Agrodiversity Lessons in Mountain Land Management

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Intensification of crop production in the mountains has long been perceived as unsustainable. However, since the late 1980s it has become increasingly evident that decline and collapse are not always inevitable. The present article provides examples from the highlands of northern Thailand to show that local food security can be improved while impacts on the resource base and the environment are minimized. This was achieved with the help of cropping systems developed and adapted by farmers themselves (Figure 1). Studying farmers' management techniques will allow this success to be repeated elsewhere, but only if it is based on the idea of dynamic variation in cropping system management that occurs within and between mountain agroecosystems, defined as agrodiversity.

FIGURE 1 A mosaic of mountain land uses: vicinity of Mae Cham village, Chiang Mai, Thailand. (Photo by Kanok Rerkasem)

A mountain agroecosystem on the verge of collapse

The following account of the Hmong village of Pah Poo Chom (see following description) found in the files of the Tribal Research Center in Chiang Mai aptly portrays the dire situation of the highlands of northern Thailand in the 1970s and 1980s:

> After seven years most of the surrounding forests had been cleared and cropped with rice, opium and maize. There was increasing competition for land from the neighboring villages of Thai, Lahu and Lisu. In 1970 the village grew 35 *rai* (5.6 ha) of opium, but the yield was very low. The village was extremely poor, and more than 55% of the total adult population was addicted to opium. Many had to make a living from employment outside the village.

The highlands of northern Thailand are populated by several ethnic groups. The people originally made a living from slash-and-burn systems of land use broadly classified as rotational and pioneer types of shifting cultivation. Rotational shifting cultivators (Karen, H'tin, Lua, and Khamu) typically settled in one place to grow rice and associated crops in a system of rotation involving 1 year of cropping and 9–14 years of fallow. Pioneer shifting cultivators (Hmong, Lahu, Lisu, Yao, Akha, and Haw) were migratory.

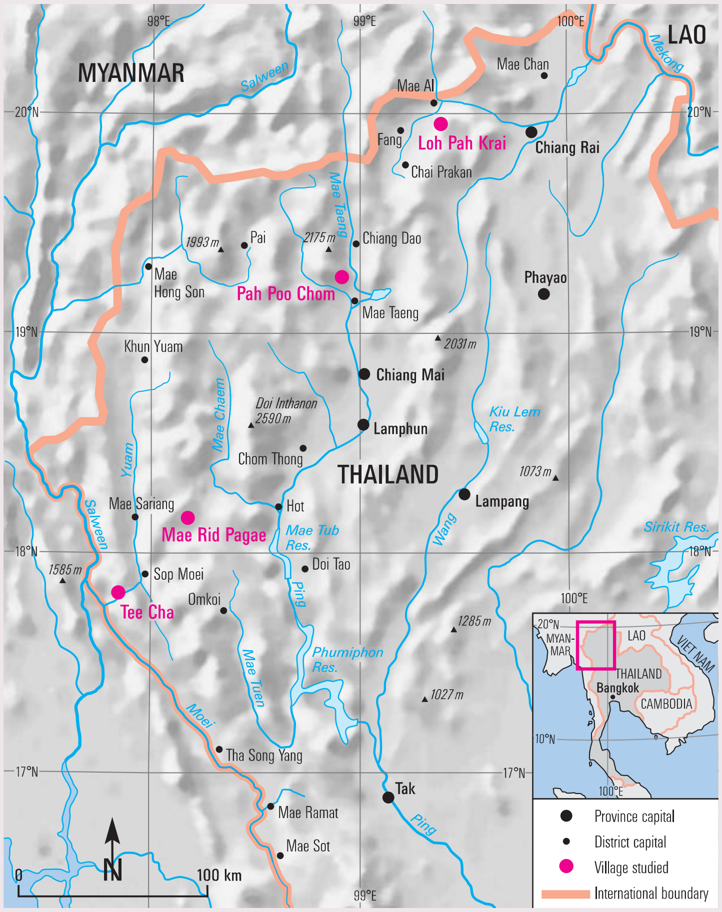
It was a harsh way of life with a constant risk of crop failure. The system was nevertheless sufficiently productive and sustainable as long as land and mature forests were plentiful. Since the 1950s, however, internal and external pressures have been mounting. These include rapid population growth and growing national concerns about loss of forest cover, soil erosion, and other impacts on the environment and natural resources, especially water. Agricultural land has been drastically reduced by demarcation of large areas for watersheds, national parks, and wildlife sanctuaries.

Coping with change

In addition to increased pressure on the land, there were other changes in the 1980s. Law enforcement against opium became more rigorous. New opportunities emerged as the result of increased integration into the national economy, better communications, and access by road. New cropping systems and modification of old ones appear to have raised productivity. Some form of forest conservation is practiced in almost every village. Four sample villages (Figure 2) illustrate that success was not restricted to any particular ethnic group and that it did not come about because of the transfer of any single magic external technology. It was the product of many different innovations and practices, some originating locally, others imported into the mountains, but all adapted to individual fields, farms, and villages.

Pah Poo Chom is a Blue Hmong village situated in Chiang Dao, 100 km north of Chiang Mai. The community first settled on a mountain ridge in 1963. Most of the surrounding forests had been cleared by 1970 and cropped with rice, maize, and opium. A major investment during the 1970s to develop wetland rice cultivation was unsuccessful. Productivity was too low to feed a population of 116; the village was on the brink of collapse. But Pah Poo Chom has become a very different village since the early 1990s. With a population of about 250, it now uses only about 30% of its land. The steeper slopes are covered with forests. Obvious signs of prosperity can be seen in the number of pick-up trucks and other consumer goods. Cash cropping, with sprinkler-irrigated lichee and vegetables, has been adopted on a major scale, but successful management of local plant genetic resources has also contributed to food security and income generation.

FIGURE 2 Map of 4 sample villages: Pah Poo Chom, Mae Rid Pagae, Loh Pah Krai, and Tee Cha. (Map by Andreas Brodbeck)



Loh Pah Krai was a typical opium-growing Lahu village. With their pioneering form of shifting cultivation, the villagers moved through the highlands growing opium, maize, and upland rice. After "eating up forests in three provinces," they settled at Mae Ai, north of Chiang Mai, in the mid-1960s. A sizeable tract of irrigated rice land was bought from lowland Thais. By the early 1990s the village was making a living from rice–soybean cropping systems in the irrigated fields and maize–legume systems on the slopes. Several farmers now have elaborate home gardens with 30–40 species, including annual crops, fruit and other trees, local and introduced vegetables, herbs and spices, and various semidomesticated species.

FIGURE 3 Upland rice field after harvest, with *pada*. (Photo by Kanok Rerkasem)

Mae Rid Pagae is a Skaw Karen village in Mae Hong Son, near Myanmar. In the past, the village subsisted on rotational shifting cultivation supplemented by limited irrigated wetland rice and off-farm employment in the nearby town of Mae Sariang in bad years. The introduction of cabbage in the early 1980s raised productivity significantly. The success of Mae Rid Pagae, however, is not a matter of just growing cabbage; new cropping systems have evolved, incorporating cabbage production and components of traditional cropping systems. Cabbage is grown in paddies with irrigation in the dry season, after wet season rice. On the slopes, upland rice and cabbage are grown in rotation. Rice yield has doubled or tripled, possibly because of the residual effects of fertilizers and clean weeding of cabbage.

Tee Cha is a Pwo Karen village, established more than 200 years ago, in the Salween watershed on the Myanmar border in Mae Hong Son. It is one of the few villages where rotational shifting cultivation is still productive. Good forest cover dominates the village landscape. The cropping system in Tee Cha is predominantly subsistence and is managed partly on a communal basis. Although situated in a less densely populated area than most highland villages, it is also experiencing external and internal pressures on the land. In a much-shortened rotation, maintenance of productivity is attributed to an innovative use of local fallow-enriching species, especially *pada* (*Macaranga denticulata* Muell. Arg.) (see Box 1 and Figure 3). In addition, local domesticated, semidomesticated, and wild species contribute significantly to food security.

BOX 1

A local fallow-enriching species, *Macaranga denticulata* Muell. Arg. *(pada)*

Pada is a small tree of the family Euphorbiaceae. Its primary use is in fallow enrichment; the wood may be used for fuel and the leaves for wrapping. During the cropping year, *pada* seedlings emerge in thick carpets among the rice. Farmers manage *pada* in a number of ways; the seedlings are not considered weeds and are thus not eradicated during hand weeding, but dense stands may be thinned. Seedlings may also be transplanted to areas with poor establishment. A good stand of *pada* reaches almost over the farmers' head by the time of rice harvest (Figure 3). Dense stands of *pada* (>4000 trees/ha) are associated with an upland rice yield that is about twice that with 1000 trees/ha or fewer. However, after only 3 years of dense *pada* the rice yield is only 1 quarter of that after 6 years. Attempts to transfer *pada* to neighboring villages have so far been unsuccessful.

The agrodiversity approach

"Agrodiversity" is used here as a means of analyzing and understanding innovation and management of cropping systems in the mountains. Agrodiversity has been defined as the dynamic variation in cropping systems, output, and management practice that occurs within and between agroecosystems. It is characterized by biophysical differences and the many changing ways in which farmers manage diverse genetic resources and natural variability and their practices in dynamic social and economic contexts (Brookfield 2001).

Diversity in the biophysical environment

The highlands are places of great diversity in the biophysical environment. Successful cropping systems are often those that can take advantage of special sets of conditions. Utilizing 16 ha of former paddy for irrigated orchards and vegetable fields, Pah Poo Chom has no major soil erosion problems. Pah Poo Chom is but 1 of numerous highland villages that have taken advantage of gravitation to supply piped water for domestic use and irrigation. Tee Cha's "luck" in the presence of *pada* and other natural fallow-enriching species is shared by few other shifting-cultivation villages in the neighborhood (see Box 1).

The primary constraint on technology transfer from the outside is poor characterization and documentation of the biophysical environment of the highlands. On the other hand, the farmers' understanding of the local biophysical environment is well known among those familiar with the mountains of northern Thailand (see Box 2). Farmers readily speak about variations in soil, temperature, water, position on the slope, the special characteristics of local plants, and various seasonal conditions. Much can therefore be learned from them, but this requires more than a few hours of visits by national and international "experts."

BOX 2

Knowledge and skill in crop management of mountain farmers

Headman, Hmong village of Khun Sa Nai, Chiang Mai, on wetland rice cultivation in narrow highland valleys:

> *The soil is warm in the bottom fields. We need one kind of rice. At the top we need another kind because the soil is cold and hard.*

H'tin farmer in Namsod, Nan, on effects of trees in upland rice:

> Du (Pterocarpus *sp*) *is good for rice, which you can see growing right up to the trees. We can leave many of these in the field; they are good timber too. But see how no rice grows under this* mamuen (Irvingia malayana); *you don't want them in the rice field. We keep just this one tree for the seed that children love.*

Headman, Hmong village of Khun Sa Nai, Chiang Mai, on rice for poor soils:

> *Akha rice is good for poor soils. For upland fields with poor soils, we get our rice seeds from the Akha.*

Karen farmer, Pang Gorm, Nan, on legumes and upland rice:

> *You cannot grow these legumes just anywhere among the rice; they are very aggressive and will climb everywhere and smother the rice. We grow a few hills of these on the edge of the field and provide some dead twigs and branches for them to climb. But this* tua lawd or tua sord *(a cowpea) is one we can grow among the rice. Its branches will grow several meters, but always stay hugging the ground and never climb or do the rice any harm.*

Karen farmer, Mae Rid Pagae village, Mae Hong Son, on the seasonality of insect pests in vegetables:

> *We have to spray a lot in the dry season, but hardly ever in the wet season. See how everything is growing in the forest when it rains? The insects have plenty to eat and don't need to come and eat our vegetables. But in the dry season there is nothing for them to eat except our crops.*

Karen farmer, Mae Sariang, Mae Hong Son, on soil erosion and land formation:

> *Soil loss from those fields at the top is good. We need a few more years before this land (at the bottom of the slope) can be leveled and bunded for wetland rice. But soil loss from that field up there is no good because it will ruin the wetland rice field just below it. Luckily, the field is under my control, so I can take care that the forest cover is never cleared and the soil not disturbed.*

Diversity in management and innovation

Saophang Saetao (Figure 4) is one of the few farmers in Pah Poo Chom who manage agroforest edges to produce medicinal plants and a special kind of bamboo for making a traditional Hmong musical instrument known as *can*, as well as wild vegetables, timber, and herbs, like other farmers. Saophang's knowledge of forestry and traditional medicine and his skill in crafting the highly priced *can* are especially important to agroforest edge management. Other farmers, mainly women, manage the hedges for traditional food plants. Wild vegetables from Pah Poo Chom's agroforest edges sell well in Chiang Mai City. The managers of agroforest edges in Pah Poo Chom are all old farmers who have retained knowledge and skills from the opium-based cropping systems. Younger farmers tend to focus only on cabbage and lichee.

Saophang and others like him can be called "expert farmers," whose qualifying characteristic is their crop management ability. Those who specialize in food crops other than rice are usually women, whose special gender-related skills and knowledge are exemplified by the management of numerous domesticated and semidomesticated food plants, including 20–30 different kinds sown mixed with rice (Figure 5). It is not always easy to identify expert farmers, however; those who are most capable are not necessarily the most outspoken or articulate.

Diversity in local genetic resources

Plant genetic resources available for local use are the key to the successful new cropping systems discussed previously. Production of cabbage, pepper, carrot, lettuce, tomato, potato, etc relies on the most modern varieties of imported seed. These, however, have not displaced traditional local germ plasm, even in villages that have gone into commercial production on a major scale. Local plant species and varieties continue to contribute significantly to food security, especially where there are problems with the market, for example, when vegetable prices collapse or the lichee trees do not set fruit. Local plant genetic resources are even more valuable to those with limited access to the market, including villages with poor transportation such as Tee Cha and people who have not been highly successful with cash cropping, which includes the village poor everywhere.

Wild and semidomesticated species, as well as rice and the various crop species associated with it, all contribute to food security. Saophang's agroforest hedge in Pah Poo Chom contains 92 species of plants. In addition to *pada*, other soil-improving species are only beginning to be identified and characterized by researchers. Rice is still the primary subsistence crop in most highland villages, although its relative importance has declined with the spread of new cash crops. Virtually all of the rice varieties grown in the mountains are from local germ plasm. At least 15 local varieties have been identified in Tee Cha; each farmer grows 2–5 varieties. Taste preference for traditional varieties is one reason for lack of success with "improved" rice varieties in the highlands. The other reason is that new varieties bred for wide adaptation have failed to meet the diversity of biophysical conditions in the highlands. Through their maintenance of the local germ plasm of native strains of rice, other food crops, and semidomesticated species, these farmers provide the world at large with a valuable service of in situ conservation of plant genetic resources.

FIGURE 4 Saophang Saetao and a *can* made with a special bamboo from his agroforest edge. (Photo by Kanok Rerkasem)

Diversity in institutional arrangements

The ability of local institutions to manage the common resources of land, water, and forests can be the 1 condition on which the success or failure of new cropping systems depends. When former opium-growing villages bought their irrigated rice land in order to settle down, in addition to transfer of technology for growing wetland rice they had to adapt rather complex communal institutions to the management of the irrigation system. The Lahu of Loh Pah Krai have had to learn to manage sharing of irrigation water within the village and with neighboring villages as well as to organize maintenance of the physical structures of the irrigation system. In contrast, conflicts have erupted between highland and lowland villages in many areas where institutions for water sharing were poorly developed. The presence of roaming livestock is often the primary constraint on vegetable production. Common sense might suggest fences, but in Mae Rid Pagae the enforcement of a communal law is an additional factor. Owners of the vegetable fields have a responsibility to make their fences cattle-proof during the day. Livestock owners are fined for damages that occur at night,

FIGURE 5 A seed mixture of rice and 24 other kinds of crops sown by Mrs Inar in Tee Cha. (Photo by Kanok Rerkasem)

when the animals need to be tied or locked up in stalls.

Rotational shifting cultivators such as the Karen of Tee Cha owe the productivity and sustainability of their land use system primarily to traditional land management institutions. Communal management ensures that fallow forests (ie, forests that cover the land during fallow) are allowed to regenerate quickly after 1 crop season and grow undisturbed before slash-and-burn takes place again. Rotational shifting cultivation is less successful where communal land management has broken down or was never practiced in the first place. In remote places, enforcement of local rules and regulations is often the only effective way to protect forests against encroachment, over-harvesting of timber and other forest products, and forest fires.

Conclusion

Land use in the highlands of northern Thailand has undergone dramatic changes under external and internal pressures. Some farmers have been able to cope by adopting cropping systems that are more productive and have minimal impact on the environment. This has been done with local innovations in crop management that have replaced or improved traditional shifting cultivation. The 4 sample villages are not unique; many others can be found throughout the region. The key to these successes is local innovations that have come about through (1) farmers' knowledge of spatial and temporal diversity of their biophysical environment, (2) local availability of plant genetic resources and farmers' knowledge of their special adaptation and other characteristics, (3) the crop management skills of individual farmers, and (4) effective institutional arrangements for dealing with the management of common resources. The ability to manage this "agrodiversity" to the advantage of their specific cropping or land use system is the unique qualification of successful, expert farmers. Analysis of the 4 elements of agrodiversity is useful in any attempt to improve the performance of crop production in mountain agroecosystems by outside experts.

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FURTHER READING

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