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Homegarden Systems: Agricultural Characteristics And Challenges

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HOMEGARDEN SYSTEMS: AGRICULTURAL CHARACTERISTICS AND CHALLENGES

Inge Hoogerbrugge and Louise O. Fresco

Increasing human population densities have, throughout history, resulted in land use intensification, i.e. an increasing frequency of agricultural production in space and time until land is permanently cropped. Higher outputs per unit land area require increased inputs of human and fossil energy, nutrients and biochemicals. If these external inputs are unavailable, land use intensification may lead to soil mining and low production levels. Only two systems of traditional, low input farming in the humid tropics have evolved under conditions of high population densities: wet rice cultivation and homegardening. In different ways, both systems allow some degree of soil fertility and pathogen management under permanent land use. The agronomic aspects of wet rice systems have been studied extensively, but surprisingly little is known in comparison of homegardens.

There are two reasons why the study of homegardens is of great importance. First, we need a better understanding of the evolution of homegardens in the light of increasing population pressure and urbanization in what could be called the 'classical' homegardening regions of Asia. Homegardens are not static, even if they seem to be age-old adaptations to high population conditions, such as on Java. Increasing population pressure, the proximity of large urban markets, the availability of modern agro-chemical inputs, the introduction of new crop and tree species, and the migration of rural labour to the cities may all exert their impact on homegardening. Second, a study of homegardens may prove essential to understand their scope for regions outside the 'classical' homegarden areas, where population now starts to rise to comparable levels reaching the limits of ecological carrying capacities. It is possible that homegardening could become an alternative for low input farmers with diminishing areas of land and few means to intensify food production in areas of rapidly growing populations and where the natural conditions of soil fertility and climate are such that permanent cropping is possible. The relevance of a study of homegardens lies therefore both in understanding the homegarden's flexibility in the light of changing conditions in Southeast Asia and its applicability to certain parts of Africa and Central America.

Although the importance of homegardens has long been acknowledged (e.g. Terra, 1932), agricultural scientists have rarely if ever been interested in traditional homegarden systems. Most of the agronomic work on homegarden crops has been conducted with a view to introducing commercial horticulture in the tropics. Qualitative inventories of crop and tree species have been produced occasionally by anthropologists, home economists or nutritionists. As a result, the agronomic, let alone the quantitative information on homegardens is extremely scanty and directed towards desirable improvements rather than

actual practices. Yet it is essential to obtain an answer to questions like: 'what crops, in what densities, with what types of inputs and what yields are grown where?'. No overview of traditional gardens exists to date, making it difficult to target research for homegarden improvement or to review its usefulness for other parts of the world. This paper discusses many sources of 'informal' or 'grey' literature on agronomic aspects of homegardens, including several unpublished field observations. It aims to increase the understanding of current garden systems, of their evolution and of their potential for increasing food security.

Because the vast majority of homegardens is found in Asia, and therefore the literature referring to that part of the world is much more extensive, we concentrates on the humid tropics of Asia. Wherever possible, agronomic information on other regions has been included, but field level studies of traditional gardens are very limited in other continents. We have attempted to indicate the relevance of the patterns found in Southeast Asia to other parts of the (sub)tropical world.

A Definition of Homegarden Systems

There is an enormous diversity in homegardens, and their phenomenon has been studied in a rather haphazard way. So it should not be a surprise that there are many definitions of homegardens, each emphasizing different aspects, depending on the objectives of the researcher. The cultural background and gender of the scientist influence the perception of the subject (Gupta, 1989), while this may differ considerably from the view of the homegardeners themselves. Having reviewed this list, we suggest the following definition:

"a homegarden is a small scale, supplementary food production system by and for household members that mimics the natural, multi-layered ecosystem."

As a system of permanent land use, the homegarden has well-defined boundaries and is located at or within reasonable distance from the residence. As a type of cropping system, it comprises soil, crop, weed, pathogen and insect sub-systems, which transform solar energy, water, nutrients, labour and other inputs into food, feed, fuel, fibre and pharmaceuticals (Fresco and Westphal, 1988). In some cases, animal species are kept in or near the garden. It generally occupies 'marginal' land and uses 'marginal' labour and 'traditional' techniques.

'Marginal' land refers to plots that are too small, of inconvenient sizes (e.g. narrow strips) or unsuitable for field crops or grazing because of their location or because of their slope. Small plots in villages and near riverbanks and roadsides are preferably used as gardens. 'Marginal' land does not necessarily suggest that the soil fertility of homegarden land is lower than that of the surrounding land. Fertility of gardens often increases considerably as kitchen waste, manure and nightsoil are applied to the plot for several generations. The average size of a homegarden is always less than that of the arable fields in the region. The boundaries of a homegarden can be either physical (such as hedges, fences, ditches and so on) or based on mutual agreements.

'Marginal' labour refers to the fact that labour inputs in the homegarden are flexible, depending on slack periods in field cropping or in off-farm work and reflect the low opportunities for alternative employment. The labour for gardening is nearly always provided by household members instead of hired or exchanged labour. The capital and energy inputs in the garden are low.

'Traditional' techniques does not suggest that age-old techniques are always applied, but that modern cultural practices (agro-chemical inputs in particular) are used infrequently or occasionally, depending on individual household strategies. Homegarden technology reflects the general level of agricultural technology in the region: crop and animal species and varieties which are environmentally adapted are grown or bred with locally known husbandry methods, while few exotic species are found.

Homegardening can be distinguished from commercial horticulture and arable cropping by the scale of operations: a highly diversified production on small, intercropped plots with crop and animal species. It focuses on providing a combination of products for subsistence and cash. While the provision of additional food and/or cash constitutes the main function of gardens, they may also be used for small-scale experimentation, and leisure and ornamental functions. Because of these characteristics garden systems differ considerably across locations and are referred to by many terms (Fernandes and Nair, 1986; Ninez, 1984; Ninez, 1986a), making a comparison of observations extremely difficult.

The most important difference between homegardening on the one hand and commercial horticulture and arable cropping on the other is the fact that the garden never provides the main source of income or food to the household. The main source of income or food is arable agriculture, forestry or wage labour, within or outside the agricultural sector. The garden always forms an additional source. In the case of non-agricultural or near-landless households who have no other land but their homegardens and depend on wage labour for food and income, homegardening may constitute an important form of supplementary production. The exact definition of homegardening is complicated by the fact that homegardens, as all land use, reflect changing responses of farmers to a changing environment. Homegardens may be evolving towards commercial horticulture and therefore display some of the characteristics of a commercial enterprise. It should be kept in mind that homegardening is a very flexible and changing activity.

Area Under Homegardens

Total and Relative Area

Estimates of the total area under homegarden vary considerably, partly because of differences in definitions, and partly because of the absence of regional quantitative data. For example, 20% of the cultivated area of West Javan villages is claimed to be homegarden and 16% to be *talun-kebun*, ie a garden-like annual-perennial rotation system (Christanty et al, 1986). However, according to our definition above, the *talun-kebun* should also be included as a type of homegarden. This would lead to an overall figure of 36% of the area of the village cultivated as homegarden, instead of 20%.

Because many statistics exclude the gardens of households without agricultural land, areas are often underestimated. In Sri Lanka, 41% of the households have a homegarden without having a farm (Ensing et al, 1985). In many official statistics this area is excluded from the land under homegardening. Total area estimates are often extrapolations of samples which may show large differences in garden area per village. These can be as high as 10–75% of the total cultivated area in Java (Stoler, 1978). Furthermore, most studies are restricted to rural homegardens, and urban gardens are rarely taken into account, with some exceptions for Zambia (Sanyal, 1985), the Pacific (Thaman, 1977; Vasey, 1985) and Togo (Schiller, 1991). Nutrition programmes focus on urban homegardens to improve the nutritional status of a family (eg Gershon et al, 1986; Niñez, 1985). In view of the rapidly growing urban population all over the world, the importance of urban gardens cannot be underestimated, and more information is badly needed.

At the (sub)national level, the percentage of total area under homegardening is only known for Sri Lanka – 30–40% of the cultivated area (Verheij, 1982; Ensing et al, 1985) and Java – 20% (Wiersum, 1980; Terra, 1954; Sollart, 1975; Bompard et al, 1980), although some national Indonesian statistics can also be found (Flach, pers. comm 1991). More information is available on the proportion of land used for gardening in relation to the total farming system, which varies between 10–60% of the total farm area (Table 1).

In Sri Lanka, 81-100% of the farms include a homegarden (Ensing et al, 1985; Brown et al, 1983), while a total 90% of the households cultivates a homegarden (Verheij, 1982). This figure is similar to that for Java (Christanty, 1981), but much higher than that for Africa (17-43% in Sanyal, 1985; Engel et al, 1985).

Table 1: Percentage of Farm Land Used for Homegardens

Region	Average % (Range)
Sri Lanka	50
Java	(8.7–58.8)
Java	14
Java	23 (19–42)
Java	18

Sources: Brown et al, 1983; Christanty, 1981; Laumans, 1985; Matahelumual and Verheul, 1987; Terra, 1954.

Area of the Individual Homegarden

The area of a single homegarden differs considerably, ranging from several squares to a maximum of 2 ha, as shown in Table 2. The size of a homegarden is related to the status of the household (Ahmed et al, 1978) and influences cropping intensity, plant density and labour used. Size correlates inversely with garden intensity (Stoler, 1978), plant density (Jacob and Alles, 1987; Verheij, 1982) and labour input (Stoler, 1978). Size is not necessarily related to diversity (Jacob and Alles, 1987), though other authors state that size is positively related to the number of different species grown (Sollart, 1975; Ensing et al, 1985).

Table 2: Area of Homegardens (m^2)

Region	Range (m2)	Average	Sources
Sri Lanka		7000	Brown et al, 1985
Sri Lanka	1600-2400		Ensing et al, 1985
Sri Lanka	4000-20000	10000	Jacob and Alles, 1987
Sri Lanka		2000	Verheij, 1982
Java	200-1300		Christanty et al, 1986
Java	172-521		Eijkemans and Ham, 1982
Java	200-1700	1000	Laumans, 1985
Java	<1000		Michon et al, 1983
Papua New Guinea		372	Vasey, 1985
Peru	up to 1000	600	Ninez, 1986a
Grenada	500-2000		Brierley, 1985
Zambia	190-324		Sanyal, 1985
Zambia	2000-12000	6800	Fernandes and Nair, 1986
Zambia	5000-20000		Gliessman, 1988
Zambia		12300	Newman, 1985
Zambia	10-120		Torres, 1986
Nigeria	200-1000		Okafor and Fernandes, 1987

Labour Inputs in Gardening

Data on labour inputs and timing are scarce, most likely because they concern supplementary labour. The available data do not allow for much comparison because no specification of area is given. A maximum of 8% of the total working time is spent on homegarden activities (Stoler, 1978), while in peak periods a labour input of two persons/day can be reached (Niñez, 1986b). On a per hectare basis, small gardens appear more time consuming than larger ones, due to a more intensive cultivation. Table 3 provides an overview of labour inputs in homegardening.

While in Africa most tasks seem to be performed by women (Thaman, 1977; Engel et al, 1985), in Sri Lanka women only provide labour at peak times (Ensing et al, 1985; Jacob and Alles, 1987). In Indonesia men perform land preparation activities and cultivate the tree crops, while women and children cultivate the annual crops. Harvesting is done by all household members, while marketing is a predominantly male activity (Christanty et al, 1986; Bompard et al, 1980; Laumans et al, 1985; Matahelumual and Verheul, 1987). In Papua New Guinea most tasks are performed by women (Vasey, 1985).

Table 3: Time Spent on Homegardens

Region	Time	Range
Asia	<1 h/day	
Java	1 h/week/100m²	<0.5 - > 5 h/week/100 m²
Peru	50 min/day	<0.5 h/day - 2 pers/day
Java	8% total working time 1600 h/year (<0.3 ha)	1600 h/year (<0.3 ha) 2100 h/year (0.1 – 0.3 ha) 4700 h/year (<0.1 ha)
Pacific	4.5 h/week	0 – 20 h/week

Sources: AVRDC, 1985; Eijkemans and Ham, 1982; Ninez, 1986b; Stoler, 1978; Thaman, 1977.

Financial Inputs in Gardening

Only two sources report on financial inputs, one of them on hired labour. Actual quantitative data on fertilizer, transportation, hand tools and chemicals are unreported or difficult to interpret. In Sri Lanka 87.8% of the total money input in the garden is spent on labour (Jacob and Alles, 1987). In Peru 10% of the total return is used as capital input (Niñez, 1985). The lack of data might indicate that very few external financial inputs are used, but no conclusions can be drawn.

Crop Species and Varieties

Diversity in species and varieties are among the most striking features of homegardens. As many as 240 (sub)species have been reported in a single garden (Bompard et al, 1980). Unfortunately, it is often unclear whether the literature refers to single plots or to the total number of species found in a sample of homegardens. The number of species per unit area is estimated at 8/100 m^2 (Soemarwoto, 1987). Many authors only mention important groups of plants with one or two examples of species but without a detailed listing. If one groups 'fruits' and 'fuel plants' as perennial, the number of perennials reported ranges from 20 to 89. Corresponding figures for annual species range from 19 to 107. In a garden, or sample of gardens, different varieties of the same species can often be found. The number of Musa spp and cultivars, for example, may be as high as 21 (Guhardja, 1988) or even 40 (Bompard et al, 1980; Michon et al, 1983). Table 4 lists the number of species found by different authors. A listing of crop and animal species derived from the literature, mainly referring to Asia, provides insight in the importance of species across homegarden systems (Table 5).

Another way to approach the importance of species grown is through the percentage of farmers growing a given crop in homegardens (Brown et al, 1983; Ensing et al, 1985; Evers et al, 1985, Jacob and Alles, 1987; Sanyal 1985). For example, in East Java coconut, jackfruit, banana, arecapalm (Areca catechu), mango, citrus, breadfruit, coffee, papaya and kittulpalm are grown by more than 50% of homegardeners (Evers et al, 1985). Jackfruit,

coffee, pepper, coconut, plantain, tea, clove, nutmeg, citrus and papaya are grown in more than 50% of the gardens in Sri Lanka. There is very little data on the distribution of annuals, although it has been reported that maize, rape, tomatoes, groundnut, beans and pumpkin are grown in 50% or more of the gardens in Zambia (Sanyal, 1985).

Diversity is obviously a function of climate, but it is also closely linked with household needs for food and cash. Diversity seems to decrease with:

- Altitude;
- the length of the dry season;
- the share of cash crops;
- population density;
- labour shortage at household level; and
- distance to urban areas.

Table 4: Number of Plant Species Present in Homegardens

Region	Number (no./ha)	Remarks	Source
Java	110		Bompard et al, 1980
Java	>39		Guhardja, 1988
Java	228	Sundanese	
Java	196	homegarden	Abdoellah & Isnawan, 1980
Java	191	Javanese homegarden	Atmosoedaryo and Wijayakusumah, 1977
Java	241		Bompard et al, 1980
Java	112	Kebun talun	Christanty, 1981
Java	127	homegarden	Christanty, 1981
	148	range 8–52, average 25–30 species per ha	Ensing et al, 1985
	4–18	80% farmers 8–15	Jacob and Alles, 1987
	184		Mergen, 1987
Java	250		Michon et al, 1983
	15		Newman, 1985
Peru	70		Ninez, 1986a
Java	351	range 30–272, average 100 species per ha excluding weeds	Soemarwoto, 1987
Java	180		Sollart, 1975
Papua New Guinea	61–81		Thaman, 1977
Sri Lanka	>100		Verheij, 1982

Table 5: Useful Plant and Animal Species in Homegardens		
Perennial	**Annuals**	**Animals**
Banana sp	Cassava	Chicken
Coconut	Maize	Cows
Citrus sp	Yam sp	Ducks
Jackfruit	Sweet Potato	Goats
Papaya	Taro	Sheep (infrequent)
Coffee	Beans	Pigs
Mango	Chili Pepper	Bees
Pepper	Groundnut	Fish
Avocado	Eggplant	Water Buffalo
Clove	Pineapple	Guinea Pigs
Guave	Cucurma sp	Rabbits, Donkeys, Horses and Pigeons

Cultural Practices in Homegardens

Soil Preparation

Soil preparation in homegardens involves preparing beds (including seedbed), digging plant holes and laying out terraces and ridges if necessary (Brierley, 1985; Christanty et al, 1986; Ensing et al, 1985; Matahelumual and Verheul, 1987; Niñez, 1986a; Okafor and Fernandes, 1987). No cases of ploughing are mentioned.

Planting and Plant Spacing

Both direct planting and transplanting from a seedbed occur in gardens. Intercropping is reported by most authors, but single plantings are found in the case of vegetables (Brierley, 1985) and clove trees (Bompard et al, 1980). Homegardeners may switch from intercropping to single cropping when improved planting material is introduced (Christanty et al, 1986). There are some indications that improved varieties or new species are experimented with first in the homegarden, before the new plants are introduced in arable cropping. This points to an important role of homegardens in agricultural innovation.

Spacing in homegardens is rarely reported, although some information is available on spacing of perennials. In East Java 1.2 fruit tree per 100 m² is grown, ranging from 0.8 to 2.1, and 1.9 wood/fodder tree per 100 m², varying from 1.2 to 2.6 (Laumans et al, 1985). In Sri Lanka an average of 14 trees per 100 m² are planted on a high density farm, of which 7 are coffee and 2 are areca palms. A low density farm has an average of 0.7 tree per 100 m², 0.1 coffee tree and 0.1 areca palm (Jacob and Alles, 1987). There are some indications that overall densities decrease with garden size: 1530 plants per 100 m² in a small homegarden and 74 per 100 m² in a large one (Bompard et al, 1980).

Crop Husbandry

Although homegardens are principally rainfed systems, supplementary irrigation is commonly practised in the dry season (Christanty et al, 1986; Matahelumual and Verheul, 1987; Sollart, 1975; Freeman and Fricke, 1984). Watering frequency depends on the crop, and varies from twice annually (Eijkemans and Ham, 1982), to once a week (Matahelumual and Verheul, 1987) or twice daily (Thaman, 1977). Water saving is achieved through wide spacing and the use of mulch (Vasey, 1985). Dry season gardens along the main flood plains are a well-known feature in semi-arid climates, such as in the Sudan-Sahel region.

Soil fertility is maintained through rotation of crops and the application of farm yard manure, compost and chemical fertilizer. Fallowing is rarely mentioned (Brierley, 1985), and on soils of high inherent fertility no measures are taken at all (Thaman, 1977).

Homegardens are sometimes protected from roaming animals and theft by live fences (Matahelumual and Verheul, 1987; Fujisaka, 1986; Soemarwoto et al, 1985). Pest control is again crop-dependent. Amaranth, for example, is treated with chemicals and tobacco to control pest outbreaks, while mechanical pest control is practised in other crops (Matahelumual and Verheul, 1987). Pesticides are generally uncommon, but may be introduced with improved cultivars or hybrids. Traditional means to control pests are sand against white ants, burning of banana pits to control weevils, manual insect control and removal of sick plants (Ensing et al, 1985). No references to integrated pest control have been found, although the individual treatment of plants can be considered as such. It is possible that the increasing use of biochemical products may affect homegardens, and would present major human health problems because of the direct consumption of the garden products by the household. However, there is no written evidence on this.

Weeding is done if necessary (Christanty et al, 1986; Sollart, 1975; Chin, 1985), but there are relatively few reports on weeding, suggesting that this is a typical ‘marginal’ activity carried out intermittently when labour is not needed elsewhere.

Other cropping techniques used in homegardening are transplanting, thinning, pruning, staking, grafting, ratooning and mulching (Christanty et al, 1986; Ensing et al, 1985; Fernandes et al, 1984; Matahelumual and Verheul, 1987; Okafor and Fernandes, 1987; Soemarwoto et al, 1985; Vasey, 1985).

Outputs from Garden Systems

Physical output figures are rarely reported and if so, they are difficult to compare. Experimental vegetable gardens yield 0.22 – 1.22 kg/day from 18 m² (AVRDC, 1985), and an average of 1.5 kg of produce per day in a Thai homegarden can be obtained (Gershon et al, 1986). In Hawaii an overall fresh yield of 1.373 kg/m²/day is reported (calculated after Yang, 1979). Plantain production per ha in compound gardens may be up to five times higher than in commercial plantations (Nweke et al, 1988).

Output may also be expressed in relation to the household's food needs. An average 2000 m² kitchen garden on Grenada does not produce enough to meet household needs for vegetables and fruits (Brierley, 1985). In Indonesia, 30% of the families with homegardens are not self-sufficient (Matahelumual and Verheul, 1987), while a homegarden supplies 1 – 18% of the calories and 14% of the protein requirements of a family (Christanty, 1981). These figures vary between 32% and 44% (Freeman and Fricke, 1984), 14% and 18% (Terra, 1954) or over 40% of the calories (Stoler, 1978). For Sri Lanka it has been calculated that over 80% of the staples, 60% of the leaf vegetables and 20% of all other vegetables, 80% of the fruit and 40% of the species for family use are grown in homegardens (Ensing et al, 1985). If average food expenditures for a household are known, these figures may be translated into economic values.

The volume of sale of products from gardening is generally limited (Bompard et al, 1980), although the proportion may be as high as 75% (Stoler, 1978). In Sri Lanka 57% of the cultivators sell products from their homegarden (Ensing et al, 1985). The contribution of the homegarden to the household income lies in cash saved on food purchases and in cash earned through sale of homegarden produce. Income from homegardens has been studied frequently, mainly in Indonesia (Table 6), but the results do not allow comparison.

Table 6: Income from Homegardening as Proportion (%) of Total Household Income

Region	Proportion (%)	Remarks	Source
Java	23.6	Poor people	Christanty et al, 1986
Java	9.0	Well off people	Christanty et al, 1986
Java	20–35		Bompard et al, 1980
Peru	10		Niñez, 1985
Java	51.1	Javanese garden	Abdoellah and Isnawan, 1980
Java	41.6	Sundanese garden	Abdoellah and Isnawan, 1980
Java	41.5–51.1		Eijkemans and Ham, 1982
Java	10–30		Freeman and Fricke, 1984
Java	20–30		Gliessman, 1988
Java	>20		Stoler, 1978
Java	22-33	Maximum 83%	Terra, 1932

New Perspectives on Homegarden Systems

As this paper illustrates, homegardens are extremely diverse as a result of differences in agro-climate as well as in the objectives of the homegarden growers. The homegardens currently found in many parts of the world must be seen in the light of the evolution of land use by people. It is likely that following a long period of hunting and gathering, the emergence of shifting cultivation has been coupled to the planting of fruit and other useful trees in the fields during fallowing. The subsequent sedentarization of agriculture has led to the creation of more or less permanent gardens with a mixed composition of tree and annual species. With increasing population pressure on the land, we may expect a surge in the importance of gardening as a means of securing useful plant and animal products for resource-poor households, both in rural and in urban areas.

The diversity of homegardens suggests that it is important to develop criteria to classify them, in order to determine relevant differences and to target agronomic research. From our review the following criteria for a classification of homegardens appear the most appropriate:

- function: additional (staple) food production or income generation;
- structure: multi-layered vegetation, i.e. a mixture of annual crops with perennial trees or an 'open' structure, i.e. with annual crops;
- continuity of production: permanent cultivation throughout the year or seasonal production; this feature is largely dependent on climate and soil characteristics and labour availability;
- dominant crop (and animal) species and their combinations: these follow generally from these characteristics, but must be described in detail for a workable classification of homegardens in a given region; and
- intensity of input use, both of external and household resources.

Misconceptions

The review also allows us to put several misconceptions about homegardens to rest. Notwithstanding their great variation, homegardens are characterised by the fact that they are not exclusively subsistence oriented, but provide households with cash as well as food crops. While a homegarden is not meant as more than a supplementary food source, the type of crops grown demonstrates the importance of homegardens in the supply of energy foods: the most frequently mentioned crops are sources of carbohydrates, not primarily of vitamins. In fact, vegetables and fruits – the classical garden crops – play a minor role. This could be related to high land pressure, where arable cropping cannot fully provide households with enough calories. In any case, the implication is that the promotion of homegardens as vegetable and fruit gardens alone is likely to be unsuccessful, unless one is aiming at commercial fruit growers. Although animals are reported, the interaction between crop and animal components of the garden is rarely documented, even if fodder crops are often present in the garden.

Most homegardens are found in densely populated areas with reasonably fertile soils. One of the most striking aspects of homegardening is that cultural practices depend on the crop species and are administered individually to each plant. Crop density, especially of tree crops, is considerably higher than in arable or plantation fields. The number of perennial species is also high, but this might reflect the temporary absence of annuals due to seasonal influences.

Although women's labour constitutes an important input, the stereotype view that gardening is a female activity does not hold. Labour inputs should be examined more closely, also because it seems possible that in case of labour shortage the diversity of the garden crops decreases.

Future Developments

Homegardens cannot be studied in isolation from the farming systems of which they form a part. In all those areas where population pressure is reaching the limits of carrying capacity, farming systems are evolving towards greater land use intensification leading to a greater specialization and application of external inputs. A fragmentation of land holdings resulting from population pressure may lead to a conversion of arable land into gardens (Ensing et al, 1985), requiring off-farm employment and agricultural intensification to compensate for the loss of agricultural production (Christanty, 1981). In this light, three directions for the future development of homegardens appear to be emerging.

1. Homegardens as sources of supplementary production and activity, using 'marginal' land and labour. This is their role in the 'classical' homegarden regions of Asia, a niche which may become more important in the peri-urban areas of Africa and Latin America. The success of this type of homegardens will depend on the way species diversity can be maintained at low (external) input levels so that a variety of household goals can be met in a flexible way.

2. Homegardens as a specialised, commercial activity in areas with good infrastructure and sufficient purchasing power, in particular specialised orchards and/or horticulture. The success of these homegardens will depend on increasing the productivity, especially of trees, through the introduction of a limited number of improved clones with high energy-fixing capacity (Verhey and Coronel, 1989). This implies an increasing reliance on well-timed labour (which may be competing with other household tasks or arable cropping). Commercialisation of homegardening may also lead to a greater dependence on external inputs and on price and product fluctuations.

3. Most frequently in highly urbanized areas, homegardening may provide a source of leisure as well as of desirable products (vegetables, flowers) for home consumption and limited sale. This is the role that homegardens may also have in western societies.

An Agenda for Research

Although the need for a concerted international effort on homegarden crops, in particular vegetables, has recently been stressed (CGIAR/AVRDC/SADCC, 1989), we must conclude that there is often little understanding of the cropping systems in which these crops are produced. Implicitly, many agronomists and development workers assume that homegardening is some preliminary form of commercial horticulture, and homegardens are eagerly promoted in development programmes to improve standards of living. Without a proper understanding of the agronomic and economic aspects of homegardens, these programmes are likely to fail.

This literature review demonstrates that the comparative advantage of homegardens lies in their complementary character in terms of resource use. This implies that agricultural technology, such as new varieties of biocides, should be screened carefully. Furthermore, every effort to improve homegarden productivity must take account of the dynamic nature of homegardens and their adaptation to a changing world.

The fact that our understanding of the agronomic aspects of homegardening is still very scanty has two major implications. Firstly, agronomists and extensionists should act with great care if they are planning to introduce new techniques. Homegardens are very diverse, with respect to the commodities produced, the techniques used and the purpose they have for households. There is no such thing as a blueprint approach in agricultural research and development, and certainly not in homegardening. Several areas merit further study, both through observation of current practices and through carefully designed experiments, 'on-farm' ('in-garden') and under controlled conditions. Modelling certain subprocesses, such as light interception and nutrient uptake in complex, multi-species situation will also be necessary. More specifically, the following priority areas can be distinguished: integrated nutrient management, soil biology in gardens, integrated pest and disease management, water management and water use efficiencies in semi-arid and dry season gardens, optimal annual/perennial combinations, integration of animals in gardens.

Secondly, the socio-economic and practical literature on homegardens is much more comprehensive than that on the technical agronomic and crop production aspects. In other words, much more is known about the existence of homegardens and their importance for households and recommended practices, than about how homegardens actually function ecologically. However, improvements in homegardening are not possible without a good understanding of the diversity of existing systems. This applies both to regions where homegardens have a long-established tradition, and to regions where they have recently been introduced. The transfer of homegarden technology from Southeast Asia to Africa and Latin America is only feasible if we understand the performance of different homegarden systems in a range of ecological, demographic and socio-economic conditions.

Moreover, there are many agronomic issues regarding homegardens that merit further attention. For example, one important question we cannot yet answer is whether and under what conditions homegardens are sustainable land use systems.

We would welcome the establishment of an international database on the agronomic and socio-economic aspects of homegarden systems established. Such a database would provide a comparison of current cropping techniques and would allow some preliminary screening of the applicability of potential technical improvements. The database on homegardens should include the following minimal data for each type of homegarden:

- type of garden (supplementary, specialised, urban with possible country-specific subtypes, such as supplementary gardens in rice-based farming systems);
- crops grown (including perennial), with specification of varieties;
- crop density and numbers of individuals;
- crop associations in space;
- crop rotations (in time, both intra-annual and inter-annual);
- animals raised (including fish), numbers, (additional) feed sources;
- crop husbandry techniques: timing and application of inputs (labour, manure or fertilizer, water etc.) broken down into crop/tree/animal specific techniques, and general techniques which apply to the garden as a whole;

- production per commodity (crop, animal, broken down per useful product, eg fruits, bark, fodder etc), on an individual plant/animal basis as well as per unit of time and area;
- economic value of inputs and outputs.

Such an effort requires careful coordination of country-level databases, through the use of an international format, coordinated, for example, by the Asian Vegetable Research and Development Centre (the AVRDC), or any other appropriate agency. This format could follow the proposed prototype database on land use, developed recently for FAO (Stomph and Fresco, 1991). It will need to be linked to data on climate and soils that are currently elaborated by FAO and other agencies. Details on socio-economic aspects may be added in due course, but these are of a different nature and cannot be easily compared across regions. An international data-base will not be established overnight, but we would like to encourage the readers to develop ways and means to initiate regional or national databases on the subject of homegardens in their countries with a view to promoting what is one the most important low-input cropping systems in the (sub)tropical world.

An Agenda for Policy

Constraints on Homegarden Productivity

There are many constraints on homegarden productivity:

1. Lack of inputs such as seeds, capital investments, tools, which very often simply are not available (Engel et al, 1985; Best, 1987; Brown et al, 1983; Ensing et al, 1985; Guhardja, 1988; Matahelumual and Verheul, 1987; Niñez, 1986a; Vasey, 1985);

2. Shortage of land and insecure land title (Engel et al, 1985, Ensing et al, 1985; Evers et al, 1985; Fernandes and Nair, 1986; Solon, 1988; Thaman,1977);

3. Pests, diseases, free roaming animals and theft (Engel et al, 1985; AVRDC, 1985; Fernandes et al, 1984; Thaman, 1977; Vasey, 1985).;

4. The lack of knowledge by farmers and of supporting organizations like extension services (Best, 1987; Ensing et al, 1985; Laumans, 1985; Matahelumual and Verheul, 1987; Thaman, 1977);

5. Shortage of time or labour (Engel et al, 1985; Best, 1987; Solon, 1988; Thaman, 1977);

6. Low soil fertility, loss of fertility and soil erosion (AVRDC, 1985; Bompard et al, 1980; Matahelumual and Verheul, 1987; Thaman, 1977);

7. Lack of water (Matahelumual and Verheul, 1987; Niñez, 1985a; Vasey, 1985);

8. Use of unsuitable species (Evers et al, 1985; Ensing et al, 1985; Niñez, 1985a);

9. Constraints in marketing (Best, 1987; Ensing et al, 1985; Evers et al, 1985);

10. Post harvest losses (Okafor and Fernandes, 1987); and

11. Lack of specific agricultural and horticultural research (Evers et al, 1985).

Challenges for Homegardens

In recognising the need for homegarden improvements, governmental and non-governmental agencies should take into account the highly dynamic nature of homegardens. As a result of population growth and market integration, homegarden functions shift gradually from subsistence production of a great variety of (staple) foods to commercial production of a few specialised horticultural crops, and, ultimately, perhaps to a source of leisure. As a result, the constraints and needs of homegardeners differ considerably depending on the function of the gardens. Any homegarden programme must define its target groups and the probable developments of their homegardens in the next decade.

Furthermore, explicit attention to homegardens is seldom given by government agencies, with the exception of some food and nutrition-oriented programmes. Governments should take into account the role of homegardens in such diverse activities as urban and rural land use planning, fertilizer and seed supply programmes, water control and sanitation, agricultural and nutritional extension projects, and marketing boards.

It also means that homegardens must be recognised as a legitimate form of land use in various training programmes for policy makers, researchers and extensionists. Non-governmental organisations are more likely to be aware of the existence of homegardens. However, there is a tendency for these organisations to concentrate on the low-input and subsistence aspects of homegardening and to ignore their dynamic nature.

Finally, homegardens are not only a low-input form of land use. Their survival may very well depend on increased but well-balanced use of environmentally safe inputs of fertilizer and nutrients, especially in Asia. Quality control of the products may be another area requiring further development, as many homegardens may be able to compete with commercial growers only through the quality and careful handling of (specialised) products. In the future, the environmental effects of increased biocide use in homegardens and processing of homegarden products are of great importance and must be closely monitored.

Notes

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