Paper #54

Indigenous Fallow Management on Yap Island

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ABSTRACT

On Yap Island, indigenous management of the fallow in shifting agriculture has resulted in the development of site-stable taro patch and tree garden agroforestry systems. These systems are relatively sustainable and supportive of household economies, with some surplus for local market sales. However, a broad range of crops whose harvest is complementary to those produced in the agroforestry plots are still produced by shifting systems of agriculture in wild lands outside of villages. These are used to produce surpluses for special occasions. Although traditional techniques for intensification of these shifting systems have been developed, and are still remembered, current practices tend to be more extensive, and forests are being depleted. These traditional technologies need to be re-applied to make the shifting agriculture systems of Yap Island more sustainable and this process could be enhanced by the integration of modern scientific technologies.

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PAPER OUTLINE

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Introduction

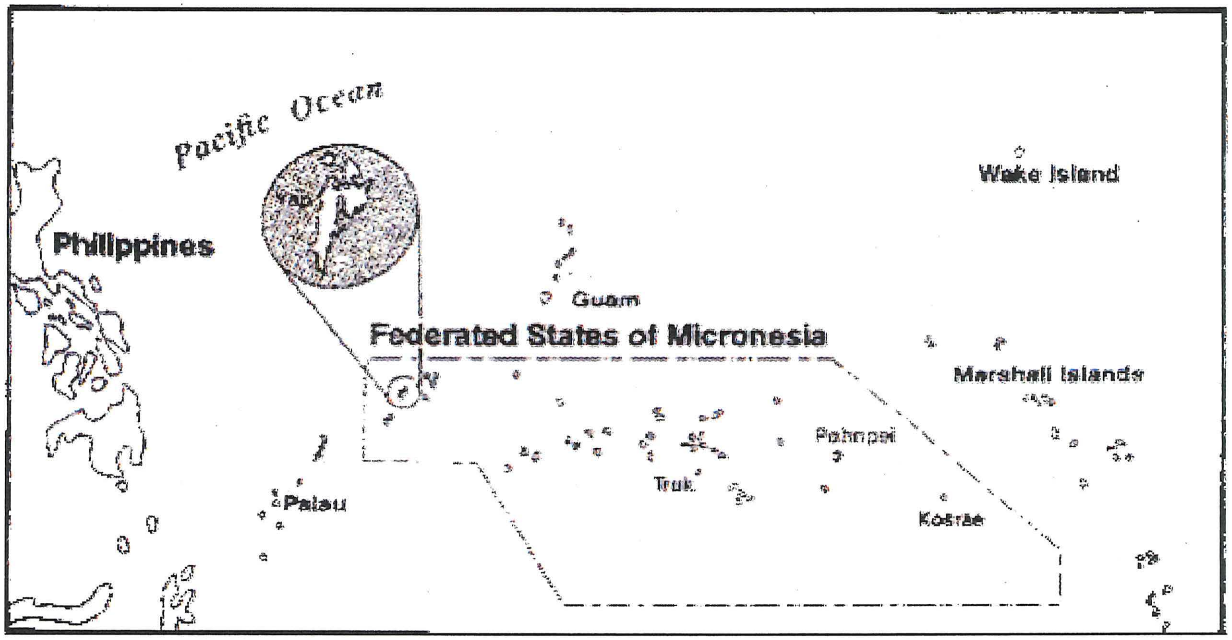
Islands are useful places to consider agricultural intensification because their limited size makes agricultural production very sensitive to population growth. The people of Yap Island have addressed the need to provide food for a growing population through a diverse set of adaptations, including intensification of shifting agriculture and the development of site-stable tree garden and taro patch agroforestry systems (Falanruw 1985, 1990). Today's agricultural activities are carried out in a range of wild to domestic habitats. At the wild end of the spectrum, bulbils of *Dioscorea alata,* or bits of *D. nummularia* yams, are placed in slightly dibbled soil within the forest and left to grow for some years with little attention, then harvested with little disturbance of the forest. At the other end of the spectrum, a wide variety of crops such as *Cyrtosperma chamissonis* taro, breadfruit, bananas, *Inocarpus fagiferus* nuts and *Citrus* spp. are harvested from year to year from almost completely domesticated agroforests where there is no fallow. However, in spite of the efficacy of the agroforestry system, shifting systems are still used as well. This paper focuses on indigenous strategies for managing the fallow of the shifting systems, where gardens are alternated with wild or semi-wild vegetation.

Study Area and Methods

Yap is a close cluster of four high islands with a total area of about 92 km^2 , lying within a broad fringing reef at 9° 33' N latitude and 138° 09' E longitude in the western Caroline Islands (Figure 1). Average rainfall is about 300 cm per year, with periods of drought, that is, rainfall below 6 cm per month, for one to four months each year. Soils are of both metamorphic and volcanic origin, and are relatively infertile. Estimates of the island's population prior to European contact range from 26,240 (Hunter-Anderson 1983) to 50,000 (Hunt et al. 1949), giving a population density of between 273 and 530 people/km^2 . After contact, the population declined rapidly to a low of about 2,607 in 1947 (Lingenfelter 1975). However, since then it has been growing rapidly, and reached 6,919 by 1994 (Yap State, 1996).

Descriptions of the agricultural and agroforestry systems utilized on Yap are based on participant observation over about 25 years. Data on vegetation profiles, species composition, and crop production was gathered from 102 randomly selected agricultural and agroforestry sites. As well, crop and crop production data was gathered from an analysis of records of produce sold at the Yap market between 1973 and 1992 (Falanruw 1995). The species composition of the fallow of an indigenous garden was compared with species found in an introduced gardening system through an inventory of species within transects through the two sites (Ruegorong 1995).

Figure 1. The Study Area. Yap is in the western Pacific, part of the Federated States of Micronesia



Results

Shifting Gardens

Basically, the development of shifting gardens involves opening the forest canopy and planting a mixed sequence of food crops. Sites used for such gardens are generally secondary forest. The under-story is slashed and trees are ring-barked or girdled with fire during the dry season and left standing to serve as yam trellises. Crops are planted as the trees are defoliating, and the ground is generally covered with mulch and crops by the time the heavy rains arrive. A sequence of crops is harvested over a period of one to three years. At the end of the active gardening phase, the site may be converted into a site-stable agroforest, or allowed to revert to wild vegetation.

Enhancement of the Fallow to Develop Site-Stable Agroforestry Systems

If a family settles in the area, the cropping site may be enriched with useful species and developed into a tree garden and taro patch agroforest. This generally involves developing raised areas for house platforms, trails, and tree crops, with soil excavated from low areas, which are developed into taro patches. This landscape enhancement allows trees to be grown in close proximity with root crops, as well as the maintenance of a forest of useful species producing a variety of products from year to year, with no fallow phase. If unwanted trees grow, or the agroforest becomes too shaded, trees are cut or girdled with fire and the area is transformed into an intermittent mixed garden for a time. Breadfruit, *Artocarpus altilis*, provides both fruit and wood and is especially amenable to this type of management. It readily sprouts from roots and, in this manner, migrates into suitable areas and contributes to the reformation of tree gardens.

Intensifications used in Shifting Systems

In upland areas beyond villages, gardens are generally allowed to lie fallow after the cropping phase. However, under conditions of increasing population pressure and decreasing forest resources, a series of methods are adopted to maintain or increase production from the gardens. Where there is an intermittent tree canopy, trees are girdled and left standing to serve as trellises for yam vines. Species whose roots do not compete with crops are retained and managed to provide some shade. Other species deemed to be good for a garden, such as the fragrant giant fern *(Angiopteris evecta)* and useful wild shrubs and trees, may be cut back and allowed to grow again at the end of the active gardening phase, or allowed to grow on the periphery of gardens where they do not shade the crops. Ditches dug around the garden help to prevent the invasion of roots from outside.

A wide variety of crops are planted in suitable micro sites. When one crop is harvested, another generally replaces it. For example, when yams are harvested, *Xanthosoma* taro is planted in the hole left by the yam tuber. Pumpkin vines and *Cucurbita* spp. are planted in the early phase of the garden. They serve to protect the soil and produce edible tips and fruit. In the latter phase of the garden, they are replaced by sweet potatoes, which are more tolerant of poor soil and also provide a ground cover, as well as another crop. Bananas also serve to shade out invasive weeds. Most gardens are small and surrounded by forest, so there is a constant rain of seed carried by fruit bats and birds. Gardens are selectively weeded and, in the later phases, desirable seedlings are allowed to grow. *Hibiscus tiliaceous*, a shrubby tree believed to contribute to soil fertility, may be planted or allowed to grow in shifting gardens (Zan and Hunter-Anderson 1988). Often, this occurs as a result of planting cuttings around the perimeter of ditched beds in order to retain piles of stems placed around the perimeter of the garden. The cuttings grow and often dominate the succeeding fallow. *H. tiliaceous* was present in all one to four year old fallows surveyed in this study (Falanruw 1995). The planting of *H. tiliaceous* may have been more systematic in the past, when fibers from special varieties were needed for fish nets, ‘grass’ skirts, and other uses. In recent years, Yapese women have begun to associate *Leucaena leucocephala* with more fertile soil, and some broadcast seed of this species in the garden to enhance the fallow.

Further intensification of shifting gardens includes the segregation of yam beds into more fertile and well-drained parts of the garden. Special attention is also paid to the preparation of yam planting sites, including the development of mounds utilizing fertile soil from ditches around the garden, and heavy mulching with off-site as well as on-site material. Community groups may also create more intensive yam gardens for special occasions, with pyramid-shaped trellises. In such cases, the whole bed is heavily mulched with materials from the site as well as special mulches, soil and ash brought to the site. Individual yam vines are trained to grow around the pyramid trellis so that the end result is a pyramid of leaves in which shading is minimized.

A more intensive sequence is the conversion of a relatively infertile site into a banana orchard by developing ditched beds that are very heavily mulched with material brought to the site. Fertile soil from surrounding ditches is added periodically. Following one or more harvests of special varieties of bananas, equally special varieties of yams are grown in the banana mulch and enriched soil of the ditched beds, using pyramid trellises. In this system, the fallow is converted into a banana grove that enriches the site for subsequent cultivation, beginning with yams and continuing with other crops until the biomass and fertility of the site is exhausted. At this point, with limited materials remaining for trellises and mulch, the ditched garden beds may be used to grow sweet potatoes, which are more tolerant of poor soils. Along early visitors to Yap, Cantova (1722) mentioned the cultivation of sweet potatoes in gardens surrounded by ditches. In the preparation of sweet potato sites, the on-site vegetation is slashed or merely pressed down. Additional mulch, including sea grass (Enhalus acoroides), may be added. Then the layers of mulch are covered with soil from the ditches surrounding the garden bed. This method is similar to that used to grow sweet potatoes in the highlands of Papua New Guinea (Sillitoe 1996), except that the beds are rectangular, rather than round.

Extensive Gardening

Yap's population decline was reversed after World War Two. The new American administration provided opportunities for wage employment and the men were less likely to be available for the heavier gardening chores, such as erecting the central poles for pyramid trellises. Women, having more children to care for, turned to more extensive cropping methods, such as the creation of 'roll-over gardens.' Because the population had tumbled so dramatically, they were able to borrow adjacent land and re-invest planting material from a first garden into a new garden next door. In this way, they were able to harvest a wider range of crops, with second year crops such as bananas harvested from the old garden, and first year crops coming from the new garden. However, the system resulted in a larger contiguous open area and reduced the opportunity for seedlings of forest trees to germinate and grow. Today's gardeners also 'high grade' an area by using a site for one year to produce the most prestigious crop, yams. Then they abandon the site and move to another. Another form of extensification is careless burning, resulting in wildfires that destroy a greater area of forest than is needed for a garden. Such methods more rapidly convert forests into areas of secondary vegetation.

A comparison of vegetation maps based on aerial photographs taken in 1946 (Johnson et al. 1960) and 1976 (Falanruw et al. 1987) shows a 3% increase in secondary vegetation and a matching decrease in upland forest. A more recent timber survey (MacLean et al. 1988) indicates more extensive conversion of forest to secondary vegetation. This survey measured the volume of timber in a stratified random sample of plots. The plots were chosen by placing a grid over the 1976 vegetation map and selecting a random sample of plots from grid intersections that fell in areas mapped as upland forest, mangrove, or swamp forest. Field surveys of the eleven chosen plots revealed that five fell into small agricultural developments and one fell on a recent burn, leaving only five plots with trees big enough to measure. Two of these were in mangroves and three in forest. This suggested that about 55% of the forest present on 1976 photos had been converted to agricultural use or burned. Thirty-six percent of the timber volume measured on the plots was composed of fast-growing secondary tree species. It therefore appeared that much of the area demarcated as forest on the 1976 map either contained areas of secondary forest or had been converted to secondary forest by 1983.

In addition to the impact of more extensive methods of shifting cultivation and repeated burning, indigenous gardens are now more likely to be smothered by invasive species such as *Chromolaena odorata* (*Eupatorium odoratum*) and *Merremia peltata,* or made inaccessible by the noxious spiny *Mimosa invisa*. These species are shaded out in small gardens where the canopy rapidly reforms, but can dominate sites where clearing has been too extensive.

The island's forest resources are being exhausted and there is a constant need to intensify agricultural production. Most government and development agencies have invested in introduced systems of open canopy row cropping, but these have not been successful.

The effect of the many selective activities by which traditional gardeners manage both their gardens and their fallow is not as immediately impressive as the development of row crop gardens with bulldozers. But the end result may be more productive and more sustainable. In order to measure the benefits of indigenous practices on fallowed land, the species composition of an indigenous garden in its second year of fallow was compared with the species that invaded a government demonstration plot abandoned for two years (Ruegorong 1995). Both gardens were made on the same soil type, and were separated by a strip of forest. The demonstration garden was created by bulldozing an area about ten times larger than most indigenous gardens, and planting rows of bananas and other crops. It was made up of numerous individually owned plots, whose establishment was subsidized by the Government, but whose subsequent management was left to the owners. Unfortunately the plots were more open to weeds and the task of weeding was more intensive than in traditional gardens. The motivation to work harder was limited by the lack of a market for the main crop of bananas[1] and the yams grown in the demonstration plots lacked the prestige of those grown in indigenous gardens and could not compete. Almost all of about 61 demonstration gardens were abandoned within a year after the departure of the consultant who promoted them. The impact of the two systems on the potential for forest regeneration can be evaluated by comparing the succession of species present in the fallows (Table 1). The utility of species occurring in the fallows of the two systems is compared in Table 2.

[1] The ability of indigenous systems to produce bananas had earlier been demonstrated when a market opened and, without the aid of a consultant, the production of bananas for the market increased six-fold to meet demand (Falanruw 1995).

The indigenous garden had a greater number of native tree and fern species, while the demonstration garden had more species of grass and weedy shrubs, suggesting that the indigenous garden would develop into a forest fallow, while the demonstration garden was less likely to develop a tree canopy and would instead proliferate weedy species. In the indigenous garden, 73% of the species were native, many of them useful. All but four of the 22% of introduced species were feral crops, which would produce small subsequent harvests as well as providing planting materials for subsequent gardens. In the demonstration garden, 48.5% of the species were native and the 43% of introduced species were mainly weeds, with only two species of feral crops persisting. The weeds included recently introduced invasive species not yet commonly found in indigenous gardens. In all, there were local uses, such as food, fiber and medicines, for 66% of the species growing in the indigenous garden, while only 20% of the species in the introduced demonstration garden had any use (Table 2).

Table 1. Species Composition of a Fallowed Indigenous Garden Compared with an Abandoned Introduced Row Crop Garden

	Trees		Shrubs		Ferns		Grass			Herbs			Vines		Total species			
Species status	N	I	N	I	N	I	N	I	?	N	I	?	N	I	N	I	?	Total
Indigenous garden	14		5	1	5		1		2	2	3		3	4	30	9	2	41
Introduced garden	7	1	2	7	1		4	1	1	2	4	2	2	1	17	15	3	35

N= native species; I= introduced species; ?= species could not be determined

Adapted from Ruegorong (1995).

Conclusions

The conversion of shifting cultivation sites into tree garden and taro patch agroforestry systems provides the benefits of continuous production from a variety of crops in close proximity to residences. At the same time, these systems provide the ecological services of forests and thereby contribute to ecological stability. These systems are well adapted to providing for household economies with surpluses for sale. This is demonstrated by the fact that most local produce sold between 1973 and 1992 was produced in such systems (Falanruw, 1995).

The limitation of the tree garden and taro patch system is that it cannot be rapidly intensified to provide surplus production for special occasions. This function is provided by the shifting cultivation system, and may be a reason why it is maintained even though it is less sustainable. The shifting system allows for extensive management when the ratio of forests to people is high, but it can also be refined and intensified when the ratio of forests to population is lower. The simultaneous maintenance of both site-stable and shifting systems also provides for variety and complementary crop production, as the main crop of the shifting systems, *Dioscorea* yams, is counterpoint to the production of the main tree crop, breadfruit. Maintenance of both systems also provides resiliency resulting from a diversity of crops and production systems in an area of variable rainfall and occasional typhoons. A similar combination of site-stable and shifting systems is found elsewhere, as in the combination of rice paddy and shifting gardens in Indonesia.

Table 2. Summary of Species Composition, by Status and Use, of a Fallowed Indigenous Garden Compared with an Abandoned

	Percentage of Native and Introduced species			Total Percentage of useful species
	N	I	?	
Indigenous garden	73	22	5	66
Introduced garden	48.5	43	8.5	20

N= native species I= introduced species, ? = species could not be determined

Adapted from Ruegorong (1995)

While the tree garden and taro patch agroforestry systems appear to be sustainable, there is considerable opportunity for improving current practices of shifting agriculture. It appears that the system would most benefit from the re-application of traditional intensification methods, although there would also be benefits from an integration of research technologies and indigenous practices.

Research Priorities

These include the following:

- Documentation of methods, measurement of production, and evaluation of sustainability of indigenous systems while traditional practitioners are still available.
- Research on the potential contributions of *Hibiscus tiliaceous* to soil fertility. While indigenous gardeners on Yap and other islands in the Pacific regarded this species as enhancing soil fertility, there appears to have been no studies of its characteristics.
- Research on the potential nutrient contributions of microbial enriched silts to garden beds in ditched-bed agricultural systems.
- Management of roots invading gardens by use of ditching technology.
- Suitability of machinery for creating ditches in indigenous gardens.
- Management of, or substitutes for, species such as *Leucaena leucocephala,* which appear to enhance soil fertility, but which can be invasive.

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