Incremental Agroforestry: Enriching Pacific Landscapes

William C Clarke and Randolph R Thaman

Logging in western Melanesia can be seen as a drama wherein the logging companies are cast as villains representing "rapacious foreign exploitation," while the local people, and their nation, play the victims who realize in the end that they have suffered costs greater than the meager financial returns they have received (Duncan 1994; Fingleton 1994). If the essence of tragedy in drama is that the events suffered are self-inflicted, then indeed the Pacific's forest loss is tragic, for a distinctive feature of natural forest in Pacific Island states is that nearly all of it is located on land held under customary tenure, and landowners are an essential party to any logging (Fingleton 1994). Other papers in this issue discuss the failure of local jurisdiction and governance to prevent forest loss in western Melanesia. In Polynesia, two recent studies of the extensive conversion of forest to agricultural land in Western Samoa depict causes for forest loss quite different from those of western Melanesia but again illustrate how fallacious it would be to argue as a general principle that local empowerment leads to sustainable environmental management from a conservationist point of view (Paulson 1994; Ward 1995).

Whatever the causes of deforestation, one of its costs is the loss of biodiversity, a process that has been of global concern since the signing of the Convention on Biological Diversity at the United Nations Conference on Environment and Development, the "Earth Summit," held in Rio de Janeiro in 1992. Because forests are the terrestrial ecosystems richest in species diversity and the principal habitats of indigenous Pacific Island plants and animals, as island forests are lost so is their

The Contemporary Pacific, Volume 9, Number 1, Spring 1997, 121–148

embodied island biodiversity. It was to this sort of loss—common across the tropical world—that E O Wilson referred when he wrote that the "sixth great extinction spasm of geological time is upon us, grace of mankind" (1992, 343).

As there is almost no likelihood that forest loss in the Pacific will slow during the next several years—and perhaps not until most of the loggable forests are cut and most agriculturally usable land now under forest has been converted to agriculture—the forests that remain are fated to dwindle away, their demise augmenting the worldwide spasm of extinction. Against this bleak scenario of deforestation and the extinction of biodiversity there exist possibilities for protecting and increasing biodiversity in the agricultural, village, and urban landscapes, even though at present the tendency there is also toward ecosystem simplification and the loss of biodiversity.

Our purpose in this paper is first to examine the processes of simplification and loss of biodiversity within these humanized landscapes, specifically, the process of "agrodeforestation." Then we turn to a countervailing strategy we have called incremental agroforestry, which could help to address agrodeforestation and enrich biodiversity in humanized or semihumanized landscapes as a practicable means of addressing the erosion of biodiversity in the Pacific Islands.

Our basic premise is that some of the effort now devoted to preserving or protecting natural forests—a goal that Pacific Islanders, and their governments, do not always share with foreign conservationists—should be turned toward a more achievable target of managing humanized landscapes and ecosystems so as to maintain and incrementally increase their biodiversity. This designed or human-induced diversity, which can be called "agrobiodiversity," will in some cases be very different from the forest's biodiversity, and cannot serve as a replacement for the loss of the forest's indigenous, often endemic, plants and animals. It can, however, supply functional subsitutes for many of the material and spiritual benefits derived from native forests. Importantly, maintaining or creating agrobiodiversity has the merit that it calls for manipulation, for building, for enhancement and enrichment, rather than being a plea for the static nonuse or preservation of forests—people being much better at modifying landscapes than at perpetuating or conserving them.

Agrodeforestation in Pacific Island Landscapes

Agrodeforestation has been defined as "the removal of, or de-emphasis on the planting and/or protection of trees in the context of existing agricultural land use systems" (Thaman 1989, 3). Compared with deforestation, the more incremental process of agrodeforestation has received little attention, although its significance is also great because many of the utilized scapes of the Pacific Islands are pervaded with planted or protected trees, and because many of the smaller Pacific islands, such as Tikopia in Solomon Islands, Aniwa in Vanuatu, the extensive grassland areas of highland New Guinea, and the rapidly expanding periurban areas of Melanesia, have little or no remaining truly natural forest. For many of these areas, most of the remaining trees are found in active agricultural areas, fallow lands, villages, and around residences in towns.

Agroforestry, which in a modern, simplified guise has recently become popular in development circles, is now known to be a widespread and ancient practice, whereby planted or protected trees enhance the productiveness, the cultural utility, and the ecological stability of agroecosystems (Thaman and Clarke 1993, 10). Community studies by anthropologists, geographers, ethnobotanists, and others across the tropical world have revealed the sophistication, complexity, and ecological stability of indigenous systems of agroforestry. Regional studies of agroforestry in Amazonia (Irvine 1987; Denevan and Padoch 1988; Posey and Balée 1989) and generally in the tropics (Nair 1993, section 2) reveal the great diversity of traditional systems and their component trees as well as their ubiquitous role in the production of food and materials and the provision of a wide range of ecological and social amenities. Clarke and Thaman, in their study of the diverse agroforestry systems created by Pacific Island societies over centuries or millennia of settlement (1993), found 419 agroforestry species, almost all of which are present in Melanesia, that are planted or protected as integral components of agricultural systems—a richness or agrobiodiversity that is in stark contrast with the handful of exotic species that have been put forward by development agencies and modern agroforesters as a way to "introduce" agroforestry into the Pacific Islands. Throughout Melanesia, the inhabitants have created intensely humanized landscapes, which to the uninitiated may look like natural forest, punctuated here and there by gardens or grassy ridges—land-

scapes waiting for development, when seen through the eyes of the undiscerning foreigner or visiting technical expert. Instead, as Decker and Thaman wrote about the humanized forest of the Marquesas Islands of French Polynesia, much of it is a human artifact,

> intricately linked to the inhabitants' production of food, materials, and cash crops. The individual trees are the wheels of the forest factory, turning out a great variety of products while also working slowly together to enhance the future productivity of garden soils and to help maintain the present stability of slopes and the clarity of streams. . . . It would be useful in planning for the future welfare of land and people to recognize this factory's existence and its significance, before dismantling it under the false impression that it serves little purpose and has no connection with human activities. (1993, 121)

Agrodeforestation can thus be seen as the dismantling of an arboreal factory. As the factory's components cease to be used, so too an immense store of empirical knowledge about traditional agroforestry species and systems begins to be lost, although over the past few years there has been a growing recognition by scholars and within the development community that indigenous ecological knowledge—"people's science," as Richards called it—has much to contribute to sustainable agricultural development (Richards 1985; Gliessman 1990; Norse 1992; Clarke 1993; Warren, Slikkerveer, and Brokensha 1993; Brookfield and Padoch 1994; DeWalt 1994). The alternative term "traditional environmental, or ecological, knowledge" is used by authorities who stress that similar knowledge is held by nonindigenous groups who have "acquired such knowledge and skills through hands-on experience living in close contact with their environment," the term *traditional* referring to "cultural continuity transmitted in the form of social attitudes, beliefs, principles and conventions of behavior and practice derived from historical experience" (Johnson 1992, 4).

Examples of agrodeforestation can be drawn from Fiji, where trees of cultural and ecological value that were traditionally almost always protected when clearing fallow land for new gardens are now disappearing from the agricultural landscape. Instead of being protected or pruned and pollarded, they are now bulldozed, uprooted, ringbarked, or burn-girdled at the base to maximize monoculture, often plow-culture, of sugarcane, taro, sweet potato, cassava, kava, ginger, or cocoa for export or local sale. Even the Pacific's "trees of life," coconut palms, are either not replanted or fall prey to indiscriminate burning, careless plowing, bull-

dozing, or frequent tropical cyclones. A wide range of fruit trees, including mango, citrus, avocado, Malay apple, oceanic lychee *(Pometia pinnata),* Polynesian vi-apple, Tahitian chestnut *(Inocarpus fagifer),* tropical almond *(Terminalia catappa),* breadfruit, and traditional banana and plantain cultivars, have been felled either to add an additional row of cash crops or to provide utility timber or firewood from an increasingly agrodeforested landscape. Even *koka (Bischofia javanica)*—formerly the most abundant tree in many fallow areas in Fiji, the source of red-brown dye for culturally important tapa cloth in Fiji's Lau Islands, an important medicinal and firewood plant, a favored source of quality house posts, and a known, deep-rooted enhancer of soil fertility—which was commonly severely pruned or pollarded (but not killed) is being destroyed by a generation of young farmers who no longer see the benefits of trees. Or, they may see the long-term ecological and community benefits but are driven by short-term commercial and economic imperatives to remove the trees (Clarke and Thaman 1993, 192–193).

In Tonga, to the east of Fiji, agrodeforestation has led to the rapid expansion of degraded *saafa (Panicum maximum)* grasslands on the main island of Tongatapu and serious deterioration of the fertility and structure of Tonga's rich volcanic soils (Thaman 1976). Particularly implicated is the recent large-scale expansion of squash cultivation, which has led to unprecedented tree removal and the indiscriminate use of fertilizers and pesticides (Thaman and Whistler 1994). According to 'Ofa Fakalata, head of the Research Division of the Ministry of Agriculture, Tonga's squash industry has reached the "crisis and disaster phases of its development," with an increasing number of growers finding that no matter how much fertilizer or pesticide they apply, their yields are dropping. He refers to these damaged areas as "Hot Spots . . . big areas of land that have been cleared, with hardly any trees left, and where the land has been farmed continuously for a number of years. . . . so that the structure of the soil in these areas has been destroyed and the soil no longer can absorb water to feed the plants." Fakalata believes that "if nothing is done now to deal with the problem these Hot Spots could spread and contaminate the whole country" (Fonua 1994, 13). Export squash monoculture is now expanding rapidly into Vanuatu, where it could lead to similar widespread agrodeforestation and the expansion of degraded grasslands and shrublands.

Similarly in Samoa, a concentration on the monocultural production of

cocoa, bananas, copra, and taro, beginning with German occupation last century and continuing, with interruptions by disease and hurricanes, up to today, has led to the removal and endangerment of many important trees of agricultural systems (Thaman and Whistler 1994; 1995). In the Cook Islands the removal of trees and mixed-tree groves on the islands of Rarotonga and Aitutaki for monocultural cash cropping has been responsible for one of the most agrodeforested landscapes in the Pacific Islands (Thaman 1993).

In Melanesia, although population density is generally much lower and far more natural or partly natural forest remains than in Polynesia, a similar scenario of agrodeforestation occurs, particularly on smaller islands or islands with high population densities, such as Ambae in Vanuatu and Malaita in Solomon Islands. Useful trees that were protected in the past are erased from forests by logging. In agricultural landscapes, cash crops such as cocoa, coffee, or coconuts expand, and beef cattle farms are extended, for either local sale or export. The long-standing official promotion of the monocropping of coconuts, cocoa, coffee, and other export crops in association with rapid population growth in western Melanesia brings a widespread shortening of fallow periods, which leads to agrodeforestation as fallow growth shifts away from woody regrowth toward degraded shrub-grassland or fernland complexes. Trees selectively protected during the cultivation phase increasingly suffer attrition as gardening phases become more frequent or as land is cleared to make way for pasture or for perennial cash-crop trees or shrubs such as cocoa and coffee. Frazer succinctly described this general process for an area in North Malaita, Solomon Islands, between 1971 and 1985:

> A notable change over the period has been the growth in cash cropping. The area of tree crops doubled between 1971 and 1985, production of cocoa increased threefold and copra production increased four times. While this expansion has increased cash incomes, the increased area of tree crops, combined with population growth, have caused a growing shortage of land. Land for food cropping is scarce and much of that available is far away, imposing additional work burdens on women who do most food crop gardening. One response to the land shortage has been to reduce bush fallow periods, causing declines in crop yields and some land degradation. Land scarcity is also a cause of the growing number of land disputes. (Frazer 1987, ii)

The sorts of pressure described by Frazer lead to the loss of protected or preserved trees in the fallow vegetation and gardens as well as to a

decline in the sophisticated systems of agroforestry that marked much traditional agriculture in Melanesia. For instance, two valuable trees that are probably suffering agrodeforestation (and are certainly being lost because of logging) are: canarium almond, Java almond, or galip nut (*Canarium* spp), which occurs in anthropogenic high densities in mature fallow forests in Solomon Islands and has many uses, most notably an oil-rich seed kernel highly prized in the diet and also sold commercially; and Oceanic lychee *(Pometia pinnata),* which is also selectively protected during garden cultivation and shows a human-induced clumped distribution in the fallow forest. Oceanic lychee is an important seasonal fruit tree and source of medicine, timber, and firewood (Thaman 1993, 227, 255–256).

Selected Melanesian agroforestry practices are described by Clarke and Thaman (1993, 34–84). These practices and the trees used vary considerably from place to place, but mostly they entail a humanization, taming, or "agriculturalization" of the forest in conjunction with gardening short-term crops. Many of the practices are sophisticated, productive, and require little labor. As Annie Walter said with regard to traditional tree farming in Vanuatu, the real work of tending these trees is more intellectual than physical (1994, 189). For instance, the traditional orchards, or agroforests, of the Maring people of Papua New Guinea came into being as a transmutation of expiring gardens of shorter-term crops, among which four kinds of trees were planted. The most important of these was the spiny-leafed *Pandanus* species known widely as *marita* in Papua New Guinea. The massive fruit of this tree was steamed in the earth oven and made into a tasty, bright red sauce, which was eaten with various edible leaves and provided the major source of vegetable oil in the diet. The strong, long leaves of this domesticated *Pandanus* also make a good roofing material. The second most important of these orchard trees is *Gnetum gnemon* (*tulip* in Tok Pisin), a graceful tree that bears edible leaves, inflorescences, and fruits, and the underbark of which provides an excellent fiber. The two minor trees in these orchards were the breadfruit, important here for its edible seeds rather than for the flesh of the fruit, and a small fig species *(Ficus wassa),* which provides material for bark cloth and bears edible leaves and fruit. Once established, the orchards require little labor but provide a valuable supply of food and materials for decades, until they gradually merge back into secondary forest and their sites again become available for gardening (Clarke 1971; 1993).

It is doubtful, however, that this exquisite design, which revolves through a decades-long sequence of gardens, orchards, anthropogenic

secondary communities, and gardens again, can survive in a Papua New Guinean world where population is growing rapidly; where groves of cash-cropped coffee trees replace indigenous trees; where men and whole families drift away to towns, perhaps never to return, so that rights to portions of land fade; where secondary forest regresses to woodland and grass; and where the oil-rich *Pandanus* sauce can be replaced by imported grease (Clarke 1993, 254).

That neither national governments nor international agencies show much concern with the loss of agroforestry species and systems, compared with the widespread apprehension about logging, results in part from the insidious, incremental character of agrodeforestation. It is difficult to map and less amenable to measurement or geographic-information-systems analysis and display than logging because it lacks the visible "retreat of the forest." But like deforestation, it diminishes biodiversity, particularly of useful plants. In this regard it runs parallel with the genetic simplification occurring among short-term crop plants, where the polycultural bias toward a diversity of species and cultivars that characterized traditional agriculture, and which included useful fruit and nonfruit trees, is giving way to a concentration on cash crops and on fewer but higher-yielding and faster-growing species and cultivars.

In addition to their diminution by the demands of cash cropping and commercial livestock production, traditional agroforestry systems are also being eroded by mechanization, by increasing population pressure on land, by changing socioeconomic conditions such as increasing poverty and landlessness among immigrants and squatters, by new forms of education (the shift away from ecological learning by the younger generation, while in garden and forest with the older generation, toward national curricula aimed at modernization and taught in formal, often urban-based schools), by new kinds of aspirations, or by adaptations in land-tenure systems whereby the traditional complex systems of usufruct—rights to enjoy the use of the fruits of the land while not holding sole rights to the land—are weakened.

At the level of planning offices, sectoral ministries, or aid donors and international development agencies, the survival and maintenance of indigenous tree species and agroforestry systems have not been supported because of ignorance of their existence or utility as well as a bias in favor of packaged interventions and tree species or genotypes derived from modern science. The characteristics of indigenous agroforestry and its

multipurpose trees may not fit neatly into institutionalized sectoral divisions or into the physical configurations such as alley cropping or contour hedge rows championed by institutional agroforestry. It seems almost as though the diversity of species, cultivars, functions, and spatial configurations embodied in most indigenous or traditional agroforestry systems cannot properly fit into contemporary scientific experimentation or economic models (Thaman 1988; Clarke and Thaman 1993). Consequently, aid donors, governments, agricultural and forestry scientists, biotechnologists, and economists in the tropics have largely turned away from the biodiverse agroforestry systems that have resulted from centuries or millennia of on-site experimentation and empirical observation of the local tree flora.

The ignorance among the younger generation of the ecological, economic, and cultural importance of trees bodes ill for the future of indigenous agroforestry systems. Most of the trees that still provide food, timber, firewood, medicines, or serve other cultural and ecological functions in Pacific agroecosystems have been planted or protected in the past by the parents, grandparents, or earlier ancestors of the current generation. Many of these trees are not being replaced or protected by a present generation that commonly knows neither the vernacular names nor the uses of such species. Walter described this decline in traditional botanical lore as it is happening in Vanuatu:

> The younger generations, using a foreign language at school, tend to have poor knowledge of the names of all the cultivated plants. Frequently, children grow up far from their own villages and are no longer able to recognize all the different types of edible species. More seriously they are losing interest in the traditional food plants used by their ancestors. Although these plants used to grow without much human assistance, they were indirectly protected from harm by the older generations' knowledge of their usefulness. The elders used to enjoy assembling collections of a wide variety of types for each edible species, partly just for the joy of having as many different forms of the same plant as possible. The younger generations no longer do this, or they do it to a lesser extent. By losing the taste for this botanical lore, they very quickly lose the option of using these trees. The biological diversity of their diet, the number of food plants available to the villagers who depend on this resource, can only continue decreasing. (Walter 1994, 192, 194)

In the past few years, however, in association with the growing recognition by scholars and the development community of the scientific value

(as well as the cultural-political value) of indigenous or traditional ecological knowledge—the "people's science" already mentioned—there are moves to introduce elements of such knowledge into formal education. And in institutionalized agroforestry there is a growing recognition of the value of the traditional systems. Nair wrote of "underexploited trees in indigenous agroforestry systems" (1993). Montagnini considered the advantages of incorporating native tree species into agroforestry systems (1990). Clarke and Thaman, in their study of Pacific agroforestry systems, also urged a deeper appreciation and use of the species found within the diverse traditional systems (1993). Rogers has made the intensification and modification of traditional uses and species of nitrogen-fixing species the cornerstone of a major European Community-funded agroforestry development project in Samoa (Rogers, Iosefa, and Rosecrance 1993; Pattie and Rogers 1993).

The coupling of modern and indigenous systems of agroforestry can only serve to enrich or help maintain biodiversity, thus countering the general trend toward biological simplification—though some forms of traditional tropical agriculture and home gardening remain notably rich in species and varieties (Landauer and Brazil 1990; Brookfield and Padoch 1994). A more cost-effective way to further such diversity is to promote the protection and incremental enrichment planting of trees that are already part of traditional agroforestry systems suffering depletion. This is not to suggest that the battle to save naturally biodiverse ecosystems or to promote new agroforestry species and technologies be abandoned. Rather, it is to propose that there is work to be done "behind the lines" of the advancing front of forest clearance and biodiversity loss. Where forest has been removed, where agrodeforestation has taken place, there can be an incremental arboreal reconstruction, the result of which, although different from and less complex than the vanquished systems, will contain and protect more biodiversity than is to be found in most contemporary agricultural systems and on many smaller Pacific islands where there remains virtually no native inland forest to protect, only agroforest.

Incremental Agroforestry

Although planting trees has always received good press—Johnny Appleseed, Arbor Day, and such—it has received little attention in the conserva-

tionist campaign for biodiversity prominent over the past few years, or during the "Green Revolution" over the past thirty years. In part this may be because biodiversity is believed to be a natural phenomenon, something to be saved or protected rather than created, and something separate from the working landscapes of humankind. This belief continues despite a wide literature describing how preindustrial societies have created biodiverse cultural landscapes, which include a bewildering range of planted and protected tree species and varieties and an even more remarkable range of cultivars or "land races" of almost all major annual and perennial domesticated crop species (Harlan 1975). Anthropologists and geographers have grasped this complexity through long-term village studies, but their understanding has until recently rarely crossed the interdisciplinary borders into the worlds of scientific agronomy, agricultural economics, forestry, and aid donors (Clarke 1971; 1993; Hyndman 1994).

A related obstacle is that conserving forests and their more "charismatic megafauna" is a more attractive political goal than working to increase biodiversity incrementally within the agricultural realm. This priority of wild forests over trees is analogous to the nutritional dilemma wherein famine receives more official attention and funding than does widespread chronic malnutrition because addressing the dramatic event yields more political gain than trying to ameliorate quotidian processes, even though ongoing malnutrition kills more people and inflicts a greater economic and social price in the long run than famine and natural disasters (Berg 1973).

Another reason that agrodeforestation may not be seen to be as deleterious a process as the loss of forest biodiversity is that it is seen as an inevitable accompaniment of agricultural modernization, in that trees obstruct the use of machinery and at times are competitive with annual crops, the yield of which must be increased to feed growing populations or meet export requirements. It is at times the case, although not always, that trees reduce the yields of annual crops. It is also the case that planners and agronomists hold a definite bias toward single-commodity production carried out on clearly demarcated (usually rectilinear) tracts of land intended to produce crops efficiently at set times. In contrast, traditional Pacific Island agricultural landscapes are rich in biodiversity and in types of domesticated or quasi-domesticated vegetation (Clarke 1994, 17–19). They are also varied in what and when they yield, and have an

amorphous, seemingly random, spatial organization that can be seen as inefficient and difficult to administer or to assess economically (figure 1).

Even if concern is kept focused solely on the utilitarian values of a diverse gene pool—rather than extending concern to the inherent existence value of biodiversity for its own sake—the wide range of domesticated or quasi-domesticated multipurpose trees found in traditional agricultural systems has so far received little attention compared with annual crops for which there are increasing numbers of seed banks and germ plasm collections (Oldfield and Alcorn 1991; Sandlund, Hindar, and Brown 1992).

Although descriptive research has been carried out on trees within agricultural systems, considerably more work is needed to answer questions regarding the ameliorative and protective functions of trees, for instance, the extent to which they enhance agroecosystem stability, increase the numbers of predators of crop pests, serve to attract pests away from crops, enrich soil, prevent soil erosion, or protect garden areas from strong winds and sea spray (Gliessman 1990; Nair 1993; Thaman, Smith, Faka'osi, and Filiai 1995). There is also a need to gather quantitative data on the yield and the subsistence and commercial value of the diversity of trees in traditional agroforestry systems, something that agronomists and agricultural economists have rarely attempted, ostensibly because of the inherent diversity and complexity of these systems, which are not readily amenable to western scientific quantification.

To implement the building or enhancing of biodiversity through incremental agroforestry does not require ponderous agricultural development projects. Rather than remaining in the hands of urban scientists, economists, and administrators, incremental agroforestry—in the sense of planning and decision making as well as the actual work involved—can be in the hands of local people, who already know the land's capability and the characteristics of the local species, and who will remain working the same land, able to observe and experiment with the trees over years, decades, and generations. In this way, as has been the practice in the Pacific Islands for millennia, incremental agroforestry constitutes a constructive, rather than an intentionally protective, occupation of the landscape, an evolutionary process counterbalancing land degradation and agrodeforestation.

It will not be easy to stimulate and facilitate such a process. On a physical level, a basic element has to be the availability of planting stock (seeds, seedlings, cuttings), but because the trees to be used are almost

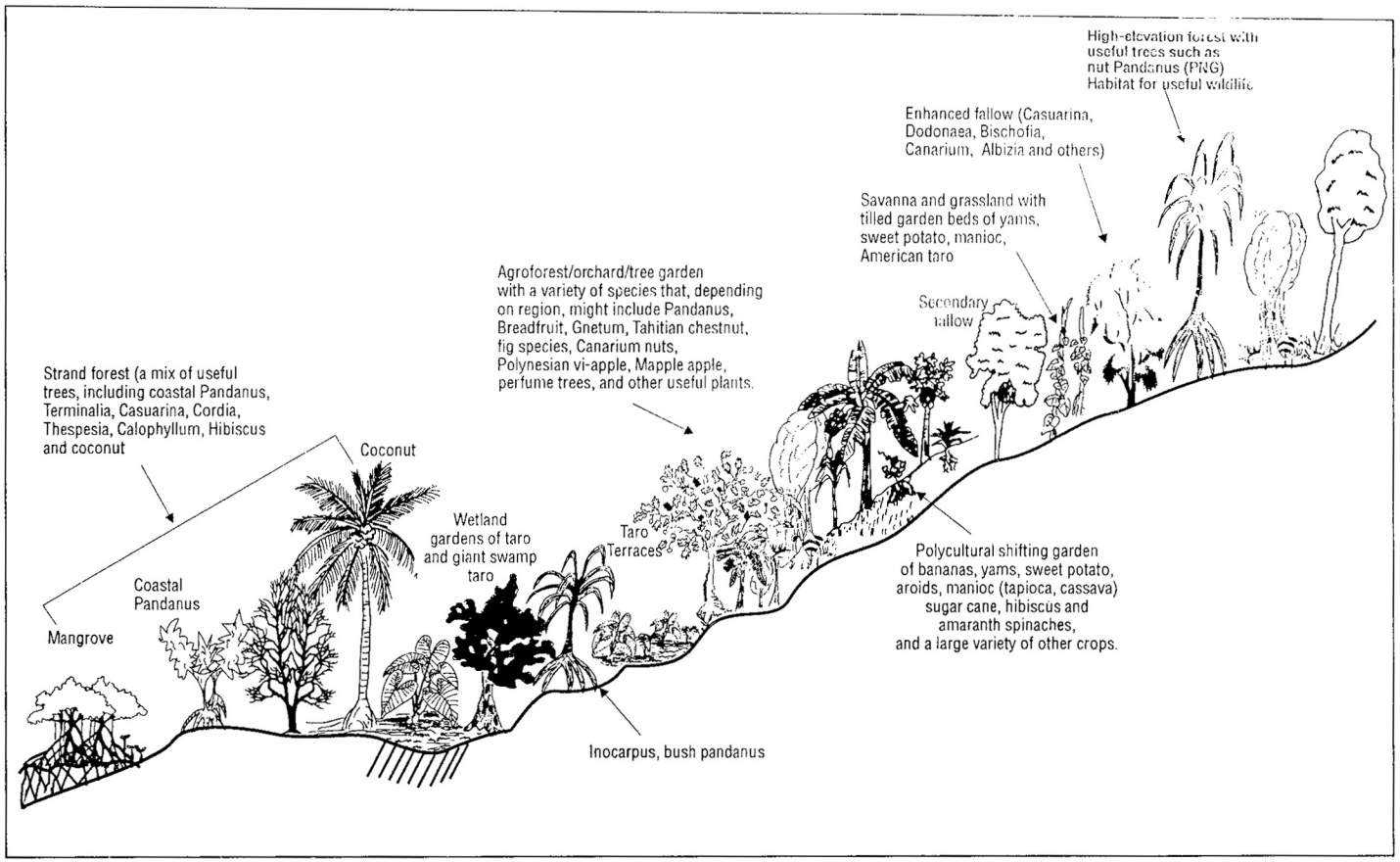

FIGURE 1. Schematic representation of Pacific Island humanized landscapes. (Adapted from Barrau 1958, 1961.)

exclusively local, the elaborate, capital-intensive, and often centralized nurseries necessary to build up stocks of exotic plantation species will not be needed.

Another difficulty lies in mobilizing local gardeners and farmers, men or women, to propagate and use the planting materials in the face of pervasive commercial imperatives, and the modern economic and agronomic pressures that favor agrodeforestation and monocultures. It is known, for instance, that subsidies do encourage the planting of coconuts in the Pacific Islands, but people do the work to gain the subsidy, not because they value having more coconut palms. Direct payment for planting or the provision of free planting material can lead local participants to have doubts as to their future rights to the trees and their products. Evidence is ubiquitous throughout the Pacific Islands that where plants are given away, rather than being purchased or propagated by the planters themselves, they are generally not cared for. Or, where usufruct rights to trees are separate from land rights, tree planting and protection may face social barriers as tenure becomes more individualized, or privatized—a process now widespread in the Pacific Islands (Ward and Kingdon 1995).

On the other hand, although botanical lore is being lost, there remain cultural and personal attachments to individual trees, both those in forests and those found in cultural landscapes nearer settlements. Named and appreciated trees and their products play important economic, cultural, and aesthetic roles and feature prominently in songs, myths, traditional feasts, perfumes, leis and garlands, and prestigious exchange items such as fine mats and tapa cloth (Thaman 1992). These sorts of attachments could be capitalized on to encourage incremental agroforestry. Similarly, the even more deeply symbolic associations of trees with *kastom* or *vanua* (the first the neo-Melanesian or Pidgin word for "custom" signifying tradition or way of life, and the latter a Fijian and Vanuatu cognate of Pacific Island Austronesian words for "land" or larger islands and their inhabitants) could also be stressed and reinforced as incentives for communities to plant and protect trees in the context of land—and cultural—management and preservation. These words cannot be translated simply but have to do with proper lifestyles, customs, and values of peoples, often in association with particular places, their islands, or their lands, which have been passed on to the current generations by their ancestors. For instance, in some areas of Fiji, after a child's umbilical cord falls off, it should be planted with a tree seed, which, as it grows, represents the

child, becomes a part of the person. If the tree grows to be strong and beautiful, it bodes well for the child and provides a strong bond with place and community (Williksen-Bakker 1990). Such beliefs can be expected to play a role in recent cultural revitalization movements and so gain power for motivating action related to preserving the trees as symbols.

Examples of Incremental Agroforestry

Traditionally, the practice of incremental agroforestry has been an evolutionary process based on one-by-one, almost imperceptible additions of new trees, new cultivars, and new non-tree plants to existing systems of polycultural production. Its purpose was biological enrichment of the landscape for economic and cultural purposes. The result has been evolutionary progression, the gradual addition of new plants to existing assemblages, a process based on people's own observations of how a given plant performed, or how useful or culturally acceptable it promised to be, and how best it might fit into existing systems. It allows the local people to carry out a process on their own terms and in their own time frames. In accord with current views of development, they would be able to maintain, or sustain, their own culture and livelihood.

The evolutionary process just described contrasts strongly with types of institutionalized agroforestry that have met with limited success since World War Two and in many island countries have contributed to agrodeforestation rather than to agroforestation. For example, during the colonial period and continuing into the postindependence period in most Pacific states, there was a move to introduce new, high-yielding varieties of the coconut palm to increase export production of copra, often the only agricultural export of small outer-island communities. To facilitate the "copra revolution," millions of useful traditional agroforestry trees were sacrificed while millions of dollars and much labor were expended on such coconut replanting and rehabilitation schemes. Many of them have been of little benefit economically and can be seen to have been detrimental culturally and in terms of biodiversity because of the depletion of a wide range of other useful trees.

Because institutionalized agroforestry developments have been most significant spatially in Micronesia and Polynesia in terms of the proportion of land used, they can to some extent serve as an example of what might happen more extensively in Melanesia.

In the atoll nations of Kiribati and Tuvalu, a variety of coconut development and coconut replanting schemes have been attempted over many years. For example, a British-financed Coconut Replanting Scheme focused on improving seedling selection and planting technology in areas of suboptimal fertility, with planting and maintenance encouraged by subsidy. By the time the scheme was discontinued in 1981, 2079 hectares (8 percent of the land in Kiribati) had been replanted (Barr 1993). Evaluation of the scheme showed that most of the newly established trees produced very few nuts, even after twenty years, because they had been planted in exceedingly nutrient-poor soils (Trewen 1983).

Beginning in 1983, long-term trials were begun in Kiribati and Tuvalu with the aim of drawing up a comprehensive set of recommendations for both the rehabilitation of existing replanting schemes and for new plantings (Barr 1993; Trewen 1985). To regain landowner confidence in Kiribati, the Coconut Demonstration Project was started in 1988 to disseminate necessary agronomic information, so that landowners could then make up their own minds about the viability of the recommendations for replanting compared with rehabilitation. The plots (thirty-six in total) were intended to show that, with some changes in husbandry (primarily mulching and not burning) plus the use of small amounts of fertilizer, coconut plantings can be rehabilitated and maintained at productive levels, and that replanting can be done with greater success (Barr 1993).

Unlike the old replanting scheme, the Coconut Demonstration Project does not recommend clear-felling before replanting. Rather, it recommends that farmers selectively fell unproductive trees and fill the gaps with selected seedlings. Farmers are also encouraged to retain other trees and plant species they deem useful, especially those bordering the ocean or lagoons, both areas where "zero disturbance" is recommended. Such practices cause far less disturbance to the ecosystem and to nutrient recycling, and preserve plants of subsistence value to island families. Although in its infancy, this "incremental" approach seems to show greater acceptability and actively discourages further agrodeforestation in the floristically impoverished agricultural landscapes of atolls.

Similarly, the United Nations Development Program's Integrated Atoll Development Project, which began in 1985, had as its main objective the promotion of sustainable atoll development through the introduction, promotion, and implementation of appropriate technologies and strategies. Emphasis was placed on participatory action and the use of indige-

nous institutions as the basis for development. Kiribati and Tuvalu were both included in the project, with the island of Tamana in Kiribati serving as a pilot area. Results on Tamana showed that although the improved home gardens established as part of the project's work in agriculture were neglected and had deteriorated, tree crops, such as papaya, lime, and breadfruit, which were already familiar to the Islanders, remained (Liew 1992), again showing the resilience of an incremental addition of trees.

In the associated effort to promote improved tree cropping and agroforestry, the trees that proved most successful were long-established species, such as limes, breadfruit, native fig *(Ficus tinctoria),* tamarind, custard apple or sweetsop *(Annona squamosa),* and casuarina (Liew 1992).

In Tuvalu, interest has increased in the promotion of an incremental agroforestry that focuses on multipurpose indigenous species, fruit trees, and nitrogen-fixing trees. Indigenous species endangered by agrodeforestation and given high priority (Seluka 1993) include the important food crops of breadfruit and the native fig. Part of the agroforestry endeavor will be a landscaping program, at first confined to Funafuti (the atoll where Tuvalu's capital is located), but later extending to all eight islands in the group, with the aim of planting both local multipurpose and exotic timber species, such as casuarina, which is not indigenous to the atolls of the central and eastern Pacific, but which can withstand the harsh conditions (Tuvalu 1993).

On Aitutaki in the Cook Islands, where agrodeforestation has been severe because of over forty years of a strong emphasis on modern citriculture, banana cultivation, and the monocropping of vegetables, and where current and long-established institutionalized agricultural and agroforestry programs have failed or had limited success, more incremental or evolutionary approaches are being tried, such as attempts to replant native trees such as *Cordia subcordata* and *Thespesia populnea,* two of the best woods for carving and both of considerable cultural significance in eastern Polynesia (Thaman 1992, 1993).

In the current promotion of multipurpose agroforestry in Tonga, the main activity is in Vava'u, where experimentation and extension work are ongoing. Projects include boundary planting of timber species around allotments with several introduced species. Trials are also being conducted on the intercropping of kava and vanilla with timber and nitrogen-fixing trees. Vanilla and cassava under Caribbean pine have also been tried, as have vanilla and kava with *Leucaena* (an introduced leguminous

small tree) and several other species. The results of these trials are not yet available, but an evaluation of agroforestry activities in Tonga suggested that more emphasis should be placed on some of the indigenous or long-established species, all of which have high cultural utility (Thaman and Whistler 1994).

Most recently, at the request of the prime minister, the Forestry Division has completed a pilot coastal reforestation-revegetation project in cooperation with the South Pacific Regional Environment Program and the University of the South Pacific. The project was an attempt to reestablish coastal forest on the sea side of agricultural holdings on the windward blowhole coast of Tongatapu near Houma. The area had been deforested to expand monocultural planting of bananas and to supply wood for banana boxes during the banana boom of the 1960s and early 1970s. Deforestation has been made worse by indiscriminate burning, which has favored the establishment of Guinea grass at the expense of coastal and inland tree species, including coconuts. As a result, it has been very difficult to grow ground crops and useful trees because of excessive salt spray and recurrent fires. The incremental reestablishment of coastal trees and forests is seen as central to the area's rehabilitation (Thaman and others 1995). The project is of particular interest regionally because coastal deforestation is widespread, and the identification of strategies for coastal reforestation and the deliberate propagation of indigenous coastal species could have widespread application as a model throughout the Pacific, especially in the face of the possibility of a rise in sea level (Thaman and others 1995).

In Western Samoa, where agrodeforestation has been intense as a result of over a century of emphasis on the monoculture of coconut, cocoa, bananas, and, most recently, taro production for export, the alley-cropping research project of the European Community–funded Pacific Regional Agricultural Program has reviewed the potential of nitrogen-fixing trees suitable for intercropping with taro. Although some introduced species have performed particularly well as biomass producers, indigenous Samoan preference has been taken into account with the favored species *Erythrina subumbrans* and *E variegata* as the backbone of the project. Alley-cropping systems have also been tried and have reduced weed growth to such an extent that labor required for weed control was reduced to as little as twelve percent of that required in control plots. In monitoring weedy species under such alley-cropping systems, a shift away

from grasses to broad-leaved species is apparent, whereas the excessive use of the herbicide Gramoxone (paraquat) to control weeds over the past decade had led to increasing dominance by rhizomatous grassy species (Rogers and others 1993).

The important aspect of the Samoan trials is that efforts have been made to identify and use indigenous or long-established trees, rather than concentrating on recently introduced exotics. Preliminary results of this project, which has focused on learning from Samoan farmers, have been favorable, although the unfortunate devastation of the taro intercrop by leaf blight has forced the project to shift to other crops such as yams, giant taro *(Alocasia macrorrhiza),* and tannia *(Xanthosoma sagittifolium).*

In Vanuatu, a project has been initiated on the island of Pentecost, where the population density is relatively high (about 110 persons per square kilometer). The project is aimed at countering the declining yields caused by the shorter fallow periods that eventuate when population grows and cash cropping expands. Intended techniques include improved fallows, hedgerow planting of exotic species on steep slopes between alleys of traditional crops, and the rotation of timber species with crops as in the *taungya* system of southeast Asia. Interestingly, research on the area by geographers and soil scientists revealed an indigenous system of boundary marking by means of contour hedging with native trees, which functioned to slow soil erosion sufficiently to form accumulation terraces. At least a century old, and recognized by local farmers to have conservationist value and, particularly with the use of *Hibiscus tiliaceus* in the hedgerow plantings, to improve the yield of yams and inhibit insect infestation, the system is going out of use, probably because of the greater labor requirements associated with an increase in cash cropping (Brookfield and Padoch 1994, 37).

Another project directly related to traditional agroforestry is intended to protect and develop local fruit-bearing trees in Vanuatu. The work, which has been undertaken by ORSTOM under the Department of Agriculture of the Vanuatu government, has included an inventory of fruit-bearing trees on all the islands of Vanuatu, together with gathering information about traditional ways of tending the trees, consuming the fruit, and the trees' physical requirements for growth. About forty tree species were found to produce edible fruit, with most species made up of a rich variety of cultivars. The project organizers recognize that the goal of maintaining and expanding the cultivation of these trees must not only respect their

existing diversity but must also strive to make the younger generation appreciate their value and maintain the body of knowledge that supports this rich fruit-bearing complex (Walter 1994).

These examples show that in many places shifts toward techniques that include aspects of incremental agroforestry are occurring, and that there is a growing interest and openness on the part of governments and aid donors in examining indigenous systems of agriculture and agroforestry, including use of their component species. But the rhetoric is not always implemented, as in the case of the Fiji-German Forestry Project, which began in the mid-1980s with laudably broad terms of reference that included scope in the program for a polycultural and traditionally based approach to agroforestry development. With regard to farming systems, consultants to the Fiji-German Forestry Project clearly stressed the potential benefits of tree planting to control erosion in ginger-root crop and sugarcane areas; leaving some fire-resistant trees unfelled, and planting trees as improved fallow for shifting agriculture in the rain forest zones; preserving remaining forest areas, planting small tree groves, living fencing, and fodder trees in the extensive areas of highly eroded and degraded *talasiga* (sunburnt) grassland; intercropping cocoa with appropriate shade trees, with coconuts, or planting new cocoa plantations in forest areas where unfelled tall trees would provide an additional output of fuelwood, fruits, and timber; grazing cattle in pine plantations, root cropping around pine stands, mushroom cultivation on dying trees, and enrichment of monocultural pine plantings with other species; planting trees along unprotected rural roads; and promoting and improving home gardens and smallholder agroforestry (Haen 1988, 17–21; Maydell 1987).

In the project's implementation, however, emphasis remained strongly on the introduction of, and intensive experimentation with, a single exotic tree species, *Calliandra calothrysus,* in ginger-producing areas. After the expenditure of millions of dollars over a ten-year period, there was virtually nothing to show for the efforts apart from the strengthening of local institutional expertise and forestry education. Only a few farmers adopted *Calliandra,* and recent evidence shows that the control plots outyielded the experimental *Calliandra* plots, despite additions of considerable amounts of inorganic fertilizer and chicken manure. Little was done to preserve existing agroforestry systems or to maintain a balance between commercial agroforestry activities and activities that ensured protection of the existing subsistence base. One project consultant, who had

considerable sympathy for maintaining a viable subsistence system, felt very strongly, early on in the project, that neither the Fiji Government nor the German funding agency would support an approach that placed emphasis on the subsistence aspects of agroforestry or the analysis of existing agroforestry systems as "demonstration plots" into which selected improvements could be gradually introduced (John Beer 1988, personal communication).

Conclusion

Tree-planting activities have been officially promoted in Melanesia and elsewhere in the Pacific Islands for close to a century. Recently, many of them have been referred to as "agroforestry." During this time, whether the activities have been initiated and managed by colonial or postcolonial agricultural and forestry departments or, most recently, by international aid agencies, the emphasis has remained strongly monocultural, often promoting large-scale production of crops for export or, in the case of timber and fuelwood production, plantation or woodlot forestry, which is also designed for export or import substitution. Even the intercrops are usually cash crops destined for export or local sale. Consequently, most "tamed" indigenous tree species and the wide range of traditional cultivars have received little official promotion, and have been the focus of only limited research. Few technical experts or development entrepreneurs have enough knowledge about traditional mixed agricultural systems and their species, particularly tree species, many of which have no English common names, to promote them. More often than not, the traditional systems have been degraded, displaced, or eliminated in the name of institutionalized modern agricultural, forestry, or, more recently, agroforestry development.

This sort of loss is not restricted to the Pacific but is a pantropical process, as Brookfield and Padoch described in their paper on the widely unsuspected dynamism and diversity of traditional resource-management systems (1994). Such "agrodiversity," they argued, may offer the best resource-management solutions for the future:

> There is a close relationship between agrodiversity and managed biodiversity. Because of the diversity of cropping and resource systems that exists, agrodiversity serves as a major means of conserving both structural and spe-

> cies biodiversity. And agrodiversity is under pressure to simplify, threatening not only a set of "traditional" systems but also those systems' adaptivity and the knowledge base that makes adaptivity possible. (Brookfield and Padoch 1994, 9).

The traditional Pacific humanized landscape schematized in figure 1 is intended to convey the sort of systems of managed biodiversity that Pacific Islanders created through the incremental addition and adaptation of species and agroforestry strategies within their complex resource-management systems. It would be quixotic to urge a return to the mainly subsistence purpose of such a system, but its physiognomic and floristic structure offers something closer to sustainability than modern, input-dependent monocultures. It illustrates as well that "effective management systems do not have to be invented only by modern science" (Brookfield and Padoch 1994, 43).

"Incremental agroforestry," as we have named it, is one traditional resource-management invention that added much agrobiodiversity to Pacific Island landscapes. Its continued and intensified practice would counterbalance to some extent the losses in biodiversity now brought about by logging, agricultural simplification, and agrodeforestation. It offers a way to bring a designed diversity to the huge area of land already under human use. By its very nature, incremental agroforestry will be slow and undramatic, based on the small actions of local people day by day. But it is smallholder farmers and villagers who can continue to create diversity, working the land they know intimately. Incremental agroforestry is an evolutionary process—not a project. Its dynamism, which has acted to modify and enrich Pacific Island landscapes from first settlement, could complement attempts at forest protection and plantation-forest development and provide incremental steps to help stem the present inclination to simplify and eradicate life's diversity in the modernizing island states of the Pacific Ocean. To encourage actions that favor incremental agroforestry does not depend on increasing local empowerment, for such already exists. The issue is one of incentives and knowledge: how to learn, or learn again, that trees constitute natural capital that pays interest for a long time; how to balance individual or family gain against long-term community benefit; how to initiate or strengthen ethical and social commitment to the protection and maintenance of the richness of diverse landscapes; and how to bring into clearer focus the importance of human actions in the creation, not merely the protection, of Earth's biodiversity.

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Abstract

Whether deforestation results from logging or from conversion of forest land to agriculture, one of its costs is the loss of the natural biodiversity of forest plants and animals. Further loss of forests and their embodied biodiversity is inevitable

in many Pacific islands. Countering this bleak scenario are possibilities to protect and increase "agrobiodiversity" in agricultural, village, and urban landscapes even though those landscapes, too, are often now undergoing simplification and degradation. It is suggested that the process of "incremental agroforestry"—defined as the systematic protection and enrichment of arboreal biodiversity within the context of existing agricultural landscapes—would complement the laudable international and local initiatives to protect biodiversity in indigenous forests and benefit communities that depend on humanized biodiversity for their economic and cultural well-being.

KEYWORDS: agrodeforestation, biodiversity loss, incremental agroforestry, landscape simplification