple foods for home consumption. But during the paceklik the sale of coconut and bamboo increases and there is a high consumption of secondary staple foods (Achmad et al., 1980). Harvesting for sale is also important just prior to *Idhul Fitri*, the end of the fasting month when people are hard pressed for cash (Terra and Satiadiredja, 1941).

Stability between years is less clear, however, because many homegarden perennials show marked fluctuations in yield from year to year and income stability is affected by market demand. Nevertheless, the inherent polyculture of the homegarden spreads the risk of adverse effects from pests, weather, and economic factors among many species and their varieties. This results in a higher level of stability than in the rice fields.

SUSTAINABILITY

The sustainability of the homegarden is its ability to maintain long-term production at a desired level. It is thus a function of the intrinsic structure of the homegarden and of the disturbing forces that emanate from the surrounding biophysical and socioeconomic environment. Because the homegarden is one of the world's oldest forms of agroecosystem, it must be regarded, at least in general terms, as highly sustainable. Contributing factors are (1) the dependence on solar and human labor power; (2) the almost completely closed biogeochemical cycling of minerals, which, together with a minimal rate of soil erosion, ensures that soil fertility is maintained; and (3) a rich genetic resource that minimizes pest and disease problems and enables the system to respond to a wide variety of changing demands.

During the long period of their existence, homegardens have been subjected to severe disturbances of many kinds. Some are natural, such as volcanic eruptions and earthquakes; others, no less violent, are socioeconomic in origin. Their present resilience is a product of this past history. Today they are being stressed by new pests and diseases, by the surrounding large-scale forest clear cutting and erosion, and by population growth and economic development.

One of the most important intrinsic features of the homegarden is its ability to withstand the natural forces of soil erosion. Several interacting factors are important. The almost closed canopy provides some protection, at least from intense rainfall (Astuti, 1987), and, because the majority of the plants are less than a meter high, the raindrops falling through the canopy hit the soil surface at a rate considerably below their terminal velocity. But by far the most important factor in preventing erosion is the protective layer of litter (Coster,

1937; Wiersum et al., 1979; Soemarwoto and Soemarwoto, 1984; Young, 1986). Most homegardens have a heavy litter layer that is only removed from the buruan . The importance of the tree canopy and the undergrowth lies not so much in their direct effect on erosion but in their capacity to provide continual replenishment of the litter. Nevertheless, erosion is probably somewhat higher than in the natural forest ecosystem (Ambar, 1986).

EQUITABILITY

There are few detailed contemporary figures on the sharing of homegarden produce. Traditionally the Javanese and Sundanese abide by the precept of living *rukun*, which can be loosely interpreted as living harmoniously with their relatives and other members of the community, as well as with the mystical spirits that are believed to dwell in villages, rice fields, and surrounding forests (Hidding, 1935; Geertz, 1960; Hardjowirogo, 1984; Magnis-Suseno, 1984; Mulder, 1984). An important way of expressing rukun is through offering rice and homegrown products, such as coconuts, banana, maize, cassava, fish, and, eggs, to relatives and neighbors. According to popular belief, the essence of the food is consumed by the spirits. Such offerings are given at births, weddings, and deaths, and on other important occasions, such as the Javanese new year and the birthday of the Prophet Muhammad. Offerings are also given to ward off dangers or to cure diseases. Food obtained in this way can amount to a significant proportion of the diet--about 6 percent of total food consumed (Institute of Ecology, 1985), 3 to 36 percent of calories, and 3 to 40 percent for proteins consumed (Ochse and Terra, 1934). Conversely, the costs can be high for the donor, averaging 20 to 30 percent of total food expenditures (Ochse and Terra, 1937).

The produce of the home garden is also shared on a regular day-to-day basis. In traditional villages, relatives and neighbors may enter a homegarden to use water from a well, to take dead wood, or even to take fruits and vegetables. They seek permission in advance but this is rarely denied. This freedom may go so far that the owner complains of having little left for his/her own harvest (Penny and Ginting, 1984). Removal of plant products for medicine or for religious ceremonies is never denied. In some areas there is the belief that for a medicine to be effective it must be stolen and hence it is taboo to ask for permission. If an owner discovers such an act, s/he will pretend not to see it.

Homegardens are the responsibility of the entire family, which often includes the extended family, because offspring may build their house in their parents' homegarden (Achmad et al., 1980). Poor people, with permission, may also build their houses in homegardens, but in return have an obligation to do some work for the owners. The homegarden, however, provides only limited labor opportunities for the landless, because of its low labor demand and the low opportunity cost of family labor. Fifty years ago only nine percent of the total workdays in the homegarden were from hired labor (Ochse and Terra, 1937). Today the amount is probably much less.

CURRENT TRENDS

Two processes currently have a major impact on the homegarden. The first is the growth of commercialization and the market economy in both urban and rural areas; the second is population growth.

Since 1969, when Indonesia launched the first of its successive five-year development plans, there has been a considerable growth in the numbers of upper and middle class people who can afford high-quality housing and nutrition. One consequence has been a rising demand for better quality fruits and vegetables, and homegardens have responded by improving the quality of their produce, selecting for those varieties and species with a high market demand. Thus, near Jakarta and other major towns the diversity of crop varieties has been substantially reduced. In Depok, the main fruit-producing district of Jakarta, only four banana varieties were recently found in a sample of 15 households. In the interior Saguling area the same number of households produces 25 varieties. In the 1920s, 75 mango varieties were reported in the Cirebon area, not far east of Jakarta (van Rijn, 1928-29), but a recent survey revealed only 48. Given this trend, noncommercial crop varieties will soon be eliminated from homegardens in Java and replaced by commercial monocultures, as already has occurred in the mandarin-growing centers of Garut in West Java and Batu in East Java. This genetic erosion is likely to result in increasing risks of outbreaks of pests and diseases. Mandarin trees are now heavily damaged by citrus vein phloem degeneration (CVPD) disease (Tirtawidjaja, 1983). In 1977 there were five million diseased trees in Indonesia. This doubled by 1981, causing an average annual loss of 17 percent of the harvest (Ramelan, 1983). Cloves, which are being extensively introduced into homegardens, are being severely damaged by *Phyllosticta* spp., a new disease that is spreading rapidly. In West Java almost 20 percent of the clove trees are damaged.

A further consequence of commercialization is the increasing demand for inputs and hence credit from banks and other sources of capital. The homegarden is changing from a system characterized by low yields, low inputs, and low risks to one of high yields, high inputs, and high risks. Frequently this results in villagers becoming indebted to unscrupulous middlemen and moneylenders. The seasonality of many cash crop harvests produces large incomes that tend to be used for ceremonies and consumption rather than reinvestment in the homegarden. As a result, net annual incomes may have increased only on paper, and welfare may have declined. Furthermore, because most traditional vegetables have low commercial value they are usually the first to be removed from the garden. As more produce is sold and less consumed, there is a further danger that the dietary role of the homegarden in providing vitamins and minerals may be lost. Finally, commercialization results in a reduction of equitability; there is less sharing of the harvest, even with relatives, and the traditional rights of the poor disappear.

Rural people in Indonesia respond to population growth by bringing new land under cultivation, by intensifying cultivation in order to obtain higher yields per unit area, and, more recently, by migrating to towns and cities. Between 1905 and 1925 there was an increase in agricultural land per capita in Java from 0.107 ha to 0.180 ha, but this declined to only 0.087 ha in 1980 (Booth, 1985). In upland areas, in particular, conditions are deteriorating as declines in landholdings result in decreased income, which in turn

reduces the capacity of farmers to maintain the land. Terraces cannot be repaired, new ones cannot be constructed, and more agricultural wastes are used for fuel instead of being returned to the field as mulch or compost. Under these conditions soil erosion accelerates and yields decline. The combination of declining landholdings and decreasing yield forces people to grow more staple foods in their homegardens, which take over, partly or wholly, the function of food production of the upland fields. In the heavily eroded areas of South Jogjakarta in Central Java, where upland rice, maize, and cassava now dominate homegardens, the process of erosion, declining yields, and general land deterioration that occurred in upland fields is being repeated in homegardens.

In urban areas the need for upper and middle class housing has resulted in the conversion of extensive areas of agricultural land to residential areas. Individual houses in these residential areas have homegardens, but their area is small relative to the total residential area. Replacement of the homegarden with housing, shops, offices, roads, and other infrastructure also increases rainwater run-off and hence produces greater flooding.

As we have argued, traditional homegardens have many desirable characteristics. Although gross yields per hectare are relatively low, they have tended to function largely outside the market economy to cheaply satisfy a wide variety of domestic needs. The produce, which is widely shared in the community, is an important supplement to diet and income, particularly during the critical time between the rice harvests. They are a valuable genetic resource, and they protect against soil erosion. In general, homegardens are a stable and highly sustainable system.

But these desirable features are now being threatened. To increase productivity, plant and animal forms are selected for their high market value and species and varietal diversity are declining. The consequences will be a serious loss of genetic resources, paralleling what has happened in rice; loss of the layered canopy structure and litter, with an increased risk of soil erosion; loss of the recycling system that will result in high inputs of fertilizers; loss of natural pest-control agents, leading to the use of pesticides; loss of stability of production both within and between years; loss of the high variety of supplementary nutrients; and, finally, an end to sharing of products with relatives and neighbors.

HOMEGARDEN DEVELOPMENT

Too often rural development is planned from an urban viewpoint with little regard for the perceived and actual needs of the rural people or the ways in which they would like to see change occur. The range of functions of the homegarden and its socioeconomic status are rarely considered. Usually only specific functions are targeted, for example improvement of nutrient supply or increase in income from a particular source. For example, the government introduction of a high- and fast-yielding dwarf hybrid coconut was not accepted by the villagers, because it displaced the middle canopy trees, such as banana and mangosteen, leaving the upper canopy space empty. Several high-yielding and nutritious vegetable species have also failed, largely because they were shade intolerant.

Nevertheless, the homegarden does have a potential for improvement, provided it is based on sufficient understanding and sound principles. More detailed analysis of plant associations in the homegarden could provide a better knowledge of the ecological and economic compatibility of different plant species. This could lead to new planting patterns based on a selection of species and varieties in terms of such variables as nutrient content in the produce and market demand, as well as light tolerance and root structure. Such improved designs, however, need to retain the combination of perennial trees with annuals. Perennials require less labor for their care and hence are more affordable to poorer people (Stoler, 1981). They fill the troughs of the lean periods (Chambers and Longhurst, 1986), while annuals play the role of the early succession plants, providing high net primary productivity (Ewell, 1986). Improved designs also need to preserve the traditional recycling system while eliminating its drawbacks, particularly high health risks in areas where human excreta is used to fertilize fish ponds.

The development of postharvest technology of homegarden products can help create added value and jobs in the nonagricultural sector and lessen dependence on land. Examples are the processing of fruits to jams and juices, of bamboo to household utensils and furniture, and of maize and soybean to chicken and fish feed. Such processing reduces waste of highly seasonal and perishable products and buffers the price drop during the rainy season. It links homegarden productivity to the national economy as part of an agricultural demand-led industrialization in which the primary gainers would be the farmers and rural poor (Adelman, 1984).

However development is handled, genetic erosion will nevertheless be inevitable. A possible solution is to establish economic botanic gardens located in selected ecological regions to conserve the local species and to maintain banks of seed collections and/or tissue cultures of homegarden varieties. The difficulties and the costs involved are high, but, because genetic preservation also provides universal benefit, the international community should be willing to bear some of the costs.

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