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AGROFORESTRY PATHWAYS FOR THE INTEGRAL DEVELOPMENT OF SHIFTING CULTIVATION

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SUMMARY

Agroforestry is not so much an "alternative" to shifting cultivation as a systematic approach to reintegration of its basic elements into more productive, sustainable and politically viable forms of land use under pressure of population and competing uses for land, labour and other production inputs. Any attempt to successfully improve, replace or otherwise integrate shifting cultivation must recognize that the problems of integration are as much political and institutional as ecological and technological in nature, and that integration is interactive.

Different technological options open up from different stages of intensification in swidden systems. A review of evolutionary typologies of shifting cultivation gives rise to a framework for the identification of system specific agroforestry interventions and development pathways. Technological proposals are limited to a short list of the most promising agroforestry interventions in "main sequence" swidden systems. These include: "integral taungya," economically and biologically enriched fallows, variations on the "alley cropping" theme, and various forms of tree crop permaculture. The emphasis is on technologies appropriate to mixed household economies. Examples and quantitative data are cited to substantiate the main hypotheses behind the proposals.

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INTRODUCTION

As a land use system which represents the de facto integration of agriculture and forestry, the problem of shifting cultivation falls squarely within the purview of agroforestry. The deliberate management of woody fallow vegetation as part of the rest cycle of fallow-based agricultural production fully qualifies all but the most prodigal forms of shifting cultivation as a type of agroforestry by virtue of the temporal integration of woody and herbaceous components. Many swidden systems, moreover, embody a highly integrated and concurrent spatial association of trees with crops, not to mention the spatial and temporal associations with domestic and wild animals found in many swidden systems.

It is now widely acknowledged that shifting cultivation, in its more traditional and culturally integrated forms, is an ecologically viable and economically rational form of tropical agriculture as long as population densities are low and fallow periods are long enough to maintain soil fertility (Dobby 1946, Watters 1960, Nye and Greenland 1960, Allan 1965, Spencer 1966, Gourou 1966, Greenland 1975, Kulle 1983, Okigbo 1984). Current interest in the improvement or transformation of shifting cultivation is justified by the fact that previously stable swidden systems are now breaking down under pressure and something must be done to regain a sustained yield path.

In the search for solutions to the problem of shifting cultivation, attention has turned to agroforestry. Since shifting cultivation is a type of agroforestry, agroforestry is not so much an "alternative" to shifting cultivation (Nair and Fernandes 1984) as a systematic approach to the reintegration of its basic elements into more productive, sustainable and politically viable forms of land use, under pressure of population and competing uses for land and labor.

The aims of integration include:

1. Integration of land use systems for sustained productivty;

2. Integration with national economies for equitable development of local resources and communities;
3. Resolution of land use conflicts through technological integration of trees into farming systems and farmers into forests;
4. Integration of cross-sectoral research and extension efforts to identify, develop and disseminate the needed technologies in cooperation with local communities.

The focus of this paper is on agroforestry options for the technological integration of swidden systems at different stages of development. The technical proposals are limited to a short list of the most generally applicable and promising interventions in systems located on the main sequence of swidden intensification in humid and subhumid tropical environments, where shifting cultivation plays its greatest role. Since different technical options and development pathways open up from different stages of intensification, the discussion of agroforestry interventions is preceded by a review of evolutionary typologies and development theories.

CLASSIFICATION AND EVOLUTION OF SWIDDEN SYSTEMS

Shifting cultivation has been defined as an agricultural system in which the fields are cleared, usually by fire, and cultivated for shorter periods than they are fallowed (Conklin 1957). Although some writers have argued for a restriction of the term to systems involving relatively long fallow periods (Ruthenberg 1971, Lanly 1983), in general usage the term "shifting cultivation" is often applied to any fallow-based agricultural practice involving the movement of cultivation sites. The broader concept will be used in this paper since it is more consistent with an evolutionary perspective on the later developmental stages of shifting cultivation.

Numerous criteria have been employed in the classification of swidden

systems (Okigbo 1984). For present purposes it is sufficient to highlight the following two main criteria: 1) the degree of socioeconomic integration and 2) the level of land use and labour intensity of particular systems. As regards the former criterion, the distinction has been drawn between "partial" and "integral" systems of shifting cultivation. Partial swidden reflects "predominantly only the economic interests of its participants (as in some kinds of cash crop, resettlement, and squatter agriculture)," whereas integral systems "stem from a more traditional, year round, community-wide, largely self-contained, and ritually-sanctioned way of life" (Conklin 1957).

The "self-sufficiency" of long fallow integral swidden systems is a relative matter. Historically many integral swiddeners engaged in international trade and even today play an important role in the export economies of their countries. In Indonesia, most of the pepper, coffee, bezoin, coconuts, tobacco and rubber is grown by shifing cultivators (Pelzer 1978, Dove 1983). In Africa there are few, if any, purely subsistence agriculturalists left today (Prothero 1972).

The classification in terms of land use intensity has been elaborated by Boserup (1965, 1981), Allan (1965), Ruthenberg (1971), Benneh (1972) and Greenland (1973). Table 1 lists the main characteristics of the four major stages in the evolution of shifting cultivation.

The role of population pressure as the driving force behind the intensification of shifting cultivation toward permanent forms of agricultural land use is elucidated by Boserup (1965, 1981). Initially, as population density increases in an area, fields are simply cropped more frequently, leading to a shortening of the fallow period. If the fallow period becomes too short to allow complete restoration of soil fertility, the swidden "degradation syndrome" sets in, driven by the need to clear and plant larger fields to meet a given production target, which in turn results in shorter fallows, and so on.

Table 1. The main stages of intensification in the evolution of shifting cultivation. (After Greenland 1974 and Boserup 1981)

Stage 1	Stage 2	Stage 3	Stage 4
Simple shifting cultivation	Recurrent cultivation long term medium short	Recurrent cultivation with continuously cultivated plots Shifting cultivation with permanent tree or other cash crops	Continuous cultivation
(Greenland 1974)			
Forest fallow	Bush fallow	Short fallow	Annual cropping Multicropping
very sparse 0-4/km^2	sparse 4-16/km^2	medium 16-64/km^2	dense 64-256/km^2 to very dense 256+/km^2
---------- population density ----------			
(Boserup 1981)			

If the pressure on the system cannot be removed by migration, the only way out of the degradation cycle is to adopt technological changes in the cropping system which result in higher yields per unit of land. Changes either in the frequency of cropping (resulting in a higher intensity of land use) or in the technology of cropping systems (resulting in higher output per unit of land) have been accompanied historically in pre-industrial agriculture by lower yields per unit of labor. The intensification sequence depicted in Table I can be characterized as a "reluctant evolution," since farmers quite rationally avoid the adoption of more intensive practices as long as extensive, less labor-requiring alternatives are still able to satisfy their production objectives.

Although swidden intensification can be conceived as a continuum from long to short to zero fallow, movement along the continuum is not always unidirectional. "Disintensification" or a return to more extensive agricultural practices (Brookfield 1972) often results when farmers migrate to new agricultural frontiers, or when population pressure in an area is relieved. The higher returns to labor from more extensive forms of shifting cultivation, incidentally, is one of the main incentives for "forest encroachment" by shifting cultivators, and is largely responsible for the negative reputation of shifting cultivation among foresters.

At Stage I, shifting cultivation is practiced under conditions of low population density, where land is generally a "free good" and may be considered, for practical purposes, "infinite" since a given swidden plot may never be brought back into cultivation or not until the rest-period required for full vegetative regeneration and fertility restoration has long been exceeded (Carniero 1960). This is the most ecologically balanced, economically attractive and culturally integrated form of shifting cultivation. Historically, it has provided a reliable subsistence with ample leisure for other activities, including the exploitation of minor forest products for purchase of luxury goods. Forest fallow swiddeners now show increased involvement in a variety of tree cropping activities to meet new cash demands for clothes, school fees, and medical services, accompanying increased interaction with the external world.

Unfortunately, under pressure of population and national interests in the exploitation of local land, timber, mining and other resources, the forest fallow system is becoming increasingly difficult to maintain. Hence, the transition to Stage 2. This marks the beginning of a precarious period for shifting cultivators, with the advent of the previously described "degradation syndrome" and generally increasing labor costs for weeding, etc. While field patterns vary from area to area, most of the agricultural plots are still fallowed, although permanent, multistorey home gardens associated with increasingly sedentary residential practices may become more prominent in the landscape.

Stage 2 merges into Stage 3 as population densities continue to rise, either through endogenous population growth, immigration or "clustering" of people (FAO 1984) around service centers and transportation infrastructure. Fallows are shortened but the length of the cropping period may remain the same, or even increase through the adoption of more sophisticated rotation practices (Okigbo 1984). Field patterns have usually shifted by Stage 3 toward a mixed mosaic of permanently or semi-permanently cultivated fields on the best land with recurrently cultivated fields on the less fertile land (Greenland 1974). Home gardens and market oriented tree gardens may also become prominent, thus taking land out of the fallow cycle and necessitating further intensification of swidden practice.

There is also a strong association of the two subtypes of "partial" swidden Conklin (1957) with Stage 3, i.e. "incipient" swidden, practiced by immigrants from permanent field agricutural areas, and "supplementary" swidden, practiced by permanent field cultivators as a necessary adjunct to their main permanent field activities. Although both of these variants give rise to the typical mixed field pattern characteristic of Stage 3, lacking interest in or experience with the fertility prolonging techniques of the integral swiddener and motivated by shorter term economic objectives, it is often the exploitative practices of partial swiddeners which give shifting cultivation its negative reputation among agriculturalists and planners.

Although it is a natural outgrowth of shifting cultivation under population pressure, Stage 4 marks the end of shifting cultivation. Fields are now used for at least one crop per year, and with multicropping may be used continuously. Without fallow to restore soil fertility and control weeds, industrial inputs such as fertilizer and herbicides or, alternatively, highly labor intensive practices are needed to sustain productivity. In the absence of sufficient industrial inputs to maintain very high levels of crop offtake, it is a serious question as to how much further the intensification of annual crop husbandry can be pushed.

Most populations in the tropics are growing rapidly, some at the rate of 3 to 4 percent per annum, with a doubling time of about 20 years. Outmigration in search of employment is increasingly commonplace and many rural areas are taking on the characteristics of the "remittance economy." Population growth due to greater access to modern medical care, increased clustering of population because of the desire to live near schools, markets, transportation facilities, etc., and loss of arable land to perennial cash crops and other uses, creates a situation within a generation which might previously have taken centuries to develop, if at all. Major breakthroughs are needed to sustain and increase the population carrying capacity of the rural areas (Prothero 1972, Unesco/UNEP/FAO 1984).

AGROFORESTRY OPTIONS AND DEVELOPMENT PATHWAYS

Agroforestry is not the solution to every problem, but in the case of shifting cultivation there are a number of agroforestry approaches which hold promise for sustainable increases in the productivity of systems at different stages of intensification (see Figure 1). Table 2 depicts, in slightly more detail, the matching of these technologies to specific stages.

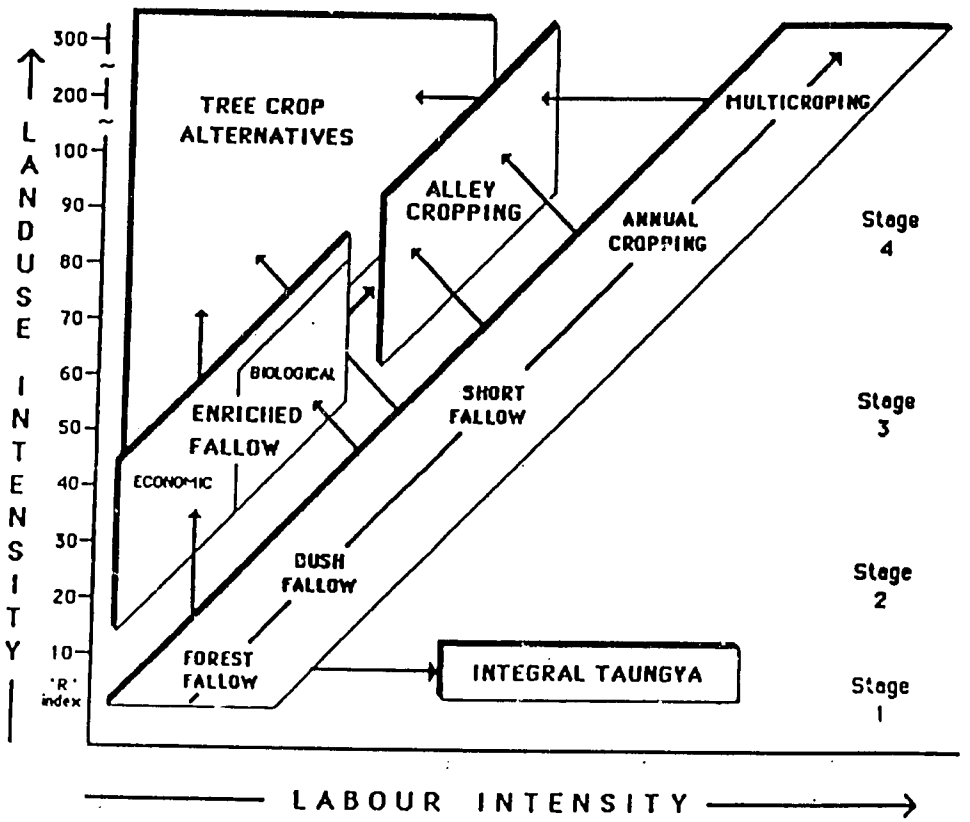

Figure 1. Agroforestry Pathways for Swiden Intensification. The R index (Joosten 1962) values shown on the left give an approximate indication of the land use intensity corresponding to the stages shown. R = (C/C+F) x 100. Where: C = cropping period, F = fallow period. The R index is also equivalent to the percentage of land in cultivation, as read from aerial photos. Boserup's (1981) treatment as a "frequency of cropping" index allows the interpretation to be extended to multicropping. For R > 100, R corresponds to the number of crops taken per year.

Table 2. Stages in the intensification of shifting cultivation and matching agroforestry options. Primary and secondary priorities/feasbilities are indicated by X and x, respectively.

	Stages of intensification			
	1	2	3	4
Improved Fallows				
"Integral taungya"	X	x		
Economically enriched fallows	X	X		
Biologically enriched fallows		X	x	
'Alley cropping"			X	X
Tree Crop Alternatives				
Tree cash crops	X	X	x	x
Home gardens		x	X	X
Interstitial plantings		x	X	X

IMPROVED FALLOWS

"Integral Taungya"

By analogy with integral shifting cultivation, the proposed concept of "integral taungya" is meant to invoke the idea of a taungya practice which offers a more complete and culturally integrated approach to rural development: not merely the temporary use of a piece of land and a poverty level wage for labour, but a chance to participate equitably in a sustainable agroforestry economy.

The social aims of the proposed approach are high, and they are nowhere fully realized in practice, but perhaps the "Forest Village" schemes in Thailand come closest to the ideals of "integral taungya." To make participation in the foresty effort attractive to traditional shifting cultivators, in some variants of this approach the Thai foresters not only encourage farmers to grow long term perennial cash crops by widening the between-row spacing of the commercial forest species, but also allocate permanent agricultural plots to the participants within the forest village scheme. In addition, they pay attractive wages for a variety of work opportunities in the forestry sector of the schemes and provide a range of community development inputs, such as housing assistance, clinics, schools, and places of worship (Boonkird et al., 1984). Far from an "exploitative" practice (Seth 1981, Foley and Barnard 1984), this Thai variant of the taungya system shows signs of becoming a model example of what is meant by "integral taungya."

Although it has been suggested that taungya can only work where land scarcity prevails (Enabor 1974), from the viewpoint of a socially integrated approach to land use, the greatest opportunity for taungya forestry in the context of shifting cultivation is where the fallow is long enough to allow regeneration of forest trees with minimal disruption of existing swidden practice, i.e. in Stage 1, although with intensification of field crop practice it could be extended into Stage 2.

In general, the lower the agricultural land pressure, the heavier the reliance on cash income and community development incentives to make the scheme attractive to farmers. Social equity considerations aside, self-interest alone may justify this approach to foresters as one of the few realistic ways of enlisting farmers as allies, rather than enemies, in the forestry production effort (Raintree 1984).

Enriched Fallows

For improvement of swidden systems at the early stages of intensification, agroforestry interventions must meet fairly stringent criteria of adoptability. Shifting cultivators in Stage 1, and to a lesser extent at the beginning of Stage 2, are likely to enjoy fairly high returns to labor, and any technology with the hope of being adopted must avoid increasing the labor requirement beyond an acceptable level for a given production target. Also, it is important to choose practices that are not so dissimilar to current farming methods as to invoke unnecessary cultural resistance. Improvement of the existing fallow practice, therefore, suggests itself as the "path of least resistance."

There are two variations on this approach: economically enriched fallows (designed to increase the economic value of the fallow vegetation by enrichment with trees valued for their cash or subsistence uses), and biologically enriched fallows (designed to enhance and accelerate the vegetative regeneration of soil fertility and control of weeds).

Interest in the adoption of biologically enrichced fallows is not likely to arise until the swidden farmers themselves have had some experience with the struggle to maintain soil fertility, and this does not usually occur until Stage 2 in the intensification sequence. There are many examples, however, of economically motivated fallow enrichment by long fallow shifting cultivators (Olofson 1983); for example, the planting of cedar and bamboo in the fallows of the Lingnan Yao of Kwangtung Province in China (Lebar et al. 1964), and of casuarina by the Siane of New Guinea (Salisbury 1962). The Ifugao of the Philippines are famous for their rice terraces, but a little known feature of the system is the use of swidden in the watershed above the terraces to establish multipurpose fallow woodlots whose diversity exceeds that of the natural forest (Conklin 1980).

One of the most interesting examples of economically enriched fallows is the rattan planting of the Luangan Dayaks of Borneo, which has been

practiced on fallowing swiddens since the last century. The 7 to 10 year growth period necessary for a good rattan harvest fits nicely with the fallow requirement for stable swidden agriculture in this area and the practice, while returning a good cash income, does not disrupt the swidden cycle of food production (Weinstock 1983). The cultivation of rattan on this model may be the solution to current shortages of this traditional forest product in the Philipppines and elsewhere in the region.

Reports of biological fallow enrichment practiced by bush fallowers are harder to find in the literature, but some examples may be cited from Africa and Asia. Benneh (1972) and Okigbo and Lal (1979) report planted fallows of Acioa barteri, Anthonotha macrophylla, and Alchornea cordifolia on ultisols in eastern Nigeria (Getahun et al. 1982). An interesting practice from southwestern Nigeria is the vegetative propagation of Gliricidia sepium for live yam stakes. Loppings of the coppicing branches provide green manure during the cropping period and the trees are left to enrich and accelerate the fallow between cropping cycles (Agboola et al. 1982). A similar practice using Leucaena leucocepha has been reported from Indonesia (Dijkman 1950). Livestock may also be integrated into planted fallows (Lazier et al. 1982, Bishop 1983).

As some of these examples suggest, in practice the distinction between economically and biologically enriched fallows is not rigid, since the same trees might fulfill both functions. As a principle of good agroforestry design, priority should be given to the selection of dual purpose fallow species, whose adoption for direct economic benefits at an early stage of intensification would amount to an early adoption of the biologically enriched fallows needed for later stages (Raintree 1983a).

Variations on the "Alley Cropping" Theme

"Alley cropping" may be defined as a zonal approach to agroforestry in which field crops are planted in the alleys between hedgerows of nutrient-cycling trees or shrubs which are kept pruned throughout the cropping season to control shading and below ground competition while providing green manure and mulch material for the benefit of the associated crops. The term was coined by researchers at the International Institute of Agriculture (IITA) in Nigeria (Wilson and Kang 1980), but the practice itself appears to have originated some five decades earlier on the island of Timor in Indonesia (Metzner 1981).

Wilson of IITA describes alley croppping as a "continuous fallow" practice (personal communication), foregoing the normal meaning of "fallow" to emphasize its functional processes. By selecting improved fallow species and by planting them in widely spaced rows, the functional benefits of fallow can be made continuous and the labor efficiency of the practice can be enhanced. Variants of the technology employing herbicides and zero-tillage or mulch-tillage methods and tools have been developed (Wijewardene and Waidyanatha 1984).

Similar "continuous fallow" functions might be performed by more intimate mixtures of trees with field crops, e.g. the Acacia albida systems of the Sahel (Felker 1978). The proposal here of the zonal "alley cropping" model is not meant to be exclusive of other plant arrangements, where they may be a more appropriate way of accomplishing the same functions (Huxley 1980; Huxley and Raintree 1983).

The economic benefits of various experimental alley cropping systems have been examined by Raintree and Turay (1980), Verinumbe et al.(1984), Hoekstra (1984), and Ngambeki and Wilson (1984). Table 3 summarizes some of the main results of the latter study.

Table 3. Yields and returns to labor of maize grown between leucaena alleys compared to other treatments. (Note: Severe drought occured during the 2nd season of 1981). Data Source: Ngambeki and Wilson (1984).

	Control	Leucaena	Nitrogen	Herbicide	Leuc+herb
1981					
1st season					
yield (kg/ha)	1957	3789	2749	3094	3358
labor (man-days)	424	890	466	422	788
yield/man-day	4.62	4.26	5.90	7.33	4.26
2nd season					
yield (kg/ha)	758	2486	998	616	1685
labor (man-days)	652	816	731	280	705
yield/man-day	1.16	3.05	1.37	2.20	2.39
1982					
1st season					
yield (kg/ha)	2159	3141	2872	1929	3660
labor (man-days)	400	548	417	245	440
yield/man-day	5.40	5.73	6.89	7.87	8.32

If sufficient care is exercised in the selection and arrangement of trees for biological fallow enrichment at Stage 2, the way can be paved for a smooth transition to alley cropping when the need for this more labor intensive practice arises at Stage 3. The general principles of this phased approach to agroforestry design, based on the concept of an "optimal pathway of intensification," have been discussed elsewhere (Raintree 1983a, 1983b) and can be applied throughout the intensification sequence.

For example, at Stage 1 or 2 groves of economically valuable trees could be established by fallow enrichment/taungya practices. Choosing coppicing species which are also capable of improving the fallow biologically, would pave the way for greater sustainability of swidden practices in the latter phase of Stage 2. By planting the selected trees in hedgerows at appropriate between-row spacing, the way would be clear for an intensification of the fallow practice into alley cropping in Stage 3. Initially, the two practices could be combined by means of a rotating fallow, allowing different subdivisions of the plot to rest every few years, thereby decreasing the labor requirement for weed control and perhaps maintaining the fertility balance at a higher level. Eventually, as population pressure increases, this fallow would be eliminated in favor of continuous alley cropping at Stage 4, and ultimately, to effect the final measure of intensification the farmer could develop the vertical dimension of the system by planting a variety of multipurpose trees. At this final stage of intensification the system might begin to resemble the multistorey home garden and to exhibit its characteristic labor efficiency (see below).

TREE CROP ALTERNATIVES

The transition to tree crop based systems is differentially feasable from different stages along the intensification sequence. From Stages 1 and 2 the adoption of market-oriented tree crop systems is fairly easily achieved as an intensification of fallow enrichment practices and less easily achieved at Stages 3 and 4, due to the commitment of land to other uses and the relatively long lag time between planting and first harvest although taungya techniques can ease the burden of the establishment phase by providing early returns of interplanted field crops.

Since the planting of tree cash crops will often take land out of subsistence food production, after Stage 1 extensive plantings must

usually be accompanied by some form of field crop intensification. Alternately, trees for cash and/or subsistence uses can be planted in "interstitial" locations around the farm, and the subsistence contribution of trees can be increased through the intensification of home gardens.

Tree Crops for the Market

A clear example of the transition to market-oriented tree crop production is the conversion of swidden plots into fruit orchards on Palawan Island in the Philippines (Eder 1981). High population density (200/km^2), an overall land use intensity index (R) of about 60, stable land tenure and proximity to a good market are all conducive factors in this transition, as are the higher returns to land and labor from the tree crop system. Eder's data show that the income from fruit orchards (mainly coconut, banana, cashew and citrus) is about 5 times more per unit of land and about 3.8 times more per unit of labor than upland rice swiddens, the main alternative land use. About 50 percent of the farmland in the area is now planted to tree crops.

A similar land use pattern has developed in bush and short fallow areas of West Africa, with extensive smallholder plantations of oil palm, cacao, coffee, cola nut, plantain and banana covering as much as 67 percent of the farmland in southern Nigeria, and with crops like cacao giving labor returns about twice that of short fallow food crops (Getahun et al. 1982). Coconuts, rubber, oil palm, cacao and coffee play a similar role in tropical Asia (Pelzer 1978), but with a higher intensity of intercropping in multistorey commercial systems based on coconut (Nair 1979, Liyanage et al. 1984). Understorey livestock grazing or foraging adds another dimension to the productivity of these systems.

One of the most interesting examples of aboriculture is the man-made dipterocarp forests of Sumatra (Torquebiau 1984). The exploitation of wild Shorea spp. for commercial resins has a long history among shifting cultivators of Southeast Asia. Sometime before the 19th Century

domestication of Shorea javanica occured in the complex agroforests of Southern Sumatra, where the trees are intercroped with as many as 19 other crops. The economics of the system have yet to receive detailed study, but Torquebiau estimates the income from the tapping of the resin alone to be about U.S. $1,100/ha/year.

Trees for the Support of Population

In his study of Ibo farming practices in Southeastern Nigeria, where population densities range as high as 1000/km^2, Lagemann (1977) found a strong positive correlation between population density and the intensity of tree use. Land area devoted to multistorey compound gardens increases with population density, reaching 29 percent of the cultivated area and producing 59 percent of the crop output in the most densely settled areas. The observed shift in land use is explained by the fact that the output from the compound gardens is 5 to 10 times greater in monetary terms than that from the outfield plots, and the returns to labor are 4 to 8 times higher. A system of comparable intensity has been reported in a high density area of East Africa (Fernandes et al. 1984).

In Java where rural population densities are among the highest in the world, three forms of tree gardening have been distinguished, ranging from intensive multistorey "home gardens" to more extensive "mixed gardens" and "village forests" (Wiersum 1982, Hunink and Stoffers 1984). Here again, the area devoted to home gardens increases with population density, occupying anywhere from 15 to 75 percent of the cultivated land (in a mosaic with wet rice, rainfed arable crops and other tree garden types), producing more than 20 percent of household income and 40 percent of household caloric requirements, and providing one of the highest returns to labor of all available employment opportunties (Stoler 1978).

One of the most striking examples of the capability of tree crops to support increased population density is the tree-based economy of Roti and Savu islands in eastern Indonesia, where nearly total exploitation of the multipurpose lontar palm (Borassus sundaicus Beccari) has allowed the development of a vigorous and diversified economy which far exceeds the population carrying capacity of the degraded swidden systems of the neighboring islands of Sumba and Timor (Fox 1977). The pivot of this economy is the tapping of the sugary sap of the palm, which constitutes the staple food of the people and one of the main sources of carbohydrate for semi-intensive pig rearing. The palm is also the source of a bewildering variety of other useful materials, and its litter is used as organic mulch for permanent vegetable gardens. Since the returns to labor in this land use system are relatively high and subsistence needs are easily met, there is leisure for a variety of other economic pursuits, and the general wellfare of the population is noticably higher than that of their swidden counterparts on the neighboring islands.

An interesting aspect of this land use system is that it appears to have developed as the culmination of a long process of swidden intensification, when the inhabitants of the islands discovered that the hardy tree which came to dominate the degraded fallows was more useful than the crops it replaced. One wonders how many other superior agroforestry economies are lying latent within existing swidden systems.

The role of trees in this economy is exceeded, perhaps, only by the tree-based systems of the Pacific atolls and low islands (Barrau 1971), where even the drinking water is often provided by a tree (i.e. the coconut). In this connection, the underexploited potential of the palms (Johnson 1983) is so striking as to deserve special mention. Several writers have argued the superiority of tree crop-based land use systems (Smith 1950, Douglas and Hart 1976, Felker and Bandurski 1979, Mollison and Holmgren 1981, Bowers 1982) but nowhere is the argument more cogently stated for tropical environments than by Tosi and Voertman (1964):

The really critical problems to be overcome, then, if high productivity resources exploitation systems are to be developed for these life zones, would seem to be those of achieving an efficient economic utilization of the diversity of massive, fast-growing, perennial plant species and vegetational types which these environments are themselves efficient at producing.

CONCLUSION

The examples cited in this paper tend to support the view that properly selected and integrated trees can play a major role in the intensification and, in the end, the replacement of shifting cultivation by more productive and sustainable forms of agroforestry land use. "Integral taungya" is a socially oriented adaptation of conventional taungya practice which may help achieve a community of interest between shifting cultivators and foresters in areas of low agricultural land use intensity where sustained forestry production is a national priority. Given the indications of consistently higher returns to land and labor from systems emphasizing direct tree crop production, priority should be given to the tree crop alternative wherever culturally feasible pathways exist. However, since farmers will generally express a preference for the cultivation of their own field crop staples, it is noteworthy that some of the more sustainable intensification options, such as "alley cropping," would appear to offer quite favorable returns to both land and labor and can be combined with tree crops as part of the total land use mix.

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