INDIGENOUS AGROFORESTRY IN THE PERUVIAN AMAZON: BORA INDIAN MANAGEMENT OF SWIDDEN FALLOWS

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In recent years students of Amazonia have emphasized that some of the most successful food producing adaptations to the rain forest habitat have been those of the indigenous tribes, and that consequently we have much to learn from these "ecosystem" people. "Refined over millennia, Amazon Indian agriculture preserves the soils and the ecosystem... If the knowledge of indigenous peoples can be integrated with modern technological know-how, then a new path for ecologically sound development of the Amazon will have been found" (Posey, 1982: 18; 1983: 225). (For similar statements for other tropical regions see, for example, Nigh and Nations, 1980; Clarke, 1977; Eckholm, 1982: 34-35; and Klee, 1980). In particular, Indian cultivation is characterized by multiple cropping and interaction with natural vegetation.

Attention has been directed to several forms of traditional management of tropical forest resurces: 1. the diverse, multistoried swidden (shifting cultivation field) which protects the soil and allows for habitat recovery under long fallow (e.g., Conklin, 1957; Harris, 1971); 2. the house garden, or dooryard garden, also diverse and multistoried, but with a large complement of tree crops and with soil additives from household refuse, ash, and manure (e.g., Covich and Nickerson, 1966); and 3. the planting, protection, and harvesting of trail side and campsite vegetation ("nomadic agriculture" or "forest fields"), involving wild, semi-domesticated, and domesticated plants (e.g., Posey 1982; 1983: 241-243). A related type of plant management is the manipulation and utilization of swidden fallows, a form of agroforestry involving a combination of annual crops, perennial tree crops, and natural forest regrowth.

Swidden-fallow management apparently is widespread among Amazon tribes and some local mestizo farmers, but rarely among colonist farmers. However, it has received little attention; brief mentions include: Denevan (1971: 508-509) for the Campa in eastern Peru; Posey, 1982; 1983: 244-245) for the Kayapó in central Brazil, Basso (1973: 34-35) for the Kalapalo in central Brazil; Eden (1980) for the Andoke and Witoto in the Colombian Amazon; Smole (1976: 152-156) and for Harris (1971: 487, 489) and Torres Espinoza (1980) for the Shuar in eastern Ecuador. Some observers have assumed that all that is involved is a return to abandoned swiddens to search for residual crops left from the former cultivation, but indications are that actual management occurs, including planting and protection as well as utilization of certain useful wild plants that appear at various stages of fallow succession.

The purpose of this paper is to examine the swidden fallows of an Amazon native group, the Bora of eastern Peru, with the objective of de-

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monstrating how fields are gradually abandoned. This contrasts with most studies of shifting cultivation which focus on why fields are abandoned, and which present a sharp distinction between the field (swidden) and the abandoned field (fallow). For the Bora there is no clear transition between swidden and fallow, but rather a continuum from a swidden dominated by cultivated plants to an old fallow composed entirely of natural vegetation. Thirty-five years or more may be required before the latter condition prevails. Abandonment is not a moment in time but rather a process over time.

Agroforestry is currently receiving considerable attention as a potentially stable and ecologically viable form of tropical forest land use (King and Chandler, 1978; Hecht, 1982; Budowski, 1981; Salas, 1979; Hart, 1980; Spurgeon, 1980). One of the major recommendations of the recent U.S. National Research Council (1982: 4, 5, 146) report on tropical development is that the agroforestry systems of indigenous people should be studied and recorded before such knowledge is lost. We believe that certain features of Bora swidden-fallow management can be incorporated into systematic models of tropical agroforestry systems. Indeed, an examination of Bora land use indicates that "agroforestry" is new in name only to native groups in the Amazon. Under denser populations in the past (Denevan, 1976), large areas of Amazon forest may actually have been stages of productive swidden fallows. Whole biotic components were largely selected and managed, a condition Nigh and Nations (1980) call "intermediate disturbance", and which Gordon (1969: 69; 1982: 73-78) in Panama calls an "orchard-garden-thicket" or "tree garden".

The Research Area

Field work was undertaken from July to December, 1981, in the Bora settlement of Brillo Nuevo on the Yaguasyacu river, a small affluent of the Ampiyacu river (between the Napo and Putumayo) which joins the Amazon at Pebas, 120 kilometers northeast of Iquitos. The climax vegetation of the area is Humid Tropical Forest. The closest meteorological station to Pebas is Francisco de Orellana, 75 kilometers distant, where an annual average of 2,757 millimeters of precipitation was recorded (1964-1972). There is a distinct seasonal distribution, with rains peaking from December to May and abating from June through November, but with the driest month (August) still having 133 millimeters. Temperatures average around 26°C throughout the year (ONERN, 1976: 37). Brillo Nuevo is situated beside an oxbow lake formed by the Yaguasyacu. The area is a hilly, dissected fluvial terrace interlaced with numerous seasonal streams. The soils are primarily deep Ultisols (paleudults, tropohumults, and tropudults). They include red and yellow clay soils, red and brown sandy soils, and gley soils (tropaquods) in depressions. The Bora prefer to farm the clay soils and red sandy soils (Gasché, 1979).

There were 43 families living in the settlement. All are descendents of tribal groups brought to the Ampiyacu from the Igaraparaná-Caquetá region of Colombia following Peru's loss of a border war with that country in 1934. They were resettled on land eventually granted to them by the Peruvian government and to which they retain community title. (The study was undertaken at Brillo Nuevo, rather than with a community long established in its habitat, because of previous agroforestry research there by project member Salvador Flores.) The Bora are gradually being assimilated into Peruvian society through missionaries, commerce, and access to Pebas, Iquitos, and Pucallpa. Bora villagers speak Spanish, wear manufactured clothing, and market handicraft items and lumber. Bora subsistence, however, retains many of its traditional elements, with a reliance on swidden agriculture, house gardens, fallow management, fishing and collecting, and hunting, in the high forest. Previous accounts of the Peruvian and Colombian Bora include Whiffen (1915), Jiménez (1933), Forde (1934), Girard (1958), Gasché (1980), Guyot (1971, 1972, 1973, 1975a, 1975b), and Paredes (1979).

Background: Bora Shifting Cultivation

A brief survey of Bora agriculture was conducted to grasp the fundamental dynamics of the system, and to understand how cultivation techniques might influence fallow-field character and management. Various aspects of cropping are examined below, including spacing, zonation within fields (*chacras* in Peru), and the schedules of planting, harvesting, and weeding. Together, these affect the eventual structure and composition of the fallows (*purmas* in Peru). Almost the entire area of village land is in some stage of secondary forest due to shifting cultivation since the Bora arrived there 50 years ago. However, high forest begins at 20 minutes walking distance from the village and extends northward across the Colombian border.

Family fields are dispersed throughout the forest surrounding the communal *maloca* (residence of the village *curaca* or ceremonial head). Fields are often closely clustered because farmers find it convenient to visit several on one trip. Most plots are accessible within 15 minutes on foot from the maloca; others are across the Yaguasyacu and are reached by dugout canoe. Both primary and secondary forest are cleared for swiddens. Primary forest sites are recognized as more fertile, while secondary forest (fallow) is closer at hand and more easily felled. The oldest clearly identified fallow is about 35 years of age. There is botanical evidence, however, of secondary forest over 40 years of age. (Presence of buried and surface postsherds indicates previous occupation of the area at unknown times by unknown Indian farmers.)

The Bora say that a minimum of ten years of fallowing is needed before a plot can be cut and planted anew. Most swiddens, however, appear to be prepared from fallows 20 years of age or older. For the Bora, one indicator of a fallow ready to be felled and cropped is a lack of shrubby growth near ground level.

Most fields are cut and burned during the months of least rain; however a field can be prepared any time the weather permits. Field sizes range from a fourth of a hectare to one hectare. Axes and machetes are the only tools used for felling the forest. Cutting is often accomplished within hours by community work teams, but individual families can cut a field over a period of several days. Often small hills are chosen as field sites, the highest part of the hill becoming the center of the field. Fallen vegetation is allowed to dry for two or three weeks before burning. Selective cutting, a common management technique of swidden farmers, is practiced by the Bora. Valuable timber species, such as tropical cedar, are routinely spared during clearing, and various palms and other useful trees are commonly left in or on the edges of newly cleared fields; others may coppice and be protected (Figure 1).

The Bora plant a wide variety of crops; (Table 1) however the main staple is manioc. Some 22 varieties of sweet and bitter manioc are known by the Bora, and a newly planted field bristles with manioc cuttings spaced 50 to 80 centimeters apart. The Bora intersperse pineapples, fruit trees, and minor annual crops amongst the manioc. Both seeds and seedlings of trees are planted. Minimum spacing for fruit trees is said to be between 1 and 2 meters. However, as the planting period may extend over several weeks, farmers forget from day to day where tree seeds are already planted and often place seeds closer together inadvertently. Consequently, a few planted trees end up growing virtually side by side.

Some crops are aggregated within the field. Fruit trees are commonly clustered on high land, topography permitting. Areas away from field boundaries, or near trails, also appear to be preferred sites for these trees. Patches from 1 to 2 meters square are made into planting beds for tubers on sites selected according to ash distribution or local soil variations. The Bora recognize various soil types, based upon texture and color. Coca is almost always planted in well tended rows near trails and field entry ways.

Peanuts, grown in second or third year fields, are planted using a special management technique. In a small area from which manioc has recently been harvested, soil (previously loosened by manioc growth and root decay) is gathered and packed into several dozen mounds measuring from about 0.5 to 1 meter square. Ashes brought to the fields from home cooking fires are mixed in with the soil as fertilizer. Between six and a dozen shelled peanuts, previously soaked overnight in an insecticide solution of crushed basil leaves and water to prevent ant predation, are planted in the mounds. From two to four cuttings of sweet manioc are placed laterally into the sides of the mounds.

Bora names for swidden stages are based upon a field's capacity to produce manioc. A field containing the first, most productive planting of manioc is called an *úmihe*. As an úmihe is gradually harvested and replanted, it becomes a *kapúuwa*, the term for a field yielding less productive secondary replantings of manioc. The Bora consider two replantings of manioc the maximum possible. When manioc is not longer replanted the field is termed a *jía*, which is roughly equivalent to fallow field or purma.

Initial crop zonation influences subsequent management options and the pattern of forest regeneration. First, clustering fruit trees in the field center or in areas of access allows them to be easily harvested and weeded as the field matures. Second, heavily disturbed or weeded areas, particularly the coca and peanut zones, frequently will only support sparse, grassy secondary growth. This may be due to local soil exhaustion or compaction, plant allelopathic effects, removal of seedlings of secondary species during intense cultivation, or some combination of these.

Fig. 1 Photo of coppicing macambo in one year old swidden.

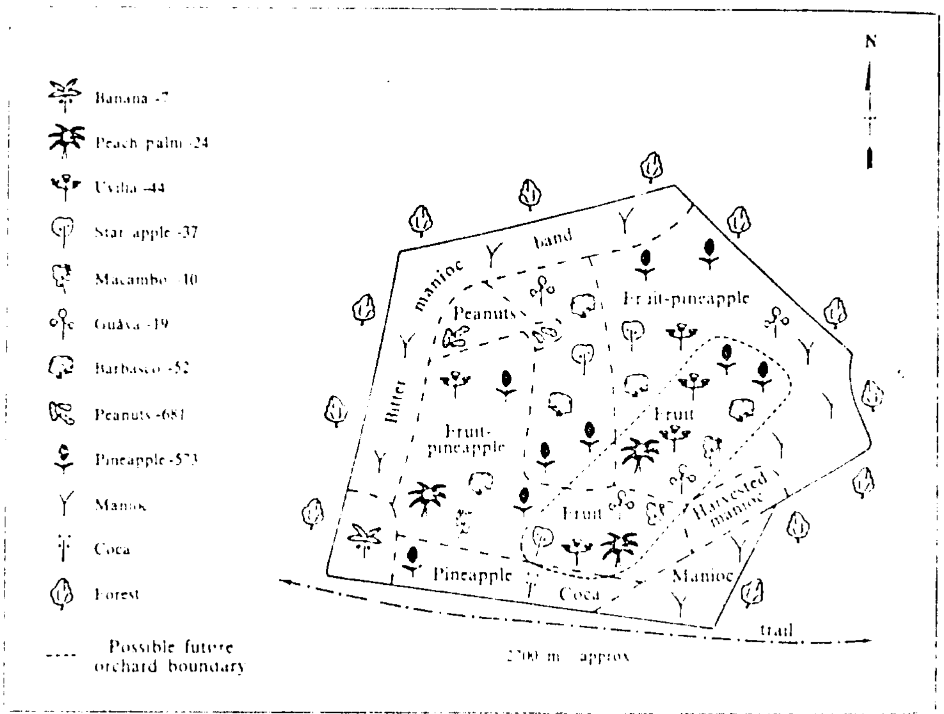

Fig. 2 Map of three year old transitional field (Kapúuwa).

(See Uhl, *et al.*, 1981, for a discussion of microhabitat preferences of secondary seedlings in Amazonia).

The crop composition of Bora fields can vary widely. Some fields have an apparent low diversity index, planted only with manioc, pineapple, and maize (mainly for poultry), and perhaps a few scattered plantains. Others are rich in species and numbers and feature complex zonation. While a range of options is to be expected in any swidden system (Denevan, 1971), the two extremes seem to be common in Bora swiddens. A similar duality is noted by Harris (1971) for tribes in the Orinoco region of Venezuela, where fields seem to be either primarily monocropped with staples or polycropped with abundant subsidiary plants. In many of these cases the crop composition in any one field may in part be determined by what a farmer has available from other fields in various stages of development. Since a Bora family may have six or more fields of different ages and crop mixtures, diversity between fields fulfills the same function of assuring a supply of varied crops as does diversity within a single field. Another significant point regarding crops is that simplified fields receive few visits after two or three years of harvests, while diversified fields have longer lasting utility in the fallow stage.

Bora Swidden Fallows

Fields of different ages were selected to examine vegetation structures and the process of abandonment. This paper examines plots of three, five, six, nine, and 19 years of age from date of cutting. Each field was measured to determine its approximate size and percent canopy cover; the vegetation was described; and the owners were interviewed to record cropping histories, fallow age, and to help inventory plants found within the fields. The vegetation was sampled using the line-intercept method. In each selected field, subplots of vegetation were identified for study. These included plant communities in areas occasionally weeded and areas of unweeded secondary vegetation. Each zone was sampled by extending two 10-meter long intercepts into the zone from randomly determined points. Plants along the lines were collected and identified by their Bora names. In addition, Bora informants identified useful plants.

The plots are not strictly comparable in terms of relief, or soil type, or planting histories. However, finding a series of fields with identical histories and characteristics is impossible in practice. Nonetheless, a dynamic model of abandonment is revealed by comparing vegetation patterns in different aged plots.

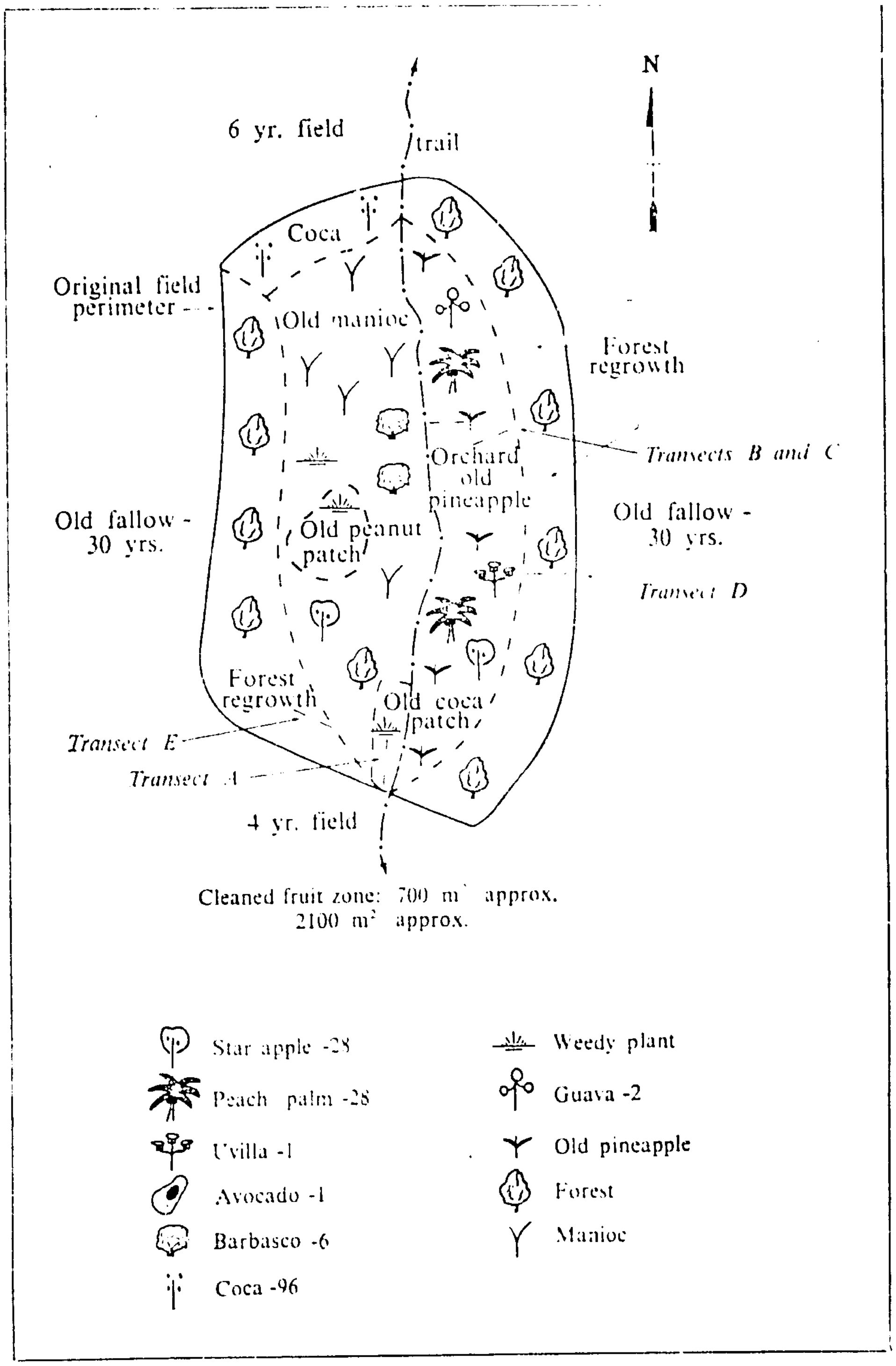

Fig. 3. Map of five year old transitional/fruit orchard (Kapúuwa).

The swidden fallows described below reflect a strategy of managed succession designed to solve a shifting cultivator's dilemma of how to maintain field production in the twilight of the cropping cycle, while at the same time permitting forest regeneration. Abandonment is similar to Manner's (1981: 360) evaluation of the swidden cropping cycle, which he describes as a "successional series partly regulated by human populations on the one hand, and ecological processes on the other". A kapúuwa, or transitional field, is chosen to head the sequence here because it represents a stage when human management is still relatively intense and forest regeneration is only just beginning.

Transitional Swidden: Three Years Old

Figure 2 is a representation of an enriched Bora swidden, cut from 30-year old fallow, located five minutes on foot from the settlement center. The field had developed multiple canopies, featured complex zonation, and contained at least 20 cultigens. Guava, uvilla, macambo, and peach palm were the dominant tree species, all measuring between 3 and 4 meters in height. The trees provided a 30 percent field cover, but had not reached their peak yielding periods. Fruit-tree density in general was greatest near the southern end along the trail. The understory of manioc was sparse because tree roots and shade prevented replanted manioc from fully developing, as illustrated in Figure 4 for a four-year old field. A small peanut patch, also containing chili pepper and other minor crop plants, was located near the northwest corner. Bananas were more or less clustered on the southwest downslope corner. The field was surrounded on three sides by 30-year old forest and on the south by newer fields less than one year old.

The kapúuwa, or transitional field, is a rapidly changing mosaic of vegetation reflecting Bora management techniques. Weeding, harvesting, and replanting manioc are performed in one small area at a time, producing a pattern of different aged stands of both manioc and associated secondary growth within the field. Weeds are often pulled out by the roots. In Figure 2 the pineapple zone on the left is weeded and the one in the center is unweeded. Selective weeding, another widespread swidden technique, is practiced by the Bora. Seedlings of useful tree species are often spared; however it is not axiomatic that all are left untouched.

In fields at this stage, tree coppicing was readily observed (Figure 1). Some of the fruit trees in the field may have been coppicing trunks of trees planted in the field when it was a chacra 30 years before. *Inga* species, useful as soil nitrogen fixers, are persistent coppicers, so abundant that they are nevertheless dispatched with machetes as annoyances. Others, such as copal, resprout and are protected. This tree grows slowly, reaching harvestable age (edible fruits) within some 20 years. A bonus of useful coppicers appears to be one advantage in clearing fallows for new fields.

Because the field was periodically weeded, secondary growth had made little headway except for invasion at the edges where fallen trees were not burned during field preparation. Some 2 or 3 meters of unweeded field perimeter had been ceded to the encroaching forest. The growth primarily consisted of fast spreading vines and thin saplings.

TABLE I

COMMON BORA CULTIVATED AND PROTECTED ECONOMIC PLANTS

Common Name (English; Peruvian)	Bora Name	Scientific Name 1	Use 2
•Annatto; achiote	—	*Bixa orellana*	H, U
•Annona, cherimoya; anona	tacááhe	*Annona cherimola*	F
•Assai, chonta; huasai	toóllíuji	*Euterpe* sp.	F, C
•Avocado; palta	—	*Persea americana*	F
•Balsa; topa	hiñuuneyo	*Ochroma* sp.	U
•Banana; manzana, guineo	ujueh	*Musa* sp.	F, U
•Barbasco	muuicurriwa	*Lonchocarpus* sp.	U
Basil; albahaca	—	*Ocimum micranthum*	F, U
•Breadfruit; pandilla, árbol de Pan	nájahe	*Artocarpus incisa*	F
Caimito	mutsitsche	*Pouteria caimito*	F
Calabash tree; pati	—	*Crescentia cujete*	U
•Cashapona	iíwajcyo	*Iriartea* sp.	C
•Cashew; cashu, marañón	añaáajibe	*Anacardium occidentale*	F
•Cedar (tropical); cedro	—	*Cedrela odorata*	C
•Chambira	niijthe	*Astrocaryum chambira*	C, H
Chili pepper; ají	—	*Capsicum* sp.	F
Citron; Citrón	—	*Citrus* sp.	F
•Coca	iipi	*Erythroxylon coca*	M
•Cocona	roolláhe	*Solanum* sp.	F
Coconut	—	*Cocos nucifera*	F
Cocoyam; huitina	ááníwa	*Xanthosoma* sp.	F
•Copal; copalhuallo	miijíllehe	*Hymenaea courbaril*	F, C
Cotton; algodón	—	*Gossypium barbadense*	M
Cowpea; chiclayo	—	*Vigna unguiculata*	F
Culantro	—	*Eryngium foetidum*	F
•Cumala	allíuunéhe cúúrueo	*Iriartea* sp. or *Virola* sp.	C
Dale-dale	cúúnijcye	*Calathea allouia*	F
•Genipa, huito	—	*Genipa americana*	H
•Guava; pacay	túútsihye, ajivahe	*Inga* sp.	F
•Guayaba	—	*Psidium* sp.	F
Huaca, barbasco	awáámihe	*Clibadium asperum*	U
•Huacra pona	aalláàhe	*Iriartea* sp.	C
•Huamansamana	méneco	*Jacaranda* sp.	C
•Huicungo	tsutsábah	*Astrocaryum huicungo*	C
———; katuífbah	katuíbah	*Cyclanthus* sp.	H
Lemon; limón	—	*Citrus limon citratus*	F
Lemon grass; yerba luisa	—	*Cymopogon*	F
•Llanchama	páácámico	*Olmedia* sp.	H
•Macambo	áahe	*Theobroma bicolor*	F, U
Maize; maíz	—	*Zea mays*	F
Manioc; yuca	áánuwa (bitter) baajúriwa (sweet) pácyóómuwa (sweet)	*Manihot esculenta*	F

(Cont.)

Transitional/Orchard Fallow: Five Years Old

Some of the processes outlined above were noted in this field, also cut from a 30-year old fallow (Figure 3), but at a later stage of development. The field contained a manioc kapúuwa zone; however the unharvested manioc plants were small. As cuttings are routinely thrust into the earth after harvesting the roots, manioc can continue to grow without forming much below ground material. Manioc is also a persistent plant; cuttings merely thrown aside will occasionally take root. Twelve other cultigens were originally planted, of which six were still clearly harvestable: coca, caimito, peach palm, uvilla, avocado, and barbasco.

Zonation resulting from management was evident. The large coca patch was well weeded and maintained. A small coca patch was abandoned and empty, as was a peanut patch. Secondary growth in both these abandoned areas was limited to short grasses, low herbs, and occasional seedlings of pioneer forest trees. A fruit zone extended the length of the field along the trail. The understory consisted of a viney thicket mixed with low herbs growing amongst old pineapples and stray spindly manioc stems. This thicket formed an intermittent subcanopy 1.5 meters in height. The overstory was primarily comprised of equal numbers of well spaced, productive caimito (3 to 5 meters in height) and peach palm (8 to 10 meters in height) providing a 25 percent canopy over the zone.

Secondary vegetation had swallowed about a third of the original plot. The regrowth zone contained trees 10 to 15 meters in height and measuring from 8 to 15 centimeters in diameter. Melastomataceae, *Cecropia*, *Jacaranda*, and *Inga* were common. The trees and abundant upper story vines formed a 100 percent canopy. The forest floor was a dense tangle of herbs, including abundant Melastomataceae, Piperaceae, and Araceae. Palms were few.

In this transitional field, pineapples, fruit trees, and other minor plants deemed useful were maintained. The pineapples may be harvested for up to five years; thereafter the fruits produced are small and bitter tasting. Visits to the field follow the ripening schedules of the fruits, although visits for hunting also occurred periodically. The main activity besides harvesting fruit was weeding. Coca was weeded every three months; the fruit trees and pineapples received a slash weeding by machete every three to four months.

The farmer identified many useful plants, both in the weedy orchard and kapúuwa zones and in the reforested perimeter. The most immediately harvestable species are vines and low herbs. These include utilitarian vines and ceremonial plants not now used by the Bora, including reeds, once used to make decorative noseplugs and flutes, and plants yielding body paints. Other useful, but not yet harvestable species were construction and other woods in the seedling stage.

The reforested zone contained a great number of species. Thirty-four plants appeared on two 10-meter transects, 13 of which were considered useful. Six were construction woods; four provided materials for weaving and dyeing baskets; and three were firewoods.

Most of the useful forest species in this fallow will not be harvestable for ten to 30 years. Rapidly growing construction woods are har-

TABLE I (Cont.)

Common Name (English; Peruvian)	Bora Name	Scientific Name [1]	Use [2]
•Mauritia, moriche; aguaje	iñéjhe	*Mauritia flexuosa*	F, U
Orange; naranja	—	*Citrus sinensis*	F
•Papaya	—	*Carica papaya*	F
•Peach palm, pejibaye; pijuayo	méeme	*Bactris gasipaes*	F, U
Peanut; maní	mátsájca	*Arachis hypogaea*	F
Pineapple; piña	cudsiha	*Ananas comosus*	F
•Plantain; plátano	—	*Musa* sp.	F
Pomarosa	—	*Syzygium malaccensis*	F
Rice; arroz	—	*Oryza sativa*	F
Shapaja	—	*Scheelea* sp.	C
•Shimbillo	wachááboowa	*Inga* sp.	F
Soursop; guanábana	—	*Annona muricata*	F
•Star apple (see caimito)			
Sugar cane; caña	—	*Saccharum officinarum*	F
Sweet potato; camote	cáátu	*Ipomoea batatas*	F
Tangarine; tangerina	—	*Citrus reticulata*	F
Tobacco; tabaco	—	*Nicotiana tabacum*	M
•Umarí	númuhe	*Poraqueiba sericea*	F
Ungurahe, ungurahui	—	*Jessenia bataua*	F
•Uvilla	baácohe	*Pourouma cecropiaefolia*	F
Yam; sacha-papa	—	*Dioscorea trifida macrocarpa*	F
•Yarina	tókehíībah	*Phytelephas*	C

1. Common names tentatively matched with scientific names from Soukup (1970); most not collected.

2. *Use Code*
   F: Food and Beverage
   C: Construction or Thatching
   H: Handicrafts and Dyes
   U: Utilitarian
   M: Medicinal and Drugs

• Plants appearing in fallows

Fig. 4. Photo of four year old transitional field (Kapuuwa). Residual manioc in the foreground; uvilla tree to the right; a macambo branch juts out top left.

vestable, but they are so plentiful around Brillo Nuevo they receive no special care. The Bora casually harvest useful herbaceous plants as needed.

Orchard Fallow: Six Years Old

This orchard fallow is mapped in Figure 5 and illustrated in Fig. 8. Cut from primary forest, it is astride a sloping hill surrounded by newer fields on three sides.

The plot consisted of two general vegetation communities: a residual fruit orchard occupying about one sixth of the original cleared area, and abundant secondary growth surrounding the orchard. The original field was planted with over 26 crops, some of which are tree species now surviving within the orchard. Caimito was the most numerous planted species, and these trees measured 3 to 5 meters in height. A canopy was formed by uvilla (5 to 8 meters in height) and peach palm (10 to 13 meters in height). Several 18-meter tall *Cecropia* trees dominated the orchard area. The orchard had a 70 percent canopy cover and was well lit by sun splash. Recent weeding had resulted in an open floor of grassy vegetation covered with slashed mulch. Harvesting fruit in such orchard fallows is a casual pastime. The Bora use poles equipped with vine loops on the ends to ensnare and pluck fruit-laden racemes from high branches. Coca, however, had suffered from shading and harvesting was reduced. Cuttings are removed for replanting in nearby new fields. There is little evidence of manioc besides occasional stubble debris.

Growth surrounding the orchard was topped by 25-meter tall *Cecropia* and Rubiaceae trees towering over dense stands of 10-to-15 meter high trees, saplings and old plantains. There was a thicker shrub understory containing members of Piperaceae and Rubiaceae, short saplings, and palm sprouts. The forest floor had accumulated a thin layer of leaf litter, and no grasses were present. An array of useful spontaneously appearing species similar to those in the five-year field were present in the regrowth zone.

Orchard Fallow: Nine Years Old

This fallow (Figure 6), cut from high forest, demonstrates how long a managed orchard-fallow succession can be maintained, although size is small and diversity is low at this age. The orchard zone was only 250 square meters, and cultivated trees were few; however, a vigorously growing unshaded coca patch still remained. The patch contained 82 evenly spaced, well tended bushes. Coca was clearly the most valuable crop available here. The owner visits the field on a regular basis to harvest the leaves, and on those occasions may refresh himself with uvilla, guava, and caimito foraged from the residual orchard.

The secondary regrowth was a woody thicket, 10 to 15 meters in height, with many vines and substory shrubs. Several useful trees including cedar were on the field's perimeter. Because this field is a downriver site, soils and topography differ from the upland sites nearer the settlement zone. The downriver sites are less well drained, and thus the secondary communities differ from the other fallows studied.

TABLE II

SUCCESSION OF HARVESTABLE PLANTS * IN BORA FIELDS AND FALLOWS

Stage	Planted Harvestable	Spontaneous Harvestable
High forest.	None	Numerous high-forest construction, medicinal, utilitarian, handicraft and food plants available.
Newly planted field (úmihe); 0-3 mo.	All species developing	Dry firewood from unburned trees for hot fires
New field (úmihe): 3-9 mo.	Corn, rice, cowpeas.	Various useful early successional species.
Mature field (úmihe); 9 mo. - 2 yrs.	Manioc, some tubers, bananas, cocona, and other quick maturing crops.	Abandoned edge zone has some useful vines, herbs.
Transitional field (kapúuwa); 1-4 or 5 yrs.	Replanted manioc, pineapples, peanuts, coca, guava, caimito, uvilla, avocado, cashew, barbasco, peppers, tubers; trapped game.	Useful medicinals, utilitarian plants within field and on edges. Seedlings of useful trees appear. Abandoned edges yield straight, tall saplings, including *Cecropia* and *Ochroma lagopus*.
Transitional fruit field (kapúuwa); 4-6 yrs.	Peach palm, banana, uvilla, caimito, guava, annatto, coca, some tubers; propagules of pineapple and other crops; hunted and trapped game.	Abundant regrowth in field. Many useful soft construction woods and firewoods. Palms appear, including *Astrocaryum*. Many vines; useful understory aroids.
Stage	Planted Harvestable	Spontaneous Harvestable
Orchard fallow (jia); 6-12 yrs.	Peach palm, some uvilla, macambo; propagules; hunted game.	Useful plants as above; self-seeding *Inga*. Probably most productive fallow stage
Forest fallow (jia); 12-30 yrs.	Macambo, umarí, breadfruit, copal.	Self-seeding macambo and umarí. High forest successional species appearing. Early successional species in gaps. Some useful hardwoods becoming harvestable, e.g. cumala. Many large palms: huicungo, chambira, assai, ungurabe.
Old fallow; high forest	Umarí, macambo.	Same as high forest above. Full maturity not reached until 50 years or more.

* Plants are identified in Table I.

Forest Fallow: Nineteen Years Old

This one older forest fallow (Figure 7) was surveyed for useful tree species. The original swidden was cut from mature forest and, according to the owner, planted with at least 11 species, including several varieties of fruit trees.

The forest displayed clear stratification. Low vegetation consisted of herbaceous plants, including ferns, measuring 30 centimeters to 1 meter in height. Above was a second stratum of thin, straight saplings, 5 to 6 meters high, including many palms. Seventy-five percent of the canopy was provided by trees 15 to 18 meters in height, while emergent *Cecropia* and *Jacaranda*, both 25 meters tall, filled out the canopy. The forest floor was 40 percent covered in leaf litter and walking was unhindered, except in small thicket-filled gaps created by felling trees to harvest grubs.

All individual trees measuring 15 centimeters in circumference within a transect 10 meters wide and 102 meters long (length of the field) were tallied. Some 233 trees belonging to 82 species were counted. Over half the trees were single occurrences.

Our informants identified 22 useful trees in the transect, fitting into the following categories:

a. Construction materials: 11 species, 25 individuals, including two varieties (three individuals) of highly valued cumala; 13 huicungo palms, used for general thatching, were also present.

b. Medicinals: four species, four individuals (not yet identified).

c. Food: two species, 11 individuals, consisting of eight macambos and three assai palms bearing edible fruits.

d. Artisan material: one individual, a dye-bearing tree (not yet identified).

e. Utilitarian: four individuals, four species. These included three palms from which salt is distilled, and one tree from which pitch is extracted and used to seal canoe hulls (all not yet identified).

In addition there were at least two other species of trees from which edible grubs are harvested. The only apparent survivors of the prior swidden were the macambos, which were clustered within the transect 60 meters downslope. These were harvested sporadically.

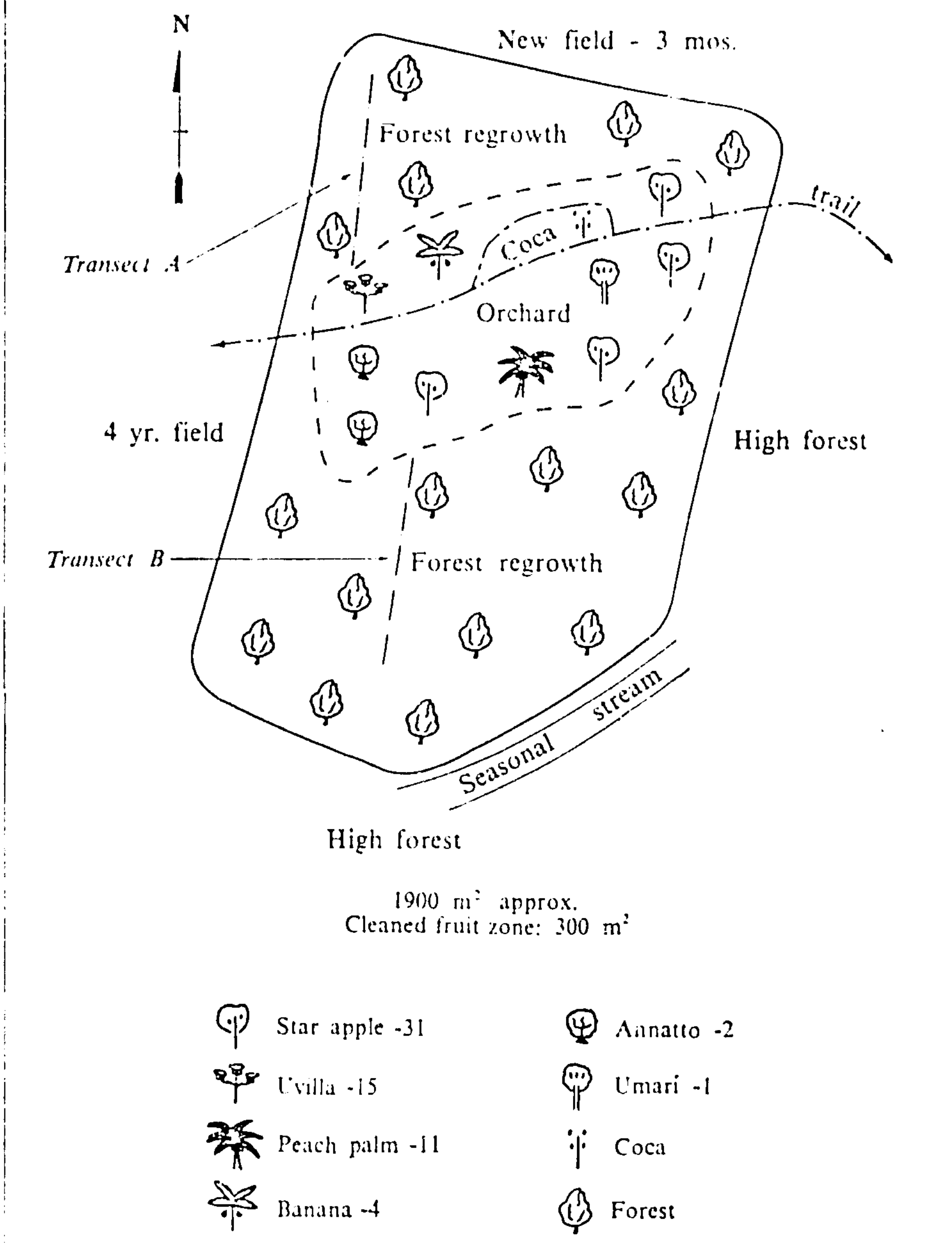

Fig. 5. Map of six year old orchard fallow.

None of the above trees, all of which are common, appeared to receive individual attention. The cumalas were not yet harvestable, nor will they be for about a decade. This old fallow apparently receives few visits for collection purposes, but hunting trips and grub foraging are frequent.

The Process of Abandonment: Analysis

The Bora recognize that two ecological processes, soil depletion and secondary succession, must be confronted. They acknowledge that manioc is not sufficiently productive to merit harvest after three or four years, mainly, they say, because of soil depletion, but also because of weed invasion. Abandonment of fields planted almost entirely in manioc occurs within the space of a year. However, if fields are polycropped with trees, weeds may be the major obstacle to extended field use. Management shifts from replanting manioc to dealing with encroaching secondary vegetation threatening tree crops. With periodic weeding, trees can remain productive for several years before disappearing into the secondary forest, often succumbing to the effects of shading and competition for nutrients.

Our observations indicate that the most productive fallow stage is between about four and 12 years. Before four years, fruit trees are not yet producing or have limited production. After 12 years, management is minimal and many of the smaller useful plants are shaded out. Harvesting of some species continues, however, for up to 20 to 30 or more years. Another important characteristic is seasonality. The various Bora fruit-tree species yield sequentially allowing a spread of produce throughout the year.

A number of tree species planted in Bora fields are, however, adapted to growing in dense secondary forests. Umarí and macambo are common cultivated trees found in old fallows, either growing alone or in groups. These survivors of swidden orchards are valued components of Bora fallows. At 20 or 30 years of age most fruit trees cannot be easily harvested; however the Bora occasionally gather the fallen fruits. A valuable function of fallen fruit is that they attract game animals. It is common to find an umari fruit on the forest floor with tooth marks of a majás *(Cuniculus paca)* or other browser. For this reason older purmas are good hunting grounds.

The process of abandonment and forest regeneration clearly has a spatial aspect. While successionary processes are complex, there is a tendency towards a pattern of centripetal forest regrowth which might be explained largely as a result of the history of weeding. Harvesting and weeding of manioc holds regrowth at bay. Once a manioc zone is abandoned, terrain is gradually surrendered to the forest and the field shrinks in size.

Abandonment is also related to how harvesting proceeds sequentially from grain producing annuals (rice and maize) to root crops and pineapples to fruit trees and spontaneously appearing utilitarian trees and vines.

Table II shows the succession of harvestable plants in Bora fields and fallows. While the Bora recognize many useful fallow plants, many go unharvested and are essentially neglected. The main reason for this is that high forest, from where sturdy construction woods and vines are harvested, is still a short walk away. At present most plants used for handicrafts, for example, are taken from high forest. Nevertheless, as the high forest frontier becomes more depleted and distant, secondary growth species become more important. There is evidence that this is occurring. The Bora have recently become interested in planting hardwoods and useful palms in swiddens and in fallowed fields.

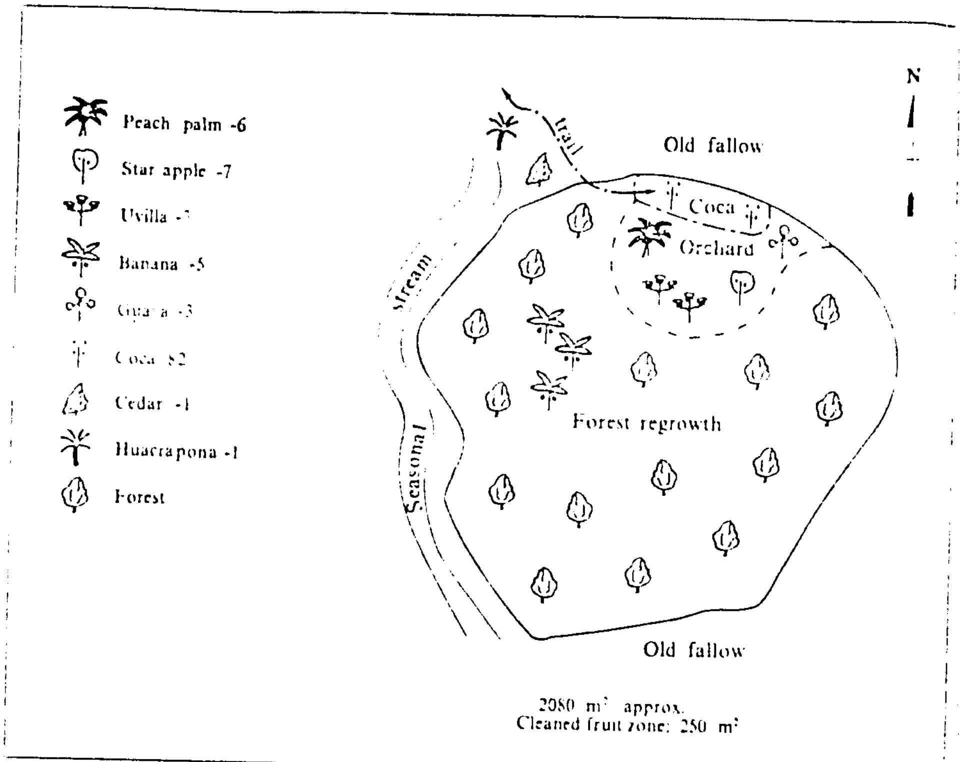

Fig. 6. Map of nine year old orchard fallow.

Phased Abandonment: Implications for Agroforestry

There are similarities between complex swidden systems and agroforestry systems (Hecht, 1982). Agroforestry combines the production of trees and other crops on the same unit of land (King and Chandler, 1978), a strategy essentially identical to swidden-fallow management. Both systems rely on the succession of tree crops following the harvests of short-term cultigens.

Viewed in this fashion, Bora agriculture converts to an agroforestry system during the early stages of forest fallow. The enriched swidden to fallow sequence closely resembles the natural succession analog approach to tropical agroforestry outlined by Hart (1980; also Uhl, 1983: 78-79). Hart suggests that select cultigens be placed in the niches normally occupied by common early successional species. The analog plants would have growth structures and resource requeriments similar to those of their weedy counterparts. Thus, rice or maize replaces early annual species, bananas replace wide-leafed *Heliconia*, and late appearing tree crops mimic early successional tree species. Whether by accident or design, the Bora seem to follow this approach. Bananas do well in low shaddy areas, where *Heliconia* plants are also common. The most obvious example is uvilla which matches its ubiquitous cousin, the *Cecropia*. Guava is also in the same genus as its semi-domesticated analog, the shimbillo. Further research may reveal other similarities between naturally appearing species and cultigens which could be incorporated into swidden agroforestry type models.

Another feature of Bora swiddens that could be useful in agroforestry design is the use of space. Bora tree clustering according to local topographical conditions suggests that slope and terrain should be considered when planning agroforestry plots. More important, slowly abandoning ground to secondary forest may be a sound strategy for tropical farming. There is no reason to think that agroforestry plots should have 100 percent planted standing biomass. Managed forest regrowth could provide useful products, as well as canopy cover for the soil and a source of stored nutrients for when the forest is cleared to begin the swidden and agroforestry cycle anew.

Swidden-fallow agroforestry, enriched with tree crops planted in areas of forest regrowth, could approximate the "tree-garden" model of silviculture which may have been a pre-Columbian agricultural adaptation in the Caribbean lowlands of Colombia, Central America, and the Maya region (Gordon, 1982). This model involves a combination of overstory fruit trees and sub-canopy woody shrubs, interspersed with open areas of swiddens containing maize, bananas, manioc, and other crops. Systematic swidden-fallow agroforestry would have a fruit orchard core, or series of cores, but these would be embraced by areas of regenerated forest. The forest, in turn, could be enriched by a variety of useful analog species able to compete in the viney sub-canopy, or later on as canopy species (fruit, timber) in high-forest fallow. Timber species would be appropriate late-fallow enrichment trees. Over a large area, swidden-fallow agroforestry would resemble Gordon's model. It would be more a thicket and less a plantation. Furthermore, the grow.. rate of managed successions may be as fast or faster than natural successions (Uhl, 1983: 79).

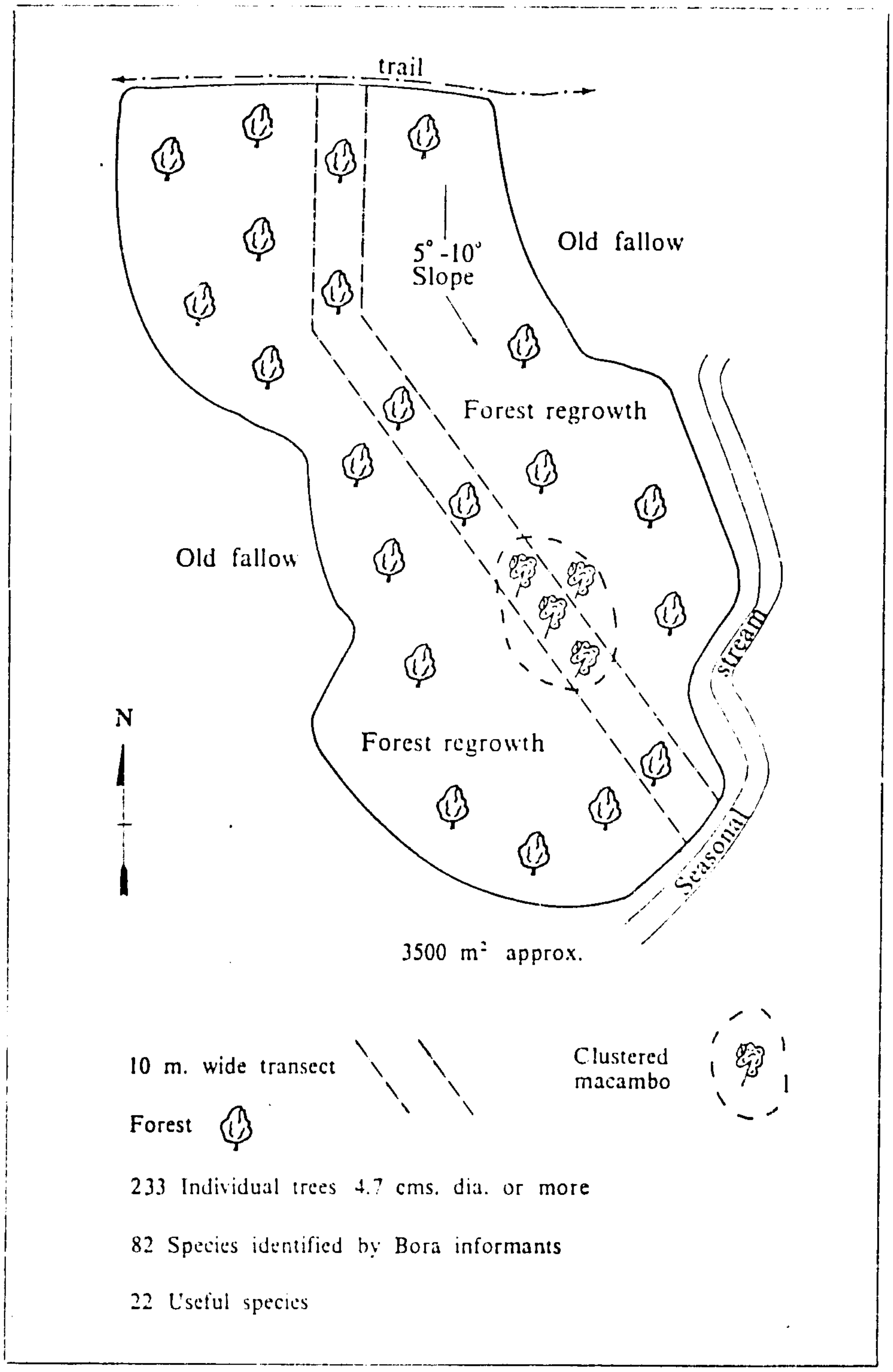

Fig. 7. Map of nineteen year old forest fallow.

Swidden-Fallow Products

The cumulative dietary contribution of fruits and nuts, even when harvested casually, may be significant. Certainly they provide a continuing (seasonal) variety of minerals, fats, and vitamins to tropical diets dominated by roots and tubers rich in carbohydrates. Some trees, moreover, can provide major staples. The peach palm, very important to the Bora for its fruit and heart, can compete with maize as a nutritious food (Hunter, 1969; Johannessen, 1966). In addition, plant products useful for beverages, condiments, construction, tools, drugs, and medicines are of more than minor importance to village societies and economies.

As with major and minor natural forest products, those of swidden fallows frequently reach markets beyond the village, at regional, national and international levels. Even remote traditional cultivators are willing and able to respond to market opportunities for forest products and manage those products accordingly. Pelzer (1978: 286) argues that a large percentage of the rubber, black pepper, copra, coffee, and benzoin harvested for cash in Southeast Asia comes from small-holder swiddens through intercropping "in what is ordinarily thought of as the 'fallow' period of the swiddens". The ultimate success of agroforestry systems will depend on such cash cropping.

For isolated communities such as Brillo Nuevo, cash cropping of forest products is problematic. Tropical cedar and other timber trees can be floated down river to market. One can only be impressed by Boras planting or protecting tropical cedar seedlings in their swiddens and fallows, anticipating a substantial cash return for their children 30 years later. The use of swidden-fallow products, such as palm and liana fibers, tree bark, and dyes, for the manufacture of handicraft items can bring an income to Bora households. The considerable tourist and export trade in the Iquitos area provides an outlet for traditional items such as hammocks, bags, baskets, bowls, and ornaments. On the other hand, the marketing of perishable food items does constitute a difficult problem for remote villages such as Brillo Nuevo, especially in view of the poorly developed processing and marketing facilities in the region. Toasted macambo nuts, a

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Bora delicacy, could have market potential. Palms such as *Jessenia* and *Mauritia*, potential sources of edible oils (Balick, 1982), are common in Amazon forests and could be integrated into agroforestry models.

The history of the Amazon has been one of commercial harvesting of forest products (quinine, copal, sarsaparilla, barbasco, palm heart, Brazil nuts, rubber, timber). Much of that history involved the destruction of important resources by unwise harvesting practices and the economic and social exploitation of indigenous peoples. Sustainable and equitable procedures are possible, and trade in forest produces can be enhanced by incorporating forest species of commercial value into agroforestry systems. Such commercial orientation would, of course, necessitate not only the development of specific agroforestry designs and techniques, but also appropriate processing, transportation, credit, and marketing facilities. The economic possibilities for Amazonian plants are vast (Myers, 1983). An argument might well be made that the potential value of marketable production from sustained-yield agroforestry plots, including swidden fallows, can be significantly greater per year per hectare than that from cattle ranching or shifting cultivation.

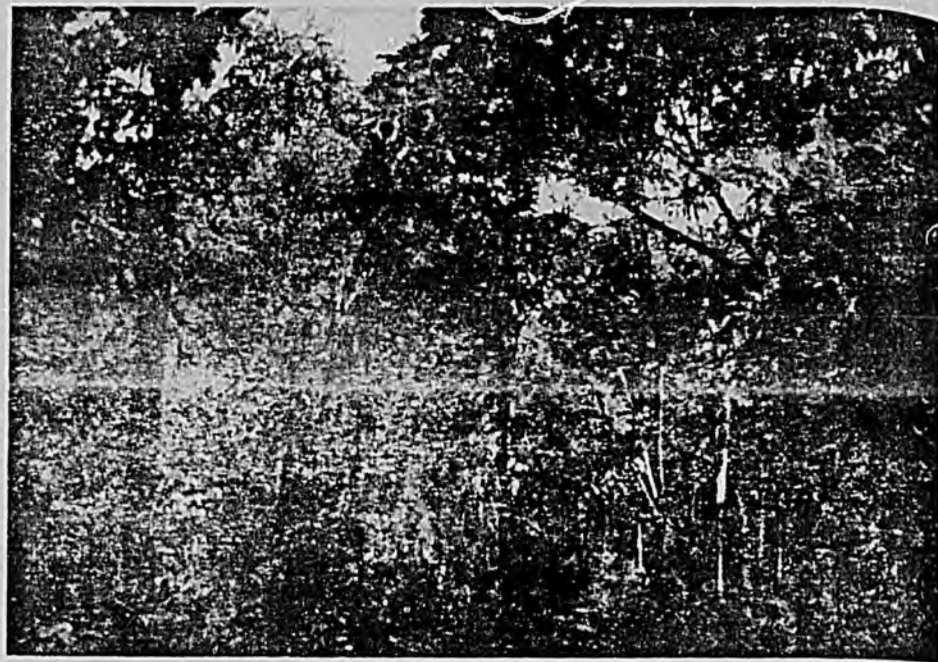

Fig. 8. Photo of six year old orchard fallow. Uvilla and peach palm are present. Note open well lit floor.

Conclusions

The Bora process of swidden abandonment is in reality a conversion of a short-term cropping system into a longer-term agroforestry system. Some general conclusions regarding abandonment and fallow management are possible.

1. Fallowing is multipurpose. The secondary forest is not only nutrient storage for future cropping, but an important niche for secondary crops and useful spontaneously appearing plants. We identified 133 different useful species in Bora fallows. We propose that an appropriate designation be established to account for enriched fallows, a characteristic which may be common in tropical swidden systems. The term "orchard fallow" could be used to describe the structural and functional aspects of traditional agroforestry. In a subsequent "forest-fallow" stage, economic plants are still present but are more dispersed, fewer in number, and less managed.

2. Viewed properly, a swidden site is never completely abandoned as a resource zone. Secondary harvests of fruits, spontaneously appearing species, and even animals continue until the forest is removed for further cropping.

3. There exists an identifiable sequence from original forest with some economic plants present, to a swidden with numerous individual economic plants present, to an orchard fallow or agroforestry phase combining managed economic plants and natural vegetation, to a forest fallow in which economic plants are fewer but still present in greater numbers than in the original forest. Likewise, there is a corresponding sequence in the proportions of biomass which are cultivated or managed, spontaneous economic, and spontaneous non-economic.

4. Research is needed on analog species with growth architectures and nutrient requeriments adapted to secondary forest environments.

5. Swidden-fallow management is not unique to Amazon Indians. We observed it with the peasants in Tamshiyacu upriver from Iquitos. It appears to be widespread in Africa (De Schlippe, 1956: 215-216; Dubois, 1979) and in the Pacific, including the Philippines (Conklin, 1957: 125-126; Oración, 1963), New Guinea (Clarke, 1971: 82-84, 138-139; Hyndman, 1982), and Micronesia (Yen, 1974). It may once have been common in Middle America (Gordon, 1969, 1982), and it is still practiced by the Huastec in Mexico (Alcorn, 1984). We have much to learn about these systems.

6. Agroforestry drawing on traditional management methods and combining planted species and natural secondary vegetation could be an ecologically appropriate and economically viable alternative to destructive short-fallow shifting cultivation in tropical areas. The ideal model would provide food crops during the swidden stage and cash crops and other products during the fallow stage. The cash crop perennials should be relatively fast maturing species which can be harvested by around 10 years so that the cycle can be renewed as soon as possible. Such a model would help fullfill the need for sustained production of food and other needed products and simultaneously do minimal damage to a fragile environment.

REFERENCES

Alcorn, J. B. (1984): *Huastec Mayan Ethnobotany* (Austin, University of Texas Press).

Balick, M. J. (1982): Palmas neotropicales: Nuevas fuentes de aceites comestibles. *Interciencia*, 7: 25-29.

Basso, E. B. (1973): *The Kalapalo Indians of Central Brazil* (New York, Holt, Rinehart, and Winston).

Budowski, G. (1981): The place of agro-forestry in managing tropical forests. In: F. Mergen (ed.), *Tropical Forests: Utilization and Conservation* (New Haven, Yale University School of Forestry), pp. 181-194.

Clarke, W. C. (1971): *Place and People: An Ecology of a New Guinean Community* (Berkeley, University of California Press).

Clarke, W. C. (1977): The structure of permanence: The relevance of self-subsistence communities for world ecosystem management. In: T. P. Bayliss-Smith and R. G. Feachem (eds.), *Subsistence and Survival* (London, Academic Press), pp. 363-384.

Conklin, H. C. (1957): *Hanunóo Agriculture* (Rome, FAO).

Covich, A. P. and N. H. Nickerson (1966): Studies of cultivated plants in Choco dwelling clearings, Darien, Panama. *Economic Botany*, 20: 285-301.

Denevan, W. M. (1971): Campa subsitence in the Gran Pajonal, eastern Peru. *The Geographical Review*, 61: 496-518.

Denevan, W. M. (1976): The aboriginal population of Amazonia. In: W. M. Denevan (ed.), *The Native Population of the Americas in 1492* (Madison, University of Wisconsin Press), pp. 205-234.

De Schlippe, P. (1956): *Shifting Cultivation in Africa* (London, Routledge and Kegan Paul).

Dubois, J. (1979): Aspects of agroforestry systems used in Moyombe and Lower Congo (Zaire). In: G. de las Salas (ed.), *Workshop: Agro-forestry Systems in Latin America* (Turrialba, CATIE), pp. 84-90.

Eckholm, E. P. (1982): *Down to Earth: Environment and Human Needs* (New York, W. W. Norton).

Eden, M. J. (1980): A traditional agro-system in the Amazon region of Colombia. In: J. I. Furtado (ed.), *Tropical Ecology and Development* (Kuala Lumpur, International Society of Tropical Ecology), Vol. 1, pp. 509-514.

Forde, C. D. (1934): The Bora of the western Amazon forest. In: C. D. Forde, *Habitat, Economy and Society* (London, Methuen), pp. 131-147.

Gasché, J. (1979): Cultivo de corte y quema y evolución del medio forestal en el noroeste del Amazonas: ecología de los sistemas de cultivo indígenas en la selva peruana (Paris, Centre National de la Recherche Scientifique), mimeo, 24 pp.

Gasché, J. (1980): El estudio comparativo de los sistemas de cultivo nativos y su impacto sobre el bosque amazónico. In: *Consulta Científica Subregional sobre las Actividades de Corte y Quema en el Ecosistema de Bosque Tropical* (Iquitos, Man and the Biosphere Program), pp. 61-74.

Girard, R. (1958): Los Bora. In: R. Girard, *Indios Selváticos de la Amazonia Peruana* (México, Libro Mex), pp. 85-124.

Gordon, B. L. (1969): *Anthropogeography and Rainforest Ecology in Bocas del Toro Province, Panama.* Office of Naval Research Report (Berkeley, Department of Geography, University of California).

Gordon, B. L. (1982): *A Panama Forest and Shore: Natural History and Amerindian Culture in Bocas del Toro* (Pacific Grove, Boxwood Press).

Guyot, M. (1971): Recherches etnographiques dans les bassins des rios Caqueta et Putumayo, Amazonie colombienne: les Bora (compte rendu de mission). *Journal de la Société des Americanistes*, 58: 275-283.

Guyot, M. (1974): La maison des indiens Bora et Miraña (Etudes sur la territoire et l'habitat dans l'oueste amazonien). *Journal de la Société des Americanistes*, 61: 141-176.

Guyot, M. (1975a): Le système cultural Bora-Miraña. In: P. Centlivres (ed.), *Culture sur Brulis et Evolution de Milieu Forestier en Amazonie de Nord-Ouest* (Geneva, Musée d'Ethnographie), pp. 93-109.

Guyot, M. (1975b): Mission chez les Indiens Bora et Miraña (Amazonie colombienne, 1969-70). In *Amazonie Nord-Ouest* (Neuchatel, Musée d'Ethnographie), pp. 17-28.

Harris, D. R. (1971): The ecology of swidden cultivation in the Upper Orinoco rain forest, Venezuela. *The Geographical Review*, 61: 475-495.

Hart, R. D. (1980): A natural ecosystem analog approach to the design of a successional crop system for tropical forest environments. *Biotropica*, 12 (Supplement, Tropical Succession): 73-83.

Hecht, S. B. (1982): Agroforestry in the Amazon Basin: practice, theory and limits of a promising land use. In: S. B. Hecht (ed.), *Amazonia: Agriculture and Land Use Research* (Cali, Centro Internacional de Agricultura Tropical), pp. 331-371.

Hunter, R. J. (1969): The lack of acceptance of the pejibaye palm and a relative comparison of its productivity to that of maize. *Economic Botany*, 23: 237-245.

Hyndman, D. C. (1982): Biotope gradient in a diversified New Guinea subsistence system. *Human Ecology*, 10: 219-259.

Jiménez Seminario, A. (1933): Breve estudio sobre la tribu Bora. *Revista Universitaria* (Cuzco), 22: 173-191.

Johannessen, C. L. (1966): Pejibayes in commercial production. *Turrialba*, 16: 181-187.

King, K. F. S. and N. T. Chandler (1978): *The Wasted Lands: The Program of Work of the ICRAF* (Nairobi, International Council for Research in Agroforestry).

Klee, G. (ed). (1980): *World Systems of Traditional Resources Management* (New York, Halsted Press).

Manners, H. I. (1981): Ecological succession in new and old swiddens of montane Papua New Guinea. *Human Ecology*, 9: 359-377.

Myers, N. (1983): *A Wealth of Wild Species: Storehouse for Human Welfare* (Boulder, Westview Press).

National Research Council (1982): *Ecological Aspects of Development in the Humid Tropics* (Washington, D. C., National Academy Press).

Nigh, R. B. and J. D. Nations (1980): Tropical rainforests. *The Bulletin of the Atomic Scientists*, 36 (3): 12-19.

ONERN (1976): *Inventario, Evaluación e Integración de los Recursos Naturales de la Zona Iquitos, Nauta, Requena y Colonia Angamos* (Lima, Oficina Nacional de Evaluación de Recursos Naturales).

Oración, T. (1963): Kaingin agriculture among the Bukidnond of south eastern Negros, Philippines. *Tropical Geography*, 17: 213-224.

Paredes, P. O. (1979): *Bora-Witoto-Ocainas: Estudio Etnológico de las Comunidades Nativas del Rio Ampiyacu, Bajo Amazonas* (Iquitos, Ministerio de Agricultura).

Pelzer, K. J. (1978): Swidden cultivation in Southeast Asia: Historical, ecological, and economic perspectives. In: P. Kunstadter, E. C. Chapman, and S. Sabahasri (eds., *Farmers in the Forest* (Honolulu, University Press of Hawaii), pp. 271-286.

Posey, D. A. (1982): The keepers of the forest. *Garden*, 6 (1:) 18-24.

Posey, D. A. (1983): Indigenous ecological knowledge and development of the Amazon. In: E. Moran (ed.), *The Dilemma of Amazonian Development* (Boulder, Westview Press), pp. 225-257.

Salas, G. de las (ed.) (1979): *Workshop: Agro-forestry Systems in Latin America* (Turrialba, CATIE).

Smole, W. J. (1976): *The Yanoama Indians: A Cultural Geography* (Austin, University of Texas Press).

Soukup, J. (1970): *Vocabulario de los Nombres Vulgares de la Flora Peruana* (Lima, Colegio Salesiano).

Spurgeon, D. (1980): Agroforestry: A promising system of improved land management for Latin America. *Interciencia*, 5: 176-178.

Torres Espinoza, W. (1980): Prácticas agropecuarias en la Amazonia ecuatoriana. In: *Consulta Científica Subregional sobre las Actividades de Corte y Quema en el Ecosistema del Bosque Tropical* (Iquitos, Man and the Biosphere Program), pp. 37-53.

Uhl, C. (1983): You can keep a good forest down. *Natural History*, 92 (4): 69-79.

Uhl, C., K. Clark, H. C. Clark, and P. Murphy (1981): Early plant succession after cutting and burning in the Upper Río Negro region of the Amazon Basin. *Journal of Ecology*, 69: 631-649.

Whiffen, T. W. (1915): *The North-West Amazons* (London).

Yen, D. E. (1974): Arboriculture in the subsistence of Santa Cruz, Solomon Islands. *Economic Botany*, 28: 247-287.

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