

FARMERS' MANAGEMENT OF FALLOW SUCCESSION IN THAILAND

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1. Introduction

Fallow management is a common practice of traditional shifting cultivation in Southeast Asia and it survives throughout the region for many centuries (Spencer 1966). The systems are often found among the ethnic minorities in the region but governments, on the other hand, see the system as a primitive form of agricultural production, destruction to the forests and watersheds, wasteful and unproductive. The negative view of traditional shifting cultivation has much influence on government policy to “stop” the traditional cultivation and replace the system with alternative practices with no fallow. The alternatives often turn out to be less productive and unsustainable, e.g., construction of bench terrace and vegetative strips to support sedentary agriculture in Northern Thailand (e.g., Harper 1986 and Enter 1996. Removal topsoil in the bench terrace construction could reduce yields of subsistence crops for a number of years before soil stabilization takes place.

In Northern Thailand, numerous development agencies and the Royal Thai Government had a huge campaign to eradicate poppy opium and settle or resettle ethnic minority community in permanent villages. The development efforts were started in 1972 when crop replacement programme was launched in the country and the external inputs were lasted until 1998. State laws and regulation are also adopted to stop hill farmers cutting forests hence fallow management is also illegal. Community has to change their traditional management towards intensive forms of management and management of fallow is currently much shorter. This is, perhaps, happening widely in the region where traditional shifting cultivators are in transition to sedentary forms of land use with limited fallow management.

This paper will bring together experiences from the PLEC activity in the region and northern Thailand where farmers are finding ways to overcome the problems of declining yields in subsistence crops and increasing demand of land use for other purposes.

2. The National Setting

Northern Thailand is part of the mountain area of the Mainland Southeast Asia (MMSEA). The sub-region may be referred as the Greater Mekong and is defined as the sub-region that spans from Myanmar to Vietnam, including Cambodia, Laos, Thailand and the neighbouring Yunnan province of China (e.g., CMU-Consortium 1995, Thomas 2000 and Ratner 2000). About half of the total area in the six countries of the region is mountainous with a dominant of tropical forest cover. It is home to diverse cultural ethnic groups with pockets of rapid population growth and severe poverty, e.g., Cambodia, Laos, Myanmar and Vietnam. While populations of Cambodia,

Myanmar and Vietnam are growing at more than twice the rate of Thailand or China, population in Laos is increasing at faster rate of over three times.

Shifting cultivation is the dominant form of traditional management of the forest farmers in MMSEA. It involves clearing of a site of vegetation by slash and burn methods. After short cultivation, the systems would allow for a long fallow period to restore natural vegetation. The extent of shifting cultivation in Asia is not accurately known but it was estimated at a wide range of 70-120 million ha (Banerjee 1995). Data for MMSEA are compiled in Table 1, which shows area under shifting cultivation of different countries.

Table 1. Extent of land under shifting cultivation in mountainous area of Mainland Southeast Asia sub-region.

Country	Area (10 ³ ha)		Under Shifting Cultivation	% Forest under shifting cultivation
	Land	Forest		
Cambodia	17,652	12,163	n.a	n.a
Laos	23,080	13,173	400	3.04
Myanmar	65,774	28,856	181	0.63
Thailand	511,770	12,735	400	3.14
Vietnam	32,536	8,312	3,500	42.11
Yunnan (Tropical China)	46,000	920	130	14.13

Sources: Banerjee (1995), Sam (1994), FAO (1995), Fujisaka (1991) and Lovelace (1991)

In Northern Thailand, Karen, Hmong, Akha, Yao, Lahu, Lisu, Khamu, Lua and H'tin are the major traditional shifting cultivators who are the ethnic groups of MMSEA. Officially, these people are seen as illegal migrants from the neighbouring countries, Laos and Myanmar in particular, for the past few decades. Certain group, like the Karen and Lua, could have been here already for the past centuries, however. The pattern of movement for certain groups, i.e., Hmong, Lisu, Yao and Akha, may be extended as far as Vietnam and China at the beginning. With exception of Thailand, other countries in the region encourage migration and permanent settlement on the mountainous area to reduce population pressure in the lowlands.

With huge demand of natural resources from large population, rapid economic growth and development in the country, forest resources and biodiversity are depleting quickly. The national forest cover decreased from 53.3 % of total area (273,628 km²) in 1961 to as low as 25.6 % (131,485 km²) in 1995 (RFD 1997). Northern Thailand has been able to maintain the highest forest cover of 73,885 km² or about 43.5 % despite a long history of commercial logging since 1864. After the 1988 flooding disaster in the South, the Cabinet enacted a logging ban of 1989 with policy to maintain at least 40 % forest cover on nationwide. As being the major national watershed, the *Chao Phrya* River Basin, the forests in the northern region are kept strictly for conservation and this has had the big impact on fallow management of the traditional shifting cultivation.

At present, there are some 1 million people living in the forests and protected area of northern region (Table 2). The implementation of forest protection and watershed conservation measures have taken the land away from the people with rapid transformation to government plantation of industrial species and reforestation projects, national parks and wildlife sanctuaries. On the other hands, diverse biophysical setting and low labour cost have invited private sector to intensify agriculture on mountainous area for external markets. Large tracts of land have turned into intensive production of annual cash crops and vegetables. Severe land shortage in the lowlands is forcing lowland farmers moving uplands and opening up new land for intensive agriculture. Hence, there has been a considerable increase in the demand for land on the mountain from various stakeholders, this trend is continuing. Forest conservation measures have taken the

Table 2. Population in specific land categories above 600 m from the sea level, 1997.

Land Category	National	Northern Region	Percentage of National
Reserve forest	611,400	589,279	94.6
National parks	39,421	37,877	96.1
Wildlife sanctuaries	40,600	30,900	76.1
No hunting area	2,001	1,957	97.8
De-gazetted area	283,878	250,104	88.1
Planned reserves	8,322	8,322	100.0
Military occupied land	5,500	Data Not Available	-
Total	991,122	918,439	92.7

Source: Compiled and adapted from Department of Public Welfare (1997)

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3. Farmers' Management of Fallow Succession

3.1 Types of Traditional Shifting Cultivation and Fallow Management

Traditional shifting cultivation may be conveniently divided into two different types; "rotational" and "pioneering" shifting cultivation. Lowlanders who recently encroached and/or transmigrated to the uplands are sometimes counted as another type of shifting cultivators but they are not traditional shifting cultivator and their practices are destructive to natural vegetation and the environment.

Rotational shifting cultivation is managed on permanent basis, around the established village in which local households rotate their fields and fallow forests. In Northern Thailand, the Karen or Lua would clear a large tract of land by slashing under growth and weeds, and looping big trees of secondary forests for drying and burning before the onset of the wet season. Burning of vegetation releases nutrients previously stored in the forest biomass onto the soil surface and available for the following crops during cultivation periods. Burning also helps to neutralize acid soil, which is quite common in tropical uplands of MMSEA. The fields may be in crops for 1-2 years to avoid intensive use of land leading to severe soil fertility depletion and increasing weed infestation. The community then decides collectively to choose the next field in rotation, leaving the first field to lie fallow and naturally regenerate. After fallow regeneration reaches mature stage providing sufficient biomass to enable productive re-cultivation, the full cycle of shifting cultivation is complete and this may take 10-15 years depending the degree of land scarcity.

In contrast to rotational shifting cultivation, the pioneer system usually involves non-permanent villages that move into the primary forests for longer periods of intensive cultivation, perhaps 10-15 years. When the soil fertility is severely depleted, the fields are ready for abandon for natural regeneration. Farmers then move to a new location in another area with primary forest. The practice of pioneer shifting cultivation is said to be unsustainable and destroy natural vegetation, resulted in grass climax such as *Imperata cylindrica* or *Chromolaena odorata*. Thus, shifting cultivation system is now collapse.

The collapse of shifting cultivation systems may be theoretically illustrated in Figure 1 to show the separatrix from the upper stable equilibrium to the lower unstable equilibrium domains. Working with available data published at that time, Trenbath et. al. (1985) attempted to model shifting cultivation with respect to soil fertility and vegetation change. Long fallow regeneration, say 10-20 years, would allow shifting cultivation to be function on sustainable basis within mature forest domain. Intensification of shifting cultivation due to, say, population pressure may threaten the system to collapse. Short fallow period means the delay in natural regeneration and hence repeated practice of short fallow could lead to deterioration of shifting cultivation due to soil fertility decline and perhaps, weed, disease and pest build up also.

In short, the model reveals that shifting cultivation may be permanently collapsed if system flips over the domain of unstable equilibrium. The question is how can the shifting cultivation system be managed so as to be maximally productive while keeping the dynamic of the system within the stability domain of mature forest? How far is any given fallow plot from the “dangerous” separatrix? If the plot is already in the grassland domain, how much fertilizer is needed or how much effort is needed to control weeds in order to bring the plot back to the forest domain?

The dynamic of shifting cultivation has led to the belief that as long as population density is low and the pressure to produce large surpluses of crops is also low, rotational shifting cultivation is a highly sustainable system that does not result in significant degradation (e.g., Kunstadter et. al. 1978, Rambo 1990 and Lovelace 1991). In reality, forest farmers such as in Northern Thailand are facing difficulties in maintaining all types of shifting cultivation. Under the high population density, restriction of land use and sedentary settlement, the shifting cultivation in Northern Thailand have undergone enormous change for the past 30 years. Short rotation, intensive cultivation and total transformation of land use are replacing shifting cultivation in a short time. Farmers’ management changes abruptly from traditional long bush fallow to short fallowing

period in, say, permanent cropping practice. The question then becomes how can farmers cope with the change and still manage the system productively and sustainably?

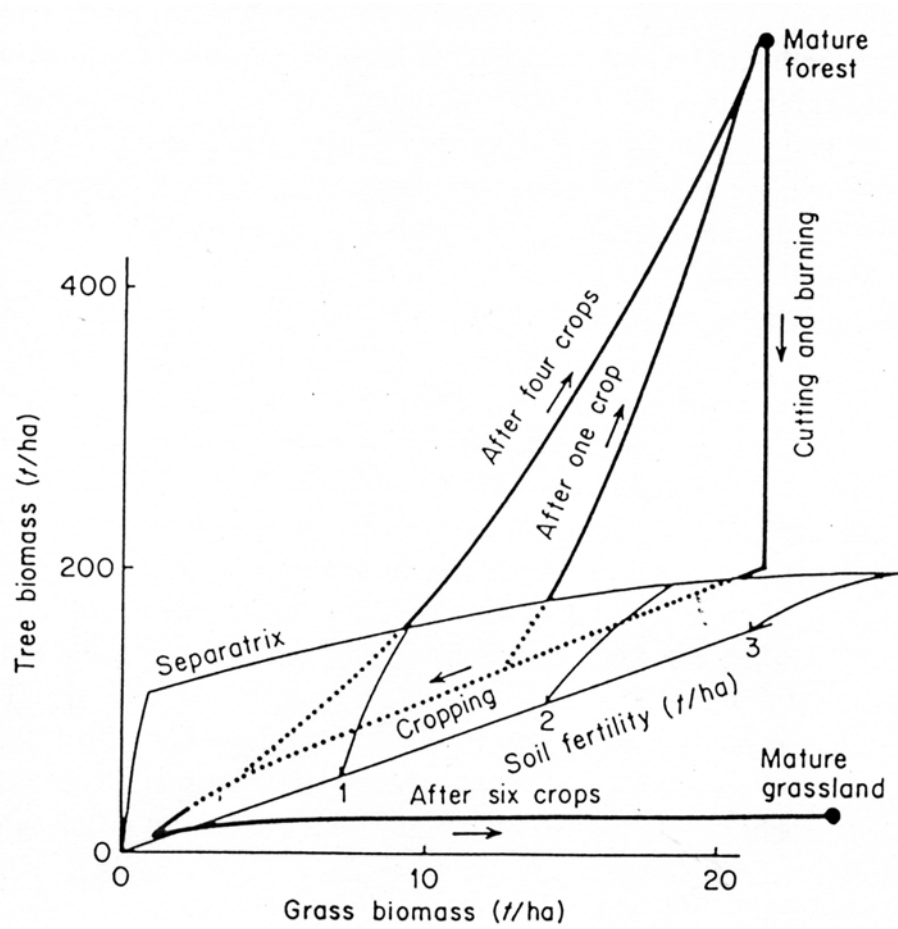


Figure 1. Management of fallow succession and sustainability of shifting cultivation systems (Trenbath et. al. 1985).

3.2 Farmers Innovations

(1) *Weed succession domain*

To enrich fallow, certain technical recommendations are readily available and many have been suggested for fallow improvement, e.g., introducing fast growing tree species for enriched fallow or alley cropping practice with fast growing legumes such as *Luecaena leucocephala*, *Gliricidia sepium*, *Cajanus cajan*, *Flemingia congesta* and others. Attempts have been made with these alternatives but the scale of success is often limited with highly variable results. There are some technical problems associated with the techniques, for instances, heavy infestation of aphids after the introduction of *Luecaena leucocephala*, poor seed germination and establishment. Small holders are finding difficulties in applying these alternatives to overcome problems inheriting from short fallow in shifting cultivation. Upland farmers in many areas in the region are seeking other alternatives on their own

Experience in Laos has shown the ability of a Phu Thai community to manage fallow succession to maintain productivity of upland rice (Keovilayvong et. al. 1991). Originally, the villagers were practicing rotational shifting cultivation with slash and burn techniques. Up to 1964, the rotational periods have been reduced and fallow regeneration would reach only early stages of forest succession with bamboo dominant. This is a common pattern of fallow succession in the region, which requires a minimum of 7 year of forest regrowth. It was said that with no disturbance, secondary forest might return to maturity stage at 15-20 years. On the other hand, over harvesting of bamboo could drive the system to grass climax, e.g., *Imperata cylindrica* or *Pennisetum pedicellatum*, and they are fire resistance in open habitat.

With land limitation, farmers are producing upland rice intensively and cultivate the land for 2-3 crops before leaving the fields for fallowing. Length of fallow periods is also determining the dominant species in fallow; i.e., either a broadleaf weed (*Chromolaena odorata*) or mixture of bamboo species. Farmers recognise contribution of *Chromolaena odorata* as soil builder. After 4 year of regrowth, solid stand of *Chromolaena* could improve soil fertility and soil structure substantially. Production of upland rice in the area may vary between 600-1500 kg of output per 50-60 kg of seed sown (Chansina, et. al. 1991).

Farmers in northern Thailand are also finding other weed species useful for soil building in the 1-3 years of fallow regeneration, e.g., *Ageratum conyzoides*, *Eupatorium adenophorum* and *Bblumea balsamifera* (e.g., Schmidt-Vogt 1995). With soybean and rice in permanent rotation, farmers in *Mae Chaem* district of Chiang Mai province are managing fallow of weed succession to maintain crop productivity. Soybean was introduced as an alternative cash crop by private sector for about 15 years and spread quickly a few years later. It is still the dominant cash crop in the area. However, sustainability of this permanent rotational system has yet to be studied. The extreme case of management of fallow succession with dominant weed is found in PLEC demonstration, the *Hmong Njua* of Pah Poo Chom village. The village was established in 1960 as part of the hilltribe resettlement programme with supports from the Department of Public Welfare and international donors. The village started off with some 10 households, voluntarily migrated from the higher altitude areas of *Khun Kong* and *DoLuang*. It was said that the village was occupied by the lowland *Thai* before the *Hmong* resettlement and the site was exploited heavily from successive forest concession up to 1967.

After about 8-10 years of village establishment, most of the secondary forests in the village were cleared for growing opium poppy and upland rice with low yields. Early study has predicted that the village would be collapse in the near future due to widespread of poverty, severe rice deficit, high proportion of opium addicts, severe forest destruction and land degradation as a result of inappropriate practice of shifting cultivation (Walker 1975 and Cooper 1984). The livelihoods of *Hmong* in *Pah Poo Chom* depend solely on a few income generation activities, i.e., selling of opium and supplement income from low wage labour from tea plantation nearby.

Since then, the population has grown to 143 persons in 57 households. The current farming activities are highly diverse with various combinations of annual crops, high value vegetables, fruit trees, some traditional subsistence and cash crops, collection of minor forest products (Rerkasem and Rerkasem 1994). The economic status of local households has been improved greatly and the village is being classified as a “well-off” village. However, land available for agriculture is quite limited and pressure on land is increasing. Farmers are coping with the limitations with intensive use of land under management of weed as ground cover in fallow period of crop rotation.

Mimosa invisa is a thorny leguminous weed introduced from the lowland village nearby for fencing household gardens to prevent crop damage from domestic animals. It is prolific seed producers and hence spread out rapidly to agricultural land and other land use types. At the beginning, *M. invisa* has become the most troublesome weed and it was difficult to control due to the thorny characteristic. Burning before planting upland rice and other swidden crops also promotes seed germination and hence high degree of weed infestation. The cost of weed control increased greatly. At that time, land productivity in *Pah Poo Chom* was very poor with insufficient production of subsistence crops. Certain pieces of land were highly exhausted from intensive growing of upland rice and maize for a long time and hence they might have to be abandoned permanently.

In a mean while, some farmers observed beneficial values of *Mimosa* residual. Soils under *Mimosa* for a period of time were much better after land clearing, e.g., increasing porosity and fertility. The weed was incorporated in an intensive vegetable production afterward. The *Pah Poo Chom* farmers saw an opportunity to grow cabbage at the end of wet season, partly due to favourable climate at the site but importantly the niche market after main cabbage production in the wet season. Supplement irrigation was set up for low-cost sprinkler system. In the dry season after the cabbage, *Mimosa* is left in the field for seed production. Burning before wet season helps to re-establish *Mimosa* for fallow period. Seed collection may be necessary where seed production is poor. *Mimosa* would grow vigorously and cover the ground densely almost the entire period of the wet season. In August, farmers slash the *Mimosa* vine and other weeds and leave the plant residues to decay before land clearing at around the end of September and early October. Slashing would kill the vinny plants of full-grown *Mimosa*. When the cabbage-growing season begins, burning is used to clear the land and seedbed preparation is carried out by hand. Soils are turn over to cover the ashes and unburned residues providing organic fertilizer to the soils. Amount of nitrogen fixed by *M. invisa* was estimated at about 47 kgN/ha (Rerkasem et. al. 1992). In the dry season when *Mimosa* are left to grow in association with maize crop, the total amount of nitrogen from fixation and available with maize thrashes may be up to 67 kgN/ha. Annual amount of nitrogen in cabbage and maize systems may be calculated at 114 kgN/ha. The weakness of *M. invisa* is shade intolerant and can be wiped out with increasing cropping intensity in the rotation. Farmers will have to find other alternatives to sustain their intensive agricultural production.

(b) *Secondary forest succession domain*

When farmers are able to maintain a longer period of fallow in traditional shifting cultivation in the face of rapid change in northern Thailand, say 6-7 years, management of fallow succession within the forest domain is possible. In *Sop Moei* district of *Mae Hong Son* province, PLEC is working with *Pwo* Karen farmers of *Tee Cha* village on a pioneer species of tropical forest locally referred as Pada (*Macaranga denticulata*). This community has been permanently established some at least 6-8 generations ago at the border of Thailand and Myanmar in Mae Hong Son province.

The village is located at about 750 m. above sea level but the field altitude may range from 600-900 m. with steep slope. There are some 142 persons in 39 households. For the past 10 years, fallow period was reduced to 6 years with 1 year in upland rice. Farmers say that productivity of the upland rice is still more or less the same level as before when the fallow period was much longer, 10-15 years. The distinct feature of the 6-year regrowth is the domination of *Macaranga* canopy in the field. In area where *Macaranga* occurs at a dense stand, the following rice crop is expected to give a higher yield. Field measurement in farmers' plots have shown that with dense stand of *Macaranga* in 6-year regrowth (4200 plants/ha) the following upland rice crops could give an average grain yield of 3.04 t/ha (Yimyam et. al. 2001). In contrast fields with sparse distribution and abundance of *Macaranga* could provide an average yield of only 1.15 t/ha.

At the end of 6-year regrowth, the biomass accumulation in *Macaranga* dominant plots could be as high as an average of 42.7 t/ha, providing nutrient inputs to the system in the order of 535, 38 and 254 kg N-P-K/ha respectively. The level of nutrient content in the *Macaranga* dominant biomass at the onset of growing season is much higher than those previously receded with 7-year fallow regrowth of the traditional *Lua* system of *Pa Pae* village nearby in the province (Zinke et. al. 1978). The *Lua* system of *Pa Pae* could provide 134 kgN/ha, 16 kgP/ha and 179 kgK/ha with 7-year regrowth of fallow vegetation. Although much of nitrogen will be lost after burning but other nutrients remain in ash and readily available to the plants. We are monitoring the systems with dense and sparse areas of *Macaranga* in order to measure the direct relationships between *Macaranga* stand and rice yields.

M. denticulata is a prolific seed producing species. The plant is self-seeding but seed production starts in the third year of fallow regrowth. Shorter fallow management would impose a limitation to seed production, hence the distribution and contribution of *Macaranga* to the shifting cultivation system. With some level of management *Macaranga* can be the dominant species in 6-year fallow rotation. Seeds of *Macaranga* are characterized by hard seeded coat and may stay in dormancy with unbroken seeds. Burning the field apparently helps for seed germination from the seed bank in the soil and seed rain from the previous year on the ground surface. The behaviors of seed germination, seedling emergence and establishment have yet to be investigated. Some attempt has been made to transfer *Macaranga* to enrich fallow in *Mae Chaem* district of Chiang Mai province but the experience has turned out to be a failure due to poor germination and seedling establishment.

At weeding time, farmers leave the young seedlings of *Macaranga* to grow in association with the upland rice. The seedling emergence occurs at about the same time of upland rice after effective rain in late April or early May. Thinning may be required in a spot of very dense population. Transplanting of the young seedlings to sparse populated area and uneven spots has

been attempted but not widely practiced now. Transplanting could have the effect of physiological shock on *Macaranga* seedlings reduces their competitive ability and seedling survival. Other factors may involve and these are being under investigation.

As might be expected, the species richness of the managed fallow is much lower than other forest ecosystems in the village, e.g., community and conservation forests, and headwater area (Table 3). Nevertheless, field observations of >6 year regrowth plots indicated that a complex vegetation

Table 3. Number of species, plant numbers and derived diversity indices of different land use in *Tee Cha* village.

Forest Type	Numbers Per Plot		Derived Indices		
	Species	Plants	Shannon-Weiner Index	Species Richness	Evenness Index
6-year Regrowth Fallow	25	143	2.11	2.09	0.65
Community Forest	54	36	3.58	9.00	0.89
Dry Dipterocarp Forest	35	19	2.97	8.03	0.84
Headwater Area	37	15	3.09	9.35	0.85

Source: UNU/PLEC-Northern Thailand Sub-cluster (2000)

with diverse tree species can be achieved with plots previously dominant with *Macaranga* during early succession. The dynamic of fallow regeneration is being under monitored with permanent plots and this is expected to continue for the next 3-4 years.

Understanding the role and contribution of *Macaranga* in the traditional shifting cultivation might provide the key solutions to the restoration of subsistence crop yields in shorter fallow systems, and the success of reforestation with natural regeneration process. As *Macaranga* is a pioneer tree in early succession, its role in natural regeneration may be associated with other long lived species in later stages of succession such as *Castanopsis* and *Lithocarpus* species and other climax species. The role of mycorrhizal fungi associated with *Macaranga* roots is also under investigation. So far, some 20 species of arbuscular mycorrhizal fungi have been recovered from *Macaranga* roots from the field (Youpensuk and Lumyong 2001). The colonization rates in the *Macaranga* roots were recorded at the high range of 75-90%. Number of spore around the root systems of *Macaranga* seedling were about 30-45 spores/g of soil.

4. Conclusions

Pressures on uplands are pushing traditional shifting cultivators in northern Thailand to intensify land use with alternative practices introduced by outsiders. In contrast farmers are adapting shifting cultivation systems into more intensive forms of agriculture and one of the significant element in traditional shifting cultivation is the management of fallow succession. Strategies depend upon the length of fallow period available and this determines suitable management regimes for fallow successions, i.e., weed succession, bush fallow and secondary forest succession. Evidences from PLEC demonstration and research sites in northern Thailand have

shown the many ways that farmers manage fallow succession with the wide range from commercial crop and vegetable production of the *Hmong* community in *Pah Poo Chom* to subsistence rice production of a *Pwo Karen* in *Tee Cha* village. Despite the differences in ethnicity and cultural background, farmers are innovative in responding with a variety of strategies to modify fallow vegetation to enhance economic and ecological functions. In the *Hmong* village agrodiversity management of fallow succession for a climax of a weedy species (*Mimosa invisa*) is being used to build soil fertility of former highly degraded land and forests. For the *Karen* community farmers are fighting to restore productivity of traditional shifting agriculture to ensure food security. People have found a local pioneer tree species (*Macaranga denticulata*) that could contribute to the sustainability of shifting cultivation through productive regeneration of secondary forest and nutrient cycling of the system under 6 year of fallow regrowth. The values of these species are often ignored. Understanding scientific processes behind agrodiversity management of these local species could be a key to the success of sustainable land management in the hinterlands of the sub-region.

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