Chapter 7
Integrating Scientific Research with Community Needs to Restore a Forest Landscape in Northern Thailand: A Case Study of Ban Mae Sa Mai

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7.1 Introduction

Like all tropical countries, Thailand has suffered from severe deforestation. By 2000 AD, natural forests (tree cover >10%, not including plantations) had declined to about 19.3% of the country's land area (9.8 million ha) (FAO 1997, 2001). Despite a ban on commercial logging of natural forests since 1989, the average annual reduction in natural forest cover remains about 0.5% per annum. Overall since 1961, Thailand has lost nearly two-thirds of its forests (Bhumibamon 1986). Loss of natural forest has resulted in losses of biodiversity and increased rural poverty, as local people are forced to purchase, in local markets, substitutes for products formerly gathered from forests. Increases in landslides, droughts and flash floods have also been attributed to deforestation whilst carbon dioxide, released from forest fires and other forms of forest degradation, contributes approximately 30% towards Thailand's total annual carbon emissions (Department of National Parks, Wildlife and Plant Conservation (DNP) and Royal Forest Department (RFD) 2008).

Part of the Thai government's response to these problems has been to conserve remaining forest in an extensive system of protected areas (including national parks, wildlife sanctuaries and protected watersheds), which now encompass 24.4% of the country's land area (125,082 km^2) (Trisurat 2007). However, many such 'protected' areas were established on former logging concessions, so large parts of them were already deforested before they were gazetted (approx. 20,000 km^2 (derived from Trisurat 2007)). A recent report by Chiang Mai University's Academic Service Centre, found that approximately 14,000 km^2 of the country's forestland was "in need of urgent recovery" (using a GIS analysis of biomass index, Panyanuwat et al. 2008).

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Fig. 7.1 Ban Mae Sa Mai in Doi Suthep-Pui National Park, with "community forest" above the village. Lychee orchards, arable land and abandoned, degraded land are also shown

In the uplands of northern Thailand, early attempts at reforestation, in the 1970s and 1980s, involved establishing plantations of pines and eucalypts including within protected areas. These monocultures may help to satisfy the growing demand for wood, pulp and other forest products and they may reduce the need to log natural forests, but they fail to provide suitable habitat for the thousands of plant and animal species that formerly inhabited the original forest. Moreover, they cannot supply local people with the wide variety of forest products and ecological services formerly provided by the original forest.

For environmental protection and biodiversity conservation within protected areas, the most appropriate kind of reforestation is forest restoration, or the "re-establishment of the original forest ecosystem that was present before deforestation occurred" (Elliott et al. 2000). This may involve accelerated natural regeneration and/or tree planting to re-establish forest structure and ecological functioning (productivity, nutrient cycles, food webs etc.) and ultimately a return to former levels of biodiversity.

However, forest restoration in Thailand has been constrained by a lack of knowledge about how to grow and plant the thousands of tree species that comprise the country's varied tropical forest ecosystems. Therefore, in 1994, Chiang Mai University (CMU) established a Forest Restoration Research Unit (FORRU-CMU), in the Biology Department, to develop appropriate techniques to restore tropical forest ecosystems on degraded land in protected areas for biodiversity conservation and environmental protection. The unit consists of an experimental tree nursery and trial plot system in Doi Suthep-Pui National Park, which conveniently adjoins the university campus. Although FORRU-CMU's remit is a technical one, involvement in the social aspects of forest restoration became inevitable because experimental plots were needed in a national park, where a large number of people were living. The plot system was established over more than a decade (since 1997) in the upper Mae Sa Valley in Doi Suthep Pui National Park, in close collaboration with both the national park authority and the Hmong hill tribe villagers of Ban Mae Sa Mai, which is located in the valley (Fig. 7.1).

The work involved developing negotiation skills and sharing of both scientific and indigenous local knowledge among villagers and scientists. Villagers were involved in every stage of the process from seed collection and growing indigenous trees in a community tree nursery to planting, caring for and monitoring trees in the plots. Over the years, these activities provided FORRU-CMU staff with a rare insight into a combination of both the scientific and socio-economic aspects of forest restoration, which we now share with readers of this chapter.

7.2 FORRU-CMU's Scientific Research Program

In 1997, FORRU-CMU began developing a 'framework species' approach (Fig. 7.2) to restore evergreen forest ecosystem to the mountains of northern Thailand, after having studied the concept in Australia, where it was first conceived (Goosem and Tucker 1995; Lamb et al. 1997; Tucker and Murphy 1997). The framework species method involves planting 20–30 tree species to rapidly restore forest ecosystem structure and function, whilst animals, attracted to the planted trees, bring additional plant biodiversity by dispersing seeds to the site.

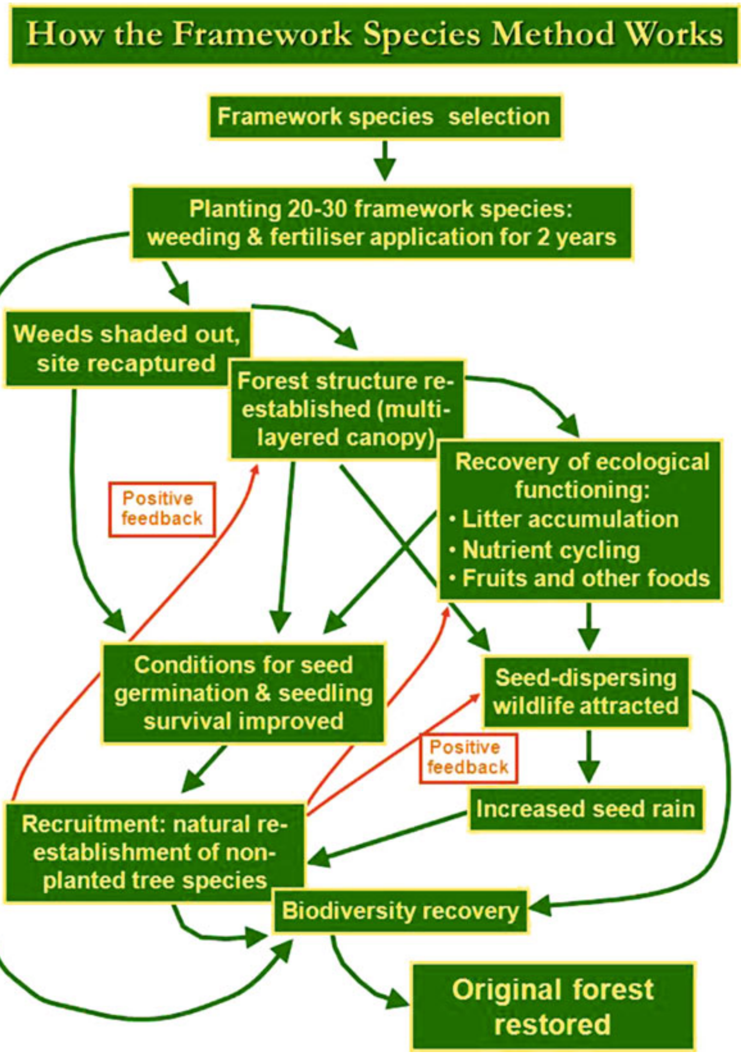

Fig. 7.2 How the framework species method works

Framework tree species are selected from amongst the indigenous forest tree flora. They are native, non-domestic tree species with high survival and growth rates when planted out in deforested sites. They have dense, broad crowns, which shade out herbaceous weeds, and are thus capable of bringing about rapid “site capture”. Most importantly, framework tree species are those that produce fleshy fruits, nectar-rich flowers or other resources, which attract seed-dispersing animals, particularly frugivorous birds and bats. The planted trees, therefore, act as “bait”, enticing such animals to drop seeds from nearby forest trees into the restoration plots. The mixture of framework tree species planted includes both pioneer and climax species. Crowns of the fast-growing pioneer trees form an upper canopy and attract seed-dispersers at an early age, whilst those of climax tree species form an understory, ready to grow up when the pioneers begin to die. Amongst the ground flora, forest tree seedlings become established from seeds brought in by birds and bats, over distances of up to 10 km, from forest fragments that remain elsewhere in the landscape (FORRU 2006).

The main focus of FORRU-CMU’s initial research program was to identify and test framework tree species for restoring forest ecosystems in northern Thailand, concentrating first on evergreen forest above 1,000 m elevation, since it has the highest conservation value compared with the other forest types of the region (i.e. highest species richness and highest numbers of rare and habitat-restricted vascular plant species (Maxwell and Elliott 2001)).

The herbarium collection and database of the local tree flora, established by J. F. Maxwell at CMU Biology Department Herbarium (Maxwell and Elliott 2001), provided an invaluable starting point for planning the research, providing a species identification service as well as distribution information for 654 tree or tree-like species, indigenous to Doi Suthep-Pui National Park, including 341 species that grow in evergreen forest.

The unit first established an office and a research nursery at the National Park’s former headquarters compound, located on the south side of the mountain, at 1,000 m elevation (the boundary between evergreen and deciduous forest types). Research began with a study of the reproductive phenology of forest trees. About 5–10 individuals of each of 100 species were identified and labelled along foot paths, leading through relatively undisturbed evergreen forest from the unit’s research nursery. From 1995 to 1998, the trees were observed, at 3-week intervals, for flowering and fruiting. The phenology study determined optimal seed collection times and provided opportunities for regular seed collection.

In the research nursery, a wide range of experiments were performed to determine optimal methods to grow hundreds of tree species for testing in field trials. The aim was to produce container seedlings of a suitable size for planting (30–50 cm tall) by the optimum planting date, which is mid-June in northern Thailand, despite wide ranging differences among the species in fruiting periods, length of seed dormancy and seedling growth rates (Blakesley et al. 2002). The research included germination trials, testing various techniques to break dormancy (Singpetch 2002; Kopachon 1995), seed storage experiments and seedling growth trials (testing various media, containers and fertilizer regimes) (Zangkum 1998; Jitlam 2001).

The research facility was also used by CMU research students, who tackled some of the more detailed options for planting stock production, such as propagation from cuttings (Vongkamjan et al. 2002), the growing on of wildlings (Kuarak 2002) and the role of mycorrhizae (Nandakwang et al. 2008). To date, more than 420 tree species have been experimentally tested in the research nursery.

Every rainy season since 1997, experimental plots, ranging in size from 1.4 to 3.2 ha year^{-1} have been planted with varied combinations of 20–30 candidate framework tree species in the Upper Mae Sa Valley (1,300 m elevation) of Doi Suthep-Pui National Park. The objectives of these plots were to (i) assess the potential of the planted tree species to perform as framework species, (ii) test the responses of the trees to various silvicultural treatments applied to maximize field performance and (iii) assess biodiversity recovery. Before planting, the plots were cleared of weeds by slashing and spraying with glyphosate, taking care not to damage any existing natural regeneration. Trees were planted randomly across the plots, averaging 1.8 m apart. Various fertilizer, mulching and weeding regimes were applied as experimental treatments during the first two rainy seasons after planting. Fire breaks were cut every January and fire prevention patrols worked throughout the dry season. All planted trees were labeled and monitored 2 weeks after planting and at the end of each subsequent rainy season. Surveys of naturally established trees and birds were carried out before planting and at various intervals thereafter, both in planted plots and in non-planted control plots.

7.3 Working with a Local Community

The field plots were established in close co-operation with the people of Ban Mae Sa Mai village which is located below the plot system at about 1,000 m elevation. Ban Mae Sa Mai is the largest Hmong hill tribe village in northern Thailand with 190 households and a total population of more than 1,800. The Hmong is one of several ethnic minorities in northern Thailand, collectively known as hill tribes. The village was originally founded at 1,300 m elevation (close to the plot system), but was moved down the valley to its present location in 1967, after deforestation caused the village water supply to dry up (according to the village elders). Construction of a government-funded primary school and other facilities helped to consolidate the community and discouraged further movement. However, the relocation event left the villagers with a strong sense of the link between deforestation and loss of water sources.

In 1981, the village and surrounding farmland were included within the boundaries of the newly declared Doi Suthep-Pui National Park. This meant that the villagers faced a legal threat of eviction, since under Section 16 of the National Park Act (B.E. 2504): "Within the national park, no person shall: (1) Hold or possess land, or clear or burn the forest;…" and the villagers had no formal land ownership rights..

To avoid possible enforcement of this law, a few of the villagers decided to demonstrate to the authorities that they were capable of being responsible custodians of the environment. They formed the "The Ban Mae Sa Mai Natural Resources Conservation Group" and painstakingly built a community-wide consensus to gradually reduce cultivation of the upper watershed and replant the area with forest trees. The village committee declared a remnant of degraded primary forest above the village as "community forest" (unofficially, since there was no community forest law in Thailand at that time). The forest protects three springs, which supply the village, and the agricultural land below it, with water. The village committee formulated regulations to prevent tree felling and hunting in the community forest and imposed fines on transgressors.

Furthermore, the villagers decided to contribute to a national project to celebrate His Majesty King Bhumibol Adulyadej's Golden Jubilee, which aimed to restore forest to more than 8,000 km^2 of deforested land nationwide. They agreed with the national park authority to gradually phase out cultivation of cabbages, corn and carrots in over a 50-ha area in the upper watershed and replant it with forest trees. The Royal Forest Department provided the villagers with eucalypt and pine trees to plant in the upper watershed, but the villagers were disappointed with the limited species choice and the results. To compensate for lost agricultural production on the upper slopes, the committee planned to intensify agriculture on the more fertile land in the lower valley. This included installation of an irrigation system to boost productivity of lychee orchards, already established there and, more recently, to develop production of high-value salad vegetables under plastic cloches.

Meanwhile, FORRU-CMU approached the national park authority to find a suitable location to establish trial plots to test the framework species method of forest restoration. The national park authority recommended the watershed above Ban Mae Sa Mai and the villagers readily agreed to accept the project in their area, since they recognized an opportunity to improve their previously unsuccessful efforts to restore forest to the upper watershed.

This partnership with a local community provided FORRU-CMU with three important resources (i) a source of indigenous knowledge, (ii) an opportunity to test the practicability of research results by local people and (iii) a supply of local labour.

Indigenous knowledge about local tree species proved useful in the selection of "candidate" framework tree species for testing. Villagers provided information on which tree species readily colonize abandoned cultivated areas, which are attractive to wildlife species and which species of potential seed-dispersing animals survive in the valley. Discussions revealed that the villagers had traditional uses for nearly all the candidate framework tree species proposed for planting, but overall, the villagers were more interested in planting trees for watershed protection than for forest products, since they already obtained enough food and earned sufficient income from agriculture.

At the request of the villagers, FORRU-CMU funded construction of a community tree nursery in the village and trained villagers in basic tree propagation methods and nursery management. The unit also employs one family in the village to collect seeds and grow the trees. The nursery now produces about 20,000 trees per year, in close proximity to the planting sites, thus reducing the costs of transporting trees for planting. It has also provided an ideal testbed, where villagers provided feedback on the practicability of species choices and tree growing techniques, developed by the unit's research program.

Villagers provided labour for all aspects of the project from nursery management to planting, maintenance and monitoring of planted trees, as well as fire prevention. Depending on the type of work, FORRU-CMU provided (i) monthly salaries, (ii) donations to the community development fund or (iii) payments for casual labour at the standard rate, from various project grants used to fund the unit.

Monthly salaries were paid to villagers who worked full-time in the community tree nursery. The village committee declared tree planting to be a "community activity", which meant that every household in the village was obliged to send one family member to join the activity (or pay a fine of 150 baht to the community fund). At the end of each planting event, FORRU-CMU presented a donation to the village community development fund. These donations were mostly used to improve the piped-water system and roads in the village.

The village committee also declared that fire prevention was a "community activity". Fire breaks were cut in mid-January (at the start of the hot-dry season) and from then until mid-April (the start of the rainy season), fire prevention teams of 16 persons manned a fire station in the upper watershed, 24 hours a day, to detect any fires approaching the planted plots and, if necessary, extinguish them. Each household provided one family member every 11 days to join this activity. An animistic religious ceremony was held at the start of the fire season to ask the village guardian spirit for a successful fire prevention program. If fire did not burn the planted trees, a pig was sacrificed at the end of the fire season to thank the spirit. This provided an ideal social event, during which the villagers, and staff of both FORRU-CMU and the national park could meet informally, strengthen their collaborative partnership and plan where to plant trees the following June. To support the fire prevention program, FORRU-CMU paid for labour to cut the fire breaks, meals for the fire prevention teams and also for the pig.

Maintenance of the planted tree, including weeding and fertilizer application, was carried out by teams organized by the village committee. For this work, FORRU-CMU paid daily labour rates to those that joined in the work. The village committee assigned the youth group of the village to help FORRU-CMU staff with monitoring the planted trees (measurements of survival and growth rates). Thus, news of the success of the tree planting experiments was transmitted directly back to the village by those who actually measured the trees.

This combination of payments and voluntary inputs helped to build a sense of local 'stewardship' of the forest restoration plots and gradually increased support for the work at the community level. Consequently the local people were more likely to protect the planted trees than destroy them. Frequent meetings were held with the villagers to share project tasks and particularly to decide on the positioning of the experimental plots, so as not to conflict with existing land uses. In addition, the head of the family appointed to take care of the nursery (Kuhn Naeng

Siwapattarapong) and a founder member of the village conservation group, acted as the main liaison, relaying information between FORRU-CMU staff and the village committee. As outside interest in the project grew, villagers also become involved in presenting the project to visitors and to the media, thus helping to build a positive public image for the village.

7.4 Technical Achievements

The main technical achievement of this work has been the development of an effective procedure to rapidly restore evergreen forest ecosystems to degraded sites, at elevations of above 1,000 m. Best-performing framework tree species were identified (Elliott et al. 2003) and optimal silvicultural treatments determined, to maximize survival and growth rates after planting (Elliott et al. 2000; FORRU 2006). With those species and treatments, canopy closure can now be achieved within 3 years after planting (with a planting density of 3,000 trees per ha).

Rapid recovery was also achieved (Fig. 7.3). Sinhaseni (2008) reported 73 species of non-planted tree species had re-colonized sample areas within the plot system. At this time these plots covered 4 ha and ranged in age from 5 to 9 years. Taking into account the 57 framework tree species, which had been planted in the sampled plots, the total tree species richness recorded in this study amounted to 130 (or 85% of the total tree flora of evergreen forest at 1,300 m elevation on Doi Suthep (CMU Herbarium Database)). Most of the tree species recorded had germinated from seeds dispersed from nearby forest by birds (particularly bulbuls), fruit bats and civets.

Forest restoration also increased the species richness of the bird community, from about 30 before planting, to 88 after 6 years, representing about 54% of bird species recorded using the same methods in nearby mature forest (Toktang 2005). The species richness of mycorrhizal fungi and lichens also increased dramatically in the restored plots, often exceeding that of natural forest (Nandakwang et al. 2008 and Phongchiewboon 2008, respectively).

The techniques were published in a user-friendly, practitioner's guide entitled 'How to Plant a Forest', in both Thai and English (FORRU 2006). This book proved very popular and demand for it in other languages was met by publishing translated editions in Chinese, Lao, Khmer, Vietnamese and Indonesian. The project also resulted in a set of research protocols and framework concepts, which researchers, in other tropical regions could apply, to develop techniques to restore any forest ecosystem type, taking into account the local tree flora and local climatic and socio-economic conditions. These were published in a handbook for researchers, entitled 'Research for Restoring Tropical Forest Ecosystems' (FORRU 2008 in English, Thai, Chinese, Khmer, Lao and Indonesian). Both books were made freely available on the web (www.forru.org).

Fig. 7.3 Before and After. (**a**) BEFORE – Deforested, cultivated, abandoned and burnt, a typical plot requiring forest restoration in Doi Suthep-Pui National Park. (**b**) AFTER – 6½ years after planting with 29 framework tree species, this plot has already developed a multilayered canopy and a dense carpet of leaf litter has replaced the herbaceous weeds

7.5 Community Achievements

Questionnaires and interviews were used to evaluate the villagers' perceptions of the project's impact, with 70 village members, from September 2005 to February 2006 (31 males and 39 females, aged 15 years or older). The interviews revealed a high level of satisfaction with most aspects of life in the village and high awareness of FORRU-CMU's activities. The majority of villagers expressed high satisfaction with activities such as tree planting and especially forest fire prevention.

Around 80% of respondents agreed that the project had helped to reduce internal social conflicts over natural resource shortages and improved the relationship between the village and outside organizations (particularly the Forest Department and National Park Authority, with which the villagers had previously been in conflict). Villagers also highly appreciated that the project had improved the public image of the village (through media coverage of planting events etc.).

Most agreed that the project had had positive effects on the natural resources, particularly water. Interviewees stated that they had noticed an improvement in water quality and increased water quantity (particularly during the dry season), as well as a reduction in soil erosion and a better local climate.

Other benefits, which the villagers appreciated, included direct monetary payments in the forms of salaries and daily payments for labour for caring for the reforestation plots, as well as support for community development, i.e., road access, water supply, fire prevention work and religious ceremonies. The development of eco-tourism in the village had also benefited from the project programs, since many eco-tourists now visited the village because they had heard about the forest restoration project there. This is generating revenue for the village from rental of bungalows and provision of meals for visitors. In addition, the community tree nursery has stimulated a few villagers to increase their incomes by producing trees for sale.

In February 2007, a second socio-economic survey was carried out to obtain more quantitative information about the perceived utilitarian benefits of the project. Members of 26 households were interviewed in the Hmong language, by a Hmong local assistant.

About 80% of the interviewees appreciated the value of direct financial inputs provided through FORRU-CMU for forest restoration activities around the community over the previous 10 years. These included employment of villagers for nursery operations, weeding and support with community projects. Villagers' estimates of this value varied widely from 20,000 to 100,000 baht per year (although the actual value was more than 200,000 baht/year). Several villagers acknowledged that FORRU's support had enabled them to receive other forms of local support ("matching funds") e.g. from the Sub-district Administration Organization (90% of villagers recognized this benefit) and from local units of Royal Forest Department and the National Park Authority (60% of villagers listed this as a benefit). Estimates of the amount of support, attracted from these other sources, varied from 10,000 to 30,000 baht per year. About 40% of interviewees agreed that the numbers of naturalists/eco-tourists visiting the village had increased markedly in the previous few years, mostly due to the forest restoration program, and that such eco-tourism was generating approximately 10,000–35,000 baht per year (mostly due to provision of accommodation).

Concerning non-timber forest products, 90% of the interviewees said that they gather some products from the forest for daily use in the family, while 40% claimed that they also sell such products for supplementary income. Villagers recognized that forest restoration had contributed to increased production of such products as bamboo shoots and stems, banana leaves and flowers, edible leafy vegetables (mostly young leaf shoots from trees); other flowers and fruits (mostly from trees) and some mushrooms. Estimates of the monetary value of such products per household varied greatly from 700 up to 11,000 baht per year.

7.6 Conclusions

The most important reason, why the villagers participated so enthusiastically in this project seems to have been their perception of the link between reforestation and watershed improvement. This was probably due to the villagers' historical experience of having to move the village after running out of water following deforestation around the original village location. Social impacts were also highly valued, particularly a better relationship with the national park authority, which reduced the perceived threat of eviction from the national park. Interestingly, economic values were usually regarded as less important. Payments from FORRU-CMU for labour and community projects, although appreciated, were clearly not the main motivation for villagers' participation, whilst collection or sales of forest products were only a minor contribution to the village economy.

Several pre-existing conditions contributed to the success of this project. Firstly, the villagers had already made the decision to plant trees when the project started, so there was no need to persuade them of the value of the activity. Secondly, the village was large and highly organized. There was a very strong sense of community and an effective village committee, supported by the majority of the population. Thirdly, the villagers had little need to exploit the forest for material needs. Agriculture for cash crops was well-developed; firewood was mostly provided from pruning lychee orchards and timber for construction was largely being replaced with concrete. Lastly the villagers were used to working with other organizations on projects. Being situated about an hour's drive outside Chiang Mai, this village has hosted many projects implemented by both Thai and international organizations over the years, so lines of communication and negotiation mechanisms already existed.

Having established an effective method to restore evergreen tropical forests on Thailand's northern mountains, the scientific work has shifted to look more closely at biodiversity recovery, long term forest dynamics (particularly survival and growth of in-coming tree species) and carbon storage.

However, the main value of this site has now become demonstrating this rather unusual "socio-scientific" approach to forest landscape restoration to other groups. The big question now is: can this approach be applied to restore other forest ecosystem types in other regions with different socio-economic conditions? Using the Ban Mae Sa Mai site as a model, FORRU-CMU is now collaborating with the IUCN and Thailand's Supreme Command to restore evergreen forest on 1,440 ha at Doi Mae Salong, with eight communities of various ethnic groups. A FORRU was established by the Elephant Conservation Network in Kanchanaburi to restore mixed evergreen deciduous forest for elephant conservation, whilst in the southern province of Krabi, a FORRU was established to develop methods to restore lowland evergreen forest to provide habitat for Gurney's Pitta, one of Thailand's most endangered bird species. Following workshops at the Ban Mae Sa Mai demonstration site, various government agencies and conservation organizations have now planned to establish FORRUs in China, Cambodia and Indonesia.

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