The Philippines

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This profile focuses on the most pressing issues of sustainable natural resource management in the sloping upland areas of the Philippines. It begins with an analysis of the historical and current dimensions of land use in the upland ecosystem, reviews and critiques proposed actions, and recommends solutions within an overarching strategy that builds on the linkages that exist between farming and forestry systems.

The upland ecosystem must be addressed as a distinct entity. The uplands are rolling to steep areas where both agriculture and forestry are practiced on slopes ranging upward from 18 percent. The sloping uplands occupy about 55 percent of the land surface of the country (Cruz et al., 1986) and have an estimated population of 17.8 million. The upland population is projected to be 24 million to 26 million in the year 2000, with a density of 160 to 175 persons per km^2. Upland inhabitants are primarily poor farming families with insecure land tenure. Subsistence food production rather than forestry is their over-

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riding priority. The paramount objective for public intervention in upland management is that of obtaining the greatest good for the greatest number of people in ways that are consistent with the long-term sustainability of the productive capacity of the ecosystem.

Forest denudation is at an advanced stage in the Philippines. Total forest cover shrank from 10.5 million ha in 1968 to 6.1 million ha in 1991. The remaining old-growth forest covered less than 1 million ha in 1991 and possibly as little as 700,000 ha. At current rates of logging, nearly all vestiges of the country's primary dipterocarp forest biota may be depleted in the next 10 to 15 years. The will of the people and government to effectively address the Philippine deforestation problem is growing, but it is still weak.

There have been several recent reviews concerning natural resource management in the Philippines. These reviews examined government policy, the political climate, and the institutional framework and made numerous specific recommendations for a major reorientation. In addition, the Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990) has recently been issued by the Philippine government. It lays out a framework for forestland management over the next 25 years. It sets a detailed, optimistic agenda that adopts a strategy of reduced public management in favor of increased private management of forest resources through people-oriented forestry.

Although this profile focuses on the dynamics of upland agricultural technology in relation to deforestation, many factors other than agricultural technology have a stronger direct influence on the rate and extent of forest depletion or conversion. These factors include inappropriate forest policy, poor policy implementation, and the insecurity of land tenure among upland farm populations. Commercial logging (legal and illegal) directly caused the majority of old-growth forest depletion during the past half century, and it continues to do so today. The accessibility to remote forestlands brought about by the opening of logging roads stimulated the settlement of small-scale farmers and resulted in the subsequent conversion of depleted forests to farms.

The initial sections of this profile examine the present state of the natural resource base of the uplands and past trends in resource degradation. The profile then reviews the importance of land and forest resources to the political economy of the Philippines and the failure of development in the Philippines in the post-World War II period. This is followed by an analysis of potential solutions to the problems identified. The solutions to the upland resource management and subsistence crises fall into a general strategy with three essential components: land tenure, resource management technology, and infrastructure delivery. The final section outlines a proposed action strategy in terms of these three components.

THE STATE OF THE PHILIPPINE UPLAND ECOSYSTEM

This section analyzes the important factors that have determined the development of land use systems in the Philippines uplands. The major forces and constraints that directly affect upland agriculture and forestry are emphasized.

Physical Environment

The Philippines is an archipelago with a total land area of 30 million ha. Although it encompasses more than 7,000 islands, the majority of these are insignificant in terms of size and population. The 15 largest islands make up 94 percent of the total land area. Luzon and Mindanao occupy about 35 and 32 percent of total land area, respectively. The Philippines is a physically fragmented state, and separateness is a major feature of its geography and culture. The island nature of the country gives it a very long coastline relative to its size. No inland area is far from the ocean.

The country has a complex geology and physiography. Although Luzon and Mindanao have major lowland areas, most of the islands have relatively narrow coastal plains. The Philippines as a whole is characterized by high relief. Steep upland areas with greater than 18 percent slope make up about 55 percent of the total area (Cruz et al., 1986). The climate is humid tropical. However, because of the mountainous terrain, the occurrence of typhoons in the northern half of the country, and the effects of two separate monsoon seasons, there is striking micro- and macrovariation in the seasonal distribution and amount of precipitation. Within-season droughts and the limited length of the growing season are common constraints, but the total quantity of precipitation is abundant: 90 percent of the country receives at least 1,780 mm per year (Wernstedt and Spencer, 1967).

The high relief, the relatively high levels of precipitation, and the frequent extreme concentration of rainfall in short periods because of typhoons contribute to serious soil erosion problems. Given the complex geology and geologic history, the soils of the Philippines are varied but are generally not as weathered as most humid tropical soils because of their relatively younger age. The inherent soil properties are limiting in many sloping upland areas (particularly where extensive erosion and land degradation have occurred), but the Philippines has a comparatively favorable soil base for a country in the humid tropics.

Land Use

In the Philippines today, about half the land is classified as alienable and disposable. This land may be privately owned. The other half, which mostly has slopes of greater than 18 percent, is classified as public forestland. Only 6 million ha has significant tree cover and less than 1 million ha of old-growth or primary forest remains (Table 1). In comparison, there was 10 million ha of old-growth forest in the 1950s. The extent of this forest conversion has reduced to critically

TABLE 1 Forest Cover in the Philippines as Determined by Various Inventories (in Thousands of Hectares)

Forest Cover	Swedish Space Corporation (1988)	German Inventory[a]	LANDSAT 1980[b]	Official 1981[c]
Pine	81	239	227	193
Mossy or unproductive	246	1,681	1,320	1,759
Dipterocarp	6,629	4,403	6,304	6,588
Closed	2,435	1,042	2,940	2,794
Open	4,194	3,361	3,363	3,794
Mangrove	149	—	175	112
Other	—	—	121	—
Total	7,105	6,323	8,146	8,652

[a]The Philippine–German Forest Resources Inventory Project (Forest Management Bureau, 1988) covers only lands it has classified as forestlands, which would exclude as much as 1.4 million ha of "forest" on alienable and disposable lands. Forest cover in mangroves was not reported.

[b]Open canopy was synonymous with "residual stands" or "young growth." Mangrove includes both mature and residual stands, as does pine. "Brushland" was not counted as "forest."

[c]Official data were based on continuous updating of earlier estimates of inventory data, including older aerial photos. "Brushland" was excluded from "forest."

SOURCES: Swedish Space Corporation. 1988. Mapping of the Natural Conditions of the Philippines. Solna: Swedish Space Corporation; German inventory: Philippine-German Forest Resources Inventory Project. 1988. In Results of the Forest Resources Inventory Project, C.V. Gulmatico, ed. Unpublished paper. Forest Management Bureau, Dilimän, Quezon City, Philippines; LANDSAT: Unpublished computer printout. Forest Management Bureau, Dilimän, Quezon City, Philippines; Official: World Bank. 1989a. Annex 3, Table 1, in Philippines: Environment and Natural Resource Management Study. Washington, D.C.: World Bank.

TABLE 2 Land Use in the Philippines (in Thousands of Hectares)

Land Cover	Area
Forest	7,226
Pine	81
Mossy or unproductive	246
Dipterocarp	6,629
Closed	2,435
Open	4,194
Mangrove	149
Other	121
Extensive cultivation	11,958
Open in forest	31
Grassland	1,813
Mixed[a]	10,114
Intensive cultivation	9,729
Plantation	5,336
Coconut	1,133
Other	90
Coconut and cropland	3,748
Other and cropland	365
Cropland	4,393
Fish ponds	205
Fish ponds created from mangroves	195
Other fishponds	10
Other land or lakes	542
Unclassified area	546
Total	30,206

[a]Mixed grass, brush, plantation, and other crops.

SOURCE: Swedish Space Corporation. 1988. Mapping of the Natural Conditions of the Philippines. Solna: Swedish Space Corporation.

low levels the habitat of the many species of flora and fauna endemic to the Philippines.

Recently, the Swedish Space Corporation (1988) completed a study—the first and only one to cover all types of land uses—of the natural vegetation in the Philippines (Table 2). On the basis of that survey, the World Bank (1989a) calculated that cultivated land covers 11.3 million ha, or 38 percent of the total land area. Cultivated area in the uplands is about 3.9 million ha.

The *1980 Census of Agriculture* (National Census and Statistics Office, 1985) estimated the area of cultivated land to be 9.7 million ha in 1980. If these data and World Bank estimates are correct, then the area of cultivated land increased by more than 1.6 million ha between 1980 and 1987, an annual increment of 229,000 ha/year. The average annual rate of deforestation between 1980 and 1987 was 157,000 ha/year. Although direct conversion from forestlands to croplands cannot be inferred, it appears that large areas of grasslands are now being converted to agricultural uses, increasing the pressure on the limited land resources.

Population Growth

Rapid population growth in the past half century is widely acknowledged as a major force in the accelerated deterioration in the country's natural resources (Porter and Ganapin, 1988). The 1990 population of the Philippines was estimated to be 66.1 million and was increasing at an annual rate of 2.6 percent (Population Reference Bureau, 1990).

Table 3 presents Philippine population data since 1948. Although the rate of growth of the Philippine population declined slowly from the 1948–1960 period to the 1975–1980 period, the population growth rate remains the highest of any country in Southeast Asia. The current population density is second only to that of Singapore (Population Reference Bureau, 1990). The rural population, as a percentage of the total population, has been declining, but at a slow rate (from 73 percent in 1948 to 63 percent in 1980). Urban growth is predominantly in the city of Manila (Pernia, 1988).

The Philippines has a serious population growth problem, but acceptance of this fact has been fairly recent. As late as 1969, Duckham

TABLE 3 Philippines Population Data, 1948–1980

Year	Population (1,000s)	Average Annual Rate of Increase over Previous Date (percent)	Population Density (Number of persons/ km^2)	Urban Population (1,000s)	Rural Population (1,000s)
1948	19,254	—	64.1	5,184	14,050
1960	27,085	3.06	90.3	8,072	19,015
1970	36,681	3.01	122.3	11,678	25,007
1975	42,070	2.79	140.2	14,047	28,024
1980	48,097	2.71	160.3	17,944	30,155

SOURCE: National Census and Statistics Office. 1980. Population, Land Area, and Density: 1970, 1975, and 1980. Manila: National Census and Statistics Office.

and Masefield stated that the Philippines had a low population density and "no real pressure of population on resources" (p. 417). This assessment seems almost naive today, suggesting how fast the settlement frontier closed in recent years and the inertia in public recognition of the current situation.

The availability of areas with low population densities and available agricultural lands has induced interregional migration in the Philippines since World War II (Abad, 1981; Abejo, 1985; Concepcion, 1983; Institute of Population Studies, 1981; Zosa-Feranil, 1987). Since 1948 the major migration patterns have been toward the frontier, primarily to Mindanao, and toward urban areas, particularly the metropolitan Manila area. Although migration to urban areas has been particularly pronounced since 1960, movement to frontier or upland areas continues (Cruz et al., 1986). Between 1975 and 1980, the destination of almost one-fourth of all interregional migrants was the uplands (Cruz and Zosa-Feranil, 1988). The major out-migration areas have been the Visayas and the Bicol and Ilocos regions of Luzon. Although substantial differences persist among some areas, the population has become more evenly distributed since 1948 (Herrin, 1985).

The upland population was estimated by Cruz and Zosa-Feranil (1988) to have reached about 17.8 million by 1988. This included an estimated population of 8.50 million people who reside on public forestlands. This population includes 5.95 million members of indigenous cultural communities and 2.55 million migrants from lowland groups (Department of Environment and Natural Resources, 1990). One-third of the upland forest inhabitants are displaced lowland farmers who do not have long-standing land use traditions such as those commonly observed among indigenous communities, which have a better grasp of the fragile nature of the ecology of their lands (Sajise, 1979). The displaced population is also growing faster. The University of the Philippines Population Institute projects that the upland population will grow at a rate of 2.72 to 2.92 percent during the next 25 years, increasing by the year 2015 to a density of 371 persons per km^2, which is a high population for sloping marginal lands.

Current and projected trends in the economy, social attitudes, and government commitment to effective delivery of family planning services may succeed in reducing national population growth rates. Even so, there is little likelihood that the upland population will participate significantly in this transition. The upland rural population has the least access to family planning programs and is least likely to accept the notion that limiting family size is in its best interest. Wherever open access to public lands prevails, children are viewed as additional labor to clear and cultivate more land.

Agriculture and the Uplands

Agriculture continues to play a major role in the Philippine economy. The Agricultural Policy and Strategy Team (1986) states:

> [N]o significant structural transformation has taken place over the past 25 years. Despite the strong industrial orientation of past economic policies, agriculture, fisheries, and forestry continue to employ half of the labor force, contribute about a quarter of the gross domestic production, and earn two-fifths of export revenues. Over 60 percent of our population lives in the rural areas. Our country remains today as it has been in the past, a predominately rural society composed of small farmers, agricultural laborers, fishermen, pedicab drivers, and others.

Agriculture's share of the total economy declined slowly in the postwar period, from 36 percent of net value added in 1955 to 29 percent in 1980 (David, 1983). Agriculture's share of the Philippine gross domestic product in 1987 (28.5 percent) was almost the same as it was in 1970 (World Bank, 1989b).

Between 1972 and 1980, the ratio between the price of rice and the non-food price index declined from 1.0 to 0.59 (Hill and Jayasuriya, 1984). The growth that did occur in the agricultural sector came not as the result of but despite government policies (David, 1982; Rocamora, 1979).

Landlessness and near landlessness in rural areas has been reported to be more than 75 percent (Rosenberg and Rosenberg, 1980), and landlessness among the agricultural farm population is almost 50 percent (Agricultural Policy and Strategy Team, 1986; Porter and Ganapin, 1988). Land reform has largely been ineffective in transferring land to the tenant cultivators because of bureaucratic delays and widespread erosion of the spirit of the agrarian reform laws (Carroll, 1983; International Labour Office, 1974; Kerkvliet, 1974; Tiongzon et al., 1986; Wurfel, 1983).

Has the limited effectiveness of land reform resulted in further concentration of control over agricultural lands? In Mindanao, commercial agricultural plantations are expanding. This expansion forces poorer farmers onto marginal lands, particularly in association with the banana and pineapple industries (Agricultural Policy and Strategy Team, 1986; Costello, 1984; Tiongzon et al., 1986; van Oosterhout, 1983). Krinks (1974) showed that there was an increasing concentration of poor farmers in a frontier region in southern Mindanao. Commercial use of agricultural land and the increased concentration of poor farmers on agricultural lands in lowland areas in Leyte has decreased the amount of land available for poor farmers, forcing poor farmers to initiate farming in upland areas (Belsky and Siebert, 1985). The expansion of land for raising sugarcane in the western Visayas from 1960 to 1975 was also primarily at the expense of small-scale upland rice and maize production (Luning, 1981). As effective control of agricultural land becomes more concentrated in the hands of wealthier farmers and corporations, small farms are becoming smaller (Luning, 1981), a process that has been accelerated by the subdivision of property through inheritance. The end result has been increasing landlessness for the rural poor (Cruz and Zosa-Feranil, 1988).

Arable land that can be sustainably farmed on an annual basis with minimal investment in land conservation covers 8.4 million ha, or 28 percent of the country (Bureau of Soils, 1977). Most of the increase in farm area since 1960 has been on nonarable land, as defined by the Bureau of Soils (1977).

Kikuchi and Hayami (1978) argued that the Philippines shifted from extensive to intensive cultivation between 1950 and 1969. As the land/labor ratio declined, the rate of increase in the amount of cultivated land slowed and the Philippine government was forced to invest in irrigation. Hooley and Ruttan (1969) proclaimed the closing of the land frontier in the 1960s.

There was widespread agreement that by the late 1960s or early 1970s, the Philippines had reached the limits of its land frontier and that future growth of agricultural output would have to come from increases in productivity rather than from increases in the area of production. Agricultural output and productivity did increase, but the area under cultivation also increased considerably. From 1970 to 1980, the number of farms increased by 1.06 million (45.3 percent) and farm area (Table 4) increased by 1.23 million ha (14.5 percent). As a result, the average farm size decreased 21 percent, from 3.61 to 2.84 ha. The continued decrease in forest area in the 1980s also implies that the area of farmland continues to increase. Thus, the notion of a land frontier based on arable, safely cultivated land is not appropriate for conditions in the Philippines (Cruz and Zosa-Feranil, 1988; Gwyer, 1977; National Economic Development Authority, 1981). In 1982, 2.5 million ha of cropland was on upland areas (Agricultural Policy and Strategy Team, 1986).

Upland Migration

Cruz et al. (1986) estimated that 14.4 million people lived in the uplands in 1980, and 77 percent of those people lived on lands officially classified as public forestlands. From 1948 to 1980, the upland population grew at a rate of 2.5 to 2.8 percent per year. This is less

TABLE 4 Deforestation and Its Relationship to Increases in Population and Farmland in the Philippines, 1948–1980

Period	Increase in Farmland (km²)	Increase in Population (millions)	Loss of Forest Cover (km²)	Area Deforested per Person Increase in Population (km²)	Ratio of Area Deforested Per Increase in Farm Area
1948–1960	20,459	7,813	25,073	0.32	1.2
1960–1970	7,212	9,596	22,465	0.23	3.1
1970–1980	12,315	11,416	21,032	0.18	1.7

NOTE: The area of forest cover in 1948 was assumed to be 150,000 km². Forest cover in 1960 was determined by the straight-line method by using National Economic Council (1959) data for 1957 and Forest Management Bureau (1988) data for 1969. Forest cover for 1970 was determined by the straight-line method by using Forest Management Bureau (1988) data for 1969 and 1980.

SOURCES: Forest Management Bureau. 1988. Natural Forest Resources of the Philippines. Manila: Philippine–German Forest Resources Inventory Project; National Economic Council. 1959. The Raw Materials Resources Survey: Series No. 1, General Tables. Manila: Bureau of Printing.

than the national rate because of the higher mortality and the lower birth rates in the upland areas than in the lowland areas (M. C. Cruz, College of Development Economics and Management, University of the Philippines, Quezon City, personal communication, 1990).

Migration accounted for the bulk of the population growth in the upland areas (Cruz et al., 1986). Of the 18.6 million people who lived in the uplands in 1988, 6 million had lived there before 1945, 2 million had migrated there between 1945 and 1948, and 10 million had migrated there since 1948 (Lynch and Talbott, 1988). In addition, high rates of migration to the uplands continued in the 1980s (World Bank, 1989a). The highest rates of population growth in the uplands were in municipalities with logging concessions (Cruz and Zosa-Feranil, 1988).

Most observers agree that migration occurs because of the lack of opportunities in the lowlands. Poor people are forced to the uplands because they have no other suitable choices. Cruz and Zosa-Feranil (1988) estimated that 70 percent of all upland migrants were landless lowlanders. These poor farmers may be referred to as shifting or slash-and-burn cultivators (Westoby, 1981).

Intensification of Rice Production in the Lowlands

Lowland rice fields in the Philippines are about half irrigated and half rainfed. Initially, the green revolution (the breakthroughs in rice varietal technology in the late 1960s) increased labor use intensity in rice production (Otsuka et al., 1990). More rice crops were produced each year (two instead of one), and more intensive management was applied. But rainfed rice farming did not experience the extent of technical change that occurred in irrigated rice farming or the same gain in productivity. Therefore, the economic disparity between the irrigated and rainfed rice fields increased (Otsuka et al., 1990).

The increased labor demand for irrigated rice accelerated the migration of labor from rainfed to irrigated areas. The intensity of labor use in irrigated rice production plateaued, however, and in many areas it declined as labor-displacing technologies gained widespread use. The technologies included broadcast seeding rather than transplanting of seedlings and herbicide application rather than weeding by hand. This reduced the labor absorption potential and the returns to labor, particularly landless labor. The income-earning prospects of the landless labor pool has declined, as exemplified by the evolution of labor arrangements that are progressively less favorable.

There is some potential for further intensification of rice cropping in irrigated areas and diversification to alternative higher income crops, including grain legumes, and tree crops. It is unlikely, however, that these changes will proceed fast or far enough to substantially increase the amount of labor that can be absorbed in lowland rice farming activities in the future, suggesting a continued rapid increase in the number of underemployed or unemployed families in lowland rural areas.

Upland Farming Systems

One of the most serious gaps in understanding land use in the uplands, particularly agriculture-forest interactions, relates to shifting (slash-and-burn) cultivation. Agriculture in the uplands consists of traditional shifting cultivation (long fallow periods), nontraditional or migrant shifting cultivation (short fallow periods), permanent or intensive agriculture, backyard gardens, pastoral systems, or any combination of these. There is no reliable information on the extent of these forms of agriculture or the proportion of shifting cultivation in grasslands or secondary or primary forests. There are also no data at the national or provincial level on how often farmers shift their plots, although case studies do exist (Barker, 1984; Conklin, 1957). Vandermeer

(1963) in a study of Cebu province, which is now entirely deforested, points out that what had originally been a shifting system of maize cultivation has now been transformed into permanent, sedentary farming. The main impetus for the change was increasing population density. Table 4 notes the relationships among deforestation, increases in population, and increases in the amount of farmland.

Analysis of an upland area in Mindanao from 1949 to 1988 revealed a dynamic land use transition from fallow rotation to permanent open-field and perennial crop systems (Garrity and Agustin, In press). The evolution of permanent, mixed agricultural systems in a pioneer community in the mountains of Laguna province dominated by shifting cultivation was documented by Fujisaka (1986) and Fujisaka and Wollenburg (1991). The planting of trees and perennial crops was observed by Cornista et al. (1986) as a typical stage in the evolution toward more permanent cultivation in communities throughout the Philippines.

Agricultural expansion has resulted in a net reduction in the country's grassland area. Data from an historical study of land use changes for an upland community in Mindanao from the immediate postwar period to the present illustrates this trend (Garrity and Agustin, In press). The area of cultivated land increased at a much faster rate than the loss of forest cover from 1949 to 1987. The steady decline in the grassland area provided the major source for the expansion of the area devoted to crops (Figure 1).

DEFORESTATION IN POSTWAR PHILIPPINES

There are few reliable historical data on forest cover in the Philippines. Many of the records that did exist have been lost. The Spanish forest records were consumed in a Manila fire in 1897 (Tamesis, 1948), the records of the Bureau of Forestry in Manila and the College of Forestry in Los Baños were destroyed during fighting in 1945 (Sulit, 1947), and the comprehensive Mindanao forest survey of 1954–1961 (Agaloos, 1976; Serevo et al., 1962) has disappeared. The authoritative source of current forest cover data is the Philippine–German Forest Resources Inventory Project (Forest Management Bureau, 1988).

Forest Types

Philippine forests are usually divided into six types: dipterocarp, molave, beach, pine, mangrove, and mossy. Dipterocarps account for more than 90 percent of all commercial forest products in terms of economic value (Agaloos, 1984). Some 89 percent of the total log

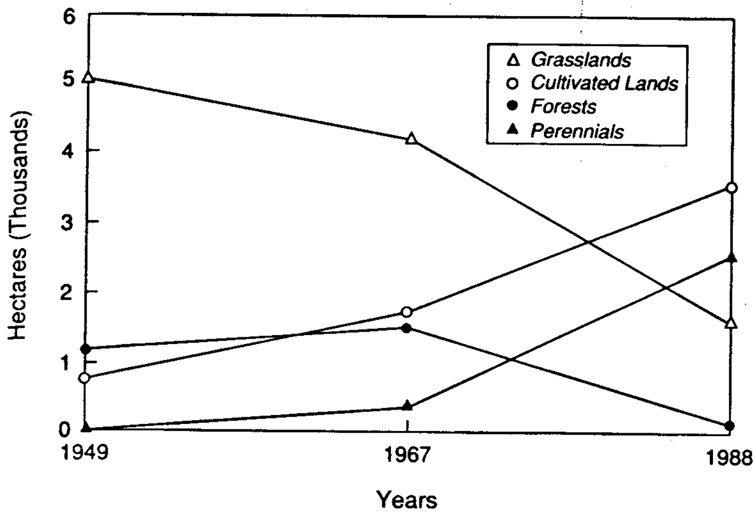

FIGURE 1 Comparative changes in major land use areas between 1949 and 1987. Claveria, Misamis Oriental Province (Mindanao), Philippines. Source: Garrity, D. P., and P. Agustin. In press. Historical Land Use Evolution in a Tropical Acid Upland Agroecosystem. Agric. Ecosyst. Environ.

production in the Philippines comes from the species *Shorea almon* (almon), *Dipterocarpus grandiflorus* (apitong), *Parashorea plicata* (tikan), *S. plicata* (mayapis), *S. negrosensis* (red lauan), *S. polysperma* (tanguile), and *Pentacme contorta* (white lauan). The largest timber volume comes from red lauan.

The molave forest, a dry, monsoon forest found only in the western Philippines, makes up only 3 percent of the total forest area of the Philippines (Agaloos, 1984) and is usually included in the dipterocarp category (Umali, 1981). Beach forests formerly grew in coastal areas as a transition between mangrove and other inland forests, but they have been virtually eradicated in the Philippines (Agaloos, 1984) and Southeast Asia (Whitmore, 1984). Two types of pine are native to the Philippines—Benguet pine (*Pinus kesiya*), found in northern Luzon, and Mindoro pine (*P. merkusii*), found in parts of Mindoro and the Zambales Mountains in western Luzon. Pine forests occupy less than 1 percent of the total land area (Forest Management Bureau, 1988).

Mangrove forests are restricted to coastal fringes and tidal flats and occupy about 139,000 ha (Forest Management Bureau, 1988), less than 0.5 percent of the total land area. They have been subjected to intense logging pressure because woods that grow in mangrove forests are valuable for fuel (charcoal) and thatch. As a result many mangrove forests have been converted to fish ponds (Gillis, 1988; Johnson and Alcorn, 1989).

Mossy forests are stunted forests with no commercial value (Agaloos, 1984; Weidelt and Banaag, 1982). They are referred to in the literature as mountain or cloud forests and as unproductive forest by the Forest Management Bureau. They are found at higher elevations (usually above 1,800 m) throughout the Philippines and cover about 4 percent (1.14 million ha) of the total land area (Forest Management Bureau, 1988).

Some 92 percent of the decrease of forest types since 1969 has been accounted for by the loss of old-growth dipterocarp forests (Forest Management Bureau, 1988). Destruction of mangroves has been rapid and dramatic as well, but the area involved is insignificant compared with the area of dipterocarps lost. The major cause of the decline of primary forests has been logging (World Bank, 1989a).

Forest Cover Before 1950

Deforestation in the Philippines has not occurred only in the twentieth century. Wernstedt and Spencer (1967) reported that forest cover declined from about 90 percent of the total land area at the time of the first contact with the Spanish in 1521 to about 70 percent by 1900. The major causes were likely to have been the steady increase in population and the spread of commercial crops (primarily abaca [a fiber from the leafstalk of banana—*Musa textilis*—native to the Philippines], tobacco, and sugarcane) as the Philippines slowly became integrated into the world economic system (Lopez-Gonzaga, 1987; Roth, 1983; Westoby, 1989).

Reliable statistics on forest cover before 1950 do not exist; thus, a discussion of forest cover and its decline must be based on estimates made by contemporary observers. Comparisons between the various estimates are problematic. Therefore, the estimates presented in Table 5 are meant to be broadly indicative. The area of the Philippines covered by forests declined from 70 percent in 1900 to just below 60 percent in 1939. Logging increased rapidly after 1945 and was back to pre-World War II production levels by 1949 (Poblacion, 1959; Tamesis, 1948). In addition, farming in the forests increased after the war because of continuing food shortages (Sulit, 1963; Tamesis, 1948). The overall extent of deforestation was estimated by Myers (1984) to be 55 percent in 1950. A figure closer to 50 percent for 1950 is probably more appropriate based on subsequent estimates.

TABLE 5 Estimates of Forest Cover in the Philippines, 1876–1950

Date	Percent Forest Cover	Source
1876	68	U.S. Bureau of the Census (1905)
1890	65	Bureau of Forestry (1902)
1900	70	Wernstedt and Spencer (1967)
1903	70	U.S. Bureau of the Census (1905)
1908–1910	50[a]	Whitford (1911)
1910	66	Zon (1910)
1911	64	Talbot and Talbot (1964)
1918	68	Census Office of the Philippine Islands (1920)
1919	67	Wernstedt and Spencer (1967)
1923	50	Zon and Sparhawk (1923)
1929	57[a]	Borja (1929)
1934	58	Revilla (1988)
1937	57	Tamesis (1937)
1937	58	Pelzer (1941)
1939	60	Food and Agriculture Organization of the United Nations (1946)
1943	60	Dacanay (1943)
1944	60	Allied Geographic Section (1944)
1945	66	Hainsworth and Moyer (1945)
1948	59	Food and Agriculture Organization of the United Nations (1948)
1948	59	Tamesis (1948)
1950	55	Myers (1984)

[a]Data are for commercial forests only.

Forest Cover Changes, 1950–1987

Since 1950 there has been a continuous decline in forest cover in the Philippines. In absolute terms, deforestation in the 1950–1969 and 1969–1987 periods were about the same (Table 6). On a percent basis, deforestation was more rapid from 1969 to 1987 than it was from 1950 to 1969, with the highest rates occurring from 1976 to 1980 (Table 7). The very high rates of deforestation observed for the 1976-1980 period were associated with the peak period of martial law, when large-scale corruption in timber extraction was prevalent (Alano, 1984; Aquino, 1987).

Although data are not strongly reliable, the rate of deforestation apparently slowed in the 1980s because the remaining forests became much less accessible. If the rate of deforestation estimated to have occurred from 1980 to 1987 continued to 1991, the Philippines had about 6.03 million ha of forest cover in 1991, about 20 percent of the country's total land area.

The Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990) estimated total forest cover to be 6.69 million ha. The area of old-growth dipterocarp forests was projected to be only 949,000 ha. However, if the old-growth dipterocarp forest has continued to decline at the 1969-1987 rate of deforestation, then only 409,600 ha of this forest type would have remained in 1991. If this rate of decline continues, old-growth dipterocarp forests will disappear entirely by 1995—long before effective management systems to preserve them can be put into place. Thus, one of the major issues confronting Philippine forestry is how to manage secondary dipterocarp forests on a sustainable basis, for which there is little proven experience.

The calculated rates of annual deforestation differ widely, depending on the data sets chosen for analysis (Table 8). The 1980 forest data are from the Forest Development Center (1985) and the Philippine–German Forest Resources Inventory Project (Forest Management Bureau, 1988), which were projected back from deforestation data for 1987. The 1987 data are from the Swedish Space Corporation and the Philippine–German Forest Resources Inventory Project. There are large discrepancies in deforestation rates among the four possible combinations of the two surveys each for 1980 and 1987. Between the smallest and largest rates of deforestation, the difference is more than 200 percent. A reasonable estimate is that deforestation

TABLE 6 Forest Cover in the Philippines, 1950–1987

Date	Percentage of Land Area	Source
1950	49.1	Projection from 1969[a]
1957	44.3	National Economic Council (1959)[a,b]
1969	34.9	Forest Management Bureau (1988)[a]
1976	30.0	Bonita and Revilla (1977)[a,c]
1980	25.9	Forest Development Center (1985)[a]
1987	23.7	Swedish Space Corporation (1988)[a,d]
1987	22.2	Forest Management Bureau (1988)[a,e]

[a]Includes forestland and nonforestlands.
[b]Does not include brushlands or marshes or swamps.
[c]Since the original figures included approximately 10 percent brushland (Revilla, 1988), the total was reduced by 10 percent.
[d]Does not include land area that was not classified.
[e]Data from 1988 were projected back to 1987.

TABLE 7 Deforestation Rates in the Philippines, 1950–1987

Period	Average Annual Change km^2	Average Annual Change Percent	Source
1950–1957	2,210	1.6	Projection and National Economic Council (NEC) (1959)
1957–1969	2,262	1.9	National Economic Council (1959) and Forest Management Bureau (1988)
1969–1976	2,081	2.1	Forest Management Bureau (1988) and Bonita and Revilla (1977)
1976–1980	3,048	3.6	Bonita and Revilla (1977) and Forest Development Center (1985)
1980–1987	1,570	2.2	Forest Development Center (1985) and Forest Management Bureau (1988)
1950–1969	2,243	1.8	Projection and Forest Management Bureau (1988)
1969–1987	2,103	2.5	Forest Management Bureau (1988)
1950–1987	2,175	2.0	Projection and Forest Management Bureau (1988)

NOTE: Deforestation rates were calculated from the data presented in Table 6.

in the 1980s was about 155,000 ha/year. The World Resources Institute (1990) estimated that deforestation is about 143,000 ha/year. This issue is discussed more thoroughly in the section on future scenarios.

The Deforestation Process in the Philippines

Figure 2 is a simplified model of the major forces that have led to deforestation in the Philippines. Although some deforestation has been caused by other factors, for example, the use of trees to make charcoal and the conversion of mangrove forests to fish ponds, the two most important activities leading to deforestation were logging (legal and illegal) and the expansion of agriculture. Both of these factors must be considered together, along with rural poverty and the open-access nature of forests (Gillis, 1988). The deforestation process in the Philippines since World War II can be characterized by two major activities: the conversion of primary to secondary forests by logging activities and the removal of secondary forest cover by the expansion of agriculture. In most cases, roads provide access to the forest for both types of activities.

Logging does not necessarily result in deforestation; rather, selective logging, properly practiced, converts a primary forest into a degraded secondary forest (Figure 2). Clear-cutting is known to have been practiced in certain areas, but this has been relatively rare in Southeast Asia (Gillis, 1988), and data on the relative extent of clear-cutting versus selective logging in the Philippines do not exist. Selective logging results in some deforestation, given the extensive road networks and collection and loading areas needed for capital-intensive logging and the extensive damage to forests reported to occur as a result of some logging operations (Blanche, 1975; Burgess, 1971, 1973; Egerton, 1953; Gillis, 1988; Philippine Council for Agriculture and Resources Research and Development, 1982; World Bank, 1989a).

The relationship between logging and the conditions of primary and secondary forests is a dynamic one. As logging converts primary forests to secondary forests, loggers move on to new primary forests. Implicit in this scheme is the notion that secondary forests do not return to a state suitable for a second harvest, although several concessionaires in the Philippines are known to have returned for a second cut. Concessionaires have not, in general, engaged in protection of secondary forests, enrichment planting, or reforestation (Food and Agriculture Organization and United Nations Environment Program, 1982). Overall, it appears that there has been minimal protection of forests in the Philippines.

Expansion of agriculture takes place primarily in secondary forests. Logged forests are more likely than primary forests to be penetrated by roads, and roads greatly facilitated the expansion of agriculture (Asian Development Bank, 1976; Edgerton, 1983; Food and

TABLE 8 Annual Rates of Deforestation in the Philippines Between 1980 and 1987 Based on Different Forest Inventories

1980 Data	1987 Data	Annual Deforestation Rate: km^2	Annual Deforestation Rate: Percent
FDC	FMB	1,571	2.2
FDC	SSC	951	1.3
FMB	FMB	2,103	2.8
FMB	SSC	1,483	2.0

NOTE: Deforestation rates were calculated from the data in Table 6. The annual decline in forest area (km^2) was determined as the difference in forest area between 1980 and 1987 using the respective estimated data sources for each year referenced in columns 1 and 2. FDC, Forestry Development Center; FMB, Forest Management Bureau; SSC, Swedish Space Corporation.

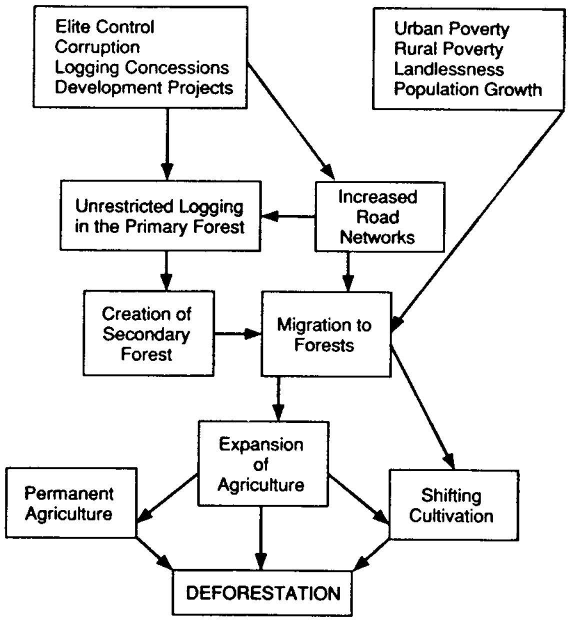

FIGURE 2 Model of deforestation in the Philippines. Source: Kummer, D. 1992. Deforestation in the Postwar Philippines. Chicago, Ill.: University of Chicago Press.

Agriculture Organization and United Nations Environment Program, 1981: Hackenberg and Hackenberg, 1971; Segura-de los Angeles, 1985; Vandermeer and Agaloos, 1962; van Oosterhaut, 1983). Also, it is much easier for poor farmers to clear secondary forests than it is for them to clear primary forests (Byron and Waugh, 1988). In an economic sense, logging lowers the costs of clearing the land by settlers (Southgate and Pearce, 1988). The majority of logged-over forestlands have been converted to grasslands or are used for agriculture (Hicks and McNicoll, 1971).

Natural forest regeneration is prevented by a range of prevailing factors: fire in uncultivated logged-over areas and ranch areas, grass succession and loss of tree seed in shifting cultivated areas, and permanent conversion to agricultural fields in intensively farmed areas. The relationships among the expansion of agriculture, the creation of secondary forests, and deforestation are also dynamic. Preceding logging and the expansion of agriculture is the construction of roads (Hackenberg and Hackenberg, 1971). These roads are primarily the result of development considerations by provincial or national government or are built by loggers who have concessions. The roads vary from little more than dirt tracks to paved highways. They facilitate the spread of agriculture by opening up new areas; this occurred in parts of Mindanao in the 1950s and early 1960s (Vandermeer and Agaloos, 1962; Wernstedt and Simkins, 1965). In addition, logging provides jobs and, thus, directly leads to population increases. The relationship between new roads and deforestation has been clearly made by Thung (1972) for Thailand and by Fearnside (1986) for Brazil.

The expansion of agricultural activities onto forested lands is driven by two forces: increases in population and widespread poverty. In addition, the expansion of agriculture in some areas is promoted by wealthier people who open up forestlands for perennial crop production or cattle grazing or simply to establish a land claim. This is often accomplished through support for poor farmers who are subsidized to clear the land. The overriding goal of the low-income households in upland regions is to produce or earn enough to eat. Food income provides basic security (U.S. Agency for International Development, 1980). Poor people are forced to engage in subsistence agriculture because it is often the only option available (Gwyer, 1978). Segura-de los Angeles (1985), in a case study of an upland agroforestry project in Luzon, noted that 88 percent of all those surveyed consumed all of the rice they produced and did not have a marketable surplus. Although upland farmers in Davao grew some commercial crops, their primary crops were rice and maize (Hackenberg and Hackenberg, 1971).

Timber Concessions

The granting of timber concessions occurred for two reasons: the legitimate desire of the Philippine government to foster development and the granting of political favors to either Philippine elites or multinational corporations (primarily U.S. corporations in the 1950s and 1960s). Postwar Philippine governments do not appear to have been concerned with development in the forest sector; rather, it appears that forests are viewed as an asset whose benefits should flow mainly to politicians and well-connected individuals (Ofreno, 1980; Palmier, 1989). As Hackenberg and Hackenberg (1971) pointed out in their study of Davao City, Mindanao, "The basis of wealth is lumber, and the profits are instantaneous for those with political connections to secure a concession" (p. 8). In fact, it is difficult to distinguish between politicians and loggers, since loggers contribute heavily to political campaigns and many politicians control logging concessions (The Economist, 1989). It is now generally accepted that commercial forest resources were vastly underpriced throughout the postwar period and that the high rents flowed to a small group of people (Boado, 1988; Cruz and Segura-de los Angeles, 1984; Power and Tumaneng, 1983; Repetto, 1988).

Factors Associated with Deforestation

Deforestation in 67 provinces was analyzed statistically from 1970 to 1980 (Kummer, 1990). The study used data on the annual allowable cut, which was greater than legally reported logging and may more accurately reflect the actual volume of timber harvested, considering the additional timber that is extracted illegally. Deforestation from 1970 to 1980 was positively related to the annual allowable cut in 1970 and to the absolute change in the area devoted to agricultural activities (Kummer, 1990). The distance from Manila was not significantly related to the deforestation rate, but in those areas of the Philippines where logging was banned during the reign of Ferdinand E. Marcos (1965–1986), the logged area determined from the rates of deforestation were actually higher than the rates where logging was allowed (Schade, 1988).

Postwar discussions of deforestation in the Philippines have tended to blame either loggers or migrant farmers in frontier areas engaged in nontraditional shifting cultivation for the decline in forest cover. These two agents cannot be considered separately; rather, they are linked. The Philippines has recently completed the Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990). The plan articulates a people-oriented forestry program that is sensitive to the current understanding of the complex underlying determinants of deforestation. The policy prescriptions and implementation devices presented in the plan are analyzed later in this chapter.

APPROACHES TO LAND USE SUSTAINABILITY IN THE UPLANDS

This section evaluates current and potential directions for formulating concrete solutions to deforestation and sustainable land use. It examines the determinants of sustainable agricultural systems and forest systems within each of the three major land use subecosystems in Philippine uplands. The approach emphasizes the interrelatedness of social and technical issues and the importance of an integrated social-technical approach to forest and agricultural development.

A large and rapidly expanding portion of the upland landscape is being converted to areas that are permanently farmed. These farms are found in the more relatively accessible sloping areas that are closest to the lowlands and nearest to roads. They are predominantly cultivated with subsistence food crops, particularly maize and upland rice, but they are partly used for perennial crop plantations, especially coconut plantations. At increasing elevations and more remote locations that are difficult to access, the land predominantly contains grasslands and brushlands. The remaining forested areas are generally the secondary forest remnants of previous logging activities or localized unlogged areas, which are found at the highest elevations and on the steepest slopes.

These three broad land use types (permanently farmed sloping lands, grasslands, and forested lands) tend to form distinct entities that flow into each other. The permanently cultivated lands expand into the grasslands as shifting cultivation on the grassland margins intensifies, and the grasslands advance at the expense of the forested lands as settlement and the relentless use of fire open and transform the forests. The human and natural ecology of each of these three entities is distinct, and technology and policy instruments must be adapted to the realities of each one.

Permanently Farmed Sloping Lands

The major issue in permanently farmed sloping lands is how to sustain and increase farm productivity to improve the welfare of the farm population and thereby reduce the rate of migration into the remaining forested lands. Increase in and sustainability of farm productivity may be achievable through policy reform and technological changes in agricultural activities, but the development of more successful farming systems in sloping settled lands will not eliminate the migratory pressure on forested lands. Technical change could make forested lands more valuable for agriculture, thus encouraging further migration. It is also evident, however, that if the current upland populations cannot become more successful in sustaining their incomes and increasing their employment opportunities, more farmers and their families will be forced to migrate from unproductive farms that can no longer support them, resulting in more rapid and destructive misuse of forestlands.

This suggests that sustainable upland agricultural production systems are necessary to alleviate many problems of human welfare in the uplands and lowlands and ensure more effective forest conservation, but such changes are not sufficient to solve the problem of the conversion of forests to agricultural uses. The essential elements of a strategy for upland development are the same as those that would apply in lowland areas. They include the need for a positive incentive framework and the availability of appropriate technical solutions. Agricultural technology can provide a crucial, supporting role in solving the forest conversion problem. Progressive policies in forestry, agriculture, land tenure, and general economic development will impinge greatly on the effectiveness and appropriateness of potential technologies.

There are many factors that limit the stability, productivity, and sustainability of upland farms, including climatic variations, biologic stresses, and social and economic uncertainties. A fundamental factor is the nature and rapidity of soil degradation.

The sloping upland soils in the Philippines fall into three contrasting types: acidic, infertile soils; young, relatively fertile volcanic soils; and calcareous soils. The strongly acidic, infertile soils, which are low in available phosphorus, are predominant. The young, more fertile volcanic soils cover large areas in the southern Tagalog and Bicol regions, on Negros Island, and in some areas of Mindanao. These have been the most successfully developed upland agricultural areas. Calcareous upland soils are found on the central Visayan islands of Cebu and Bohol. Restrictions on the available phosphorus also tend to be pronounced in calcareous soils.

In addition to the three basic classes of soils, the immense and localized variations in rainfall patterns because of the diverse topography of the Philippines, and the frequency and severity of damage from catastrophic typhoons affect the sustainable management of upland agricultural systems. Farming systems must be adapted to take into account these various conditions.

Philippine upland farmers face a diversity of land types and high levels of risk, yet they have limited access to credit and marketing resources. Under these conditions, agricultural technologists must be able to offer practical, low-cost farming practices that are viable under a wide array of conditions or that are more specifically tailored to a few conditions but that produce results quickly.

CONTOUR HEDGEROW SYSTEMS

Research on upland agroforestry in the Philippines is limited. Agriculturalists and foresters have few technical tools to cope with the enormous variety of circumstances that require attention. Gibbs et al. (1990) pointed out that the highly inadequate knowledge of agroforestry techniques was probably the weakest aspect in the successful evolution of the government's Integrated Social Forestry Program.

Leucaena Hedgerows *Leucaena* (*Leucaena leucocephala*) is common in rural areas with less acidic soils. It was indigenously grown in fencerows as a fodder source for cattle. The National Research Council (1977) indicated that the tree showed promise as a hedgerow intercrop that could supply large quantities of nitrogen and organic matter to a companion food crop. Those observations stimulated applied research on hedgerow intercropping in several locations around the Philippines. Guevara (1976) reported that hedgerow intercropping produced crop yield increases of 23 percent. Vergara (1982) cited experiments in which yields increased by about 100 percent, with no advantage of inorganic nitrogen application beyond the nitrogen supplied by green leaf manure. Alferez (1980) observed a 56 percent yield increase when upland rice was grown in alleys between hedgerows of *Leucaena*.

Hedgerows of *Leucaena* provided a barrier to soil movement on sloping lands. Data from studies on a steeply sloping site in Mindanao indicated a dramatic reduction in both runoff and soil loss (O'Sullivan, 1985). In that study, O'Sullivan (1985) also observed a consistent yield advantage over a 4-year period with maize fertilized by the *Leucaena* prunings obtained from adjacent hedgerows.

By the early 1980s, hedgerow intercropping was advocated by the Department of Agriculture as a technology that was better able to sustain permanent cereal cropping with minimal or no fertilizer inputs and as a soil erosion control measure for sloping lands. The extension of this system among Filipino farmers was encouraged by the work of the Mindanao Baptist Rural Life Center (MBRLC), a nongovernmental organization (NGO) that began working with *Leucaena* in the mid-1970s (Watson and Laquihon, 1987). MBRLC developed a 10-step program for farmer implementation of *Leucaena* hedgerows that was designated sloping agricultural land technology (SALT). SALT recommended that every third alleyway between the double hedgerows of *L. leucocephala* be planted with perennial woody crops, such as coffee trees, with the majority of the alleys maintained by continuous cropping with annual food crops. This concept offered the possibility of more diversified sources of farm income and improved soil erosion control.

By the mid-1980s, SALT was adopted by the Philippine Department of Agriculture as the basis for its extension effort in the sloping uplands. The Department of Environment and Natural Resources also used it as the technical basis for its social forestry pilot projects. A training effort for extension personnel was launched, and demonstration plots of SALT were installed on farmers' fields throughout the country. Several publications have been developed to spread practical information about the SALT system (Celestino, 1984, 1985; Philippine Council for Agriculture and Resources Research and Development, 1986).

Some adoption of *Leucaena* hedgerows occurred in high-intensity extension projects, but there was little evidence of widespread farmer interest in the SALT system. The lack of secure land tenure was implicated as a constraint to the implementation of this or any long-term land improvement system among tenant farmers or occupants of public lands. Among farmers with secure land tenure, however, the large initial investment of labor, the difficulty in obtaining planting materials, and the technical training and information required for sustained implementation were serious constraints to initiating SALT systems. In addition, the labor needed to manage the hedges, particularly to prune them 3 to 10 times each year, depending on the management system, was found to absorb a large proportion of the household's available labor. This labor investment tended to compete with other income-generating tasks and may have limited the area that could feasibly be farmed in this manner (S. Fujisaka, Social Sciences Division, International Rice Research Institute, Los Baños, Philippines, personal communication, 1989).

Hedgerows of Other Species The extension effort on *Leucaena* hedgerows suffered a major setback in 1985 when the exotic psyllid leafhopper (*Heteropsylla cubana*) invaded the Philippines, attacking hedgerows and killing or stunting trees throughout the country. This forced a search for replacement hedgerow tree species. *Gliricidia sepium* has been the most common replacement, but it must be propagated from cuttings in most areas, increasing the labor investment to establish hedgerows. Other species that have shown promise in hedgerow trials include *Flemingia congesta, Acacia vellosa, Leucaena diversifolia,* and *Cassia spectabilis* (Mercado et al., 1989; H. R. Watson, Mindanao Baptist Rural Life Center, Bansalan, Philippines, personal communication, 1989). *Alnus japonica* is used in the acid soil highlands in northern Luzon (Barker, 1990).

Pava et al. (1990) compared the changes in crop yields associated with planting a double row of leguminous hedgerows by a group of 10 farmers who adopted the system and a control group of farmers who did not. Over the 2-year interval of monitoring, maize yields increased by both methods, but the greatest increase was among the control group of nonadopters. Fertilizer use among both groups was very similar. When queried about the perceived value of the hedgerows, the farmers who adopted leguminous hedgerows emphasized that their investment in hedgerows was long-term insurance that their children could continue to farm the land.

Contour Bunding with Hedgerows World Neighbors, another NGO, made a substantial contribution during the past decade (Granert, 1990; Granert and Sabueto, 1987). The World Neighbors approach was oriented toward the development of a high degree of direct participation by farmers in devising and implementing local solutions to the perceived dominant constraints to crop cultivation on steeply sloping lands. A system of contour bunding was developed. The bunds provided a base for the establishment of double-contour hedgerows of leguminous trees or forage grasses and a barrier to surface runoff, which is carried off the field in contour ditches.

The contour hedgerow concept was applied to the strongly acidic upland soils by the International Rice Research Institute (IRRI) and the Philippine Department of Agriculture (Fujisaka and Garrity, 1988). Although these soils are generally deep, soil loss is a problem because it exposes a very acidic subsoil with toxic levels of aluminum. After 3 years of hedgerow intercropping, there was a striking natural development of terraces (Figure 3). Modest yield benefits were ob-

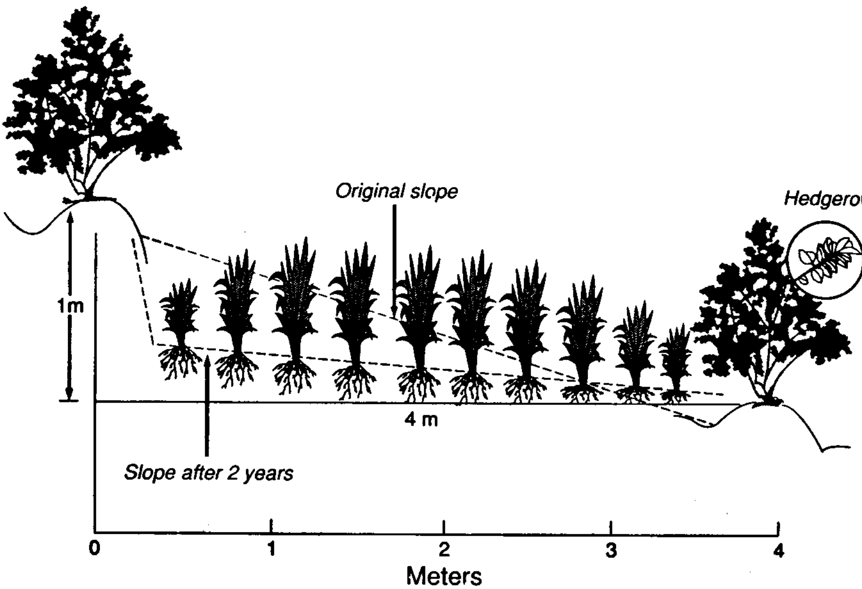

FIGURE 3 Terrace formation and crop growth in a contour hedgerow system of upland rice and leguminous trees on strongly acidic Oxisol soils. Source: Basri, I., A. Mercado, and D. P. Garrity. 1990. Upland rice cultivation using leguminous tree hedgerows on strongly acid soils. Paper presented at the Annual Meeting of the American Society of Agronomy, San Antonio, Texas, October 21–26, 1990.

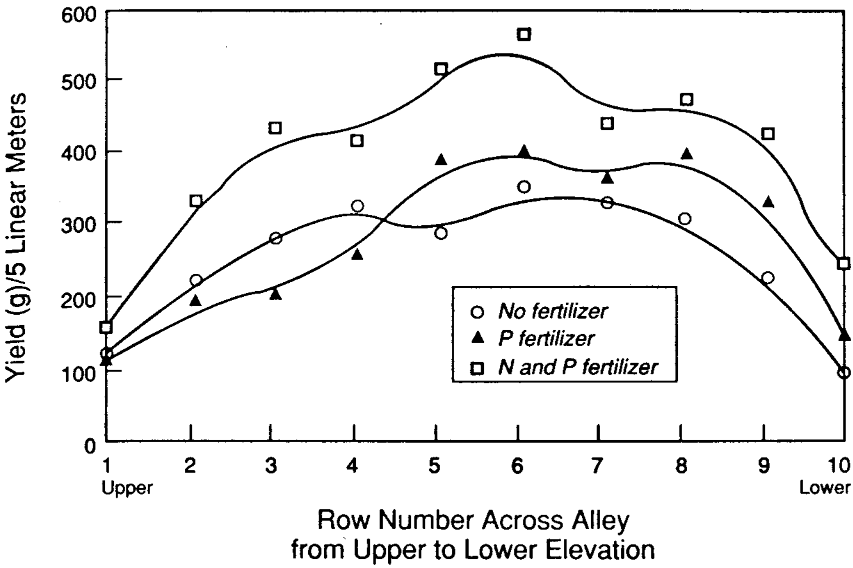

FIGURE 4 Yield (on a row-by-row basis) of upland rice grown in alleys between hedges of a leguminous tree, *Cassia spectabilis*, that supplied green leaf manure for the rice crop. P, phosphorus; N, nitrogen. Source: Basri, I., A. Mercado, and D. P. Garrity. 1990. Upland rice cultivation using leguminous tree hedgerows on strongly acid soils. Paper presented at the Annual Meeting of the American Society of Agronomy, San Antonio, Texas, October 21–26, 1990.

served when upland rice was grown between hedgerows of *Cassia spectabilis*, a common non-nodulating leguminous tree (Basri et al., 1990). Yields of maize and rice were consistently increased when they were intercropped with hedgerows of *Gliricidia sepium* (Mercado et al., 1992). However, crop yields were seriously reduced in the rows adjoining the hedges, with or without the application of external nitrogen and phosphorous fertilizers (Figure 4). The primary roots of both tree species spread laterally into the alleyways at shallow depths (20 to 35 cm) immediately beneath the plow layer. Feeder roots were situated to explore and compete for nutrients and water in the crop root zone.

Sustainability in Alley Cropping Systems The sustainability of crop yields in alley cropping systems is a major concern on all soil types. The work reviewed by Szott et al. (1991) raises particular questions about the viability of hedgerow intercropping on strongly acidic soils. The high level of exchangeable aluminum in the subsoil inhibits the deep tree-rooting patterns that are typically observed on higher-base-status soils. Phosphorus and other mineral elements are often more limiting than nitrogen in these soils. The acidity of the subsoil appears to promote intense competition among roots for mineral nutrients in the surface soil of the alleys and prevents nutrient pumping from the deeper soil layers. The organic matter inputs from hedgerow prunings of *Gliricidia* and *Cassia spectabilis* do not supply adequate quantities of phosphorus to meet the nutrient requirements of cereal crops (Basri et al., 1990). Furthermore, the prunings are composed of phosphorus that the tree may have captured predominantly from the crop root zone. The results obtained with other alley cropping systems on acidic Ultisols in Peru (Fernandes, 1990) and in Sumatra, Indonesia (Evensen, 1989), support the results obtained in Mindanao by IRRI.

Grass Strips Grass strips have also received major attention as contour vegetative barriers for erosion control in different parts of the world (Lal, 1990). Considerable work has been done in the Philippines with napier grass (*Pennisetum purpureum*), guinea grass (*Panicum maximum*), and other grasses (Fujisaka and Garrity, 1988; Granert and Sabueto, 1987). The predominant attention has been given to the more vigorous forage grasses, since they tend to provide high levels of biomass for ruminant fodder. Therefore, they are presumed to serve as a beneficial way to use the area of the field occupied by hedgerows, which is lost to food crop production. Experimental data (Table 9) and field observations of plantings in various locations indicate that use of forage grasses for intercropping has the potential to markedly reduce erosion and rapidly develop natural terraces on slopes. Therefore, the establishment of forage grasses has been extended as an alternative to the use of leguminous tree species on contour bunds.

Two major problems have surfaced from the use of grass strips. Farmers have difficulty keeping the tall, rapidly growing tropical forage species trimmed to prevent them from shading adjoining field crops. The biomass productivity of grass hedgerows exceeds the fodder requirements of most small-scale farm enterprises, and it is a burden for farmers to cut the unnecessary foliage frequently. High levels of biomass production also tend to exacerbate competition for nutrients and water with the adjoining food crops and reduce cereal crop yields (D. P. Garrity and A. Mercado, International Rice Research Institute, unpublished data).

Intercropping with Noncompetitive Species The constraints observed from intercropping with both trees and forage grasses have stimu-

TABLE 9 Soil Loss Affected by Contour Hedgerow Grasses Vegetation

Hedgerow Species	Soil Loss (cm)
Gliricidia sepium and *Paspalum conjugatum*	0.38
Pennisetum purpureum	0.62
Gliricidia sepium and *Penisetum purpureum*	1.38
Gliricidia sepium alone	1.50
Open field (conventional practice)	4.20

NOTE: Monitoring was done in a large replicated trial on-farm in Claveria, Misamis Oriental (Mindanao), Philippines, from August 1986 to April 1990.

lated an alternative concept of using hedgerows that contain non-competitive or relatively inert species (Garrity, 1989). An inert species is one that has a short stature and a low growth rate, which minimizes hedgerow-crop competition but provides an effective ground cover for filtering out soil particles. This concept places primary emphasis on the rapid and effective development of terraces to improve field hydrology and maximize soil and nutrient retention. *Vetiver zizanioides* may exemplify an inert hedgerow species (Smyle et al., 1990). *Vetiver* is found throughout the Philippines. It tends to form a dense barrier and does not self-propagate to become a weed in cultivated fields. However, it must be propagated by vegetative tillers, which is a laborious process.

Natural Vegetative Filter Strips An alternative approach that has received little attention is the installation of natural vegetative filter strips. These are narrow contour strips that are left unplowed and on which vegetation is allowed to grow naturally. They may be established at the time that a piece of fallow land is brought into cultivation or during the interval between crops in a continuous cropping system. The dominant species in natural vegetative filter strips are native weedy grasses: *Imperata cylindrica, Paspalum conjugatum, Chrysopogon aciculatus,* or others, depending on the location and the management regime to which the strips are subjected. These natural grasses can be suppressed by allowing cattle to graze them, cutting them down, or mulching them with crop residues. Natural vegetative filter strips are capable of reducing soil loss at least as effectively as commonly recommended introduced species (Table 9, *Paspalum conjugatum* treatment). They are generally less competitive with food crops than other hedgerow species, and they are adapted to local ecosystems and resilient in terms of longevity and reestablishment.

There have been some isolated observations of the indigenous development of natural vegetative barriers by upland farmers in the Philippines (Baliña et al., 1991; Fujisaka, 1990; Ly, 1990). However, research has not been targeted to exploit this option in Philippine uplands. (In the United States there has been extensive research on the use of natural vegetative filter strips for sediment and chemical pollution control [Williams and Lavey, 1986].)

Farm-level adoption of natural vegetative filter strips has been observed to be comparatively simple. Contour lines are laid out at the desired spacing. The field is plowed on the contour, allowing the designated strips to be left as fallow vegetation. In fields where the technique has been implemented, the soil in runoff water is deposited at the filter strip. This deposition, combined with the movement of soil down the slope during tillage operations, results in the rapid development of terraces of 30 to 70 cm deep within 2 years. The leveling effect of terrace formation evidently improves water retention in the field, and the loss of either applied or native soil nutrients is reduced. These effects need to be investigated under a range of field conditions.

The natural vegetative filter strip approach can be considered the initial stage in a long-term process of contour hedgerow development on farms. As terraces form, farmers may diversify the terrace risers for use in other enterprises by planting trees or perennial crops as they fit their management objectives. The natural vegetative filter strip concept may be a practical basis for the rapid, wide-scale dissemination of hedgerow technology. Therefore, a substantial effort in both strategic and farmer-participatory research on natural vegetative filter strips is warranted.

Cash Crop Production in Hedgerows may also be suitable for the production of perennial cash crops. Some perennial crops that have been used in these systems include coffee, papaya, citrus, and mulberry. The suitability of the perennial species is limited by the degree of shading of the associated food crops. The cash income that can be made is a major advantage of using perennial crops. Erosion control may not be provided by the perennial crop, but it may be provided by grass that occupies the area between the widely spaced plants.

Cattle Production Backyard production of cattle has become an important enterprise in some densely settled upland areas, particularly Batangas province. A trend toward more intensive small-scale beef and goat production is now under way in many parts of the country.

This trend is stimulated by historically high meat prices. Leguminous tree species, particularly *Leucaena leucocephala* and *Gliricidia sepium*, are widely used as high-protein forages, especially in the dry season. Backyard ruminant production will stimulate more intensive husbandry of manure. An important model of the development of leguminous trees in hedgerows is the use of prunings as a source of animal feed, either for on-farm use or off-farm sales (Kang et al., 1990). Harvesting of fodder potentially increases the value of the hedgerow prunings, but it also depletes soil nutrient reserves more rapidly because the nutrients contained in the prunings are removed from the field before they can provide their nutrients to the crop. Unless this manure is spread back on the land or replaced, and nutrient supplements provided in the form of fertilizer, the rate of soil depletion may be accelerated. Currently, the use of green leaf manure is insignificant in upland cropping systems.

The experience of the past 15 years with alley cropping and the use of contour hedgerows suggests that appropriate solutions must be tailored to the diverse soil and environmental conditions, farm sizes and labor availabilities, markets, and farmer objectives. The tendency for a package approach to be applied by extension systems must be replaced with a model that recognizes a wide range of possible hedgerow species and management systems (Garrity, 1989). There has been little attempt to clarify the appropriate hedgerow technologies for the range of specific local physical and institutional settings.

REDUCED-TILLAGE SYSTEMS

Clean cultivation is the universal soil management practice of Filipino upland farmers whether they use animal power or hand tillage on steep slopes. Crop residues are plowed under, burned, or removed and used as fodder. Retention of surface residues through conservation tillage systems is unexploited, although the value of such practices in reducing soil erosion is profound on tropical sloping uplands (Lal, 1990). Many studies have shown significant benefits from maintaining a surface mulch. Thapa (1991) found that soil loss was reduced by 90 percent by the presence of a vegetative barrier, but the maintenance of crop residues on the soil surface reduced soil loss by more than 98 percent. It has been shown (R. Raros, Visayas State College of Agriculture, Baybay, Leyte, Philippines, personal communication, 1989) that upland rice can be dependably established in thick residues without tillage in a hedgerow system, and the yields of a system with three continuous crops per year can be sustained.

At present, no practical approach has been developed to satisfactorily cope with weeds in reduced-tillage systems. Broad-spectrum herbicides such as glyphosate are beginning to be used on a limited basis by small-scale farmers, but the intense weed pressures on upland farms and the tendency for weed species to shift rapidly to resistance to herbicides has severely constrained the development of herbicide-based solutions.

The possibility of successfully using a reduced-tillage system has been reinforced by recent observations on a farmer-evolved system of maize production in Mindanao (D. P. Garrity, International Rice Research Institute, unpublished data). The system involves a crop sequence of three crops of maize monoculture per year but only one primary tillage operation annually. Interrow cultivation and late weeding during the maize grain-filling period enable the second and third crops to be planted on the day of harvest without tillage and with low weed pressures. This unconventional approach provides interesting prospects for practical techniques for reducing the tillage needed for food crop farming with limited resources.

NUTRIENT SUPPLY

External fertilizer use on food crops by upland farmers is seldom important. This is due to their severe capital constraints, transport difficulties, and low returns from fertilizer use. Therefore, a long-term decline in yields is typically observed (Fujisaka and Garrity, 1988). It is widely believed that the sustainability of food crop production could be enhanced by improved retention of crop residues and by the adoption of more diverse crop rotations that include nitrogen-fixing legumes (McIntosh et al., 1981). The limited work done to date has shown that there are mixed benefits from these practices. The practical constraints to the implementation of improved nutrient cycling practices are often considerable.

Leguminous grains play an insignificant role in upland cropping systems. Mung beans (*Phaseolus aureus*) and soybeans (*Glycine max*) are adapted to neutral and slightly acidic soils, whereas cowpeas (*Vigna sinensis*, also known as black-eyed peas) are more suited to highly acidic soils (Torres et al., 1988). When leguminous grains are inserted into cereal crop-based rotations immediately before upland rice or maize is planted, the legume improves the nutrient balance of the next cereal crop (Magbanua et al., 1988; Torres et al., 1989). Intercropping of cereals and legumes may increase their combined productivities, but it does not increase the net availability of nitrogen to the cereal crop (Aggarwal et al., 1992).

Farmers who cultivate grain legumes do so as an income or food source, but they do not usually observe better cereal crop performance as a result of the legume's inclusion as a second crop in cereal-based rotations (International Rice Research Institute, 1991). This appears to be due to the low biomass production by tropical leguminous grains that mature early and to nitrogen losses during the long fallow period between the time that the legume is harvested and the establishment of the following wet season crop.

Forage legumes have greater longevity in the field than do leguminous grains, and they produce large amounts of nitrogen-rich biomass. On high base-status soils, viny legumes such as lablab (*Lablab purpureus*) or siratro (*Macroptilium atropurpureum*) can be intercropped with upland rice or maize. They produce 100 to 200 kg of nitrogen/ha in plowed down green manure during the dry season for the succeeding wet season cereal crop (Aggarwal and Garrity, 1989; Torres and Garrity, 1990). They also provide high-quality forage during the dry season. Lablab also provides a nutritious and marketable food legume for humans (Torres and Garrity, 1990).

On strongly acidic soils, most of the forage legumes have slow establishment rates, are not resilient to pruning, and do not accumulate substantial amounts of biomass during the dry season. This may be attributed to poor rooting and nodulation in the presence of high levels of exchangeable aluminum and low amounts of available phosphorus in the soil. Their inclusion within annual crop sequences therefore often appears to be impractical without the application of lime or phosphorus or both.

PHOSPHORUS AS A CRITICAL CONSTRAINT

The acidic upland soils of the Philippines are predominantly fine-textured, with organic carbon contents of 2 to 3 percent and with a moderate level of total nitrogen. Phosphorus deficiency is frequently the most limiting nutritional problem (International Rice Research Institute, 1987) and often must be overcome before any response to nitrogen is observed (Basri et al., 1990; Garrote et al., 1986). Phosphorus pumping from the deeper soil layers is limited by subsoils with toxic levels of aluminum and low phosphorus reserves. Since constant nutrient removal or offtake is occurring, crop yield sustainability and significant biologic nitrogen fixation will depend on the importation of mineral nutrients, particularly phosphorus and lime. Greater appreciation of the importance of importing these nutrients in upland agroecosystems with acidic soils is needed.

Deposits of phosphate rock in the Philippines are an efficient source of both phosphorus and calcium (Atienza, 1989; Briones and

Vicente, 1985). The exploitation of phosphate rocks for farm use has been neglected and could be expedited. This would require greater government and commercial recognition of the fundamental importance of these minerals to permanent upland agricultural system.

PERENNIAL CROPS

Coconuts are the dominant plantation crop in the Philippines, which has the world's largest area devoted to this crop, covering nearly one-sixth of the land surface (4.88 million ha [Swedish Space Corporation, 1988]). In addition, there are about 100,000 ha of plantations of rubber and other estate trees.

Coconut trees occupy much of the steepest nonarable land at lower elevations. Although the canopy of a coconut plantation is relatively open, the land on which coconut is grown provides satisfactory soil protection against erosion when an appropriate grassy or leguminous ground cover is established. Much of the land on which coconut is grown is owned by wealthier families but is managed in smallholdings by tenants or caretakers. The livelihoods of millions of the poorest families and the economic future of many parts of the uplands are heavily dependent on the health of the coconut industry. A long-term decline in the world market demand for coconut oil is projected because of the increasing worldwide preference for vegetable oils, which have a lower saturated fat content.

Land tenure is the dominant barrier to more productive management of the lands on which coconut is grown. Landlords generally prohibit understory cropping to avoid future claims to permanent occupancy. However, numerous crop species thrive under coconuts (Paner, 1975). Multistory cropping systems—with a two- or three-tiered canopy that may include fruits, vegetables, and food crops—improve farm income and are observed in some areas. It is unclear whether the planned extension of agrarian reform to the areas planted in coconuts, which was indicated in the 1987 Comprehensive Agrarian Reform Program legislation, will have any effect in overcoming this land tenure barrier. The titling of lands on which coconut is grown to tenant farmers would result in a dramatic increase in land use intensity for coconut. This would significantly alleviate the high degree of income uncertainty for tenant farmers who grow coconuts.

FARM FORESTRY

The concept of farmers producing fast-growing trees as crops was popularized in the mid-1970s by the Paper Industries Corporation of the Philippines, which set up woodlots on farms to grow trees for pulpwood production (World Bank, 1989a). The practice has gained momentum in recent years, as the depletion of old-growth hardwood forests sent domestic timber prices steeply upward. Substantial numbers of small-scale farmers in northern Mindanao now plant in short rotations and then sell gmelina (*Gmelina arborea*) and falcata (*Albizia falcataria*) as timber. *G. arborea* is harvested and coppiced in up to three 10-year cycles. Fast-growing hardwoods such as gmelina are also integrated into contour hedgerow systems. The Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990) places emphasis on contract forestry with private individuals and communities and is supported by a loan from the Asian Development Bank. Development of these systems would be greatly accelerated if credit for contract tree growing is extended to small-scale farmers and hardwood production in hedgerows is encouraged.

DIVERSIFICATION

The most plausible model of sustainable smallholder farming in the uplands is one of diversification into mixed farming systems. Given the exceptionally high production and marketing risks in the uplands and the generally low marginal returns, a number of alternative enterprises must be undertaken on upland farms to provide stability (Chambers, 1986) and to take maximum advantage of the complementarities that occur among income-generating activities (for example, leguminous trees for fodder, green leaf manure, and fuelwood; cattle for labor, cash income, and manure).

Upland farm families must place primary or exclusive emphasis on subsistence food crop production. The land use systems that result from the pursuit of these needs, however, are the least ecologically sustainable alternatives. The issue from policy, research, and extension perspectives is how to enable the farm enterprise to move profitably along a trajectory that will continually increase the area devoted to perennial plants and decrease the area devoted to annual plants (Figure 5). The gradual expansion of home gardens, ruminant livestock production, and plantation and timber tree crops will contribute to this end. Greater private and public sector support for the development of these enterprises will be essential. However, this must be linked with the improvement of methods for greater sustained food crop production per unit area to release land and labor for other cash-generating activities.

The Philippine Department of Agriculture has only recently begun to give significant attention to the task of understanding upland

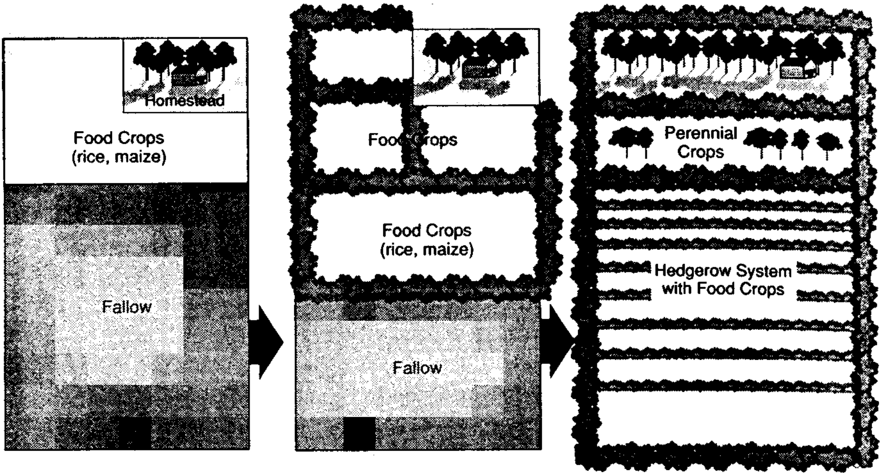

FIGURE 5 Model of the evolutionary development of a small-scale upland farm on sloping land.

agricultural technologies. Upland agricultural systems are in stark contrast to the less heterogeneous lowland systems that have historically received overwhelming attention. Therefore, a major reorientation of both the research and extension approach is under way. This reorientation involves the decentralization of operations to the local level. The Department of Agriculture has adopted a farming systems research and development model for technology generation in the uplands, with strong emphasis on farmer-participatory research (Dar and Bayaca, 1990). To be effective, this transformation must be pursued more vigorously and will require major increases in staff capability and mobility.

The Grasslands and Brushlands

The most common form of vegetation in the Philippine uplands is grass, predominantly *Imperata cylindrica* (cogon) or *Themeda triandra* (samsamong, silibon, or bagocboc) or, at higher elevations, *Miscanthus japonicus* (runo). The rhizomes of these perennials are highly resistant to fire, but the shoots are flammable during dry periods. They readily invade abandoned swiddens, land cleared of forests, and forest openings. A small portion of the grassland area may be a result of natural disturbances, but the overwhelming majority owe their existence to repeated disturbance by fire, which is usually started by humans to obtain game or fodder or to clear land (Bartlett, 1956).

At the turn of the twentieth century, 40 percent of Luzon and extensive areas of other Philippine islands were covered with grass. The land classification of 1919 estimated that grassland covered 19 percent of the country, a figure that stayed roughly constant through 1957 (Roth, 1983). An analysis (Swedish Space Corporation, 1988) of Philippine land use estimated the area of pure grassland to be 1.8 million ha, with an additional 10.1 million ha in extensive cultivation mixed with grasslands and brushlands (that is, about 33 percent of the country's land surface). This suggests that more than 20 percent of the surface area of the country is covered by grasslands (see Table 2). The grasslands appear to have served as an intermediate zone—a portion continually being transformed into permanent croplands or plantations—for a long period of time, whereas new area is created as the forest withdraws. In some intensive grass-fallow rotation systems, fire climax savannah is used indefinitely as the fallow species (for example, see Barker [1984]).

The cogon grasslands are commonly used as pasture, but they have a carrying capacity that is probably lower than 0.25 animal units (0.3 cattle) per ha (World Bank, 1989a). Cogon grass is suitable as a forage only during early growth, so the range is regularly burned toward the end of the dry season, which contributes to wildfires that penetrate and further destroy forestlands. Range management by private ranchers is generally poor, and improved management practices have not resulted in competitive economic returns. Overgrazing during the regrowth period reduces ground cover and makes grassland the most significant source of soil erosion in the Philippines. Thus, the net social returns from cattle ranching are low, and justification of this form of land use is questionable.

There has been a precipitous decline in ranching during the past 15 years. A major factor has been the communist insurgency, which targeted its operations against ranches. Associated with this has been a 50 percent decline in the size of the national cattle herd during this 15-year period.

What should be done about the grasslands? They continue to function as a migratory sink for the settlement of landless and jobless families, and in this sense, they are still a frontier. The social value of these lands, however, is greatly constrained by government land use policy and a regressive pattern of formal and informal land tenure. Although the land is publicly administered as forestland by the Department of Environment and Natural Resources (DENR), wealthy families (pseudo-landlords) have laid claim to large areas, relegating settler families to tenancy.

Small-scale farming in grasslands is predominantly practiced with animal labor. Settlers initially practice a migratory system of farming, shifting their farm area as necessary to sustain crop yields. The greater population densities necessitate rotating the fallow areas of fields within permanent farm boundaries. As the farm size decreases, permanent cropping evolves, in many cases with extremely low comparative yields (Vandermeer, 1963).

SECURITY OF LAND TENURE

Since 1894, the Philippine state has proclaimed about two-thirds of the country's area as public forestland. In 1975, all land with a slope of 18 percent or greater was proclaimed by legislation to be part of the public domain. Subsequent legislation further eroded the rights of occupant families to the land on which they lived. Although the legislation was ostensibly intended to strengthen the state's ability to conserve the forests, its unanticipated effect was to greatly weaken occupants' interest in any long-term forms of sustainable land management.

Later, the realization grew that the upland populations were going to be permanent and were increasing rapidly. This led to a succession of weak programs that involved occupancy permits and communal tree farming contracts. The Integrated Social Forestry Program (ISFP) arose in the early 1980s as an extension of the earlier approaches. It was based on a Certificate of Stewardship Contract (CSC), which grants leasehold occupancy rights for up to 7 ha of land to a family for a 25-year period and is renewable for another 25 years (Department of Environment and Natural Resources, 1990). CSC holders are obligated to use conservation farming practices, plant at least five trees per hectare, and assist in protecting adjacent forest areas. The ISFP promotes agroforestry practices, particularly contour hedgerow farming.

Although the CSC is aimed at strengthening the land tenure security of upland farm families, it is a weak instrument for doing so. Many poor farmers and their families face substantial problems in asserting a CSC claim against the claim of more powerful but absentee pseudo-landlords. The CSC lease is nontransferable and, thus, cannot be used as collateral for loans for investing in farm improvements. The CSC lease may be canceled at the discretion of the Forest Management Bureau, and it is heritable only within the 25-year lease period.

The speed of implementation of ISFP has been disappointing. Only 2.5 percent of the upland area has so far been included in stewardship leases. The Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990) targeted CSCs to be issued to 626,700 families during the 10-year period from 1988 to 1997. This would cover an estimated 1.88 million ha of public land. Assuming an average of six persons per family, this would involve a population of 3.76 million. These targets appear to be overly optimistic unless major new funding and staffing becomes available.

Secure land tenure in the uplands would decrease the number of large land claims by elite individuals who use poor families as tenants. Many poor families are part of a well-organized effort of occupation of forestlands carried out by wealthier individuals who hope to lay claim to the land by paying taxes on it. Under such arrangements, the agricultural inputs of the cultivator may be subsidized by the pseudo-landlord and personal credit may be advanced to the cultivator, or the cultivator may be contracted to plant perennial crops for an agreed price per plant and permitted to grow food crops on the young plantation until the trees become established. Then, the cultivator must move on to a new area to renew the cycle or may be hired to care for the plantation.

CSC leaseholds provide a mechanism that serves as a counterweight to the grip of local elites. Effective independence for the cultivator will depend, however, on the infrastructure and support services that will make it possible to earn a viable living from the land without the patronage of landlords. The sense of security that the CSC provides to powerless migrant farmers was explored by Pava et al. (1990). The granting of CSCs will encourage more migration into the uplands. This will happen even if recent migrants are excluded from the program. It will be especially pronounced in areas where the bulk of the fertile lowlands are controlled by a few landed elites.

FALLOW IMPROVEMENT SYSTEMS

There are a variety of farming systems in the grasslands, ranging from shifting cultivation to permanent cultivation systems. The technology appropriate for a shifting cultivation system differs from that for a permanent field cultivation system because of the major differences in labor and land use intensity required for each system. As Raintree and Warner (1986) pointed out, shifting cultivators maximize their returns to labor rather than to land and resist inappropriate labor-intensive technologies. Hedgerow farming is a solution that is suitable to the more intensive stages of permanent cultivation. A more relevant concern in shifting systems is management of fallow fields.

Barker (1984) analyzed the role of fallow fields in shifting cultivation. A crop that improves fallow fields must yield higher nutrient levels and accumulate more organic matter than the natural fallow it is to replace. Little work has been done on practical methods of rapidly regenerating soil fertility in fallow fields of the Philippines. Fallow fields are usually burned or subjected to intensive grazing. Farmers acknowledge that these practices are often ineffective in regenerating fertility, and this has been corroborated by sampling the nutrient status of fields (Fujisaka, 1989).

Leguminous cover crops have been proposed as candidates for managed fallow fields, but empirical evidence of their practical utility is sparse. The ubiquitous presence of dry season grassland fires and the difficulty in preventing fires on the grasslands will limit this practice. Protection from communal grazing is also a constraint in many areas. Problems of seed supply and seed collection limit the adoption of leguminous cover crops, but a system for marketing cover crops is rapidly developing (P. C. Dugan, Department of Environment and Natural Resources, personal communication, 1990). A much greater research effort is needed at national and local levels, particularly regarding species that can be used as food for humans (for example, *Psophocarpus palustris* [siratro]).

Systems for enhancing fallow fields with leguminous trees have been demonstrated. MacDicken (1990) described an indigenous planned fallow that has evolved on steep slopes in Cebu since before 1900. Dense stands of naturally reseeded *Leucaena leucocephala* are used in the fallow portion of the cycle. When the *Leucaena* trees are cut, the stems are placed on the contour and staked to create contour bunds. A fallow period of 3 to 7 years is followed by several years of cereal cropping. The concept of naturally reseeded fallow fields deserves serious attention as an alternative fallow for both grassland and forest agroecosystems, where natural woody plant regeneration after cropping is suppressed. Tree species that are suited to strongly acidic soils and are prolific in seed production also need to be identified. *Flemingia congesta* is a candidate species for medium-elevation sloping acid soils, and *Alnus japonica* is a candidate species for the highlands.

A tree fallow system for shifting cultivation on the island of Mindoro, which used cuttings of *Leucaena* that was intercropped with the food crops, allowed development of a tree cover on fallow land after the cropping cycle (MacDicken, 1990). The value of such systems remains unconfirmed. There are also uncertainties in applying these systems—or variations of them—to the diverse range of fallow environments on grasslands or forestlands. Exclusion of fire will also be a dominant concern in successful implementation of such systems. A major sustained research effort on managed fallows is critical.

REFORESTATION EFFORTS

The grassland areas have been a major target of Philippine government reforestation efforts for the past 30 years (Department of Environment and Natural Resources, 1990). Official forestry statistics indicate that about 1 million ha of tree plantations was planted between 1960 and 1989. This effort was managed by the Forest Management Bureau.

In most ongoing reforestation contracts, fast-growing and leguminous hardwoods are planted as nurse trees to form a protective canopy, with a few premium species planted as the climax crop. Foremost among the nurse trees are *Acacia mangium*, *Acacia auriculiformis*, *Leucaena diversifolia* (psyllid-resistant strains of *L. leucocephala*), and *Gliricidia sepium*. The major premium quality species include *Swietenia* species and *Pterocarpus grandiflorus*. Other species that can grow in areas dominated by *Imperata cylindrica* are *Gmelina arborea*, *Eucalyptus camaldulensis*, and leguminous pioneer species. Sometimes, contractors mechanically till the areas to be planted and seed leguminous cover crops during the first year to improve the soil microenvironment. In most projects, nursery-grown plantings are used.

The success record, however, has been disappointing. In a recent nationwide inventory of the status of plantations (Forest Management Bureau, 1988), the actual extent of surviving trees was found to be only 26 percent. In the central and western areas of the country, which have prolonged dry seasons, the situation was more dismal. For example, Reyes and Mendoza (1983) found that after an intensive reforestation effort in the watershed containing the Pantabangan Reservoir, the survival of replanted trees was only 10 to 15 percent because of poor weed control, pests and diseases, and fire.

Control of fires on newly established plantations is difficult and costly. Public reforestation projects are given neither adequate incentives nor appropriate management capabilities to provide protection from fires. In fact, many plantations were deliberately torched by local people who saw that there was nothing to be gained from the presence of a government plantation in their area.

CONTRACT REFORESTATION

The overwhelming failure of reforestation efforts managed by the Forest Management Bureau has recently prompted a major redirection in approach. The approach is called contract reforestation, by which DENR plans to establish artificial forests via contracts with families, communities, local governments, the private sector, and NGOs on about 630,000 ha by the year 2015 (Department of Environment and Natural Resources, 1990). Contracting consists of a two-phase strategy. First, DENR contracts for the establishment, maintenance, and protection of artificial forests for a 3- to 4-year period. If the contractors perform well in meeting the provisions of the reforestation contract, they can apply for a Forestland Management Agreement (the second phase). This entitles them to harvest, process, and sell or otherwise use the products grown on their reforested areas. The private forestland manager, however, must pay the government a share of the income from sales of production output. This share is equivalent to the amount of money needed to reforest 1 ha of denuded area when 1 ha of 3- to 4-year-old trees is cut. Harvesting and other thinning activities are done in accordance with a DENR-approved management plan.

The majority of the lands targeted for the contract reforestation program are relatively degraded or remote. Because of low profitability and high interest rates, private firms are hesitant to invest their own corporate funds to establish industrial tree plantations (Domingo, 1983; Guiang, 1981). The funds that the government has designated for this program are largely from international donors, particularly the Asian Development Bank.

DENR hopes to generate reforestation funds from production shares under the Forestland Management Agreement. In this way, DENR could spread the financial and environmental benefits of reforestation activities. It is presumed that managers have strong incentives to protect and manage their artificial forests, since they reap the major profit from the sale of the tree crops. They can also plant and intercrop cash crops, fruit trees, and other agricultural crops to augment their incomes and to provide additional incentive for protecting, replanting, or enriching the plantation forests. DENR has also provided an indirect subsidy for rehabilitating grasslands and brushlands that are not profitable under the industrial tree plantation scheme. Enthusiasm for contract forestry is tempered by apprehension about constrictive regulatory controls. If the regulatory attitude prevails during implementation of the program, as is typical of DENR programs, progress will be disappointing.

A major factor in the success of the contract forestry program is the assumption that independent managers will strive to protect their investment from fire. The excellent fire control technologies of indigenous peoples, for example, methods used on the 15,000-ha ancestral lands of the Kalahan Education Foundation, Nueva Viscaya, can be more widely disseminated (Barker, 1990).

THE ECOLOGY AND MANAGEMENT OF FIRE

When an area is cleared of tropical forest it changes from an ecosystem essentially immune to fire to one in which fires are extremely common. J. B. Kauffman's research (cited in Savonen [1990]) showed that rain forests are capable of catching fire only on an average of 1 day each 11 years, but partially logged areas burn after an average of only 6 rainless days. Grassland areas are flammable after only 1 rainless day.

Repeated burning kills potential tree propagules in fallow fields and favors grasses, in particular *Imperata cylindrica*, over perennials. When burning or other disturbance is halted, *I. cylindrica* is rapidly invaded and shaded out by taller, woody species. If the area is large enough, however, *I. cylindrica* grass may persist for decades, even after the fires have stopped, because the propagules of other plants have been eliminated.

All aspects of this discussion on technology for more productive uses of grasslands for agriculture and forestry emphasize the dominance of fire as a debilitating constraint. Determined ecologic and farm-level management research on fire control will be essential to achieve progress in the better use of grasslands. Identification of practical and cost-effective tactics will require a systems approach. A national research project on the ecology and management of fire could collate the knowledge on the subject that can be provided by indigenous peoples, design a comprehensive framework for investigation, and assist regional and local research teams in undertaking work in this area within the respective land use system research programs.

LOCAL ORGANIZATION FOR CONSERVATION AND SUSTAINABLE AGRICULTURE

During the past decade, social forestry research has provided much insight into the complex constraints in the evolution of effective community organizations to sustainably manage local upland resources (Borlagdan, 1990). Many of these organizations will be needed to serve the needs of upland farmers in thousands of villages throughout the Philippines. The initiation of farmers' organizations has so far been limited to specific project sites. Careful consideration must be given to the development of a structure that will link these organizations at the provincial, regional, and national levels. Such a structure might draw on some of the experiences of the conservation districts in the United States (Cook, 1989). These independent units of local government, of which there are more than 3,000, regulate resource use and assist farmers in implementing conservation practices. Conservation districts are created through a referendum involving all occupants of the land. They are governed by an elected board that enlists the skills and services of government agencies at all levels to advance conservation programs in the district.

Saving and Rebuilding the Remaining Natural Forests

The commercially exploitable old-growth dipterocarp forests in the Philippines are nearly exhausted. The Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990) estimates their extent at slightly less than 1 million ha. We estimate that the actual extent may be closer to 700,000 ha—or lower. Nearly all of this area is to be protected under recently enacted DENR policies banning logging in old-growth forests. Therefore, DENR anticipates that further declines in forested areas will be slight (Department of Environment and Natural Resources, 1990). It appears to be optimistic to assume that commercial logging will stop immediately, that illegal logging can be controlled (since it has been resilient in the past), and that indigenous communities and migrants to the forest will not further convert significant areas of the forest to permanent agricultural uses.

The Philippine government has now acknowledged that it is incapable of managing forestlands on its own (Department of Environment and Natural Resources, 1990). DENR recognizes the logic of community control in managing forest resources. The issue now is whether DENR mechanisms set in place to implement this concept will be sufficient to address the needs.

THE ROLE AND RIGHTS OF INDIGENOUS COMMUNITIES

The people of the indigenous communities differ in their willingness to accept the concept of stewardship leases rather than full titling of the land to the community. Their reasons fall into three categories, depending on the community's circumstances:

- Ethnic communities that have been able to maintain secure control of their land: Forest-dwelling ethnic minorities of the Cordillera who have staunchly protected their land fear that acceptance of stewardship leases will mean that they must give up their claim to ownership.

• Communities that have traditionally possessed land but whose lands are under strong encroachment pressure from lowland settlers or plantation expansion: Groups such as the Ikalahans and Mangyans struggled successfully over a long period of time to obtain a lease and consider stewardship leases to be the best practical means for trying to maintain the integrity of their land.

• Communities that have been displaced from their traditional lands: These communities, such as the T'boli, have been forcibly dispossessed and inhabit new locations where they do not have a basis for traditional land claims. Others, such as the Bilaan, have been completely dispossessed of any land and live in squalid refugee camps. These groups are desperately seeking some form of land tenure security and are highly receptive to leasing arrangements.

The predominant concern of many communities regarding land tenure is encroachment by outside interests. The first Communal Forest Lease was obtained in 1974 by the Ikalahan in Nueva Viscaya (Cornista and Escueta, 1990). The major land threat was from lowland farmers and elites from the nearby municipality who claimed land on the Ikalahan's traditional reservation. By 1988, a total of nine communal leases ranging from 50 to more than 15,000 ha were issued to a variety of groups.

An organizing force was critical to the eventual development of these leases. This was usually provided by an NGO. Developing community leadership to manage the process was an essential and often difficult process. Many failures in community management can be anticipated; therefore, a heavy investment in management skills will be essential within DENR, NGOs, and the communities.

COMMUNITY-BASED FOREST MANAGEMENT

In 1989, DENR moved to implement the Community Forestry Program (CFP) (Department of Environment and Natural Resources, 1990). This allows organized cooperatives of forest occupants and upland farmers to extract, process, and sell forest products in exchange for the community's commitment to protect, manage, and enrich the residual forest. DENR provides 25-year wood utilization permits to organized communities under a Community Forestry Management Agreement, which is renewable for another 25 years. The change in policy was intended to democratize access to forest resources, generate employment in the uplands, and manage the remaining production forests in a sustainable manner.

Under DENR's Master Plan for Forestry Development (1990), a total of 1.5 million ha is targeted for community-based forest management. The forests classified for CFP are generally fragmented, inadequately stocked, part of canceled concession areas, near rural communities, and unprofitable for large-scale commercial extraction and processing. In 1990, 26 percent of the forests classified for CFP were in good condition, 40 percent were in fair condition, and 34 percent were in poor condition. Only small-scale and labor-intensive types of forest extraction and processing will result in profitable operations in these forests.

The CVRP-1 Social Forestry Project (1984–1989) was the first test of the community-based forestry concept (Dugan, 1989). The project was located on a 17,000-ha site on Negros Oriental island that had 4,500 ha of forest and about 17,500 inhabitants. The area had been under a logging ban since 1979, but illegal deforestation continued at an annual rate of about 1,360 ha. Eighteen Forest Stewardship Associations composed of forest occupants and farmers were initiated. They assumed responsibility for managing and conserving designated portions of the forest under the guidance of the project staff. The rate of forest destruction declined abruptly—by 92 percent—as the cooperatives began policing their zones, and it remained at only 100 ha annually through 1989. Shifting (slash-and-burn) cultivation in the forest was drastically curtailed. Large-scale illegal logging was eliminated. Using labor-based technology, the cooperative members participated in limited wood extraction, which increased their incomes far beyond what they had earned previously. These projects were proven successes that supported the hypothesis that the deforestation process can be controlled only when the forest occupants have a direct stake in the enterprise.

Nevertheless, some serious deficiencies in community organization, training, and cooperative management were observed. These deficiencies led to confusion in the cooperatives, and instances of corruption and abuses of forest regulations were uncovered. The need for a major reorientation of the skills and attitudes of the foresters involved in a community-based management setting was also highlighted. Success of the approach will be possible only with a large core of committed and competent people. Currently, no organized pool of people has such expertise. The limitation of human resources in the communities and in DENR will make the rapid expansion of community-based forestry uncertain. To date, DENR's experience with implementation of CFP has been limited to the selection of NGOs to operate the program and site identification, but inadequate attention has been given to organizing and training members of the community (Guiang, 1991; Guiang and Gold, 1990). Therefore, emphasis on training programs that can teach the required managerial skills will be needed.

The technical, managerial, social, marketing, and financial management requirements of community-based forest management projects are enormous. Most NGOs, which have strong community-organizing capabilities, must strengthen their capabilities in taking resource inventories, preparing management plans, harvesting methods, marketing, processing, and managing finances.

Under a 1989 DENR directive, part of the money from the sale of products extracted from residual forests should be invested in systems that provide forest dwellers with alternative livelihoods. These systems must not be dependent on forest resources. A key need is for investment in village nurseries that will supply perennial and timber seedlings to individuals on a sustained basis.

SUSTAINED-YIELD FORESTRY

Little is known about the ecology of dipterocarp forests. It is not possible to say with confidence that any selective cutting system will ensure the sustained development and harvest of dipterocarp wood. Therefore, maintenance of the remaining fragments of lowland and upland old-growth dipterocarp forests is of the highest priority. Much more research into the ecology and physiology of dipterocarp forests is essential if the remaining fragments are to be expanded into viable forests. Previous efforts to establish dipterocarp forests have generally failed, but there have been a few cases of dipterocarp forest survival on plantations (Department of Environment and Natural Resources, 1990). The factors that govern such successes need to be investigated more thoroughly.

LABOR-BASED TIMBER EXTRACTION

Some foresters argue that sustained-yield timber extraction is highly feasible when native-style logging exclusively is used by local communities (Dugan, 1989). The experience gained from the CVRP-1 Social Forestry Project lends strong support to this contention. Timber extraction is naturally limited by the lower technical efficiency of carabao (water buffalo) logging, but the economic efficiency and profitability for both local harvesters and sawmills is attractive as compared with mechanized logging. Mechanized logging is skewed toward once-over extraction of the 150-plus-year-old virgin trees, with a return harvest expected after some 30 to 100 years, assuming that forest destruction in the logging operation did not permanently disrupt the ability of the valued timber species to regenerate.

Indigenous logging methods emphasize repeated extraction of small amounts of timber and other forest products. These labor-based systems may allow an incremental annual extraction, determined on the basis of the annual accumulation of wood that can be harvested. This would provide continuous income from a limited tract of land and would be less destructive to the environment than capital- and machine-intensive systems. Employment in forest industries may quadruple if indigenous systems are adopted (P. C. Dugan, Department of Environment and Natural Resources, personal communication, 1990).

FOREST ENRICHMENT

As communities manage forests to achieve sustainable yields, there will be a tendency to extract the higher quality species, which will eventually lead to species impoverishment—a major concern. Enrichment planting of valuable timber species is a method that has been proposed to avoid impoverishment of economically valuable species in selectively or severely logged forests. There are virtually no data, however, to verify the effectiveness of enrichment techniques or to address the numerous practical questions that arise in their implementation. A strong research effort involving species establishment and ecologic studies in the field is urgently needed. Strategic research will need to be complemented with in-depth surveys of the methods of indigenous farmers and evaluations by participating farmers from multiple locations in forests representing wide ecologic gradients.

FUTURE IMPERATIVES FOR SUSTAINABLE UPLAND FARMING AND FORESTRY

The phenomenal depletion of natural resources in the Philippines reflects major deficiencies in the country's development efforts since its independence in 1946. The outstanding characteristics of the lack of development are the failure to create jobs and raise the living standards of the majority of Filipinos as well as the large inequalities in the distribution of wealth and access to financial and social resources. Therefore, a critical consideration in an assessment of future scenarios of forestry and agriculture in the Philippine upland ecosystem must include accurate prediction of trends in the political economy.

There is a no lack of detailed studies of the state of the Philippine environment or suggestions as to what should be done. Such studies include Dames and Moore International et al. (1989), Fay (1989), Porter and Ganapin (1988), World Bank (1989a), and the Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990). The major structural problem in the Philippines has been the inequality of income and wealth. Most observers agree that land reform in postwar Philippines has failed to reduce the power of the landed elites or to transfer substantial amounts of land to tillers. Implementation of the current agrarian reform program is clouded by similar doubts.

Another dominant structural problem is the failure of the industrial sector to provide new jobs at a rate fast enough to absorb the burgeoning labor pool. Upland agricultural and environmental problems cannot be solved as long as the mass of Filipinos are unemployed or underemployed and earn less than a subsistence wage. There must be a structural shift away from agriculture. The upland sustainability crisis is strongly interconnected with national political, economic, and ecologic stability. The strategy for attacking it must be bold, but it must be sensitive to the realities of these aspects.

Elements of a Strategy

There are three overarching elements to a comprehensive strategy for evolving sustainable land use systems in the Philippine uplands: tenure, technology, and delivery. Tenure encompasses human populations and their relationship to the land. Technology covers the technical solutions and the institutional capabilities to develop them. Delivery involves the mechanisms that government institutions and the private sector use to deliver the policy and various infrastructural supports to facilitate and guide the process of change.

TENURE: PEOPLE AND EMPOWERMENT

Reduce Population Growth Rates Any strategy to address the sustainable management of upland resources must include a reduction in the rate of population growth. This must be powered by a national consensus on the need for a vigorous population control program. National and international efforts could vigorously pursue that policy dialogue by supporting the call by a group of Filipino development specialists for a new national consensus on establishing the two-child family (Porter and Ganapin, 1988).

The poorest households in the rural uplands have the highest birth and mortality rates. Government must redirect health care programs to ensure that there are greater investments in village-level health and paramedical personnel, and family planning support and education should be an integral part of the effort. The cost and political risks from embarking on a vigorous population control program will necessitate strong and sustained international support. Demographic goals and an effective organization to meet those goals must be highlighted as a fundamental component of such support.

Reform Land Tenure to Reinforce Local Stewardship Future success in bringing sustainable land use to the uplands is fundamentally dependent on major changes in the ways that public lands are managed. The Philippine government has proved to be incapable of managing the country's land area. The area under direct central government control must be decreased rapidly. Although this is a declared intention of government policy, progress has been slow.

To harness the energies of upland populations in creating sustainable land use systems and to ensure the success of reforestation and forest remnant conservation efforts, the national government must establish a new political relationship with the upland population. It must recognize the boundaries of the lands held by the indigenous occupants and move to recognize their full ownership rights. The dominant issue is empowerment of the upland people so that they can have a secure stake in the land.

The Philippine Constitution restricts leaseholds on public lands to terms of 25 years, which are renewable for another 25 years. However, further definition of the terms of the lease is at DENR's administrative discretion. As of 1988, only 2.2 percent of publicly owned forestlands were placed under leasehold arrangements; thus, only a fraction of the upland farming population has been affected. The Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990) projects a large increase in leaseholds, but DENR has not allocated budgetary support and does not have the implementation capacity to effectively carry out an aggressive program.

In addition, the form of land tenure security in the Certificate of Stewardship Contract (CSC) now being issued will not be adequate to foster viable farm operations with the degree of land stewardship needed. The CSC must be amended to enable it to be transferable and so that farmers can use it as collateral to obtain credit. The transferability of the CSC should, however, apply only to actual land occupants, to avoid an eventual concentration of landholdings.

These provisions should be interpreted as the initial stages that will eventually lead to unrestricted land titles. They give the occupants time to demonstrate their capacity to develop a sustainable land management system. Complete title to the land would then become an incentive to practice conservation farming methods and to be a good steward of the land. Granting of immediate and unconditional titles to the land is not practical because of the immense administrative work load it would entail.

A comprehensive government response must be initiated to deal with the existence of tenancy in the uplands resulting from the land claims of pseudo-landlords. Although they are illegal, these claims result in nominal tax revenues for local governments, which otherwise have very limited sources of income. It is essential that local governments realize that the changes in land tenure in the uplands will be to their benefit through taxes, income, and social stability. Therefore, the national government must make provisions for local governments to receive alternative sources of income. The 1991 Local Government Code began the process of enabling local governments to obtain local tax revenue. Two additional mechanisms that can be implemented are the allocation of authority for local governments to levy modest taxes on individual leaseholds and to undertake contractual forestry activities on the public lands in their jurisdiction.

Recognize the Ancestral Rights of Indigenous Occupants There is a strong legal basis granting ownership rights to indigenous peoples who have historically inhabited the land (Lynch and Talbott, 1988). Recognition of these rights has so far been ignored by DENR, but we believe it is a crucial element in the sustainable management of upland resources. In general, the optimum mechanism by which these rights can be recognized is a community title. The precise instrument by which secure tenure should be granted, however, may have to vary somewhat for different communities. Direct titles to the land should immediately be given to indigenous communities that have strong and cohesive leadership, particularly in the autonomous regions in Muslim Mindanao and the Central Cordillera area of northern Luzon, which have legislative power over ancestral domains and natural resources.

Initially it is not necessary that all those with ancestral property rights receive titles that recognize those rights. The most immediate need is for the delineation of the ancestral domains by survey teams, so that a common basis of understanding exists between the national government and the communities (Lynch and Talbot, 1988) and so that communities can exercise effective control over their domains.

An important activity in developing an instrument of land tenure should be the formulation of a management plan than contains flexible but comprehensive mechanisms for allocating land among the inhabitants and for applying sound land management practices. As public land management is progressively privatized, it will be necessary to give local governments the authority to apply zoning restrictions so that they can control private land usage. These functions will strengthen local governments and overcome the strong objections from some quarters that the titling of public lands will lead to abuse of the land.

TECHNOLOGY: DEVELOPMENT AND DISSEMINATION

Research Upland Agriculture New technologies will be critical to the development of sustainable agriculture in the uplands, but the technologies being extended have not been proved in the diverse environments and for the variety of circumstances farmers face in the uplands. Two issues must be addressed: What will it take to make small-scale farming permanently sustainable? What will it take to improve fallow-rotation systems where they are still practiced?

Permanent small-scale upland farming systems are evolving in the sloping upland areas and are gradually replacing shifting cultivation. Acceleration of the trend toward permanent agricultural systems will fundamentally require simple, effective soil erosion control on open fields by use of vegetation barriers and residue management; mineral nutrient importation to balance the uptake of nutrients by crops and to stimulate greater biological nitrogen fixation; and diversification toward mixed farming systems that include perennials and ruminant animals, in addition to subsistence food crops. The technologies needed to meet these needs are known. Some fulfill multiple requirements (for example, trees in contour hedgerows may provide erosion control, fodder, and crop nutrients). But knowledge of how to adapt them to the wide array of diverse ecologic niches encountered by upland farmers is still inadequate. Much can be done now to take specific action to implement these concepts. The work must rely on farmer-participatory experimentation to refine specific solutions for local conditions.

The major innovation for farming on sloping lands has been the sloping agricultural land technology (SALT) that uses hedgerows of leguminous trees. A serious constraint of SALT is its high labor requirement. On acidic soils, there are questions concerning negative crop-hedgerow interactions. A major extension problem is the lack of hedgerow planting materials of forages, multipurpose trees, and perennial crops.

Because of the limitations of trees and introduced forage grasses in hedgerows, serious efforts should be invested in the refinement and dissemination of simpler methods, including natural vegetative filter strips. The advantages of natural vegetative filter strips are their simplicity of installation, their low labor requirements, and their excellent erosion control and terrace formation capabilities. They also provide a good foundation for soil conservation efforts, so that farmers may subsequently diversify into more labor-intensive hedgerow enterprises, including those that grow perennials, leguminous trees, and improved forages.

The importation of mineral nutrients will be essential to the development of sustainable food crop production on permanent farms in the uplands. Because the majority of soils are strongly acidic, phosphorus is usually the most limiting nutrient, and lime application is often necessary to lower the soil's acidity and alleviate aluminum toxicity. Programs that help upland farmers reduce soil degradation should also consider how to provide supplies of phosphorus and lime at the most favorable prices and provide instruction as to their most efficient use. Nitrogen fertilizer is an important tool that can be used to familiarize lowland rice farmers with nutrient use and bolster national rice sufficiency.

In areas that use fallow rotation systems, there is hope for improved fallow management if fire can be controlled. The use of trees planted in fallow fields has been demonstrated successfully in systems without animal labor. Little research has been directed to the agronomics of trees in fallow fields. In systems that use animal labor, forage legumes have been tested as an alternative to natural *Imperata cylindrica* infestation, but their effects are poorly documented. Much more research will be needed to refine the agronomic practices used in managed fallows in different environments.

Other top research priorities for sloping lands involve the development of appropriate small-scale mixed farming systems, such as those that include animal, perennial, and tree production, to gradually reduce reliance on food crops. Systems research will be essential for making more rapid progress in diversifying small-scale upland farms. Many NGOs are active in promoting sustainable low-input agricultural systems in the Philippines (Garcia-Padilla, 1990) and will play an important role in adapting solutions to specific local conditions.

Integrate Livestock into Upland Farming Systems There must be greater emphasis on ruminant livestock in achieving sustainability in mixed farming systems. Most hedgerow systems supply the farm with increased quantities of legumes or grass forage. Hedgerow farming enables larger livestock populations and contributes to alleviating the deficit in ruminant meat production.

There is an opportunity for greater investment in NGO-operated programs to distribute ruminants (cattle, goats, and sheep) to small-scale upland farmers for cut-and-carry production systems. Animals would be distributed to farmers who have succeeded in installing hedgerows that contribute to conservation practices. The incentive would popularize the use of contour hedgerows and make it economically attractive to practice conservation. Farmers would receive parent animals and then retain female animal offspring, returning the parent animals so that the program rolls over and expands. International donors may also find such a program to be a sound investment, if it is well managed.

Reorient Forestry Research and Development Forestry in the Philippines will change dramatically in the next 20 years. The extraction of high-value timber from old-growth dipterocarp forests will disappear as the few remaining forests vanish or become protected. The reorientation of forestry to the development of sustainable management systems for secondary forests should begin in earnest. Interest in rehabilitating degraded forests will grow as the real value of timber rises. Tree plantations and farm forestry can then become viable income-producing activities.

Management systems in forestry must be drastically altered, but the technical knowledge base to support these changes is extremely weak. Research on both technical solutions and management systems must be accelerated to provide a sound basis for new directions. Major research efforts will be needed in the following areas: the ecology and management of dipterocarp forests for sustained production, community-oriented forest management, restoration systems for degraded secondary forests, the ecology and management of fire, the impact of policy changes on the supply of wood, and plantation and farm forestry issues. The research must be strongly oriented to the social as well as biologic sciences and requires a systems approach. The development of joint international collaboration will be important to the acceleration of forestry research.

Develop a Research Methodology It is at the interface between forestry and farming that the major future research and development challenges will be encountered (Figure 6). The forestry sector must engage in forestry for the benefit of the land and the people, and the agricultural sector must do the same, thereby creating sustainable upland farming and forestry. An understanding of the constraints and solutions is needed before upland farming populations and government can become effective partners in conserving, managing, and replanting forests while meeting basic subsistence food production needs. Teamwork is essential.

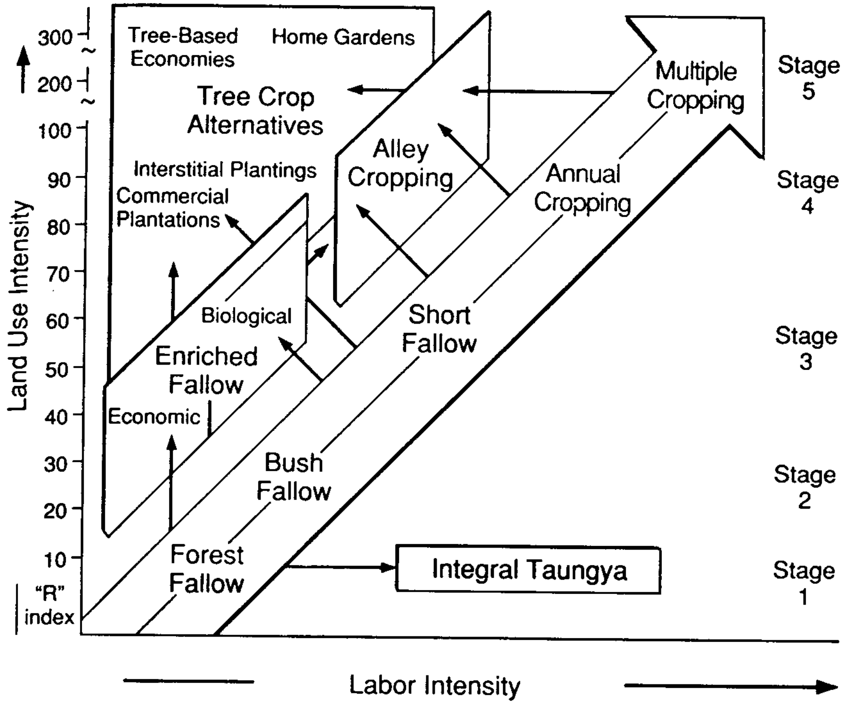

FIGURE 6 Evolution of a more integrated approach to sustainable land use in sloping uplands.

Farming systems research evolved as a framework for a more comprehensive, multidisciplinary attack on the complex constraints in agroecosystems (Harrington et al., 1989). Ecosystem-based research should be targeted to the broader continuum that includes forest management and agriculture. Such work needs a methodology that provides foresters and agriculturalists a common framework within which to interact.

Hart and Sands (1991) have proposed a sustainable land use-systems research strategy based on a farming systems approach that may provide a starting point. It applies a farming systems perspective to the land use system, targeting the land management unit within the context of its biophysical and socioeconomic environments and emphasizes the ecosystem as the starting point of problem analysis and research design (Figure 7).

The watershed is the natural unit on which to base a systems research effort because of the interconnected nature of all land uses

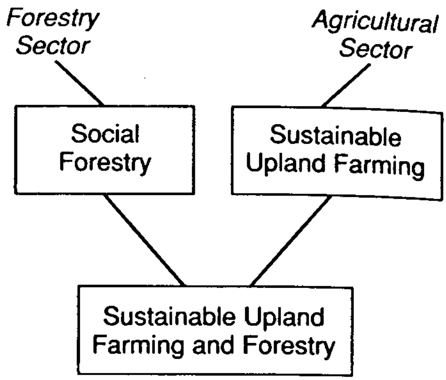

FIGURE 7 A research and development process that could be used by a multidisciplinary team as a guide in the development of an appropriate sustainable land use systems research framework. Source: Hart, R. D., and M. W. Sands. 1991. Sustainable land use systems research. In Sustainable Land Use Systems Research, R. D. Hart and M. W. Sands, eds. Kutztown, Pa.: Rodale Institute.

within a water catchment area, particularly the interplay between uplands and lowlands. The most technically and economically efficient approach would focus on site-specific conservation-oriented farming and forestry technologies. The watershed framework ensures that the social, economic, and political linkages between upstream and downstream lands are not neglected in the analyses (Magrath and Doolette, 1990).

Institutional mechanisms and project structures need to be evolved to make it feasible for the forestry and agricultural sectors to jointly participate in common research and extension work. Professionals in both sectors—long separated by administrative barriers and divergent academic traditions—need to recognize the improved research that can be the result of working together. International donors can assist in generating research opportunities; for example, the Ford Foundation has provided support to a team of foresters and agriculturalists at Central Mindanao University to develop methods of farmer participation in generating practical solutions for sustainable hillside cultivation (Pava et al., 1990).

Colleges of agriculture and forestry need to be encouraged to set up joint academic and research programs targeted to upland ecosystems. The recent initiation of the Committee on Agroforestry at the University of the Philippines, Los Baños, is a step in this direction (R. del Castillo, Agroforestry Program, University of the Philippines, Los Baños, personal communication, 1990). Mechanisms for research collaboration between professionals in DENR and the Department of Agriculture are urgently needed. These may be fostered by an expansion in scope and the participation of the Upland Working Group of DENR (Gibbs et al., 1990). Explicit linkages between the Ecosystems Research and Development Bureau of DENR and the Department of Agriculture's research programs, particularly key community-based forestry and contract reforestation projects, would generate a greater focus on the constraints to using various land use systems in deforested areas. The Philippine Council for Agricultural and Resources Research and Development, which has responsibility for approving and encouraging both agriculture and forestry research, will play a central role in expanding resource management-oriented research.

The Philippines needs a more definitive network of on-farm (field) laboratories in carefully selected watersheds where multidisciplinary research and development teams can focus their efforts. These field laboratories need sustained support with a budget structure that keeps team members working together. These sites would be linked to the less intensive applied research and extension programs carried out by NGOs and government departments. Research should be particularly sensitive to the use of techniques that enhance participatory approaches to rural development, drawing strongly on the technical knowledge of indigenous people in all phases of research (S. Fujisaka, Social Science Division, International Rice Research Institute, Los Baños, Philippines, personal communication, 1989).

Support International Research The complex upland sustainability issues faced by the Philippines are common to most countries in Southeast Asia. Because the problems transcend national boundaries, stronger international mechanisms that provide efficient research and development support to the respective nations are needed. A number of institutions and networks are involved with upland resource management (Garrity and Sajise, 1991), including the Southeast Asian Universities Agroecosystems Network, the Asian Rice Farming Systems Network, the International Board for Soils Research and Management (IBSRAM) Sloping Lands Network, and the Multipurpose Tree Species (MPTS) Network.

The major challenge is to evolve new institutional arrangements that direct research toward the upland ecosystem as a totality. A focus on the Southeast Asian upland ecosystem does not fall within the mandate of any of the Consultative Group on International Agricultural Research (CGIAR). But there are major CGIAR initiatives in forestry (Center for International Forestry Research) and agroforestry (the Southeast Asian regional program of the International Centre for Agroforestry Research). Nevertheless, there remains concern that such efforts may address only components of the upland ecosystem, whereas the key to eventual success lies in coping with the interrelatedness of the problems across sectors and in developing the capacity to strengthen each country's research and development institutions to conceptualize, plan, and implement interventions that are appropriate to each ecosystem. This will require a novel upland ecosystem-based approach to international research. The evolving concept of ecoregional research (Consultative Group on International Agricultural Research, Technical Advisory Committee, 1991), under which a consortium of international centers is planning a joint long-term effort to develop alternatives to shifting (slash-and-burn) agricultural systems, represents a promising mechanism for providing this leadership.

DELIVERY: INSTITUTIONAL CHANGE, PROGRAMS, AND POLICY

Implement Institutional Changes DENR has recognized that its future role will be primarily in development, replacing its historical role as a regulatory agency. It acknowledges that development and management of production forests and plantation forestry are the domain of the private sector and that it should support and guide this transition (Department of Environment and Natural Resources, 1990). Such a role will require a fundamental restructuring of DENR's administration, policy framework, and staff technical capabilities and attitudes. The recent enactment of the Local Government Code requires the transfer of many DENR functions to local government units, decentralizing resource management and giving much greater authority to local leaders.

The redirection of DENR must specifically include a systematic strengthening of forestry policy and planning capabilities, for which there is substantial support expected from international donors. Operations will need to be further decentralized, with much greater accountability and resources at the local level.

DENR has consistently claimed exclusive control over public forestlands, 55 percent of the land area of the country. However, the majority of that land is devoted to agricultural pursuits, not forestry. The development of sustainable upland agricultural systems is a task for which the Department of Agriculture has a much stronger capability. DENR should recognize the potential role of the Department of Agriculture in providing agricultural and agroforestry research and extension services. Within the past several years, the Department of Agriculture has reoriented its priorities to give much greater attention to upland agriculture. A much greater level of support for upland technology development and extension is required to widen this role.

Vigorously Implement the Master Plan for Forestry Development The Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990) marks a fundamental turning point in the philosophy and methodology of forest management in the Philippines. It provides a basis for a range of reforms and restructuring that is essential to future forest preservation and sustainable land use systems. The master plan contains unrealistically optimistic projections for trends in forest cover, but it provides a framework for the kind of comprehensive, directed effort that is necessary.

Enforce Timber Pricing Reform and Logging Ban New fees for timber cutting based on recent legislation have been increased to 25 percent of the actual market price (for example, for logs with a price of P2,000 [US$80.00] per cubic meter, the fee is P500 [US$20.00]). It remains to be seen how effective the government will be in collecting the increased fees and using them to increase forest protection and management expenditures.

A major national debate on a total logging ban occurred in 1991. DENR directives in 1991 instituted a ban in old-growth dipterocarp forests. Logging in secondary-growth forests was restricted to lands with slopes of less than 50 percent and land less than 1,000 m above sea level. Enforcement of these policies will be impossible, however, unless greater investments in enforcement procedures are made and forest occupants are directly involved in forest preservation through limited use of the forests. An integrated protected area system for the conservation of the most important natural habitats is under development. NGOs are seen to be the key to the successful implementation of this effort. They will assume responsibility for the management of national parks, wildlife refuges, and other wild lands.

Give Priority to People-Oriented Forestry Now that regulation of the forests by the national government has been acknowledged to be inadequate, forest protection through empowerment of people and their communities is officially accepted as the only workable model. Implementation of a successful community forestry program will be an immense organizational task that will require a strong commitment by the forest occupants and upland farmers. Capable NGOs will be a key to the program. If further conversion of forests to agricultural uses is blocked through effective community enforcement and shifting cultivation is to decline, there must be agricultural innovation to maintain viable farming systems on the lands surrounding the forests. The equitable capture of income from the limited harvest of forest products will be crucial to financing this transition.

The implementation of current policy will turn the primary responsibilities for forest protection, tree production, and land conservation over to upland communities, NGOs, and individuals. This grass roots approach will open a new era in the management of the uplands. However, it may not be any more effective in forest conservation than a top-down approach unless local management entities receive appropriate support to develop the complex skills needed to guide their efforts. Community-based organizations will require professional guidance to achieve even minimal management capabilities.

NGOs will be involved in implementing many of the new people-oriented forestry programs. They are working as partners with DENR in contracting reforestation and community forest management projects. Eventually, they might form local environment and natural resource centers that would assist the national government in training and on-farm research. Only a few NGOs are competent to handle community-based resource management on a large scale. A major priority of national and international support must be to strengthen NGOs.

The Timber License Agreements (TLAs), by which logging rights are allocated, need thorough reform. Long-term security is essential to engendering a sustainable management perspective among private forest managers. The national government, however, has the tendency to cancel leases on areas peremptorily, sometimes without due process. Many TLA holders continually fear the cancellation of their leases as political circumstances change, with the consequent loss of their fixed investments in processing plants, infrastructure, and forest development in their areas. Moreover, the total 50-year lease period (an initial 25 years that is renewable for another 25 years) does not provide sufficient time for responsible firms to practice sustained forest management. Dipterocarp forests require at least 30 to 40 years for each cutting cycle, and cutting cycles are often much longer. To overcome the destructive short-term perspective, longer lease periods will be necessary. However, these will be accompanied by much stricter enforcement of sustainable forestry practices, making the threat of cancellation solely contingent on quantifiable performance standards. TLAs will be given to only a few firms that demonstrate a people-oriented management focus.

Coordinate International Donor Imperatives Foreign assistance has been critical in all facets of the change toward people-oriented forestry and forest policy reform that has emerged in the Philippines in the recent past. The Ford Foundation's sustained support for research on social forestry developed the knowledge and institutional base for government to test the concept. Innovative projects supported by the U.S. Agency for International Development (particularly the Rainfed Resources Development Project) and the World Bank enabled new models of upland management to be implemented on a trial basis. Because the administrative and policy environment has shifted in a favorable direction, international aid to ensure the success of new models will be even more crucial.

The overall effort needs a comprehensive blueprint for sustainable upland management. The Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990) is an important step in this direction. A coordinated donor approach to upland development could assist in rationalizing the priorities and ensuring that the effort is comprehensive and consistent. The redirection of programs within DENR and the Department of Agriculture will place tremendous pressure on their limited staffs and resources. It is essential that staff supported by international projects be equally distributed among programs managed by the departments. However, project aid should be contingent on identifiable progress made by the national government in implementing policy and institutional change over a set period of time. NGOs are envisioned to assume a vastly greater role in upland development.

Deforestation Scenarios

The Master Plan for Forestry Development (Department of Environment and Natural Resources, 1990) is an appropriate starting point for anticipating future land use scenarios in the Philippine uplands. The plan recognizes the limitations of past forestry management and attempts to formulate a macrolevel plan to change the nature of the forestry sector. Specifically (Department of Environment and Natural Resources, 1990:60),

> the forestry sector of the country will be directed in the long run towards a condition whereby all of the forest resources will be under efficient and equitable management, conservation, and utilization, satisfying in appropriate ways and on a sustainable basis the needs of the people for forest-based commodities and services.

The master plan presents three scenarios to the year 2015 based on (1) a continuation of the status quo, (2) the implementation of a total logging ban, and (3) the implementation of the master plan. If implemented, the master plan would provide for extensive reforestation, continued logging of secondary forests on a commercial scale, and an aggressive integrated social forestry program. The estimated increase in total protection and production forests would be from 6.693 million ha in 1990 to 8.422 million ha in 2015.

Several major shortcomings of the plan have led to overly optimistic projections. The master plan states that total forest cover in 1990 was 6.694 million ha; however, the Philippine–German Forest Resources Inventory Project (Forest Management Bureau, 1988) concluded that forest cover in 1988 was only 6.461 million ha. The master plan may have started with a larger forest base than is justified.

The master plan assumed a deforestation rate of 88,000 ha/year in 1990. The Philippine–German Forest Resources Inventory Project (Forest Management Bureau, 1988) determined the deforestation rate to have been 210,300 ha/year between 1969 and 1988 and suggested a rate of about 130,000 ha/year in 1987–1988. Kummer (1990) calculated the rate to have been 157,000 ha/year from 1980 to 1987. It is likely that the current deforestation rate is significantly greater than the master plan's assumption.

The master plan indicates that reforestation increased from 40,000 ha in 1987 to 131,000 ha in 1989. Such a rapid increase appears optimistic, considering the actual maximum plantation survival rates of 50 to 70 percent. The sustainability of such rates is also uncertain. The master plan also assumes that secondary forests can be managed effectively to achieve sustained yields. Little evidence is available to support this, particularly the expectation that selectively logged forests can be returned to their full stocks in 20 to 40 years.

Overall, the master plan does not adequately address the numerous constraints that may limit its success. Given the past failure of Philippine forest management, the current political and economic uncertainties, and the sustained commitment of personnel and resources that is necessary, the master plan appears to be overly optimistic, even if one were to assume a best-case scenario.

Table 10 presents three scenarios of projected trends in the natural forest cover of the Philippines. These estimates were constructed to envelop the range of forested areas that may be expected. The baseline scenario assumes a current rate of forest loss of 125,000 ha/year that gradually decreases to 25,000 ha/year by 2015. It assumes that it will be about a decade before there is an effective capability to enforce policies that limit either old-growth or secondary forest loss and that a moderate rate of reforestation (75,000 ha/year) will begin to significantly reduce the pressure on the natural forest after 2000.

The worst-case scenario assumes that the political and economic fortunes of the Philippines will deteriorate during the 1990s. Reforestation rates would decline to 25,000 ha/year (Table 11). Natural forest cover loss would continue to exceed 100,000 ha/year into the first decade of the twenty-first century because of the lack of enforcement capability and political uncertainty. The natural forest cover would be reduced to 3.32 million ha by 2015.

TABLE 10 Scenarios of Natural Forest Cover in the Philippines, 1990–2015

Scenario and Year	Average Forest Loss Per Year (ha)	End of Period Forest (ha)	Annual Loss of Forest Cover (percent)[a]	Cumulative Loss of Forest Cover (percent)[a]
Baseline				
1990–1995	125,000	5,575,000	2.20	11
1995–2000	100,000	5,075,000	1.80	20
2000–2005	75,000	4,700,000	1.60	27
2005–2010	50,000	4,450,000	1.00	32
2010–2015	25,000	4,125,000	0.40	36
Worst case				
1990–1995	125,000	5,575,000	2.20	11
1995–2000	125,000	4,950,000	2.40	22
2000–2005	125,000	4,325,000	2.60	36
2005–2010	100,000	3,822,500	2.40	46
2010–2015	100,000	3,325,000	2.80	59
Best case				
1990–1995	100,000	5,700,000	1.60	8
1995–2000	75,000	5,325,000	1.40	15
2000–2005	50,000	5,075,000	1.00	20
2005–2010	25,000	4,950,000	0.40	22
2010–2015	10,000	4,900,000	0.20	23

NOTE: These scenarios are for all natural forests. They do not include plantations, and no attempt was made to provide detail on specific forest types. The total land area of the Philippines is approximately 30 million ha.

[a]Percent rates of change are calculated by dividing the absolute loss of forest cover by the average forest cover for the period in question; that is, the denominator is determined by adding forest cover at the beginning and end of the period and dividing by two.

TABLE 11 Alternative Reforestation Scenarios of Natural and Plantation Forests in the Philippines, 1990–2015 (Hectares)

	Baseline		Worst Case		Best Case	
Year	Ref	Def	Ref	Def	Ref	Def
1990	75,000	125,000	25,000	125,000	100,000	125,000
1995	75,000	100,000	25,000	125,000	100,000	75,000
2000	75,000	75,000	25,000	125,000	100,000	50,000
2005	75,000	50,000	25,000	100,000	100,000	25,000
2010	75,000	20,000	25,000	100,000	100,000	10,000
1990–2015	1,875,000	1,875,000	625,000	2,877,500	2,500,000	1,425,000

NOTE: Ref, net reforestation (area is established and viable); Def, net deforestation (net loss of natural forest cover).

TABLE 12 Estimates of Forest Cover in 2015 Based on Three Scenarios (in Hectares)

Forest Type	Baseline	Worst Case	Best Case	Master Plan
Natural	4,125,000	3,325,000	4,900,000	5,400,000
Plantation	2,275,000	1,025,000	2,900,000	3,000,000
Total	6,400,000	4,350,000	7,800,000	8,400,000

In the best case scenario, it is assumed that the master plan will be largely successful. Substantial annual reforestation (100,000 ha/year) will occur, and deforestation will drop to negligible levels by 2015. The natural forest cover at that time would be 4.90 million ha. This compares with the 5.40 million ha estimated to result from full implementation of the master plan (Table 12). The master plan assumes a confluence of numerous optimistic assumptions in limiting natural forest losses, for which the cumulative probability is low. However, the two scenarios provide similar estimates for the area of coverage achieved in forest plantations by the year 2015 (2.90 million versus 3.00 million ha), up from less than 0.50 million ha in 1991. The Philippines will be highly dependent on the successful expansion of plantation forestry to avoid the complete loss of natural forest cover.

SUMMARY

The next 30 years will be a crucial period for the Philippines. Recognition is dawning that many aspects of life will be changed. The land frontier that had always existed as a safety valve for poor and dispossessed people has disappeared during the present generation. The forest resources that had seemed virtually inexhaustible were expended in a prodigal manner. Yet, the population that relies on extractable resources from the uplands is growing as rapidly as ever. The ecologic balance has been lost, and national awareness of the dire implications of this loss is only beginning to emerge. It is difficult for a country to learn how to cope with circumstances in which all of the old assumptions are overturned. Such a serious crisis, however, also offers opportunities to take bolder steps than would be politically feasible in better times. It will be a period in which the willingness to experiment with new solutions will grow.

What is the desired vision of the state of the uplands in 2015 emerging from the current national debate? It is one of a much denser upland population than was previously anticipated. However, uplanders will be involved in managing forestlands and farmlands in novel ways. Families that occupy upland farms will have a form of secure land tenure by which they can gain credit to intensify and diversify their farming systems. Perennial and tree cropping systems will be common enterprises and will be integrated with livestock and food crop production. Cropping systems will use improved cultivars along with soil fertility-enhancing fertilizer and lime amendments and will be practiced on slopes that are naturally terraced with vegetative barriers. The structural transformation of the national economy will have occurred, and the population of the rural uplands will gradually have begun to decline.

In 2015, large areas of degraded grasslands will be managed as farm forests planted by individuals and communities under secure land tenure agreements. The natural production forests will be managed by local communities—with guidance from professional foresters—by using low-disturbance logging methods with animal labor. Indigenous communities will have secure control of their ancestral lands. The preservation forests and protected areas will be managed by communities and NGOs in collaboration with the national government. Much of the Philippines' remaining biodiversity will have been lost in this period, but protection will have stabilized some of the most representative habitats.

Such a picture of the future of the uplands may be overly optimistic. It embodies landmark changes in philosophy and policy that are now accepted by the national government and some that are already part of existing programs. The critical concern, however, is whether the political will and the management capacity can be developed to thoroughly implement the changes. During the years between now and then, judicious international assistance in research, training, policy, and financing will be critical.

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