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RESEARCH NEEDS FOR RESTORING THE FORESTS OF THAILAND

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INTRODUCTION

Public awareness of the problems caused by deforestation has never been greater. It is generally accepted that further loss of forest will cause more extreme floods and droughts, loss of biodiversity and impoverishment of rural communities. Complete protection of all remaining primary forest, however, seems an unrealistic goal, due to economic and legal constraints. Therefore, to compensate for continuing destruction, many deforested areas will have to be converted back into forest to conserve biodiversity, protect watersheds and maintain rural communities. Within national parks and wildlife sanctuaries, where the primary objectives are wildlife conservation and watershed protection, reforestation should aim to permanently restore the original forest ecosystems, as closely as possible, by accelerating the natural processes of forest regeneration. Community forestry, in buffer zones around protected areas and elsewhere, also requires restoration of near-natural forest ecosystems to provide a diverse range of forest products and ecological services to local people. The enthusiasm with which members of the general public have participated in recent tree planting events to celebrate His Majesty the King's Golden Jubilee demonstrates immense public support for forest restoration, on a large scale, using native forest tree species. These projects have been initiated and implemented by a diverse range of organizations, including the Forest Department, the Royal Thai Army, charitable foundations, private companies, religious groups and other NGOs, often working in collaboration with each other. In terms of providing people with an opportunity to get directly involved in environmental protection, these tree planting events are undoubtedly successful. However, we believe that their effectiveness in restoring forest ecosystems could be considerably improved with some simple research.

GAPS IN KNOWLEDGE

Organizations such as the Royal Forest Department and the ASEAN–Canada Forest Tree Seed Centre have carried out excellent research on the propagation of forest trees for many years (KUERKOOL, 1991; KANTARLI, 1993; YUE–LUAN, 1993; OWENS *et al.*, 1991). However, such research has tended to concentrate mostly on a relatively small number of

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economic timber species, usually grown in plantations. Whilst such plantations are excellent for the production of timber, they are not so useful for the conservation of biodiversity. For that a more ecosystem–wide approach is needed. However, attempting to recreate a natural forest, with hundreds of different tree species is much more difficult and requires knowledge which at present is unavailable. We need to understand how forests regenerate themselves naturally, identify the factors limiting regeneration and overcome them to accelerate regeneration. Planting seedlings is just one of many options; others include protecting and tending seeds, seedlings or saplings which are already present (by weeding, adding fertilizer, irrigation etc.) or preventing fire by maintaining a network of fire breaks. This approach is known as assisted or accelerated natural regeneration (ANR). In some circumstances, tree planting activities can actually reduce seedling density. A common practice is to cut paths through the vegetation, to enable tree planters easy access to the planting sites. Such paths are typically about 1 m wide and occupy as much as one third of the site. Unfortunately, vigorous cutting clears away not only the herbaceous vegetation, but many naturally-established seedlings as well. The density of naturally-established seedlings in reforestation sites can often be quite high. In Ob Luang National Park, the density of naturally-established seedlings at one reforestation site, 1,400 m above sea level, ranged from 1.3 to 5.1 m^{-2} (ELLIOTT, unpublished report, 1994). At a deforested site 1,500 m above sea level on Doi Suthep, (adjacent to a site being replanted with seedlings), KARIMUNA (1995) recorded an average density of naturally-established seedlings of 1.34 m^{-2}. Planted seedlings are usually spaced about 4 m apart, along 1 m wide paths (a density of 0.25 m^{-2}). Therefore, clearing paths for tree planting activities can, on some sites, reduce seedling density by 28–32% and thus inhibit natural forest regeneration. Whether or not clearing the ground vegetation improves the survival of planted seedlings certainly requires further research. On the one hand, the ground flora might compete with planted seedlings for light, water and soil nutrients; on the other, it might provide shade and modify the micro-climate to benefit shade-tolerant seedling species. It is likely that different tree seedling species respond to the various ground flora species in different ways, so that clearing the ground flora would be beneficial for some seedling species and harmful for others. It is even possible that, within a species, seedlings of different ages or sizes are affected by the ground flora differently. The scope for research to improve site preparation and weeding methods for tree planting projects is clearly enormous.

Another question is: which tree species should be planted on which sites? The soil and climate requirements of commercial timber species are well known, but for the hundreds of other forest tree species, very little is known. Sites vary enormously in soil, micro-climate, topography etc. and each species has its own particular requirements. Without knowledge of such requirements, selecting tree seedling species for planting is very much a matter of chance. Furthermore, unless site conditions and the performance of seedlings are monitored after planting, we will never learn which species are suited to which conditions. In addition to matching seedling species with prevailing site conditions, species chosen for planting should complement those already established naturally. Although planting additional seedlings of species already present (and therefore suited to local conditions) might result in a high survival rate and increase tree density, it would not increase the diversity of the regenerating forest. Within national parks and wildlife sanctuaries, where increasing biodiversity is a major aim of tree planting, rapid survey techniques should be developed

to determine which seedling species are already present. Species absent from, but otherwise suited to, the site should then be chosen for planting. Such species are often those limited by inadequate seed dispersal. Uncontrolled hunting has eliminated many large bird and mammal species from some national parks and wildlife sanctuaries. Those trees which depended on large animals for seed dispersal may be unable to disperse their seeds into gaps, even though some of them may be able to grow under gap conditions. Research needs to be carried out to determine whether or not local extirpation of large birds and mammals is reducing the tree diversity of regenerating forests and to identify the tree species which may be affected. Those species can be targeted for propagation in nurseries and given priority in seedling planting schemes.

One major constraint currently limiting research on forest tree seedlings is the lack of an identification guide to seedlings. Most floras identify plant species on the basis of flower or fruit characteristics. Seedlings, of course, lack flowers and fruits and even their leaves can differ considerably from those of mature trees, so conventional floras cannot be used to identify seedlings. The ability to identify seedlings is crucial for many aspects of forest restoration work. To save time and nursery space, many seedlings used in current tree planting projects are dug up from remaining areas of forest and nurtured in a nursery for a year, before being planted out. Such seedlings are often difficult to name because the parent tree is unknown. To assess which species are regenerating naturally in deforested areas, it is necessary to identify seedlings of all species present at a wide range of sizes. Therefore, research on the morphology of seedlings, grown from seed of known parent trees, is urgently needed, to provide accurate descriptions for an identification guide to the forest tree seedlings of Thailand. More research is also needed on the growing of seedlings in nurseries. Seeds should be collected from the nearest available seed source, so that the seedlings grown from them have a good chance of being genetically suited to local environmental conditions. However, knowledge of the seasonal availability of seed of many tree species is currently limited. Some information is provided in the Flora of Thailand, but many species are not yet covered. Therefore, studies of the seasonal availability of seeds (phenology) are needed to ensure that seed collection programs in forest restoration nurseries are well planned. Seed germination also requires research. Although some tree species have a prolonged fruiting period, often the seeds within the fruits are viable for a very short period. At what stage of ripeness should fruits be collected to yield viable seeds? Many species have long periods of seed dormancy or low germination rates. For such species, treatments to break dormancy and improve the germination rate need to be devised. After germination, research must be carried out to determine the most effective conditions for growth, to ensure strong, healthy seedlings, which will be able to withstand the stress of transplantation into hot, sunny gaps. Such research would include experiments with different soils and other media, watering regimes, pest control and hardening off treatments to prepare the seedlings from transplantation. After seedlings are planted out, further research in needed to develop appropriate post-planting care regimes. The enthusiasm generated by tree planting events is not always complemented by equal enthusiasm for caring for seedlings after planting and for monitoring their growth and survival. Are such treatments as weed control, irrigation, fertilizer application, mulching or fire control useful and cost-effective? Only more research can provide the guidelines needed by the organizers and sponsors of tree planting events. Although the exact figure is unknown, there are

probably more than 3,000 tree species in Thailand. Chiang Mai University Herbarium Database stores records of 886 tree species, from just a small selection of protected areas in the north. Very few of these tree species have been adequately researched. To study them all will require a major effort. However, with so much time, labour and money currently being devoted to tree planting programs, it seems sensible to carry out the research to ensure the best results.

THE FOREST RESTORATION RESEARCH UNIT (FORRU)

Last year a modest beginning was made to address some of the questions outlined above. The Royal Forest Department (RFD) allocated a small plot of land for construction of a research unit near the headquarters of Doi Suthep-Pui National Park. Sponsorship was obtained from Riche Monde (Bangkok) Ltd. and construction of the unit began in September 1994. Two months later, the Forest Restoration Research Unit (FORRU) was opened. Its aim is to determine the most effective methods to complement and accelerate natural forest regeneration in deforested areas to increase biodiversity and protect watersheds within protected areas. FORRU is a joint initiative between the Royal Forest Department and Chiang Mai University. It has a full-time staff of four who carry out a research program on tree seed germination and seedling morphology. Research advisers from Bath University, U.K. and Natural History Museum, U.K. also help to co-ordinate the project. The unit consists of a germination lab under a transparent roof, where seed germination tests are carried out; a seedling growth area under shade netting; an office and drawing room and a small computer room.

The objectives of FORRU are:

1. To develop tools for studying the restoration of natural forest ecosystems, such as a seedling identification handbook, seedling herbarium and databases of seed, fruit and seedling morphology.
2. To study the ecological processes of natural forest regeneration to determine ways in which these processes might be accelerated.
3. To identify which tree species are suitable for planting to complement natural seedling establishment.
4. To develop appropriate methods to propagate such tree species and carry out experimental planting trials.
5. To act as a demonstration unit to teach interested groups about appropriate forest restoration techniques.

Current research activities at FORRU include a study of the fruiting phenology of 106 tree species. Along existing trails, trees are observed every three weeks and scored for the presence of flowers, fruits and foliage. This work will provide information on the seasonal availability of seed for planting. Furthermore, fruit and seed characteristics are being entered into a computer database to act as an identification guide and to correlate seed characteristics with germination success. If trees along the phenology trails are observed in fruit, seeds are collected for germination trials. In addition, a target list of tree species fruiting is generated for each month, using the Chiang Mai University Herbarium Database. Extra trips are then made to collect the seeds of any fruiting species not present on the

phenology trails.

Seed germination experiments at FORRU currently aim to distinguish between those tree species which can germinate in the hot, sunny conditions found in deforested gaps and those which can germinate only in deep shade. The latter would be unsuitable for planting in sunny deforested sites. Some germination experiments are also being carried out to determine at what stage of ripeness fruits can be collected to yield germinable seeds. More than 200 tree species have been tested for germination so far. One of the major tasks of FORRU is to photograph, draw and describe seedlings at all stages of development and to make herbarium specimens for future reference. The aim is to produce a seedling identification guide which foresters can use to recognize seedlings already present in deforested sites and to select suitable seedling species for planting. Of the seedlings produced by FORRU, 29 species have been planted out on a 0.6 ha experimental planting plot. The performance of these species under various conditions of weed competition and shade will be monitored over the next 3 years. A further 15 ha of experimental plots will be established within Doi Suthep–Pui National Park over the next two years.

CONCLUSIONS

FORRU has only just begun to tackle the enormous research needs to improve forest restoration projects in Northern Thailand. However, in the short time that it has been open, the unit has developed useful methods for studying a large number of native forest tree species. Such methods are probably applicable, not only to Doi Suthep, but to protected areas throughout the region. Data on individual species, however, are much more likely to be dependent on local conditions. Phenology, seed germination rates and seedling performance are probably all highly site-specific. Furthermore, many of the tree species in other protected areas are not represented on Doi Suthep and will not be covered by FORRU. Therefore a single research unit cannot complete the task. There needs to be a network of such units in various protected areas and effective exchange of information among them, so that regional recommendations as to the most effective methods of forest restoration can be developed. We hope that FORRU will motivate other workers to set up similar research units and encourage funding agencies to provide the necessary sponsorship. Ecological research can provide the most appropriate methods to restore natural forest ecosystems, but whether or not those methods are put into practice depends on social, political and economic factors. Research into these areas is therefore also essential. Given enough time and protection from disturbance, forests usually regenerate themselves. In areas where there is still an adequate seed source, tree cover can be restored within decades; in areas more distant from seed sources, it may take centuries. Whether or not this process should be accelerated will be decided by politicians, community leaders and land managers, not scientists; but in areas where it has already been decided to assist forest recovery, it makes sense to develop and use the most scientific and cost-effective methods. Only more research can provide us with such methods.

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REFERENCES

ELLIOTT, S. 1994 Preliminary report for the Dhammanaat Foundation for Conservation and Rural Development: Growth and survival of naturally-established seedlings in the upper catchment area of the Mae Soi. Unpublished report.

KARIMUNA, L. 1995. *A comparison of ground flora diversity between forest and plantations in Doi Suthep-Pui National Park.* M. Sc. thesis, Chiang Mai University.

KUERKOOL, P. 1991. Nursery Production Techniques in Thailand. *ASEAN-Canada Forest Tree Seed Centre Project, Technical Publication No. 2.*

OWENS, J.N., P. SORNSATHAPORNKUL AND S. TANGMITCHAROEN. 1991. *Studying Flowering and Seed Ontogeny in Tropical Forest Trees.* ASEAN-Canada Forest Tree Seed Centre Project, Manual.

YUE-LUAN, 1993. Seed testing for selected tropical trees. *ASEAN-Canada Forest Tree Seed Centre Project. Review Paper No. 2.*