Chapter 33

Pruned-Tree Hedgerow Fallow Systems in Mindanao, the Philippines

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Alley cropping was a traditional practice of the Ibu tribe of eastern Nigeria (Kang 1997), who developed the concept in response to accelerating pressures on traditional shifting agriculture (Kang et al. 1990). It was described as a stable alternative to shifting cultivation in the sense that farmers no longer needed to shift from one cultivated field to another. Alley cropping combined both the fallow and cultivation phases. The key was the planting of N-fixing woody perennials in rows that followed the contours of the land (see color plate 48). Nutrient recycling was improved, greater quantities of nitrogen were biologically fixed, and nutrients that were once unavailable in deeper soil layers were brought to the surface by a nutrient pumping effect. Nutrient losses were reduced by recapture of leached nutrients or through reduced soil erosion (Kang and Wilson 1987; Raintree and Warner 1986).

However, while alley cropping has proven beneficial under some conditions, more and more farmers who adopted the practice have ceased cropping and have left their hedgerowed fields fallow. This practice has been observed in many parts of the Philippines, particularly in Claveria, Mindanao (Mercado 1997); Aklan, Iloilo; Matalom, Leyte (Fujisaka and Cenas 1993); the Bicol region (Payonga 1997); and Jala-Jala, Rizal (Gómez 1997). Similar observations are reported in Zambia (Franzel unpubl.) and Cameroon (ICRAF 1996). Apparently, there are constraints to the maintenance of contour hedgerow systems that have not yet been adequately understood. As a consequence, two questions arise: Why do farmers fallow their alley farms when alley cropping was supposedly designed to sustain crop production? Are there prospective advantages in doing so?

Our observations led us to hypothesize that farmers were fallowing their hedgerow systems to counteract two constraints commonly faced by shifting cultivators: an inevitable decline in annual crop yields, and an increase in weed pressure. The objectives of this study were to determine the farmers' rationale for fallowing their alley farms; to compare the crop yield performance from fallowed fields with hedgerows versus conventionally fallowed fields without hedgerows, but left fallow for the same period; and to analyze the overall systems productivity and profitability of the two fallow systems.

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The Study Site

The study was conducted at Claveria, Misamis Oriental, in the northern part of the island of Mindanao, in the Philippines. The nearest urban center to Claveria is Cagayan de Oro, about 40 km away. The elevation ranges from 150 to 1,000 m above sea level (asl), and slopes ranging from 8% to 60% dominate the landscape. The rainy season is from April or May to December. On average, rainfall exceeds 200 mm per month for five to six months (Garrity and Agustin 1987). A dry spell usually occurs for about two weeks in August or September. The soils are deep, mainly clay, and strongly acidic, with a pH from 4.3 to 5.2. They are classified as Ultic Haplorthox (Garrity and Agustin 1987).

Methodology

Garrity and Agustin (1987) analyzed changes in land use in the area over the past 100 years. The area was opened from forest during the first half of the 20th century and has since been dominated by *Imperata cylindrica* grasslands. As is typical in large areas of the Philippine uplands, farming in these grasslands has been predominantly based on slash-and-burn systems, with annual crops grown mainly for subsistence. Recently there has been a trend toward higher-value crops, such as coffee and fast-growing timber. However, the dominant cropping pattern is the production of two crops of maize, the first planted in April or May and the second in August or September. Double cropping of maize on the sloping land results in the annual loss of between 50 and 200 tonnes of soil per ha (Garrity 1993). Research and extension activities on contour hedgerow systems began vigorously in the mid-1980s (Fujisaka and Cenas 1993), and scores of farmers established contour hedgerow systems using either leguminous trees or forage grasses. Research trials were superimposed on some of these fields. However, rather than sustaining permanent cropping systems, most of the fields with hedgerow systems using pruned trees had been fallowed within 10 years, and cropping abandoned. These fallowed hedgerow fields provided the basis for this research.

Survey

Five groups of people were interviewed. Group 1 was composed of farmers who had fallowed their alley farms; Group 2 consisted of farmers who had continuously cultivated their alley farms; Group 3 was farmers who had marketed firewood from their hedgerows; Group 4 consisted of people who purchased firewood from these farmers, including bakers and retailers; and Group 5 was composed of farmers who collected wood from their hedgerows as a source of fuel for the family. Interviews with Groups 1 and 2 enabled us to find out why farmers fallowed their hedgerowed fields. Interviews with the other groups helped to determine the feasibility of marketing firewood as an economic product of fallowed hedgerows. Table 33-1 shows the number of those interviewed per grouping. The survey was aided by a prepared questionnaire.

Experiments

Farmers' fields were available in Claveria on which there were large plots with contour hedgerows alongside plots that had been cultivated conventionally as open-field controls. These were fields in which previous experiments had been conducted (Basri et al. 1990; ICRAF 1996). These adjacent plots had a similar history of cropping and fallow length. All of them had been fallowed for at least one year. Four fields were selected. Each contained one replicate of both the treatments (With Hedgerows and No Hedgerows). One site had two replicates of both treatments. Table 33-2 presents background information on the sites. The average period that the With Hedgerow (WH) treatments had been fallowed prior to the start of the experiment was 4.1 years. The average period that the No Hedgerow (NH) treatments had been fallowed prior to the experiment was 4.5 years.

Treatments were assigned using a split-plot design. The NH and WH treatments were main plot treatments. The time of opening of the fallow was the subplot treatment: F0 = opened during 1995, and F1 = opened during 1996. The experiment was still ongoing at the time of writing. For the purposes of this chapter, a combined analysis was used for maize yield that included all cropping seasons and treatments. Yield data were from three crops: first crop, late wet season, 1995; second crop, early wet season, 1996; and third crop, late wet season, 1996. The statistical package used was IRRISTAT 4.0 for Windows.

The cropping pattern was maize-maize using cultivar "Pioneer 3246," a hybrid yellow corn. According to the Pioneer Corn Hybrid Seed Catalogue, this variety was capable of yielding up to 7.7 metric tonnes/ha under favorable conditions. The cultural practices followed were described in Nelson et al. 1996. Several plowing and harrowing operations were conducted for the first and second crops. During the opening of the fallow plots, all of the fallow biomass was returned to the soil. The exception was the woody biomass from the hedgerows in the WH treatment, which was removed from the field with the assumption that it would be used as firewood. No external fertilizer or lime was applied. Tree hedgerow pruning was done immediately after the second plowing. Pruning was usually done once per crop (see Table 33-3), although frequent pruning was not necessary because the trees were old and were no longer coppicing vigorously. The number of trees in the hedgerows had also decreased because of natural attrition over the years.

As hedgerows mature, their production of biomass slowly declines, especially on acid soils (Sanchez 1995). In our case, the average hedgerow age was seven years. According to Nelson et al. (1996), *Gliricidia sepium* hedgerows grow old after three to five years. *Senna spectabilis* also dies back slowly, probably as a result of poor coppicing ability after frequent pruning (Kang 1997), or because of exhaustion of native soil nitrogen (Maclean et al. 1992). Therefore, the hedgerow vegetation at the start of the experiment was a mixture of aged trees and grass strips.

Table 33-1. Composition of the Hedgerow Farmer Survey Groups

Groups	*Number of Respondents Interviewed*	*Remarks*
Fallowed their hedgerows	30	The total number of farmers identified as having fallowed their alley farms was 33.
Continuously cultivated hedgerow fields	6	This group included all the farmers known to be continuously cultivating alley farms in Claveria.
Marketed firewood from hedgerows	30	Respondents came from only one village, Sta. Cruz, in Claveria, which was known for its marketing of firewood.
Purchased firewood from hedgerow farms	6	A total of only 10 suppliers of firewood were known.
Collected firewood from hedgerows for family use	30	Limited to only one subvillage, Lombagohon, in Claveria, which was one of the few places still having difficulty in collecting firewood.

Table 33-2. Details of the Experimental Fields

Cooperator	*Location (village)*	*Treatment*	*Years in Fallow*	*Hedgerow Species*
Codilla	Cabacungan	With Hedgerow	10	*Gliricidia sepium*
	Cabacungan	No Hedgerow	10	
Cuizon	Patrocenio	With Hedgerow	3	*Gliricidia sepium*
	Patrocenio	No Hedgerow	3	
Pabling	Patrocenio	With Hedgerow	3	*Senna spectabilis*
	Patrocenio	No Hedgerow	4	
Pabling	Patrocenio	With Hedgerow	3	*Senna spectabilis*
	Patrocenio	No Hedgerow	3.5	
Rene	Patrocenio	With Hedgerow	1.5	*Senna spectabilis*
	Patrocenio	No Hedgerow	2	

Table 33-3. Pruning Data

Crop	*Prunings per Crop Season*	*n*	*Average (t/ha)*	*Standard Error*
First	Twice	20	4.70	1.33
		15	0.36	0.04
Second	Once	20	1.55	0.81
Third	Once	19	1.50	0.21

Only tree prunings were applied to the alley, as we were specifically interested in the effect of tree prunings. The amount of prunings applied is shown in Table 33-3. Spot prunings were made on a few vigorous hedgerow trees, but these were not applied to the alley because they might have caused variation within the replicates. Instead, these were applied to the base of the hedgerows.

The maize crop was harvested 110 days after planting. Harvest areas were within borders one meter wide on the outside of each treatment plot. All rows across the alleyway were part of the harvest area. Grain yields are reported at 14% moisture content. The grain yield of the WH treatment is reported on field area basis, that is, the field size was reduced by 12.2% to account for the average area occupied by the hedgerows. All maize residues were returned to the soil prior to the next crop.

During the clearing operation, and for the subsequent prunings, the firewood production from the WH plots was determined by sampling a hedgerow length of 4 m. Firewood yield was determined on a dry weight basis. For economic analysis, the volume of firewood was measured by the number of bundles. It was bundled to conform with other firewood sold in Claveria stores, which averaged 29 pieces with circumference of 16 cm and a length of 64 cm. Table 33-4 shows the number of firewood bundles produced per cropping.

An assessment was made of productivity and profitability, and an analysis of sustainability criteria is planned as soon as these data are complete. Productivity in the WH treatment was composed of firewood from tree hedgerows and maize grain yield. For the NH treatment, only maize grain was considered. The fallow biomass was not valued as it was returned to the soil. Costs and returns were computed for both treatments. The amount of labor in all activities, from opening up the fallow to weeding, was timed. A limitation of this method is that extrapolation from "per plot" to "per hectare" tends to overestimate the labor value. Nelson et al. (1996) showed that the amount of labor expended is not correlated with farm size in Claveria. The costs of replanting, pruning for the second and third crops, harvesting, and postproduction were obtained from Nelson et al. (1996), who give production and postproduction estimates from the same locality that fall within the range conducted.

by other researchers. We monitored labor costs in pruning for the second and third crops. However, our values were low when compared with existing literature (Nelson et al. 1996), and we felt that we needed to verify our values by monitoring pruning labor on a larger hedgerow area. Unit costs were taken from rates prevailing in Claveria in 1996.

Results and Discussion

Most of the hedgerow systems surveyed for this chapter were established between 1987 and 1991, at the time when the classic alley cropping system was being tested in Claveria. Consequently, there were contour hedgerow systems involving four tree species left fallowed in the area. The dominant species was *Gliricidia sepium* (see Table 33-5). After they had fallowed their hedgerow systems, the farmers had left the woody perennials unpruned. When tree hedgerows are well maintained, however, their growth forms a closed, or nearly closed, canopy over the alleyways. Among the farmers interviewed, the average age of the fallow was 4.3 years, with a range of 6 months to 10 years. The majority of the farms had a fallow age falling between one and five years (see Table 33-6). It should be noted, however, that the data show the length of time the fields had been fallow at the time of the survey and not necessarily the total length of the fallow, which may have extended years longer, or indefinitely. Only 23% of the farmers had recultivated their hedgerowed farms after having left them lie fallow. The rest were uncertain as to when they would break the fallow.

Farmers gave many reasons for fallowing their hedgerow farms (see Table 33-7). The main reason was a complex interplay between land, labor, and soil fertility. It was the interaction of these factors, and not necessarily the effect of a single factor, that triggered farmers to fallow their alley farms.

Table 33-4. Volume of Firewood Produced

Season	*Average Number of Bundles*	*n*	*95% Confidence Interval*
First cropping	10,157	20	3,488 to 16,827
Second cropping	1,346	20	743 to 1,346
Third cropping	0	15	n/a

Table 33-5. Species of Hedgerow Fallows on the Surveyed Farms

Hedgerow Species	*Number* [a]	%
Gliricidia sepium	23	55
Flemingia congesta	5	12
Morus alba	5	12
Senna spectabilis	4	10
Gmelina arborea	2	5
Paraserianthes falcataria	1	2
Tithonia diversifolia	1	2
G. sepium and *S. spectabilis*	1	2
Total	42	100

Note: [a] This is not based on the number of farmers interviewed but on the total number of plots with different hedgerow species. Some farmers had more than one hedgerow species.

Table 33-6. Duration of the Fallow among 30 Surveyed Farmers with Fallowed Hedgerows

	Years									
Fallows	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Number	5	8	6	2	6	2	0	0	0	1
Percentage	16.67	26.67	20	6.67	20	6.67	0	0	0	3.33

Table 33-7. Reasons for Fallowing Hedgerowed Fields

Response	*Number* [a]	*%*
Large area–low labor–soil infertility complex	23	52.5
Sickness	4	9.0
Migration	3	7.0
Lack of material inputs	3	7.0
Used tree hedgerows for housing materials	3	7.0
Others		
—Because of trees growing in the alleyways	2	4.5
—For charcoal production	2	4.5
—Mulberry hedgerow contaminated with pesticide due to spray drift	2	4.5
—Minimizes pest infestation	1	2.0
—Good for watermelon production	1	2.0
—Displacement/removal	1	2.0
Total	44	100.0

Notes: [a] Number equals the number of answers and not the number of farmers interviewed. Some farmers had more than one response.

Beginning with farm size as the first factor: among the 30 farmers interviewed, the average farm size was 5.36 ha. Eighty-four percent of them fell within the range of 1.0 to 7.0 ha. This is higher than the national and provincial averages for farm size holdings, which are 3.0 ha and 4.0 ha respectively (Bureau of Agricultural Statistics 1996). The degree of land intensification depends upon the ratio of labor to land. The interview data show that although family size was large, and averaged eight members, the availability of labor for farm work was low. Much of the labor came only from the husband and wife. Hired labor was occasional. Only 21% of the farmers said they got part-time help from their children because they were either at school or were married. Nevertheless, 66% of the children were still dependent on their parents. The farmers said that 25% of their total farm area was left fallowed with every crop. This indicated a relatively low level of available labor for the size of farm.

With regard to the soil fertility factor, farmers said that the tree-based contour hedgerows tended to be on the most degraded portion of their farms. Although they recognized that soil erosion was reduced, they claimed that the level of soil fertility was not substantially improved by the hedgerow system. Such observations were actually validated by ICRAF field trial data (ICRAF 1997), in which it was shown that, after five years, the effect of prunings did not always significantly improve crop yields. Although trees can increase the availability of nutrients by pumping nutrients from the subsoil, the acidic soils of Claveria have only low subsoil nutrient reserves (Garrity 1993). Moreover, even N-fixation can be affected under marginal—and particularly acid—soils because the rhizobial bacteria are dependent upon phosphorus in the production of ATP needed for N-fixation (De la Cruz 1997). Even the quantity of prunings may be affected by the degree of aluminum saturation found in acid soils (Garrity 1994). According to the farmers, under poor soil

Any photographs that are not accredited were taken by the Editor.

1. Shifting cultivators in the Kassam pass area of the PNG highlands (1,200 m asl) prepare forest for cropping *Xanthosoma* taro, bananas, and a few other shade-tolerant food crops by slashing the undergrowth, smaller trees, shrubs, and vines. Less than 25% of larger trees are felled to allow sufficient sunlight to reach the forest floor (Bino, Chapter 60).

2. Valued species are often protected through iterative swidden cycles (Schmidt-Vogt, Chapter 4). In Northeastern India, *Schima wallichii* trees (shown) are often retained in *jhum* fields (swiddens) by selective felling. Farmers highly value their wood for construction and making veneer and firewood; the bark is used for dyeing and processing leather. The trees also reportedly have several medicinal applications.

3. Bhutanese farmers often maintain *Ficus* spp. (mostly *F. roxburghii* and *F. cunia*) and other preferred fodder trees on their *tseri* (swidden) land (Dukpa et al., Chapter 59). Mongar, Central Bhutan.

4. In other cases, such as exemplified by these rattan wildlings in an upland rice swidden in Luang Prabang, Lao PDR, farmers selectively retain desirable species that germinate during the cropping phase. Given market incentives, this has the potential to intensify into more actively planted and managed rattan-based fallows, such as those in Yunnan (Xu, Chapter 56) and Kalimantan (Belcher, Chapter 64; Sasaki, Chapter 38). (See also color plate 52)

5. Broomgrass (*Thysanolaena latifolia* L.) is harvested from swidden fallows, weighed and sold by many upland minorities, such as these Muser (Lao Sung) women in Bokeo, Northern Lao P.D.R. Broomgrass grows best in fields that have been burned, but reportedly causes soil degradation.

6-7. *Imperata cylindrica* is widely viewed as a problem weed. However, Potter and Lee challenge this thinking in Chapter 11 with case studies in which market demand has transformed *Imperata* into a carefully tended fallow "crop", processed for roof thatching (inset). Gianyar, Bali, Indonesia. (Photos: Justin Lee)

8. Harvesting the young shoots of *Pandanus* sp. in a fallow area in Kelabit Highlands, Sarawak. (Photo: Ole Mertz)

9. Picking *Pseuderanthemum borneense* planted in an old rubber garden in Nanga Sumpa Village, Sri Aman Division, Sarawak (Mertz, Chapter 7). (Photo: Ole Mertz)

10-11. Harvesting sago worms (inset) from an old trunk of sago palm previously felled on fallow land in Nanga Sumpa Village, Sri Aman Division, Sarawak. (Photos: Ole Mertz)

12 Tending *Diplazium esculentum* in a wild vegetable garden in Manup Baroh Village, Sri Aman Division, Sarawak (Mertz, Chapter 7). (Photo: Ole Mertz)

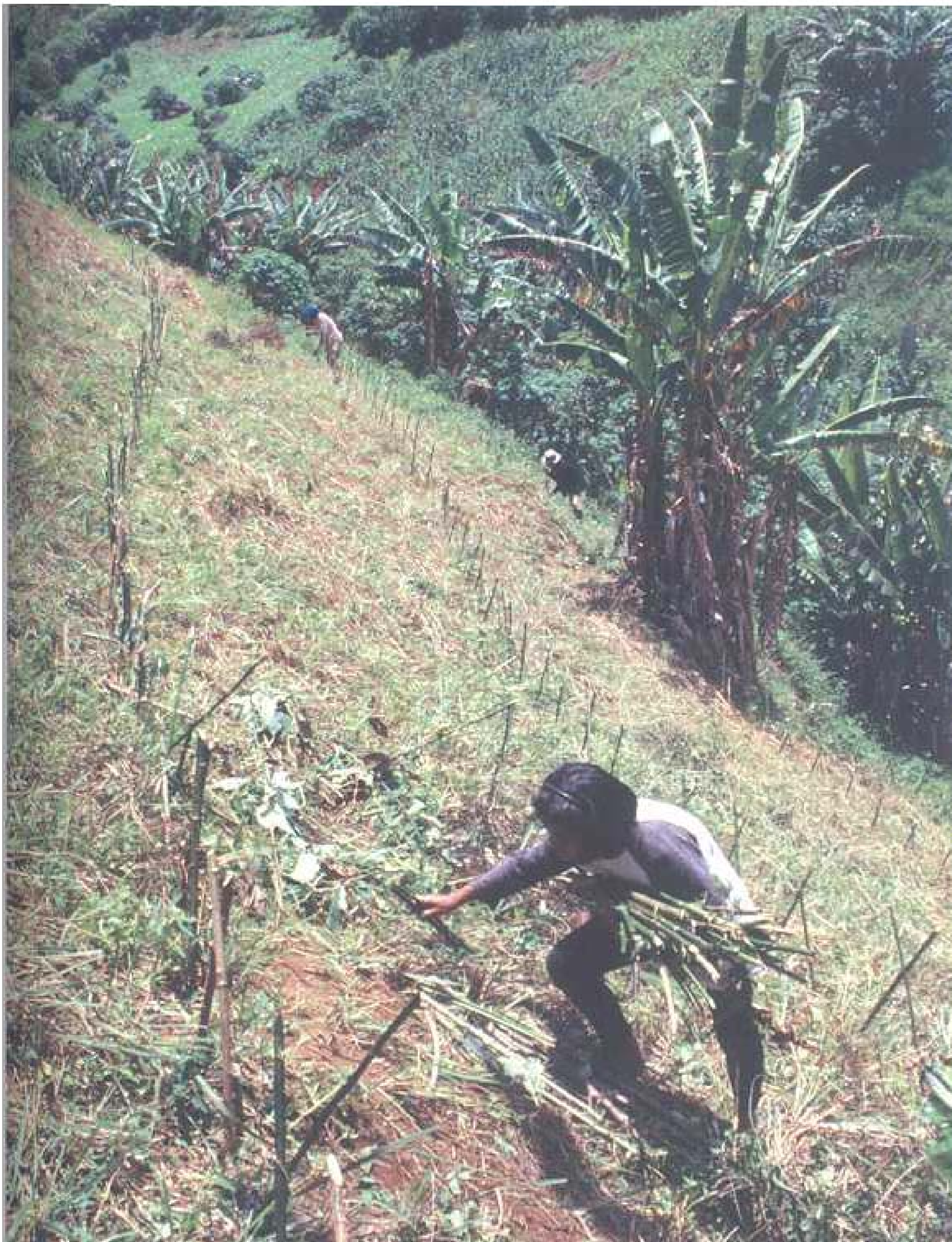
13. Swidden fallows are favored locations for hunting and gathering activities. Wildlife often come in search of crop remnants and are later attracted to the protective cover of dense fallow regrowth. Mushrooms, a wide diversity of wild food plants, and other useful products are harvested from fallows, depending on the season and stage of fallow succession (Burgers, Chapter 8; Mertz, Chapter 7; Tangan, Chapter 9; Tayanin, Chapter 6). Many of the items offered at this fresh market in Savannakhet, Lao P.D.R, are fallow products.

14. At higher elevations where forest regeneration is slower, swidden farmers have developed careful ways to maximize the benefits of available biomass. As described by Ramakrishnan in Chapter 21, Khasis farmers near Shillong, in Meghalaya, arrange slash in parallel rows running downslope and allow it to dry. Soil is later pulled up on top of the slash, forming ridges that alternate with furrows of compacted soil (shown). By burning the slash under the soil, the fire is slower, less C is lost through volatilization, and fewer nutrients leached. Crops are then planted on these nutrient-enriched ridges. See Dukpa et al., Chapter 59, for an account of the similar *pangshing* system in central Bhutan. Near Shillong, Meghalaya.

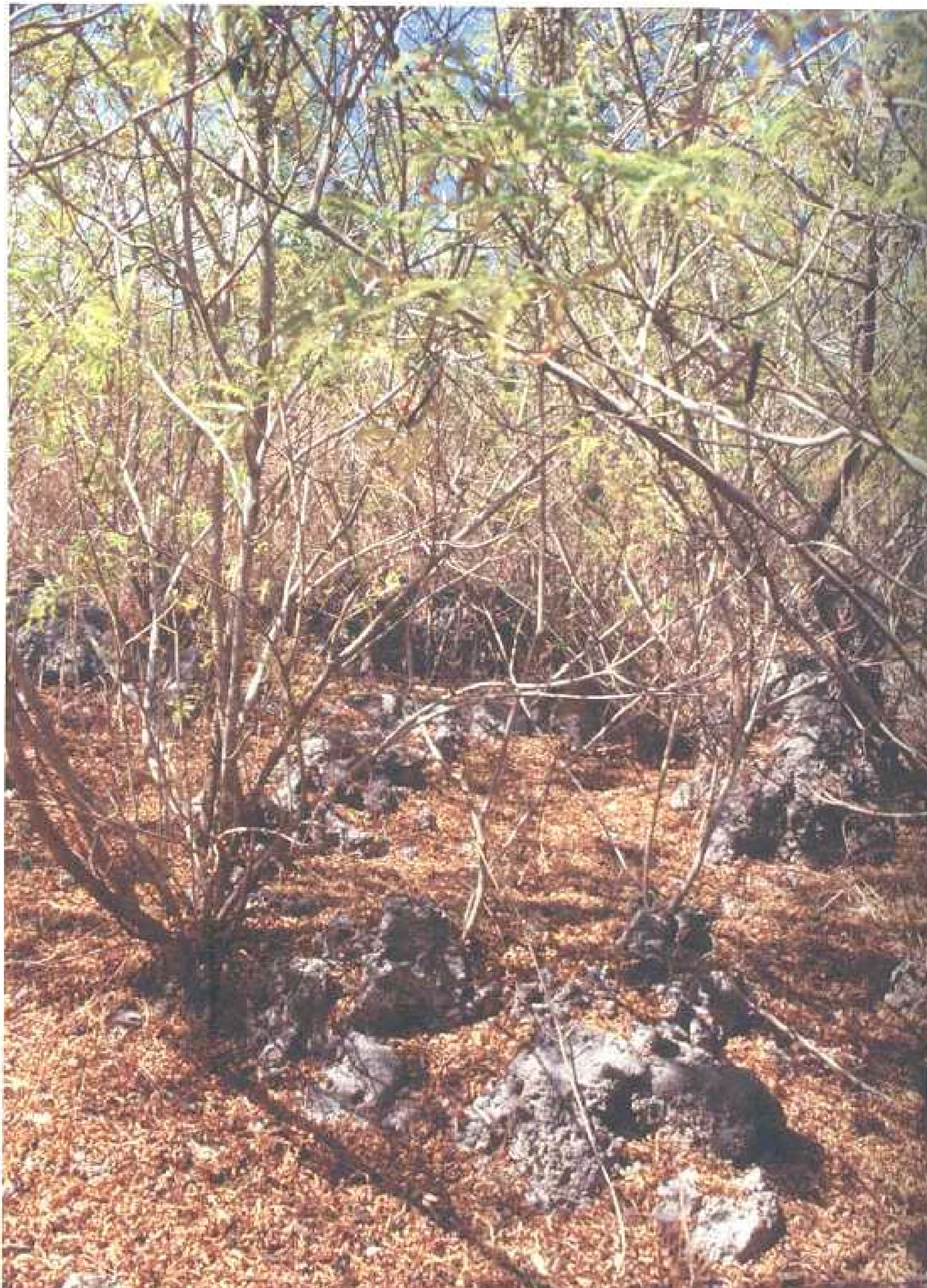
15. *Chromolaena odorata* is the most widely recognized of many exotic Asteraceae that have expanded across Southeast Asia during the last century. Its notoriety as an invasive weed in pasture land and tree plantations has earned it the attention of numerous symposia, a newsletter, and projects aimed at its eradication. However, Roder et al., Chapter 14, and Ty, Chapter 55, add to a growing pool of literature verifying its value as an effective fallow species. Pakhasukjai Village, Chiang Rai, Thailand.

16. *Austroeupatorium inulaefolium* appears to play a similar ecological role in fallows at higher altitudes (200 m to 1,800 m asl). This Minangkabau couple in West Sumatra, Indonesia, is clearing a seven-year-old *A. inulaefolium* fallow. Note that despite the dense forest cover on the upper slope, very few pioneer trees have penetrated through the dense *A. inulaefolium* thicket. This suggests that its aggressive nature may be delaying regeneration of secondary forest (Cairns, Chapter 15).

17. A farmer slashes *Calopogonium mucunoides* undergrowth in preparation to reopen a *Tithonia diversifolia* fallow in Mindanao, the Philippines. This stoloniferous legume/shrub succession is completely spontaneous and may offer a symbiotic combination of N-fixation and nutrient scavenging. It is protective of the soil, mimics the tight nutrient cycling of natural forests, and enables a high photosynthetic efficiency (Daguitan and Tauli, Chapter 57). Lantapan, Bukidnon, the Philippines.



18. Other farmers introduce vegetative cuttings of *Tithonia diversifolia* into *Imperata* grasslands, using it as a biological tool to smother out the *Imperata* and bring the land back into productive cultivation. Farmers say that the *Imperata* is choked out within the first year and, by the end of the second, the land can be reopened and a successful crop grown without fertilizer inputs. Lantapan, Bukidnon, Philippines.



19. Another exotic shrub, *Tecoma stans*, originally native to the Latin American Andes, has proven its ability to thrive and produce significant fallow biomass in the rocky coralline soils and harsh, dry climate of West Timor, Indonesia (Djogo et al., Chapter 17). The understory is clear of weeds and shows a significant buildup of leaf litter. Kecamatan Maulafa, Kotamadya Kupang, East Nusa Tenggara.

20. Yet another example of an aggressive invasion by an exotic shrub from Central America is the case of *Piper aduncum* L. in Papua New Guinea. It has expanded rapidly in the last 20 to 30 years and now dominates many swidden fallows, often in monospecific stands. Its dominance in the soil seedbank and fast growth appear to explain its success (Hartemink, Chapter 16). Nearby Lae, in Morobe Province, PNG.

21-22. In Mon District of northern Nagaland, seeds of *Macaranga indica* are scarified by the burning operation as fallows are reopened for cultivation. The germinating *Macaranga* seedlings are then nurtured in tandem with the rice crop (main photo). They go on to form near monospecific fallows, as seen in this seven-year- old stand (inset). Near Wakching Village, Mon District, Nagaland.

23. *Mimosa invisa* that self-propagates in maize fields may be managed as a green manure intercrop during the cropping phase, and then left to dominate the subsequent fallow succession. As shown in this maize field in Bukidnon, the Philippines, it provides continuous soil cover after harvest, suppresses invasive grasses, and generates large quantities of leguminous biomass. Farmers at Leyte, in the Philippines, further value thorny *M. invisa* for its ability to discourage invasion by free-roaming livestock, thereby solving problems of biomass removal, overgrazing, and soil compaction (Balbarino et al., Chapter 18). However, many farmers remain steadfastly opposed to *Mimosa*.

24. Land use pressures and market opportunities have prompted some swiddenists to integrate herbaceous legumes into their cropping patterns, often as a dry season fallow. This Akha farmer in northern Thailand says integrating peanuts (*Arachis hypogaea*) into his crop rotation has brought soil improvement and additional income.

25. Viny legumes (*Vigna unguiculata, V. umbellata,* and *Lablab purpureus*) are relay-planted into maize by Lisu farmers in northern Thailand, about one month before maize harvest. Ongprasert and Prinz (Chapter 23) describe the system as accelerated seasonal fallow management in intensified shifting cultivation. (Photo: Klaus Prinz)

26. Farmers in upland northern Vietnam also relay-plant *Phaseolus calcaratus* Roxb. (syn. *Vigna umbellata*) into maize (Hao et al., Chapter 22). After harvest, the beans climb up the stalks and form a protective rainy season ground cover. Their extensive roots (shown) also play a valuable role in stabilizing soil on steep slopes. (Photo: Nguyen Tuan Hao)

27. High population densities and a fondness for tofu probably contributed to a traditional practice in China of intercropping soybean (*Glycine max*) with maize. The legume-cereal combination boosts total productivity of the land and is suitable for smallholdings without farm machinery. Baoshan Prefecture, Yunnan.

28. In Thailand, a Karen farmer in Kanchanaburi Province harvests beans from his swidden plot. Although lentils are central to South Asian cuisine, beans are not a staple to Southeast Asian diets. This may have contributed to their under-utilization as valuable "fallow crops." (Photo: Payong Srithong)

29. *Pachyrhizus erosus* (Leguminosae), an herbaceous climber often found in disturbed areas, is reported to grow wildly on fallowed lands in northern Vietnam. Its vines have value as a green manure and the fleshy tubers are marketed as a vegetable. The genus, widely known as "yam bean" or "potato bean," originated in the Neotropics but has become naturalized throughout Southeast Asia. Market on the outskirts of Hanoi.

30. Farmer strategies may combine useful elements from several fallow management typologies. This young rubber plantation (agroforest) in Palembang, South Sumatra, is undersown with a cover crop of *Pueraria javanica*, an herbaceous legume. Note the already established rubber plantations in the background. (Photo: Meine van Noordwijk)

31. Although appearing like a carefully managed green manure crop, this stand of *Mucuna utilis* is completely spontaneous, providing benefits of accelerated soil rejuvenation and weed control. The drawbacks of this aggressive fallow species are that it becomes a weed problem when the land is reopened for cultivation, and it suppresses regeneration of secondary forests. Near Myitkyina in Kachin State, Myanmar.