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Household Food Security, Farm Trees, and Agroforestry: A Comparative Study in Indonesia and the Philippines

JILL M. BELSKY

Increasing numbers of studies suggest that farm trees and agroforestry practices improve household food security. Some have further speculated that poor farmers are responding to decreasing access to land and declining agricultural productivity by increasing farm tree and agroforestry activities because of the multiple benefits of trees, which are cash crops that demand relatively low levels of labor. This paper argues that the choice to cultivate trees, the decision as to which specific tree species are to be cultivated, and the determination of the spatial and temporal association of those trees with annual crops must all be evaluated on a historical and regional basis. Furthermore, in Southeast Asia, food security and upland farm decisions must be viewed within the broader context of the rice economy—the value people have for consuming rice, and its central position in household production decisions.

Key words: agroforestry, food security, household economy, Indonesia, Philippines

IN MANY RURAL AREAS, trees planted alone or in deliberate combination with annual crops (i.e., agroforestry[1]) play an important role in household food security (Arnold 1987; FAO 1989a, 1989b; Falconer 1990). That is, trees in farming systems contribute to household access to food throughout the year. Trees enhance household food security directly by producing foods, and indirectly through providing inputs into other food-producing parts of the farm system and by providing fuel for cooking. Trees can also provide cash crops enabling many rural households to purchase food. For the farm household with limited resources and scant ability to meet subsistence demands through agriculture, trees can provide products to eat or sell during seasonal shortfalls in food and income. Among the many benefits of trees is the fact that they demand relatively low levels of labor as compared with other cash crops. Some analysts have therefore suggested that poor farmers respond to decreasing access to land and declining agricultural productivity by increasing farm tree and agroforestry activities (FAO 1989a).

Jill Belsky is an Assistant Professor in the Department of Sociology, University of Montana. *This paper is a revised version of papers presented at the 1989 meetings of the Rural Sociological Society and the 1991 XVII Pacific Science Congress. The research was supported by the Mellon Foundation and a Collaborative Fulbright-Hays grant. The author thanks Stephen F. Siebert, E. Walter Coward, Jr., Frederick Buttel, Clare Hinrichs, Eva Wollenberg, William McBroom, and two anonymous reviewers for their very helpful comments.*

The supposed benefits of trees and agroforestry systems for poor, marginal farmers have led to greater international recognition and development funding for trees in tropical land use and agricultural planning (CGIAR 1991, FAO 1985). The task of setting development and research agendas for farm trees and agroforestry programs, however, faces many difficulties. There is a general absence of studies that move beyond localized descriptive accounts to analyze the factors that lead producers to include trees in their farming systems. Insights from empirically based local studies are critical, but need to be considered within a broader comparative framework. Furthermore, most economic studies on agroforestry systems have focused on location-specific assessment of financial returns from particular practices, rather than on an examination of agroforestry in the context of regional land use change, relative returns to productive factors, or household decision-making processes (Scherr 1992), or as an application of the farming systems approach to forestry (Jones and Price 1985). Other studies have focused on the relationship between agroforestry and particular social institutions, especially tree and land tenure (Fortmann 1985).

In this paper I argue that the questions of whether households with varying degrees of food security choose to cultivate trees, which specific tree species they will choose, and which spatial and temporal association with particular annual crops they will adopt must all be approached historically and regionally. Existing social and ecological heterogeneity in hillside or upland farming systems precludes developing blanket generalizations on the effect of household food security on farm trees and agroforestry practices for both analysis and policy/program prescription. Instead, middle-range theories (or common issues)

need to be identified and applied to specific situations. In this light, upland farm decisions in Southeast Asia must be viewed within the broader context of the rice economy. Doing so entails evaluating the importance people place on consuming rice over other foodstuffs, and recognizing the central position irrigated rice farming plays in production decisions.

In the following sections I briefly discuss current thinking about the role of farm trees and agroforestry in the farming systems of poor rural households with special attention to food security issues. I then introduce three study areas in the Philippines and Indonesia where I conducted fieldwork, and present data on the land use practices of households with varying degrees of food security. The main body of the paper is a discussion of the historical and regional factors that influenced the development and use of farm trees and agroforestry practices in three case study areas over the last century. I conclude by evaluating the implications of social and ecological heterogeneity and the rice economy for agroforestry and upland development efforts in Southeast Asia.

Background

Two contradictory notions characterize current thinking about tree cultivation among the rural poor. One is that poor farmers give priority to meeting basic food needs and will not grow tree crops because they view trees as competing with food crop production, requiring too many years until they bear useful products, and necessitating secure land tenure typically unavailable to poor farmers. The other is that tree cultivation and agroforestry are beneficial to limited resource households who cannot subsist from their own agricultural production, and who therefore achieve food security through engaging in a diversity of income generating activities, including agroforestry.

Empirical studies from the literature on Southeast Asia provide evidence to support *both* of the above assumptions. For example, case studies from the Philippines and Indonesia report that households below certain land or income thresholds are not likely to cultivate tree crops (Belsky 1984, Eder 1981, Hunink and Stoffers 1984, van der Poel and van Dijk 1987, Widagda et al. 1984, Wiersum 1982, Wollenberg 1985). Many of these households do not have access to irrigated rice lands and are not self-sufficient in rice. Their low rice self-sufficiency means that any available land (especially land near the homestead or in the "uplands"—land once forested, farmed by shifting cultivation, sloping and generally not amenable to irrigation and other modern agricultural technologies) is put into annual food crops that yield products in a timely fashion, that can be consumed or sold, and that are not subject to long-term seizure should tenure arrangements change.

In contrast, other studies suggest that tree crops are grown precisely by farmers whose land, labor, and/or income resources are too limited to meet basic food needs through agriculture (Falconer 1990; FAO 1989a, 1989b; Stoler 1978). For farmers with limited access to or control over such resources, agroforestry systems are suggested as being desirable because of multiple and lower input demands and higher returns than annual monocrops.

In this second view, the lower labor demand of tree cultivation is considered a particularly important characteristic, given the likelihood that labor is limited due to the need to engage in wage work. In a recent FAO publication (1989a), the authors argue that the low labor demand of cultivating trees enables part-time farmers to maintain land productivity without purchasing additional labor, fertilizer, herbicides, and irrigation. Moreover, income earned from tree crops may provide the capital to invest in agricultural infrastructure. In addition to providing timber and fuelwood, trees provide a diversity of edible seeds, leaves, medicines, and fruits to supplement diets and are of crucial importance in eliminating seasonal short-falls and avoiding hardships (de Beer and McDermott 1989). Trees are an economic asset resembling a rural "bank" and, as such, act as a source of insurance for poor people when emergencies arise (Chambers and Leach 1989; Chambers, Saxena, and Shah 1989). In some circumstances, planting trees may raise land tenure security (Fortmann 1985). Finally, trees alone and in combination with annual crops provide environmental protection and benefits for crop and livestock production through windbreaks, soil conservation, improved soil fertility and structure, microclimate enhancement, and wildlife habitat (Young 1989).

While not talking specifically about limited resource producers, Scherr (1992) suggests four types of long-term pressures that induce farmers to intensify tree cultivation: (1) declining access to wooded land, which reduces tree product supplies; (2) increasing demand for tree products due to population growth, new uses or products, or new markets; (3) increasing population density and declining farm size, which creates a need for trees and shrubs as fences or boundary markers; and (4) responding to declining land quality by protecting or planting trees and shrubs for windbreaks, soil fertility, erosion control, waterway protection, grazing land rehabilitation, or substituting woody perennials for row crops on erodible soils. Scherr, among others, suggests further that the rate and degree to which land users respond to such incentives are influenced by the availability of alternate resources and substitutes, tree species that grow well with annual crops, high marketability, and reasonable cost and ease of transportation from field to market (Murray 1984, Paddoch 1988, Raintree 1991). Scherr (1992:6) notes:

> Intensification proceeds most rapidly for more highly valued tree products and services. This partly explains the high management level historically achieved for tree products with high value:weight ratios and high income elasticities of demand, such as coffee, oils, nuts, fruits, and spices.

To understand the decision-making processes of farmers in Southeast Asia with regard to planting tree crops, as well as to more intensively managing them in complex agroforestry systems, it is necessary to pay attention not only to the value, price, and markets for tree crops, but to local strategies for meeting household food security. In many Southeast Asian areas, doing so entails consideration of the rice economy.

Rice is critical in many Southeast Asian societies as the major staple food. In many rural areas today, producing one's own rice remains a keystone of household food security—though by no means does food security always entail self-provisioning. In many areas of Southeast Asia, resource-poor farmers have been noted to avoid the risks entailed in cash crop production by focusing instead on food crops. This "survival first" principle has been argued as underlying many technical,

social, and moral arrangements in Southeast Asian peasant societies (Scott 1976).

Throughout Asia, rice is produced largely in lowland irrigated rice paddies, though some rice is still grown in upland fields.[2] These fields may include a variety of annual and perennial crops in addition to rice. In many instances, the same farmers engage in lowland irrigated rice farming and upland dryland farming. Many cultivators consider upland fields to be the "partner" of that which is harvested from rice fields, providing foods not available from rice fields and acting as a safeguard against a poor rice harvest (Prill-Brett 1986).

Agroforestry researchers have not completely understood how farmers divide limited labor and other resources among the various components of a rice-based farming system (Belsky 1984). The technical organization of rice production (and especially the mechanics of irrigation) often make it the central agricultural activity around which all other economic activities are organized. This situation results from the intermittent but high labor requirements of rice farming that tie large numbers of workers to the land, but leave considerable scope for investing surplus labor in alternative livelihood activities such as upland farming (Bray 1986). Supplementary livelihood activities must therefore be timed so as not to create conflicts with rice production. For large riceland owners, doing so may mean growing tree crops that require limited care and whose harvest schedule is flexible. For those whose access to growing rice is limited, doing so may mean being available for seasonal wage labor during high labor peak periods in the rice production calendar. In either case, the ways in which upland farming articulates with labor and other resource allocation practices in the wider rice economy could have important implications for understanding and possibly modifying farm tree and agroforestry activities.

Studies of indigenous agroforestry practices and attempts at introducing them, especially among the poorest segments of the community, suggest that the kinds of resources and levels of input need to match those of the farmers, or they will not be utilized over the long run (Raintree 1990). The hopes of many agroforestry projects can rise or fall on the species of trees selected, and whether they provide the kinds of products most desired by local farmers (Raintree 1991). Theoretical frameworks are sought to help identify and match resources and inputs with returns. But as the above review suggests, the failure to cast studies within their regional and historical contexts has limited our progress thus far.

Study Sites and Methods

The data for this study come from three study areas: Sungai Ning and Koto Lebuh Tinggi in the district of Kerinci, west central Sumatra, Indonesia, and Karila in west central Leyte, Philippines. In all three areas, irrigated rice production is the major lowland land use. Most villagers, however, engage in a diversity of economic activities to supplement rice farming. Cultivating hill and mountain slopes is an important source of food and income for farmers in all three sites, and especially for those people without access to irrigated lowlands. Over the last century, the "uplands" have been converted from forests to agriculture. Many of these lands have experienced agricultural intensification without the benefit of soil conservation. Many upland areas, including the three study sites, have therefore experienced severe soil erosion and their respective governments have targeted them critical for watershed and environmental conservation protection. It is not only of academic interest whether farm trees and agroforestry are practiced in these upland areas, and especially by the poorest households – it is of special interest to local forestry and soil conservation officials.

Field research involving participant observation, oral histories and social surveys was conducted in Karila from February 1983 to February 1984, and in the Indonesian villages from May 1987 to May 1988. Archival and historical research has been ongoing.

To varying degrees, social and ecological heterogeneity characterizes the three study areas. Climatic and rainfall patterns are similar across the three villages. Annual precipitation averages 2600 mm in Karila and 1945 mm in the two Indonesian sites, falling primarily between September and May. Soils are complex, highly weathered red-yellow podzolics (Ultisols) overlying sedimentary parent materials (Siebert 1987, 1990). Soils in Karila and Sungai Ning, however, tend to be more degraded and have shallower topsoils than those in Koto Lebuh Tinggi.

In the three sites, most households cultivated two or more non-contiguous upland parcels. The total size of upland farms (i.e., including all upland parcels cultivated by a particular household) were 2.6 ha in Koto Lebuh Tinggi, 2.4 in Sungai Ning, and only 1 ha in Karila. The majority of upland parcels in the Indonesian villages are owner-cultivated (86% in Koto Lebuh Tinggi and 63% in Sungai Ning), whereas only 42% in Karila are owner-cultivated. The majority of upland parcels in Karila are sharecropped. In actuality, much of the uplands near Karila and in the Indonesian sites are owned by the government and are legally designated for watershed protection. In the uplands near the two Indonesian study sites, the government has set aside 1.5 million ha as Kerinci-Seblat National Park to protect existing forests and biodiversity. Leyte Mountain National Park has been proposed by the Philippine government near the village of Karila. But despite state land ownership and designation of protected areas, farmers in all three of the study areas continue to cut forests and make farms, especially in the more remote areas within the mountains.

Household Food Security, Farm Trees, and Agroforestry in the Study Sites

All persons interviewed reported that rice is their preferred staple, and that their goal is to produce all of their rice themselves rather than purchase it from the market. The reasons behind this strategy include a desire to avoid price fluctuations, an attempt to guarantee access to particular rice varieties, and adherence to long-held cultural traditions. Even where households can afford to purchase rice on a regular basis, the custom is for them to cultivate their own rice. Under these conditions, rice self-sufficiency can be viewed as the basis of "household food security."[3] A household food security measure based on rice self-sufficiency (RSS) was developed to understand livelihood pressures and strategies in the study sites, and as a starting point for understanding the relationship between house-

TABLE 1 Distribution of Households in Each Village by Rice Self-Sufficiency (in percents)

RSS category	Village		
	Sungai Ning (n = 37)	Koto Lebuh Tinggi (n = 41)	Karila (n = 63)
Low	51	10	22
Middle	35	41	67
High	14	49	11
TOTAL	100	100	100

Chi square ($P < 0.01$).

hold food security and inclusion of farm trees and agroforestry in upland farms.

RSS refers to the proportion of the year prior to the time of the survey that rice, largely produced from lowland ricefields, fed the household. Three RSS categories were constructed: "low" (no irrigated rice is produced—most rice is purchased), "middle" (rice production accounts for roughly half of the household's rice), and "high" (rice production provides all or a surplus of the household's rice needs).

Some of the major differences among the study villages appear as we examine the distribution of households by RSS. Table 1 indicates that Sungai Ning has the highest proportion of low RSS households (51%), Koto Lebuh Tinggi the fewest (only 10%), and Karila in the middle (22%).

These patterns are the result of differences in geography, demographic pressures, expansion of corporate, farming, and national rice policy. As the only village located physically in the uplands, Sungai Ning residents must walk 4–6 km to reach the closest irrigated rice fields. There has been a large influx of Javanese migrants to the village; these people have not been able neither to afford to purchase ricelands, nor to arrange sharecropping arrangements. As a result, around half of the households in this village cannot produce irrigated rice. In contrast, Koto Lebuh Tinggi—located 16 km-away—is situated adjacent to ricefields and has not experienced much inmigration; its relatively stable population has maintained steady access to ricefields over the years, either as landowners or as share-tenants. In both of these Indonesian sites, traditional rice varieties producing one annual harvest are still grown.

In contrast, in Karila, the Philippine village, access to ricefields has been curtailed by population increase and fragmentation of ricefields, loss of ricefields to coconut and sugar plantations operated by multinationals, and national rice policy favoring high yielding rice varieties. The latter factor has resulted in existing land owners switching from sharecropping to hiring wage laborers, and to less favorable sharecropping arrangements. Despite these trends, however, the shift to high yield varieties and triple cropping has enlarged yields so that two-thirds of households are in the middle RSS category.

Given these patterns in terms of household RSS (and by implication in household food security), one could test the dual hypotheses suggested in the literature on the effect of food security and limited resources on growing farm trees and agroforestry. To do so, I constructed a variable on upland farm land use.[4] Upland land use is divided into four types arranged along a continuum from annual monocrops to perennial monocrops: (1) annual monocrops, (2) continuous intercrops or integral agroforestry, (3) relay intercropping or relay agroforestry, and

TABLE 2 Characteristics of Four Upland Land Use Types

Annual	Continuous intercrops or integral agroforestry	Temporary intercrops or relay agroforestry	Farm trees
*Tegalan**	*Pekarangan**	*Kebun-talun, Tumpang sari** or Taungya	*Kebun**
Tends to be annual crop	Continuous intercropping of annuals and perennials (multistoried)	Initial intercrop for 1–4 years, then perennial monocrop	Continuous perennial monocrop
Usually near houses	Usually near houses	Usually far from houses	Usually far from houses
Livestock part of system	Livestock occasionally part of system	Livestock rarely part of system	Livestock rarely part of system
Continuous cultivation	Continuous cultivation	Rotation	Continuous cultivation
Can grow in intermediate to poor soils	Needs at least intermediate soils	Requires deep, fertile soils	Requires deep, fertile soils
Annual harvest	Irregular but annual harvest	Annual harvest in initial stage, later one harvest	Delayed harvest
Annual monocrop	Continuous intercrops	Temporary intercrops	Perennial monocrops
High maintenance	Low maintenance	High maintenance initially then one delayed harvest	Low maintenance
High soil degrading	Moderately to highly soil degrading (depends on extent of clean weeding)	Moderately soil degrading	Minimally soil degrading

* Name in Bahasa Indonesia

(4) farm trees. Table 2 summarizes the characteristics of these four upland land use types.

When upland land use is viewed in relation to household RSS, we find no clear patterns. Statistically significant relationships between household RSS and upland land use were found in two of the study villages, Sungai Ning and Karila (Tables 3 and 5). If any pattern is discerned in these villages, it is that farm trees and agroforestry are more likely practiced by middle and high RSS households. No statistically significant relationship between RSS and upland land use was found in Koto Lebuh Tinggi because most households in that village practiced relay agroforestry (Table 4).

These data suggest the difficulties in generating a tight theory on the relationship among household food security, farm trees, and agroforestry practices. Even if statistically significant patterns were found, many questions would remain. For example, are these patterns indicative of past practices or only contemporary ones? How did these patterns emerge or change over time as well as across space? Why are particular types of annual and tree crops grown in one village, but not in others? And most germane to the question at hand, why do low RSS households from different villages adhere to different strategies for including trees in their farming systems?

In order to begin to answer some of these questions, we need to examine upland land use in its historical and regional context. We turn, then, to a brief discussion of the development of upland farming systems in each of the three study areas.

Sungai Ning

Approximately two-thirds of low RSS households in Sungai Ning devoted their upland resources to monocropping annuals and another third to integral agroforestry. The prevalence of annual cropping among low RSS households in Sungai Ning can largely be explained by their lack of access to ricefields and use of uplands to produce crops that provide quick and stable yields that can be easily sold or directly consumed. Environmental conditions also influence the situation. Half of high RSS households, however, focus on growing annual crops as well.

Situated 2–4 km from the market center of Sungai Penuh, the Sungai Ning uplands were some of the first forest lands in the district to be converted to agriculture, according to oral history reports. Descriptions by early European travelers depict upland farming in Kerinci as long-fallow shifting cultivation producing a diversity of crops including tobacco, corn, sweet potato, beans, and banana (Hoogkamer 1880, Marsden 1811). Coffee, bamboo, fruit trees, and cinnamon were often intercropped with annuals in multi-storied gardens that "mimicked" the forest. Little weeding was performed so that grasses could thrive and hold down the soil (Marsden 1811). By 1915, tobacco, potato, and onions had become more widespread and were exported to other parts of Sumatra (Van Akan 1915).

TABLE 3 Percent Upland Farm Land Use by Household Rice Self-Sufficiency in Sungai Ning (in percents)

	Household Rice Self-Sufficiency			
Upland land use	Low (n = 19)	Middle (n = 12)	High (n = 6)	Total (n = 37)
Annual monocrops[a]	**63**	17	**50**	46
Integral agroforestry[b]	**32**	**75**	17	43
Relay agroforestry[c]	5	8	**33**	11
Farm trees	0	0	0	0
Other	0	0	0	0
TOTAL	100	100	100	100

[a] Largely involves cassava, assorted vegetables, chili peppers, corn, peanut and beans.

[b] Largely involves banana and fruit trees intercropped with crops in [a].

[c] Involves cinnamon, coffee, or clove relayed with crops in [a].

Chi square ($P < .05$).

TABLE 4 Percent Upland Farm Land Use by Household Rice Self-Sufficiency in Koto Lebuh Tinggi (in percents)

	Household Rice Self-Sufficiency			
Upland land use	Low (n = 4)	Middle (n = 17)	High (n = 20)	Total (n = 41)
Annual monocrops[a]	**25**	12	0	7
Integral agroforestry[b]	0	6	15	10
Relay agroforestry[c]	**50**	**35**	**45**	41
Farm trees[d]	**25**	**47**	**35**	39
Other[e]	0	0	5	2
TOTAL	100	100	100	100

[a] Largely involves beans, chili peppers, assorted vegetables, potato, dry rice, and cassava.

[b] Involves cinnamon, coffee, banana, and fruit intercropped with crops in [a].

[c] Predominantly cinnamon relayed with chili peppers and beans.

[d] Predominantly cinnamon or coffee.

[e] Includes fallowed land.

Chi square was not statistically significant ($P > 0.05$).

TABLE 5 Percent Upland Farm Land Use by Household Rice Self-Sufficiency in Karila (in percents)

	Household Rice Self-Sufficiency			
Upland land use	Low (n = 12)	Middle (n = 42)	High (n = 6)	Total (n = 60)
Annual monocrops[a]	43	0	0	9
Integral agroforestry[b]	15	7	0	8
Relay agroforestry[c]	8	21	0	17
Farm trees[d]	8	24	67	25
Other[e]	25	48	33	41
TOTAL	99	100	100	100

[a] Largely sweet potato, corn, cassava, assorted vegetables, and dry rice.

[b] Largely coconut, banana, fruit, and crops in [a].

[c] Largely coconut relayed with crops in [a].

[d] Predominantly coconut.

[e] Predominantly abaca intercropped with tannia.

Chi square was statistically significant ($P < .01$).

Between 1912 and 1924, upland farming in Kerinci underwent a radical transformation. Permanent farms, primarily of coffee, were established in place of shifting cultivation. Dutch colonial policies that forced coffee cultivation (known as the "koffiestelsel") ceased in 1908 (about the time Dutch colonialism took hold in Kerinci), but the colonial administration bolstered coffee production in Kerinci by building roads, reducing trade barriers, and introducing a monetary tax system necessitating a cash economy.

The coffee boom led to widespread conversion of forest lands and increased cultivation of marginal lands. Colonial agricultural policy in Kerinci did not value intercropping arrangements, and the local people were instructed to monocrop coffee in rows spaced at wide intervals, and to weed regularly to avoid "dirty gardens" (Nooteboom 1929). Today we know that multistoried intercropping provides environmental benefits, including soil fertilization and protection from erosion when leaf litter is allowed to remain on the soil (Young 1989).

Coffee farms dominated the hill slopes of Sungai Ning until the price of coffee dropped with the world depression in the 1930s. As the cost of foodstuffs rose, many coffee gardens were converted to rice fields during this time (Morrison 1938). Older residents from Sungai Ning report that cassava became a predominant crop in upland farms during the Japanese occupation (1942–45) when the Japanese authorities expropriated rice to feed their armies. Many households were thus forced to use upland farms to cultivate annual crops for both food and income.[5]

Conditions remained harsh. The Japanese occupation was followed by further struggle with the Dutch colonists, and, with Indonesian independence, reconstruction of war-torn lands. It was not until the 1950s that farmers saw a commodity worth planting in large amounts in upland farms. In the late 1950s, clove trees were planted when prices rose, and when farmers realized soil conditions were too degraded in Sungai Ning to grow coffee.

In the 1950s and 1960s, there was also an influx of Javanese migrants to Sungai Ning. Many of the Javanese migrants were ex-laborers from the Dutch-operated tea estate at Kayu Auro. Unable to afford ricefields, they turned instead to cultivating the uplands. The Javanese migrants brought improved cassava cultivars and planting methods,[6] and focused on growing cassava and other vegetables, much as they did on Java. The increase in population, and in intensive (i.e., continuous) cultivation of cassava and other annual crops, increased soil erosion in upland fields. Older informants recalled that the spread of *Imperata* grass (*alang-alang*) and soil erosion were severe in upland farms by the 1960s.

Today cassava (a bi-annual crop) accounts for most annual monocropping in Sungai Ning, though other annual crops are planted as well, especially sweet potato, corn, and assorted vegetables. Cassava, which is sold as well as consumed by cultivators, offers many advantages to Sungai Ning's low RSS upland farmers: biannual harvests, ability to grow on degraded soils, low input requirements, minimal risk, high caloric value, crop residues that can be used for fencing material, and low labor demands. Continuous cassava cultivation on steep, shallow soils, however, further degrades soil conditions (Kooiman 1987), and reduces opportunity for cultivating alternative crops.

Other factors support annual cropping in Sungai Ning and enhance its popularity among low as well as high RSS farmers. The proximity to Sungai Penuh provides a readily accessible market outlet for cassava and other perishable food crops. The prevalence of government employees in Sungai Penuh increases market demand for vegetables. And because of the threat of theft, farmers are reluctant to concentrate on more valuable and slower growing perennial crops such as cinnamon.

Fruit, cinnamon, coffee, clove, and bamboo in small amounts are intercropped with annuals. These trees are residuals from previous land use, or planted as a "contingency" resource for emergency income. Continuous monocrops are found on sites that are not degraded. Three older (low RSS) farmers planted nitrogen-fixing trees *leucaena leucocephala* (*lantoro*), *gliricidia* (*gamal*), and *Parkia* spp. (*petai*) as green mulch; the latter produces a seed that is prepared as a side dish with chili sauce (*sambal*). Citrus is increasingly found in Sungai Ning because, according to residents, it is well adapted to the poor soil conditions found there, brings competitive prices, and can be easily transported and sold in the nearby Sungai Penuh market.[7] If fruits are stolen, one loses seasonal income rather than the tree itself, as is the case with cinnamon. Citrus cultivation has become more widespread since the clove tree epidemic in the 1970s.

Karila

In Karila, as well as in Sungai Ning, most low RSS households monocrop annuals in upland farms. Sweet potato, corn, cassava, tannia, and taro are widely grown by farmers in the low RSS category. Sweet potato, corn, and cassava are produced mainly as food crops, whereas tannia and taro are used as fodder for pigs. Rice is the preferred staple, but corn may be mixed with rice and eaten as the mid-day meal. When corn is limited (such as it was during the drought of 1983), low RSS households lunch on root crops or wild foods gathered from the forest.[8]

Low RSS households intercrop annual crops with fruit and, to a lesser extent, coconut trees. Coconut and abaca were historically the predominant upland crops throughout the island of Leyte. Coconut is produced largely for the production of copra and is exported. Abaca, a banana-like plant that is intercropped with tannia, produces fibers that are made into twine (also called Manila hemp). Until the advent of nylon, abaca was an important source of rope for the marine industry.

Intensification of hillside farming to include annual crops represents a more recent development. According to oral histories, Karila was settled in the late 1890s by immigrants from the nearby island of Bohol. The population increased dramatically after World War II due to natural increases and an influx of migrants from other parts of Leyte, Cebu, and Bohol. Conversion of forests and upland farming increased significantly with the influx of settlers, many of whom were seeking fertile soil, having left behind denuded and farmed-out lands.

Residents of Karila trace increases in annual cropping to decreases in access to ricelands, and hence to diminishing rice self-sufficiency. From 1967 to 1975, the area allocated to sugar cane alone on Leyte more than tripled (Jimenez and Francisco 1984). Lacking lowlands for food production, many low RSS households turned to the uplands for food production.

Of the three study areas, Karila had the most tree farms. Two-thirds of high RSS households devote their upland farms to

trees, *principally* coconut. Farmers explain the attractiveness of coconut as an upland crop by its multiple products: copra, fuelwood, *tuba* (an alcoholic drink fermented from coconut sap), coconut milk, and perhaps most important of all, its seasonal integration with the irrigated rice calendar. The low labor demands and flexibility of coconut farming do not create conflicts with the labor demands of irrigated rice farming, especially with modern rice varieties. Coconut can be harvested three times per year with some flexibility. Income earned from coconut and abaca sales are commonly used to purchase petrochemical and labor inputs required in producing three crops of irrigated rice.

That most of the land on which coconut is grown is state-owned does not seem to bother most cultivators. Their attitude may be due to the fact that farmers knew the state-claims before they migrated to the island and began cultivating the land. Or it may be due to the fact that farmers feel confident that the land and trees in question will not be confiscated, and that by planting perennial crops, they are increasing their legal claims to these lands should they ever be released for private ownership.

In any event, two-thirds of low RSS households report farming uplands as share-tenants. In exchange for caring for and harvesting coconut, they can plant (and keep) annual crops planted beneath the trees. Some low RSS farmers reported planting a few coconut trees for home use and production of *tuba*.

Other low RSS farmers in Karila, however, are responding to demographic and production pressures (especially limited access to rice fields) through means other than intensifying tree cropping. Instead of increasing dependence on trees, many low RSS households either intensify annual production, engage in off-farm wage labor, or "mine" the forest for forest products. In some cases they actually leave the area entirely. Low RSS farmers in Karila, especially young householders in their twenties, are particularly dependent on wages derived from transporting farm and forest products, and from gathering and selling forest products themselves, especially rattan (Siebert and Belsky 1985). As supplies of rattan decline, these farmers increasingly resort to producing annual crops. Out-migration, especially among teenage girls seeking work as domestics, is a popular strategy for dealing with impoverishment. Statistics suggest that high rates of out-migration (and to a lesser degree in mortality) account for the lower annual population growth rate (1.6%) recorded for the area compared to the national average (almost 3%) (BMHD 1984).

The comparatively small size of upland farm parcels in Karila (1 ha) limits the attractiveness of tree crops and agroforestry among low RSS households. Small land size increases competition between annuals and tree crops, and reduces the viability of relay agroforestry systems. After trees become established and annual cultivation becomes impossible, farmers do not have other land on which to cultivate annuals. They therefore tend to intensively cultivate the land until it is degraded and then leave agriculture completely.

Koto Lebuh Tinggi

In contrast to both Sungai Ning and Karila, most households in Koto Lebuh Tinggi have access to irrigated ricefields and devote upland resources to producing trees, employing either relay agroforestry systems or tree farms. This pattern supports the contention that tree crops are favored by households with secure access to food. Nevertheless, all the low and middle RSS households surveyed in Koto Lebuh Tinggi also cultivated tree crops, and there was no statistically significant relationship between household RSS and upland farm land use in this village. Favorable environmental and social conditions, including the lack of demographic pressure and wide access to uplands, help to explain the emphasis in Koto Lebuh Tinggi on tree cropping across all RSS strata.

Oral histories suggest that upland land use in Koto Lebuh Tinggi resembled that in Sungai Ning in the early part of the century: annual crops were cultivated, often in combination with coffee and later clove. In the 1950s–1960s, when Sungai Ning was turning more to annual crops and particularly to cassava, upland farms in Koto Lebuh Tinggi turned to cinnamon.

Cinnamon grew wild in Kerinci's forests and was primarily cut for firewood and fencing material. Commercial production of cinnamon began in the 1950s; until then, most of the world's cinnamon came from Vietnam. The growing international demand for cinnamon and the rapid increase in the local market price accounts for its increasing attractiveness. For example, in the early 1950s, 1 kilo of cinnamon was worth 8 cents; by 1961, the price increased to 35 cents, and by 1969, it rose to $2.70 per kilo (Djohan, Radja, and Nurdin 1969). Prices then dropped dramatically but made a comeback in the 1970s. Upland farmers in Koto Lebuh Tinggi were able to take advantage of high prices and cultivate cinnamon for a number of reasons.

First, soils in the area were not as degraded as were those in Sungai Ning; cinnamon thrived in the Koto Lebuh Tinggi uplands. Older residents in Koto Lebuh Tinggi suggest that the coffee boom in the post-colonial period was never as extensive as it was in Sungai Ning; coffee was cultivated, but rarely as an intensive monocrop. Older farmers explained that colonial officials and their post-independence successors rarely hiked to the more distant Koto Lebuh Tinggi uplands to make recommendations. Indigenous intercropping schemes therefore faced less outside intervention and so persisted.[9]

Second, in contrast to the other two villages, there has been very little in-migration into Koto Lebuh Tinggi; population growth over the last half-decade has been less than the district average (below 2.2% annually), and traditional community social structures endure. The ratio between population density and cultivated agricultural land is 51% lower in Koto Lebuh Tinggi than in Sungai Ning. The lack of in-migration has meant that no exogenous cultural force affects cropping patterns, such as the Javanese influence on cassava cultivation in Sungai Ning. Neither has there been increase competition with limited seasonal labor opportunities. Low RSS households report that they are always able to find employment in either irrigated rice operations or on upland farms during slack seasons (i.e., especially right before the rice is harvested). The persistence of stable human:land ratios, traditional rice varieties, labor sharing traditions, and a culturally homogeneous community enables the few low RSS households to take more risks and plant cinnamon trees.

Third, the distance of Koto Lebuh Tinggi to Sungai Penuh markets increases transportation costs and marketing difficulties for perishable annual and fruit crops. Inhabitants of Koto

Lebuh Tinggi rarely travel to Sungai Penuh, preferring to market products in the nearby village of Siulak Deras, or to sell to local village middle-men. The distance also reduces risk of theft. There are, moreover, unconverted forests in Koto Lebuh Tinggi, and hence their trees are vulnerable to pests. Upland farmers report serious predation upon upland crops by pigs and monkeys, reducing the viability of many annual crops, especially root crops such as cassava and sweet potatoes. The predominant annual crops grown in Koto Lebuh Tinggi are chili peppers and beans. These crops are grown because they are less susceptible to predation, and because chili peppers in particular bring a high market price. Both chilies and beans also retain value if not immediately marketed.

Another important aspect of geography is the access Koto Lebuh Tinggi farmers have, *de facto* if not legally, to Kerinci-Seblat National Park lands. Most of the more accessible, gently sloping lands have already been converted, but some farmers walk more than four hours one way to cultivate cinnamon and/or coffee in favorable sites within the park.

Fourth, agronomic attributes of cinnamon make it an attractive agroforestry tree species—a benefit for non-rice self-sufficient households requiring short-term income, as well as for high RSS households wishing to combine cinnamon cultivation with the production of market vegetables. Cinnamon is widely produced in relay agroforestry systems, planted along with chili peppers and beans. Optimal spacing of cinnamon trees is four meters, which enables intercropping of seedlings during the first four years after transplanting. Seedlings benefit from the regular weeding and fertilization provided to annuals. After four years, cinnamon begins to form a closed canopy and annual cultivation ceases. Cinnamon is typically harvested between six and 20 years of age, with quality and value improving substantially with age. At harvest, trees are cut at ground level and the bark stripped; the site may be replanted, but it is more common for stumps to be allowed to resprout, thus obviating the need to replant. Annual crops can again be cultivated during the establishment phase. Access to an alternate secure source of food enables most Koto Lebuh Tinggi farmers to delay harvest (i.e., until ten years or more) until high returns can be realized. Where cinnamon trees are grown by low RSS farmers, the average age and hence price at harvest is substantially lower.

Finally, the labor demands of traditional rice farming mesh well with cinnamon production. Cinnamon is weeded only once or twice a year after annual crop production ceases, and harvesting (which can occur at any time once the trees mature) is the only labor consuming activity. The low labor demands of cinnamon and high value to weight ratio also make it possible for farmers to cultivate sites located at great distance from their homes, such as within the national park.

Conclusions and Implications for Sustainable Upland Development

Studies in three villages in Indonesia and the Philippines reveal that poor farmers do not necessarily respond to decreasing access to land and declining agricultural productivity by increasing farm tree and agroforestry activities. In fact, the historical record in at least two of the study villages (i.e., Sungai Ning and Karila) indicates just the opposite: following colonial intervention and incorporation into world market systems and cash economies, shifting cultivation systems involving multistoried intercropping systems were generally transformed to intensively cultivated permanent farms. This transformation was not a smooth, evolutionary process, nor did it necessarily involve the same agricultural commodities across villages. To understand the reasons why farmers with differing access to resources and food security chose to cultivate particular annual or tree crops (and in varying spatial/temporal combinations) required a detailed understanding of the socioeconomic, political, and ecological conditions that were operative in their specific localities at particular times in their histories.

The study verifies the need to view tree growing in relation to farmers' access to resources and the production objectives inherent in resource allocation decisions. The data from Sungai Ning and the Philippine village of Karila suggest that households with low rice self-sufficiency and low food security were likely to produce annual crops rather than farm trees. In the absence of access to a secure source of subsistence (in this instance, to cultivating sufficient amounts of rice) farmers chose to cultivate annual crops because they produced food and income in a more timely manner than did tree crops. Competition between annuals and perennials remained a serious constraint on the use of agroforestry by farmers interested in food crop production (and with access to limited land).

The specific type of annual crops grown by low RSS farmers across villages differed. Cassava was favored in Sungai Ning because of agronomic conditions and the indigenous knowledge and cultural traditions of Javanese migrants. In contrast, farmers in Karila were able to grow a greater variety of annual crops due to the deeper and more fertile soils. In both situations, access to land as share-tenants may have dissuaded farmers from tree cultivation, but in Karila, sharecropping arrangements also necessitated the cultivation of coconuts. Nonetheless, some tree crops (especially fruit) were included in upland farms in both villages to provide supplementary food and income.

In contrast to the above two villages, most farmers from the village of Koto Lebuh Tinggi cultivated cinnamon trees either as monocrops or as part of relay agroforestry systems. The factors that led farmers across all RSS categories in this village to cultivate cinnamon, coffee, and, to a lesser extent, clove trees, included the wide availability of fertile land, the relatively high prices of these commodities, and their high value to weight ratio which justifies their transport from distant upland farms. Secure land tenure (*de facto* if not *de jure* for land located within the national park) also encouraged the cultivation of farm trees. Finally, low human:land ratios, cultural homogeneity, and the persistence of traditional rice farming systems all supported seasonal employment opportunities for low RSS farmers, thus mitigating the usual risks entailed in tree farming for farmers with limited resources.

Relationships among household food security, tree crops, and agroforestry should be considered to be the province of middle-range theory. This conclusion is based on the fact that the benefits and costs of agroforestry and tree growing for rural poor do suggest some very broad patterns, but that most conclusions are highly contingent on local social and ecological conditions that are likely to vary considerably. Similar conclu-

sions have been reached by others concerned about the social organization and extension of agroforestry,[10] the causes of and approaches to land degradation (Blaikie and Brookfield 1987), and general development studies. Portes and Kincaid (1989: 499) write:

> The resilient pillars of development studies are not works of grand theory, but rather detailed studies of historical and contemporary processes . . . The product of these research efforts has been a set of sensitizing concepts and middle-range theories that could be applied and tested in different settings.

Another implication of this study is the value, in the Southeast Asian context at least, of locating farm tree and agroforestry practices within the broader rice economy. The production demands of cinnamon, coffee, and clove mesh well with the requirements of traditional rice farming. This balance helps to account for the widespread cultivation of upland tree crops among peoples who are simultaneously, and perhaps more importantly, rice farmers. For irrigated rice farmers, tree crops provide multiple products that are largely supplementary in nature. Even with huge fortunes possible through cinnamon cultivation, farmers persist in cultivating rice for household consumption, and to schedule tree farm and all other productive activities around the rice production schedule. That irrigated rice farming may be the major activity and priority of upland farmers throughout these economies is not widely appreciated in agroforestry efforts. Likewise, the widespread reluctance to adopt high-yielding rice varieties and double-cropping in Koto Lebuh Tinggi (or elsewhere) can be linked with farmers' desire to maintain their well timed seasonal balance of lowland and upland agricultural activities.

Another set of implications revolves around questions of upland development policy. If tree production (particularly trees with low economical value or that are long-maturing, as is the case with many recommended agroforestry species) presents difficulties for households with low food-security, should development efforts build upon the *annual* cropping preferences of the rural poor while simultaneously seeking to improve environmental sustainability? Because of the greater tillage and fertility requirements of annual over perennial crops, annuals are generally not recommended for sloping, marginal uplands (Scholz 1983), hence the rationale for promoting trees and agroforestry as a means of improving environmental sustainability. The upland farming practices of low RSS households in Sungai Ning, and to a lesser extent in Karila, are characteristic of a well documented and vicious cycle of poor farmers intensifying annual cropping to increase yields only to further reduce future soil productivity (Bernstein 1981, Leonard 1989). Furthermore, low income cultivators frequently cannot afford soil conservation measures for various economic, political and technical reasons (Belsky 1991, Blaikie 1985). If farm trees and agroforestry are to become the mechanism that breaks this unhealthy pattern, considerable attention will need to be given to overcoming the resource and environmental limitations that place farmers in this predicament in the first place.

In many ways, the history of upland development and conservation policy in Indonesia represents a recognition of the limitations tree production can present for limited resource farmers. The policy has evolved from an initial focus on reforestation to agroforestry to annual crops produced on bench terraces. In the post-oil boom period, however, Indonesia has become a major debtor nation and thus has sought to diversify agricultural production and increase production of export commodities. The drive for capital accumulation has led to a production-led agricultural policy that focuses on particular commodities and packaged conservation technologies (such as bench terracing) that do not build upon the existing diversity of land use practices or environmental conditions. Instead of becoming a more resilient approach to upland development and conservation, a current effort such as the Regreening program does not contribute to more productive and sustainable cropping practices; and in some instances, that effort even disrupts indigenous agroforestry practices.[11]

At present, the major government and internationally sponsored upland development and conservation programs in Indonesia and elsewhere have failed to take into consideration how social structures affect land use, and how those structures are, in turn, further influenced by local ecological conditions. They fail even more conspicuously at understanding the regional and historical bases of these social-ecological interactions.

There is no *a priori* reason to assume that agroforestry or tree cultivation will automatically improve agricultural production or environmental sustainability. Environmental sustainability depends on land management practices, particularly at the soil surface, rather than on the mere presence of trees (Hamilton and King 1983). For example, farmers from Koto Lebuh Tinggi acknowledge declines in cinnamon yields from runoff and erosion. Extensive soil erosion is evident in cinnamon-relay agroforestry systems, especially following annual clean-weeding practices. Agroforestry can contribute to soil conservation, but only under certain management regimes and environmental conditions (Young 1989).

The stark reality is that efforts to transform upland farming systems via agroforestry are fraught with severe social-resource and ecological limitations, which make it unlikely that the uplands will become either the next "bread basket" of the tropics (Leonard 1989) or, more tellingly, the source of debt-relief. Achieving "sustainable livelihoods" as a means to protect the environment—or better yet, as a goal in itself—will *perforce* require diversified strategies, including opportunities for off-farm employment. Intensifying land use through agroforestry or other conservation farming techniques on severely degraded lands may not be cost-effective (Stocking 1988). Under marginal conditions, poor farmers could lose important income if they are encouraged to give up off-farm employment to support new agriculture and forestry projects. Promoting off-farm employment opportunities in critical watersheds may in fact be more beneficial to achieving conservation, as well as to increasing the incomes of low resource farmers. Developing farm trees and agroforestry systems that contribute to off-farm employment opportunities may be particularly helpful. Helping farmers to manage existing tree crops that provide rural peoples with income is important, as is helping farmers to improve wild cultivars planted in their upland farms. For example, there has been no government or institutional support for cinnamon farmers in Koto Lebuh Tinggi who have sought to improve seed stock and management practices. There has been limited research thus far on *in situ* management of economically valuable forest trees. An exception is the research the author has been involved in on rattan cultivation, collection, and prospects for management and sustained harvesting (Belsky 1992; Siebert and Belsky 1985; Siebert, Belsky, and Rauf 1992); the culti-

vation of rattan in upland farms is increasingly receiving more attention from development planners.

While agroforestry was once suggested as one of the most effective means of increasing agricultural production while overcoming environmental problems in the tropics, its limitations and contingencies are becoming increasingly evident (Steppler and Nair 1987). Some of the major constraints thus far have centered on the limitations of tree cultivation for the rural poor. Many of these insights have been extremely useful in guiding agroforestry research and extension efforts, but the reasons why farmers ultimately do or do not use agroforestry practices—or other land uses, for that matter—need to be evaluated on the basis of social and ecological conditions within particular locales and at particular historical periods, rather than on abstract theories about relationships between land use practices and the rural poor.

NOTES

[1] No attempt is made here to review the concerns and critiques of agroforestry. For a general text on agroforestry and its progress thus far see Steppler and Nair (1987). For a reader on the environmental and conservation aspects of agroforestry see Young (1989).

[2] Upland or dryland rice today is mostly planted by shifting cultivators, though it is included in upland fields in which farmers practice short fallowing and plot rotation.

[3] Rice self-sufficiency correlates highly with other measures of social and economic class. In fact, various other studies in Indonesia have stratified peasantries on the basis of rice self-sufficiency (Hart 1986, Penny and Singarimbun 1973).

[4] The upland farm land use variable is a composite measure of upland cropping practices (i.e., either annual monocrops, continuous intercrops or integral agroforestry, temporary intercrops or relay agroforestry, or farm trees) on all upland parcels cultivated by a household weighted by parcel size.

[5] Forest conversion and intensification occurred as farmers were also eager to lay claim to marginal uplands that had not as yet been allocated (i.e., according to local *adat*, or customary law). It was also a result of people fleeing to the uplands where extraction by Japanese occupiers was more difficult.

[6] In-migration to Sungai Ning rather than elsewhere may have been the result of traditional land use systems (*adat*) that restricted land sales to foreigners; they were less restrictive there than in more remote areas in the district. It might also be that land degradation was more severe in Sungai Ning and thus the value of Sungai Ning's uplands was less than it was elsewhere.

[7] There is one large citrus grower in Sungai Ning, a high RSS farmer who cultivates 200 trees as an orchard. During the major harvest season, buyers from Jambi and Medan came to his farm to pick up harvested fruits. From these 200 trees, the grower reported producing 1 million rupiah or approximately $610.00. Most citrus producers in Sungai Ning are smaller in scale, and their production is less easily quantified due to diversified marketing strategies and unspecified home consumption of fruits.

[8] See Siebert and Belsky (1985) for a discussion of the use of forest products in Karila.

[9] See Belsky (1991) for a discussion of how state soil conservation efforts in Kerinci pose threats to the conversion of indigenous agroforestry systems in Koto Lebuh Tinggi to high-input dependent annual crop-focused farms.

[10] In a major review of agroforestry extension programs, Marilyn Hoskins writes (1987:197): "It is not easy to select and describe the crucial socio-economic variables in a universal way: situations differ depending on the locality, environment and the major traditional production activities; issues overlap and are not easily considered in isolation."

[11] See Belsky (1991) for a more detailed discussion of the limitations and contradictions of Indonesia's upland development and conservation approach.

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