Reproduced, with permission, from: Myers, N. 1980. Conversion of tropical moist forests: A report prepared for the Committee on Research Priorities in Tropical Biology of the National Research Council. Washington, D.C.: National Academy of Sciences.

Role of Forest Farmers in Conversion of Tropical Moist Forests

By far the most important factor in conversion of tropical moist forests (TMF) appears to be the forest farmer. Of the various forms of forestland agriculture, the main ones are shifting cultivation of traditional style, smallholder agriculture of more recent style, and sundry types of squatter colonization. Shifting cultivation can likewise be categorized into variations in accord with local environmental factors in each of the three main TMF regions.

A characteristic common to all forms of forest farming is that the farmer clears a patch of forest of virtually all its trees, and then usually burns the wood (locally the larger logs may be sold). Hence a generic term for forest farming could be slash-and-burn cultivation--a term that is frequently though erroneously used in the limited sense of shifting cultivation.

Forest farming has been an established practice in TMF for millennia, almost entirely in the form of shifting cultivation as popularly understood. Indeed, shifting cultivation can be characterized as one of the major agricultural systems of the world. Widespread though it has been, shifting cultivation has not generally resulted in long-term elimination of forests. For example, Southeast Asia has featured shifting cultivation for at least 2,000 years, which indicates that the system is an essentially sound mode of utilizing forest environments within traditional patterns. Farmers would follow a locally migratory way of life by virtue of rotational agriculture: felling and burning a patch of forest, raising crops for 2 or 3 years until the soil lost its fertility or until weeds encroached, then moving on to repeat the process in another patch of forest, eventually returning to the original location. This proved an agricultural strategy that allowed the cultivator to make sustainable use of the forest environment. As long as there were only a few cultivators per square kilometer, generally five or less (depending on local circumstances), and provided the patch of farmed forestland could be left fallow for at least 10 years in order to renew itself, the system worked. Indeed shifting cultivation has proved highly adaptive to a broad spectrum of conditions; when applied with an understanding of the forest's capabilities and limitations--an understanding that seems to have characterized shifting--cultivator communities of many different cultures--the system appears to have been a practical and successful way of utilizing land where poor soils, steep gradients, and heavy rainfall make conventional farming methods unproductive or impossible. (For further details, see Clarke, 1976; Conklin, 1963; Denevan, 1976, 1977, 1978; Greenland, 1975; Greenland and Herrera, 1977; Hauck, 1974; Kunstadter *et al*., 1978; Nations and Nigh, 1978; Sanchez, 1976; Watters, 1971.) Now, however, in many areas, the numbers of shifting cultivators have increased to a point where there are often 3 or

more times as many people per square kilometer as formerly, with the result that they have less space for local migration. The upshot is that they tend to make intensive as well as extensive demands on forest environments, allowing local ecosystems insufficient time to recover. Soils then rapidly become exhausted, and especially in wetter areas, weeds encroach. After as few as two cycles, the cultivator is obliged to abandon the area altogether, and move on to start afresh in a new patch of primary forest, hence progressively disrupting undisturbed TMF. This 2,000-year-old phenomenon is rapidly disrupting very extensive tracts of hitherto undisturbed forest.

In addition, these traditional farmers are now being joined by large communities of subsistence peasants, who, due to lack of land elsewhere, are moving into forests where they adopt a slash-and-burn style of agriculture that leaves even less scope for forest regeneration. These recent arrivals, possessing little cultural adaptation to forest environments, tend to advance upon the natural forest in waves: They operate as "pioneer fronts" pushing ever deeper into forest tracts, leaving behind them a mosaic of degraded croplands and brush growth where there is no prospect of a natural forest reestablishing itself even in impoverished secondary form. In Peru, for example, the process has been graphically described in the following terms: "The populations overflowing from the [Andes] mountains down to the Amazon plains do not settle there, but advance like a slow burning fire, concentrating along a narrow margin between the land they are destroying and are about to leave behind, and the forests lying ahead of them" (Dourojeanni, 1975).

All in all, these forest farmers have been estimated in the mid- 1970s to total at least 140 million, occupying some 2 million km[2] (or over one-fifth) of the TMF biome (King and Chandler, 1978; Myers, 1979; Persson, 1975, 1977; Sommer, 1976; Schulte, in press). According to preliminary reckonings, they are believed to eliminate at least 100,000 km[2] of forest each year. The greatest loss occurs in Southeast Asia, where farmers clear a minimum of 85,000 km[2] each year (some of which are allowed to regenerate), adding to 1.2 million km[2] of formerly forested croplands in the region (Chandrasekharan, 1978; Kartawinata, 1975). Tropical Africa is believed to have lost 1 million km[2] of moist forest to these cultivators before the arrival of modern development patterns in the last quarter century; of Africa's present TMF expanse, as much as 400,000 km[2] may now be under this form of agriculture, with a current loss of forest estimated at 40.000 km[2] per year (Aubreville, 1947; Braun, 1974; Hauck, 1974; Persson. 1977; Sommer, 1976). A similar story applies in Latin America, though fewer details are available (Denevan, 1977; Watters, 1971).

How reliable are these estimates? Of all aspects of this survey, this may be the most difficult to evaluate. It is possible, however, to make a comparative assessment by approaching the problem from a different direction. There is reason to believe that the estimation of 140 million forest farmers represents a minimum number. At an average size of seven persons per family (a roughly acceptable figure for Central America, Colombia, Indonesia, the Philippines, and Thailand), this means there are some 20 million families. If each family clears one additional hectare each year, as seems to be minimal practice, the forest farmers are clearing some 200,000 km[2] of forest each year. True, many of these farmers exploit secondary forests; and in certain sectors of primary forest, *e.g.*, in Central Africa, population densities are still low enough to permit the forest to be used, while sustaining its quality and composition with prospect of eventual regeneration of primary vegetation. But so far as the author can determine, it is not

unrealistic to suppose that forest farmers are converting at least 100,000 km[2] of primary forest to permanent cultivation each year.

In short, the factor of forest farming could well be accounting for over 1 percent of the TMF biome each year. When considered in conjunction with other factors--timber harvesting, planned agriculture, cattle raising, etc.--it becomes possible to credit that something approaching 200,000 km[2] of TMF, and possibly even more, are being converted each year. In turn, this throws light on the popular estimate of 20 ha disappearing per minute, equivalent to only 105,000 km[2] per year; the estimate offered by the Director-General of FAO, Edouard Saouma (at the Eighth World Forestry Congress, October 1978), of 40 ha per minute, equivalent to 210,000 km[2] per year; and the author's estimate advanced in an earlier assessment (Myers, 1979), based on far less detailed documentation and analysis, of 45 ha disappearing per minute, or almost 240,000 km[2] per year.

What impact are forest farmers likely to have on TMF within the foreseeable future? Here it is important to recall that population growth rates in many countries of the TMF biome are among the highest on earth. Certain countries (Table 1) already possess large populations in relation to available cultivable land--these generally being countries where the problem of forest farmers is most pronounced, *viz.*, Brazil, Colombia, Indonesia, Kenya, Madagascar, Malaysia (peninsular), Peru, the Philippines, Thailand, Uganda, Vietnam, and all countries of West Africa and of Middle America. Thus it is scarcely surprising that a number of countries are promoting transmigration and settlement programs for their TMF zones, *e.g.*, Brazil, Colombia, Indonesia, and Peru. Unless large-population countries proceed faster than hitherto with economic development that provides opportunities other than forest farming for landless people to make a living, it is possible that the numbers of forest farmers will grow at a rate faster than that of the overall populations. In other words, population growth in the countries in question is projected to produce an increase of 60-65 percent by the year 2000, but the number of forest farmers could double or increase even further.

Let us look at three countries to see how the prospect could work out in detail. Indonesia now contains over 140 million people, 82 percent of them rural; two-thirds of the total populace are concentrated in Java, where they are exerting unsustainable pressures on the island's life support systems, thus prompting the government to mount its transmigration program to shift millions of families to the outer islands. Despite an unusually successful birth control campaign, Indonesia's population is projected to reach 226 million by the year 2000--with all that could entail for the country's remaining forests. Because of the young profile of its population pyramid (meaning that an exceptionally large proportion of future parents have already been born), Indonesia may not achieve a stationary population until the year 2165, with a populace of 330 million. Similarly, Brazil, with a present total of 118.3 million (though only 40 percent rural), is projected to reach 205 million by the end of the century, and 353 million by the time it reaches a stationary population in the year 2070. Finally, the Ivory Coast. with a present population of rather over 7 million (80 percent rural), is projected to grow to 13.2-14.0 million by the end of the century, and to reach 41 million with a stationary population in the year 2135. Unless a substantial proportion of these expanding populations can eventually be concentrated in urban areas--probably only possible, with a basically acceptable level of living standards, through widespread modernization of their economies, especially via manufacturing--it is not difficult to visualize the

impact that these huge throngs of agriculture-supported people are likely to have on remaining tracts of TMF unless their disruptive forms of farming can be modified.

A key suggestion thus arises. How can nonsustainable use of forest environments, as presently practiced by many forest farmers, be transformed into sustainable use? Alternatively stated, how can an extensive and wasteful pattern of agriculture be turned into an intensive and established form? There are various ways to step up the productivity of the forest farmer's croplands. and thereby reduce his incentive to move into fresh patches of forest every few years (Clarke, 1976; Dickenson, 1972; Greenland, 1975; Greenland and Herrera, 1977; Grigg, 1974; Janzen, 1973; Nations and Nigh. 1978, Ruthenberg, 1976; Sanchez, 1976; Seavoy, 1973). Research already indicates that shifting cultivation can be made much more intensive and efficient. Traditional farmers in West African forestlands usually achieve no more than 100 kg/ha of maize, whereas modern farmers in the same region produce many times as much (Pearson and Pryor, 1978). True, modern farming often requires a number of commercial inputs, such as fertilizer, pesticides, and high-yielding hybrid grain. But the fertilizer need could be partially met, although at much lower levels, through greater use of legumes by forest farmers; although if such crops are used as green manure, they yield no food and must be plowed under--an expensive process in a clearing in which the fertility of the soil is deteriorating and the weeds are increasing rapidly. Rice paddies are being enriched in south China by the cultivation of the water fern *Azolla* with its symbiotic blue-green algae, and this practice, although limited in the amount of nitrogen that can be provided, could well be useful elsewhere (Wittwer, 1978). In addition, a broad range of food crops can be grown, making more selective and integrated use of the forest environment. For example, Chinese farmers in western Borneo raise food grains, pepper, rubber, and a dozen sorts of vegetables, and intersperse them with fishponds and livestock grazing--a system that enables them to make permanent use of impoverished tropical soils. without need to move on every few years. The Lua of northern Thailand grow at least 120 different crops, including 75 food crops, 21 medicinal crops, 20 plants for ceremonial or decorative purposes, and 7 for weaving and dyes--thus achieving a partial mimicry of the diversity of natural forests (Kunstadter *et al*., 1978). Similarly, Lancandón farmers in the forest of the state of Chiapas in southern Mexico grow as many as 80 varieties of food and raw material crops in a single hectare, and exploit the surrounding forest environment for up to 100 species of fruits and other wild foods, 20 varieties of fish, 6 types of turtles, 3 kinds of frogs, 2 types of snails, 2 species of crabs, 2 species of crocodiles, and 3 kinds of crayfish (Nations and Nigh, 1978).

In addition, there is now being developed a basically innovative strategy to provide alternatives for forest farmers: agroforestry. This approach persuades the peasant farmer to seek a livelihood off cleared forestlands, or at least to remain within secondary forest zones, by encouraging him to plant trees rather than cut them down. In practical terms, agroforestry depends on offering the cultivor incentives to establish a patch of fast-growing trees on his holding at the same time as he plants his food crops (Bene *et al*., 1977; Budowski, 1977, 1978; Douglas and Hart, 1976; King, 1968; King and Chandler, 1978; Lugod, 1975; Pollisco, 1975; Valena, 1974; Wirakuswerah, 1979). By the time the cultivator is ready to move on, the newly planted trees will be about ready to close their canopy. The tree plantation itself is intercropped with food plants such as maize and bananas, and with coffee, tea, spices, fruit trees, and many other items. Trial projects now feature tall-growing timber or pulp trees, medium-height cash crops such as coffee, low-growing

food crops such as manioc, and fish and giant snails in water channels. Thus food growing can be combined with reforestation of forest cover.

Field experience shows that agroforestry can be financially beneficial to both cultivators and foresters. In eastern Nigeria, a cultivator can earn $200-300 from the trees he plants, while the forestry sector finds that the plantation established through agroforestry costs only $200-300/ha compared with $800 through direct planting--the Forest Service has saved $5.7 million on 11,000 ha planted in this way (Van Nao, 1978). If the cultivators use these earnings to buy fertilizer and pesticides, they can then grow 4 times as much maize, cassava, yams, and other food crops (Grinnell, 1975). A more extended form of agroforestry is being attempted in Thailand, where cultivators are being encouraged to grow rubber. The Forest Industry Organization offers a farmer a plot of land on which to plant rubber and timber trees in conjunction with food crops. After 6 years, during which the Organization pays all expenses of raising the trees in return for the farmer's labor, the farmer starts to tap the rubber latex, paying the Organization 30 percent of the income. After 30 years, when the rubber trees are worn out, they become the property of the Organization, which converts them to timber. The entire exercise produces almost 2 1/2 times as much net income for the Organization as would be the case if it established the plantations itself, while the farmer receives $880 per year in wages during the first 6 years, plus around $650 thereafter from rubber (Chaiyapechara, 1978).

Agroforestry can also be combined with private commercial enterprise; the Paper Industry Corporation of the Philippines embarked in 1974 on a program in conjunction with the World Bank to encourage farmers to rent patches of deforested land on the Corporation's 190,000 ha concession (Diaz, 1976; Draper, 1975; Keil, 1977; Tagudar, 1976; Valera, 1974). By late 1976, 3,849 farmers had planted 12,400 ha with almost 9 million trees, for eventual sale to the Corporation's pulpmills. By 1985, the Corporation expects to obtain about 40 percent of its 650,000 m[3] of pulpwood per year from its agrofarmers.

Other commercial activities allow an entrepreneur to operate in conjunction with agrofarmers, not only through a combination of agriculture and forestry, but also involving grazing land, wildlife-rearing, bee-keeping, and the like. A start on projects of this sort has been made in Bangladesh, Burma, India, Indonesia, Papua New Guinea, the Philippines, and Thailand (Chandrasekharan, 1978). But the forest is disappearing rapidly under the onslaught of increasing numbers of forest farmers, and there is still little evidence of the effective dissemination of desirable practices such as those just described on an international, or in most cases, even a national scale.