

REPORT TO THE BIODIVERSITY RESEARCH AND TRAINING PROGRAM

Y1H2 1/4/08 – 31/3/09

Project Title

การจัดตั้งพื้นที่ทดลองเพื่อคัดเลือกและปรับปรุงพันธุ์ไม้โครงสร้างสำหรับการฟื้นฟูป่าเพื่อการกลับคืนมาของความหลากหลายทางชีวภาพในระบบนิเวศป่าผลัดใบ

“Propagation and performance trials of framework tree species for restoration of deciduous forest ecosystems”

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Project Duration

2 years

Re-commencement Date (Month/Year):

1st April 2008

Expected Completion Date (Month/Year):

31st March 2010

SUMMARY

Under BRT_R 368002, various candidate framework species to restore deciduous forest ecosystems (with high growth/survival rates, rapid site capture and attractive to wildlife) were tested. Establishment of demonstration plots was challenging because i) many of the tree species tested failed to achieve framework standards and ii) some plots were destroyed by fire, cattle damage and flooding. This enabled elimination of species that fail to perform as framework species and refinements to be made to a list of most likely framework species. The purpose of the study proposed here is to concentrate on i) improving propagation techniques of those selected species (to maximize planting stock quality) and ii) developing better silvicultural treatments (to maximize field performance) and therefore establish plots with a much higher likelihood of success.

Activities underway include i) testing treatments to increase and accelerate seed germination and accelerate seedling growth rates in the nursery; ii) expansion of a field trial plot system at Huay Tung Tao, Chiang Mai, to test the impact of silvicultural treatments on field performance; iii) collection of baseline data on soil condition, ground flora and bird communities in the

planted plots and iv) an assessment of the attractiveness of planted trees to wildlife, particularly seed-dispersing birds.

สรุป

โครงการวิจัยนี้มีจุดมุ่งหมายเพื่อจัดตั้งแปลงทดลองสำหรับศึกษาวิธีพรรณไม้โครงสร้างเพื่อการฟื้นฟูป่าที่สามารถปรับใช้ได้กับสภาพแห้งแล้งของป่าผลัดใบในภาคเหนือตอนบนของไทย ซึ่งเป็นการศึกษาที่ต่อเนื่องมาจากความสำเร็จของงานวิจัย 2 โครงการที่ได้รับการสนับสนุนจากโครงการพัฒนาองค์ความรู้และศึกษานโยบายการจัดการทรัพยากรชีวภาพในประเทศไทย (BRT 240002 และ 344004) ซึ่งถือเป็นความสำเร็จในการปรับใช้วิธีพรรณไม้โครงสร้างเพื่อการฟื้นฟูระบบนิเวศป่าไม้ผลัดใบในพื้นที่สูง

โครงการวิจัยนี้ได้สนับสนุนเรือนเพาะชำ 2 แห่ง (ในจังหวัดเชียงใหม่และจังหวัดแพร่) ซึ่งปัจจุบันสามารถผลิตกล้าไม้รวมทั้งหมดมากกว่า 70 ชนิด เพื่อทดสอบศักยภาพในการเป็นพรรณไม้โครงสร้าง ได้มีการเมล็ดทั้งหมด 46 ชนิด เพื่อนำมาศึกษาในระหว่างช่วงเวลาของการนำเสนอรายงานฉบับนี้ รวมทั้งมีการออกแบบวิธีการต่างๆ เพื่อทดลองเกี่ยวกับการทำลายระยะพักตัวของเมล็ด ซึ่งในขณะที่ทำงานวิจัยอยู่นี้ ได้ทำการวิจัยเกี่ยวกับการเพาะเมล็ดของพรรณไม้จำนวน 31 ชนิดเป็นที่เรียบร้อยแล้ว นอกจากนี้ยังมีการศึกษาเพิ่มเติมเกี่ยวกับการติดดอกออกผลตามฤดูกาลของพรรณไม้ในบริเวณมหาวิทยาลัยแม่โจ้ วิทยาเขตแพร่ เฉลิมพระเกียรติ จำนวนทั้งสิ้น 71 ชนิด

ได้มีการทำแปลงทดลองเพิ่มอีกจำนวน 8 ไร่ในเดือนมิถุนายน ได้แก่ แปลงทดลองจำนวน 4 ไร่ที่มหาวิทยาลัยแม่โจ้ วิทยาเขตแพร่ เฉลิมพระเกียรติ และแปลงทดลอง จำนวน 4 ไร่ที่บริเวณอ่างเก็บน้ำห้วยตึงเฒ่า ซึ่งเป็นสถานที่พักผ่อนหย่อนใจที่อยู่ในความดูแลของกองทัพก ตั้งอยู่ห่างจากตัวเมืองเชียงใหม่ไปทางทิศเหนือเพียงเล็กน้อย ซึ่งแปลงทดลองทั้ง 2 แห่งนี้ ได้มีการศึกษาวิจัยเกี่ยวกับศักยภาพของต้นไม้ 15 ชนิด และวิธีการใส่ปุ๋ย 4 วิธี เพื่อใช้ในการปรับปรุงคุณภาพของดิน รวมทั้งได้มีการติดตามประเมินผลตลอดจนการดูแลรักษาหลังการปลูกในช่วงฤดูฝนแรกของการปลูก ซึ่งข้อมูลที่ได้จากแปลงทดลองทั้ง 2 แปลงนี้จะนำไปใช้ในการปรับปรุงเพิ่มเติมเกี่ยวกับชนิดของต้นไม้ที่มีศักยภาพในการเป็นพรรณไม้โครงสร้าง เพื่อที่จะปรับใช้ให้เหมาะสมสำหรับการจัดทำรายงานในครั้งต่อไป

แต่เป็นที่น่าเสียดายอย่างยิ่งที่แปลงทดลองปลูกป่าในโครงการพัฒนาพื้นที่ลุ่มน้ำแม่อาว จังหวัดลำพูน ได้เกิดปัญหาไฟป่าเข้าทำลายแปลงปลูกป่าในเดือนมีนาคมที่ผ่านมา ดังนั้นจึงจะนำแปลงทดลองนี้มาใช้สำหรับการประเมินศักยภาพการฟื้นตัวของพรรณไม้ในแปลงปลูกป่าหลังจากการเกิดไฟไหม้ป่า

PROJECT RATIONAL

PROJECT RATIONAL

Loss of forest habitats is undoubtedly one of the greatest threats to terrestrial biodiversity in Thailand. Continued illegal logging, fire, clearance of land for agriculture and infrastructure development all continue to erode Thailand's forest cover at an annual rate of about 0.5%. This results in forest fragmentation, with remnant forest fragments incapable of supporting viable populations of large vertebrates and rare species.

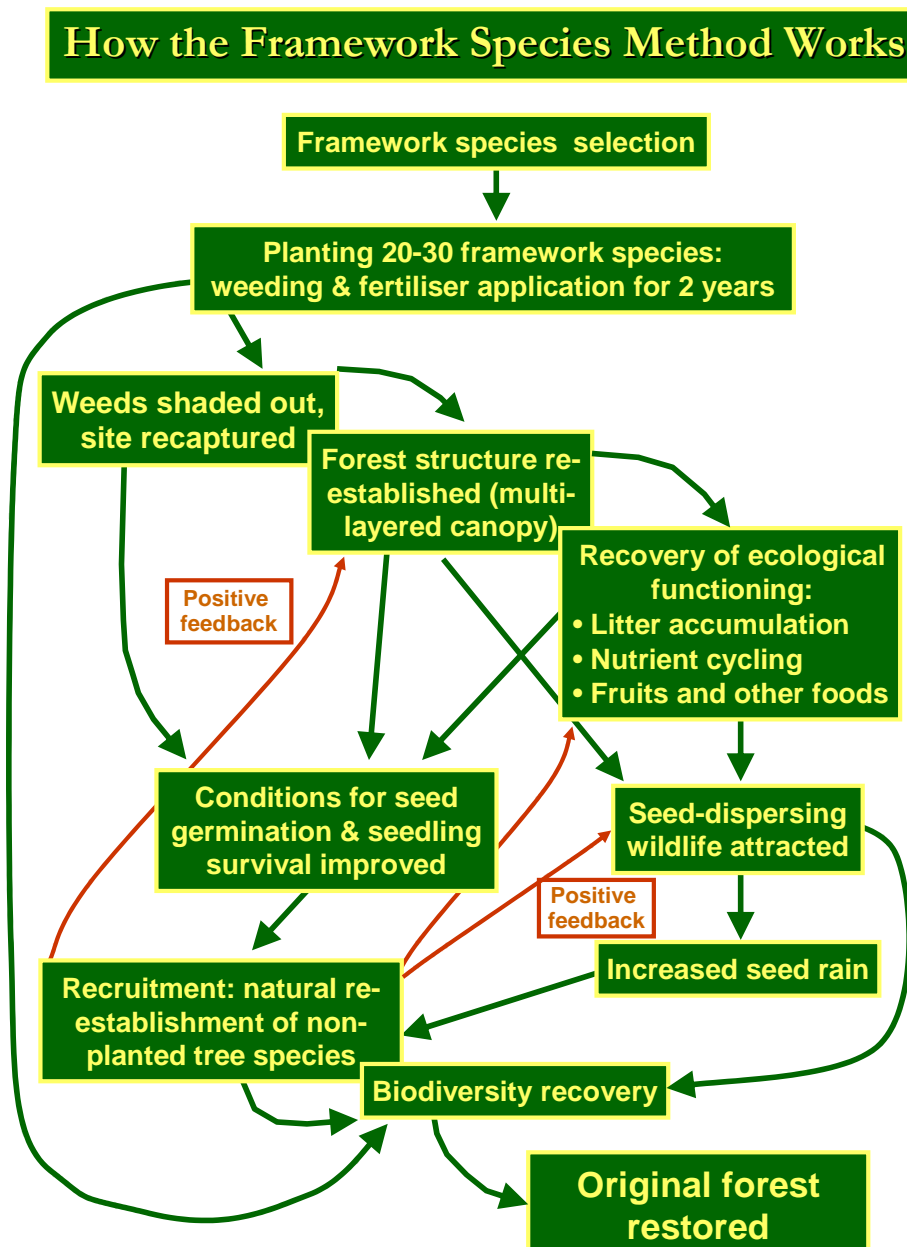
This problem is now well-recognised and consequently, tree planting has become a popular activity. However, tree planting projects often fail, due to the planting of inappropriate tree species and inadequate or ineffective post-planting maintenance regimes. Monitoring the success or failure of such tree planting projects is often neglected and consideration of the role such activities could play in the recovery of biodiversity is usually also lacking.

Tree planting and associated activities require a great deal of labour, time and money, so it is important that they result in efficient biodiversity recovery as well as other benefits such as carbon storage for climate mitigation, watershed conservation and so on. Within protected areas, where conservation of biodiversity is the primary objective, tree planting should aim to restore the original forest ecosystem as closely as possible. Although, for species-rich tropical forest ecosystems is impossible to plant *all* tree species that may once have been present, it is possible to restore tree species richness and ecosystem structure and function to levels that were originally present before deforestation occurred, by planting forest tree species that were indigenous to the original forest type. This is a specific sub-type of reforestation termed "forest restoration" (Elliott, 2000).

This project is further developing the framework species approach for the restoration of lowland deciduous forest ecosystems in N. Thailand. It involves planting 20 to 30 native forest tree species to shade out herbaceous weeds and attract wildlife into planted areas. Trees are selected based on their fast growth and dense spreading canopies, which enable them to rapidly close canopy and "recapture" sites. Framework tree species must also provide resources for wildlife, such as fruits, nectar, nesting sites or roosting sites for birds or mammals, preferably at an early age. Wildlife attracted into the plots should bring seeds with them from other forest tree species. When those seeds germinate, tree species diversity in planted plots gradually increases and the original tree species composition is restored (Goosem and Tucker, 1995).

PROJECT OBJECTIVES

1. To propagate saplings of candidate framework tree species, likely to be suitable for enhancing biodiversity recovery in degraded deciduous forest ecosystems.
2. To establish field trial plots to assess for each planted tree species i) the degree to which they meet the criteria of framework species for restoration of deciduous forest ecosystems and ii) their responses to various silvicultural treatments.
3. To create an educational and research resource that can be used to encourage forest restoration projects for biodiversity recovery in northern Thailand and neighbouring regions.
4. To collect baseline data on biodiversity levels that will enable biodiversity recovery to be monitored in subsequent studies.



RESULTS AND ACHIEVEMENTS 1/4/08 – 31/3/09

Nursery Support and Training

This project continues to provide support the FORRU-CMU's research tree nursery, at the former HQ compound of Doi Suthep-Pui National Park. Nursery manager, Mr. Cherdsak Kuaraksa left the project in November to concentrate on completing his PhD thesis. His role is now being carried out by Dr. Greuk Pakkad. The project budget provided partial support his salary and that of Nursery Technician, Kuhn Thonglaw Seethong.

The nursery also continues to act as an educational facility for a wide range of visiting groups of students and teachers interested in learning about forest restoration techniques. Since September 2008, the nursery was used as a venue for sixteen education events for visiting international schools. These included the Prem Tinsulanonda International School, Kardinia High School (Australia), Utahloy International School (China), and the Beacon International School (Philippines). Students learnt about fruit and seed structure and dispersal ("learning by eating") and potting techniques ("learning by doing") before being led on a learning trail through evergreen forest.

In November (22nd-23rd and 29th-30th) FORRU-CMU's education team ran two camps entitled "Trees for a Cooler Climate", in collaboration with the Chiang Mai office of The British Council. Ten pupils from each of ten schools joined these camps, reaching totally 100 students and their teachers. The aim was to increase awareness of global warming and the role that forest restoration could play in mitigating it. Students were taught how to calculate their carbon foot prints and how to reduce them, both by reducing CO2 emissions and by planting trees. Tree nursery starter kits were presented to all participating schools and the FORRU-CMU education team then visited the schools in March to follow-up on use of the kits and application of the skills learned during the workshops and to provide additional educational activities where needed. The school children will be invited to plant the trees, grown in their schools, at the BRT experimental plots at Huay Thing Tao in June 2009.

Left - A Chiang Mai school teacher accepts a nursery kit from British Council represent-ative, Kuhn Pavini, in front of the nursery funded by this project, during a "Trees for a Cooler



Propagation Experiments

Research at the nursery continues to focus on seed germination and seedling growth of selected deciduous forest tree species to accelerate production of and increase quality of planting stock. Germination trials to test the effects of various seed treatments to maximize and accelerate germination are underway. Seeds are germinated in modular seed trays and transferred to plastic bags, following growth of the first true leaf pair. Preliminary results of germination experiments on 21 species were presented in our previous report. Here we highlight the results on *Ficus* spp.

Ficus spp. have proved to be excellent framework species for restoring forest ecosystems. Firstly, their very dense root systems enable them to survive and grow well under the harshest of conditions and to grow back rapidly after severe damage such as burning or slashing. Most species retain their leaves throughout the dry season, by tapping into supplies of soil moisture deep underground. This makes *Ficus* trees excellent for preventing soil erosion and stabilizing river banks. Secondly, figs are an essential food for a wide range of seed-dispersing animals, including many species of birds and bats, as well as primates, civets, squirrels, bears, deer and wild pig. Consequently, *Ficus* spp are known as “keystone species” i.e. their figs sustain populations of fruit-eating animals during lean periods, when fruits are in short supply. Thus, they help to maintain viable populations of seed-dispersers, which are vital for recovery of tree species richness. Fig trees also appear to be highly resistant to attack by insects.

However, germination and early seedling development of fig tree is slow and difficult, with damping off disease being a particular problem. Therefore, over the past year, particular attention was paid to the germination of fig seeds, testing various germination media. Usually sand is recommended for germination of tiny seeds but in our experiments, forest soil emerged as the best germination medium or soil with sand. Forest soil probably provides essential mycorrhizal fungi, needed immediately after seed germination. Since fig seeds are so small, they do not contain sufficient food reserves (endosperm) to support early seedling growth. Therefore, a symbiotic relationship with mycorrhizal fungi is essential to provide the young seedling with nutrients. The symbionts may also help the young seedlings to resist the pathogenic fungi that cause damping off diseases. The data show slow growth of *Ficus* spp seedlings in plastic bags. Therefore, to produce planting stock of *Ficus* spp, vegetative propagation from cuttings is now being investigated.

Table 1 - Results of some propagation experiments on *Ficus* spp (fig trees)

Species	Seed Collection	MLD (days)	%Germination	Best Treatment	Height (cm) (1/4/09)	RCD (mm) (1/4/09)
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<i>F. benjamin</i>	20-Feb-08	43	72	Soil	-	-
<i>a</i>		13	58	Soil:Sand (1:1)	3.50	3.00
<i>F. fistulosa</i>	12-Jun-08	24	60	Soil	-	-
<i>F. glaberrima</i>		22	44	Soil:Sand (1:1)	8.74	4.24
<i>a</i>	10-Jan-08	22	66	Soil	20.18	4.12
<i>F. hispida</i>		58	69	Soil	-	-
<i>F. racemosa</i>	5-May-08	21	65	Soil	27.16	4.50
<i>F. rumphii</i>						
<i>F. semicordata</i>	9-Jan-08					
	9-Jan-08					
	17-Dec-08					

Table 2 – Growth of seedlings in the nursery (as of April 2009) and estimated total length of production schedule for selected species.

Species	Family	Thai_name	Seed collection	n	RCD (mm)	Height (cm)	Estimated Nursery Time (months)
<i>Afzelia xylocarpa</i>	Leguminosae(C)	มะคำโมง	09/01/2008	50	7.72	59.08	18
<i>Alstonia scholaris</i>	Apocynaceae	สัตตบรรณ	23/03/2008	50	8.28	35.94	15
<i>Bauhinia purpurea</i>	Leguminosae(C)	เสี้ยวดอกแดง	11/02/2008	50	3.64	24.94	17
<i>Ficus hispida</i>	Moraceae	มะเดื่อปล้อง	08/04/2008	50	4.24	8.74	15
<i>Ficus racemosa</i>	Moraceae	มะเดื่ออุทุมพร	09/01/2008	50	4.12	20.18	18
<i>Ficus semicordata</i>	Moraceae	เดื่อปล้องหิน	17/12/2008	50	4.50	27.16	7
<i>Gmelina arborea</i>	Verbenaceae	ชื้อ	26/03/2008	50	4.68	52.38	15
<i>Phyllanthus emblica</i>	Euphorbiaceae	มะขามป้อม	18/02/2008	33	2.91	23.00	16
<i>Quercus kerrii</i>	Fagaceae	ก่อพะยะ	15/10/2007	50	2.39	18.28	20
<i>Terminalia bellirica</i>	Combretaceae	สมอพิเภก	09/01/2008	50	4.73	28.44	18

In addition, potted seedlings in the nursery are also being monitored to measure growth rates and to estimate the total nursery time required to produce each species. Some selected results are shown in Table 2.

Expanding the Plot System

In the last report, we provided a description of the site conditions at Huay Thung Tao, where we have established experimental plots under this project, and details of the tree planting event run last June to expand the plot system. We have now had the soil from the site analysed and the results are presented in Table 3, below. Five-kilogram combined soil samples were collected from each site and analysed at the laboratory of Faculty of Agriculture, Chiang Mai.

Table 3 - Soil Conditions at the Plot System Site

Soil Property	Rai 1	Rai 2	Rai 3	Rai 4
pH	5.20	5.74	5.99	5.93
OM (g/100g)	1.38	2.38	1.24	2.90
Total N (g/100g)	0.05	0.11	0.09	0.15
P (mg/kg)	16.60	19.30	31.70	51.70
K (mg/kg)	125.40	144.40	172.90	449.60
Sand (%)	82.30	77.10	74.80	61.60
Silt (%)	13.70	13.90	11.20	21.10
Clay (%)	4.00	9.00	14.00	17.30

Texture	Loamy sand	Sandy loam	Sandy loam	Sandy loam
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These data serve to illustrate the challenging conditions prevalent at former deciduous forest sites: acidic soils with low organic matter and clay content (which consequently result in low moisture-holding capacity) and low levels of macro-nutrients. Such conditions predicate the need for mulching and fertilizer treatments to ensure acceptable performance of planted trees, as well as identification and selection of species, capable of thriving in such conditions.

Therefore, the plots established in June 2008, were designed to test the effects of different fertilizer types on 32 tree species (totally 2000 saplings), produced from the project's nursery, as follows:

- Rai 1 Fill + 200 g commercial organic fertilizer (Humost band)
- Rai 2 Fill + 200 g cow dung fertilizer
- Rai 3 No fill + 400 g cow dung fertilizer
- Rai 4 Fill + 400 g cow dung fertilizer

'Fill' refers to filling half of each planting hole with 100 g commercial organic fertilizer (Humost) in rai 1 and 100 g cow dung fertilizer in Rai 2 and Rai 4, before planting each sapling into the planting hole. After planting, the fertilizers (commercial organic fertilizer and cow dung fertilizer) were applied in the doses stated above in a ring 10-20 cm away from the stems of the saplings. A circular mulch mat (50 cm in diameter), made of corrugated cardboard was laid around each sapling and pegged in place with a bamboo pole.

Organized by Kuhn Kwankhao Sinhaseni, weeding and fertilizer application were carried out by Doi Suthep-Pui National Park officers and FORRU nursery staff in both the 2007 and the 2008 plots (following the above treatments), three times during the rainy season. The schedule of activities is presented in Table 3 below.

Table 4 – Summary of work carried out to maintain and monitor the experimental plot system at Huay Thung Tao

Activity	Date
Planning establishment of experimental plots	19 April 2008 (with army)
Laid out the plots	27 May 2008
Site preparation	29 May 2008
Transferred seedlings to sites	12-13 June 2008
Digging the holes	14 June 2008

Planting	14 June 2008
1st Monitoring after planting	9 July 2008
Weeding and fertilizer applications (1)	2 August 2008
Weeding and fertilizer applications (2)	14 September 2008
2nd Monitoring after planting	25 October 2008
Weeding and fertilizer applications (3)	11 November 2008
Fire break cutting	14 February 2009
Fire prevention activities	February to April 2009

Field Performance of Candidate Framework Tree Species

The planted trees were monitored for field performance twice during the past year: on 9th July to assess immediate post-planting mortality due to transplantation stress and to collect baseline data for growth calculations and on 25th October 2008 to determine growth over the first rainy season. In October, FORRU staff were joined by Pro-World Thailand volunteers to carry out growth measurements.

The survival of planted trees at the end of the first rainy season was very high for all treatments and well within the range of acceptability for framework tree species.

Table 5 – Per cent survival of the planted tree species at the end of the first growing season

Species	Rai 1	Rai 2	Rai 3	Rai 4	Species Averages
<i>Adenanthera microsperma</i>	80.0	60.0	94.1	85.7	80.0
<i>Azelia xylocarpa</i>	65.0	80.0	78.6	58.3	70.5
<i>Albizia lebbeck</i>	79.2	90.9	82.6	80.8	83.4
<i>Aphanamixis polystachya</i>	80.0	73.3	80.0	73.3	76.7
<i>Artocarpus lakoocha</i>	86.7	80.0	60.0	86.7	78.3
<i>Bauhinia purpurea</i>	80.0	60.0	100.0	90.0	82.5
<i>Cassia bakeriana</i>	66.7	58.3	100.0	63.2	72.0
<i>Chukrasia tabularis</i>	100.0	87.5	90.0	77.8	88.8
<i>Croton roxburghii</i>	60.0	77.8	90.0	72.7	75.1
<i>Dalbergia cultrata</i>	86.7	80.0	73.3	86.7	81.7
<i>Dalbergia oliveri</i>	70.0	90.0	80.0	81.8	80.5
<i>Debregeasia longifolia</i>	60.0	50.0	80.0	75.0	66.3
<i>Erythrina stricta</i>	69.2	85.7	84.6	57.1	74.2
<i>Eugenia formosa</i>	80.0	88.9	50.0	50.0	67.2
<i>Eugenia fruiticosa</i>	77.8	90.0	90.0	90.0	86.9
<i>Ficus callosa</i>	60.0	90.0	93.3	86.2	82.4
<i>Ficus capillipes</i>	100.0	70.0	88.9	60.0	79.7
<i>Ficus racemosa</i>	79.2	90.0	90.0	96.0	88.8
<i>Ficus semicordata</i>	85.7	64.3	86.7	55.6	73.1
<i>Gmelina arborea</i>	50.0	100.0	71.4	69.2	72.7
<i>Hiptage benghalensis</i>	73.3	100.0	93.3	73.3	85.0
<i>Holarrhena pubescens</i>	73.3	73.3	92.3	82.4	80.3
<i>Holoptelea intergrifolia</i>	60.0	60.0	100.0	60.0	70.0
<i>Irvingia malayana</i>	100.0	50.0	100.0	90.0	85.0
<i>Oroxylum indicum</i>	63.2	100.0	90.0	100.0	88.3
<i>Phyllanthus emblica</i>	70.0	70.0	85.7	100.0	81.4
<i>Protium serratum</i>	70.0	90.0	90.0	90.0	85.0
<i>Quercus brandisiana</i>	40.0	72.2	Not Planted	60.0	57.4
<i>Terminalia bellirica</i>	68.0	100.0	76.0	88.5	83.1
<i>Toona ciliata</i>	73.3	92.9	86.7	84.6	84.4
<i>Trewia nudiflora</i>	30.0	100.0	90.0	100.0	80.0
<i>Xylia xylocarpa</i>	100.0	90.0	70.0	100.0	90.0

Treatment Averages	73.0	80.2	85.1	78.9	79.1
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Growth was also acceptable for most species and excellent for several. The highest performing species, which had grown taller than 1 m by the end of the first rainy season

included *Gmelina arborea*, *Bauhinia purpurea*, *Debregeasia longifolia* and *Erythrina stricta*, whilst those taller than 90 cm included *Oroxylum indicum*, *Holoptelea intergrifolia*, *Trewia nudiflora*, *Ficus callosa*, *Ficus racemosa*, *Ficus semicordata* and *Phyllanthus emblica*. Again the high performance of most fig tree species was obvious, re-inforcing their value as framework species. The most effective treatment, averaged across all species, was the Rai 3 treatment (No fill + 400 g cow dung fertilizer).

Table 6 – Mean heights (cm) of planted tree species attained by the end of the first rainy season

Species	Rai 1	Rai 2	Rai 3	Rai 4	Species Averages
<i>Adenanthera microsperma</i>	71	49	62	63	61.3
<i>Azelia xylocarpa</i>	48	48	51	49	49.0
<i>Albizia lebbbeck</i>	61	108	73	60	71.5
<i>Trewia nudiflora</i>	78	114	99	78	92.3
<i>Xylia xylocarpa</i>	60	56	48	87	41.5
Treatment Averages	74.91	62.50	78.65	77.88	72.30
<i>Cassia bakeriana</i>	66	76	77	67	71.5
<i>Chukrasia tabularis</i>	48	31	60	51	48.8
<i>Croton roxburghii</i>	82	22	65	72	59.5
<i>Dalbergia cultrata</i>	52	53	64	57	56.5
<i>Dalbergia oliveri</i>	70	79	61	52	65.5
<i>Debregeasia longifolia</i>	144	62	138	103	111.8
<i>Erythrina stricta</i>	118	131	164	156	123.3
<i>Eugenia formosa</i>	61	47	57	62	54.5
<i>Eugenia fruticosa</i>	57	50	60	61	57.0
<i>Ficus callosa</i>	100	59	88	78	92.5
<i>Ficus capillipes</i>	105	55	70	112	85.5
<i>Ficus racemosa</i>	106	69	133	136	96.0
<i>Ficus semicordata</i>	110	66	120	133	98.3
<i>Gmelina arborea</i>	98	130	95	121	111.0
<i>Hiptage benghalensis</i>	61	46	57	32	49.0
<i>Holarrhena pubescens</i>	42	60	48	58	55.0
<i>Holoptelea intergrifolia</i>	97	38	84	121	90.3
<i>Irvingia malayana</i>	49	46	56	51	50.5
<i>Oroxylum indicum</i>	100	88	94	78	90.0
<i>Phyllanthus emblica</i>	93	72	99	133	99.3
<i>Protium serratum</i>	60	42	60	73	58.8
<i>Quercus brandisiana</i>	38	33	Not planted	37	36.0
<i>Terminalia bellirica</i>	55	48	58	52	53.3
<i>Toona ciliata</i>	66	54	55	67	60.5

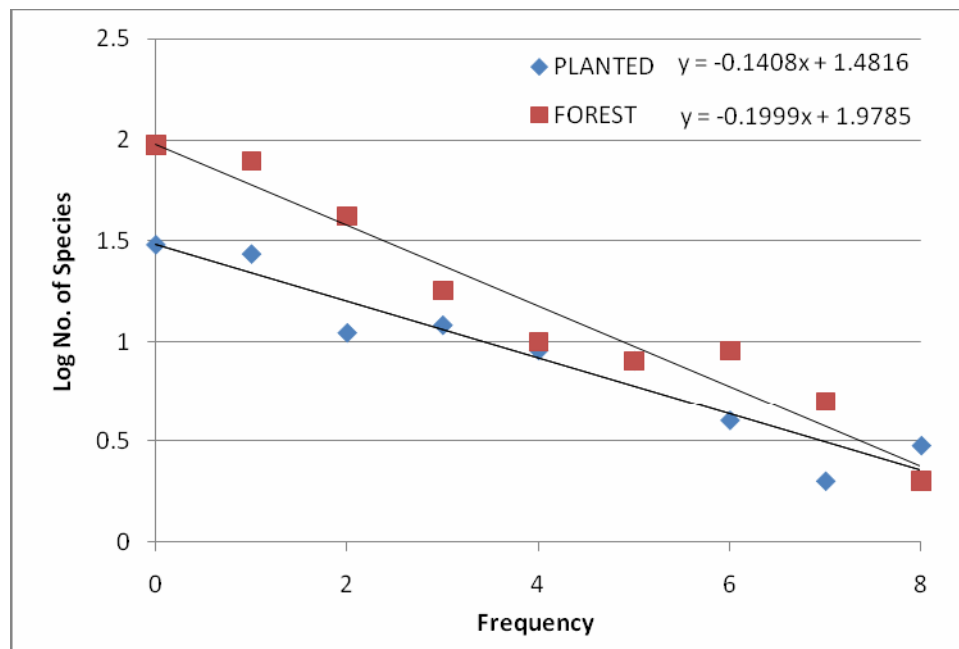


Top left: *Ficus callosa* 3.5 months after planting.
Top Right: *Gmelina arborea*, beginning to close canopy with neighbouring trees 15.5 months after planting. Mid left: *Ficus semicordata* 3.5 months after planting. Mid right: *Cassia bakeriana* 3.5 months after planting. Left:

Baseline Vegetation survey

A baseline survey of ground vegetation across the site, including nearby forest in the Doi Suthep-Pui National Park was carried out on 5-13th November 2008. Eight circular sample plots, 10 m in diameter, were laid out in planted areas (4 in the 2008 plots and 4 in the 2007 plots), and 8 in nearby deciduous forest (randomly). The ground flora was surveyed, using the Braun Blauquet scale as an estimate of cover of each species. All plants in the circles were identified to species level by J. F. Maxwell, CMU's herbarium curator.

The ground flora in the planted area was dominated by herbaceous plant species, while that in nearby forest was characterized by a high density of tree seedling and saplings. Total species richness was estimated by plotting a graph of log frequency (0-8) against the number of species occur at each frequency and extrapolating back to zero to obtain an estimate of unseen species (i.e those that occurred in zero sample units). Species richness was much higher in the forest (with 173 observed and 95 predicted; total 268 species) compared with areas affected by forest restoration activities, including weeding (77 observed species and 30 predicted; total 107). Weed control (necessary to maintain the planted trees) and lack of tree cover (as a source of natural tree seedlings), were probably the main factors causing lower species richness in the planted areas. Future vegetation surveys will be carried out to determine to what extent the ground flora diversity and species composition tend towards those of natural forest, as the planted plots mature.



Baseline data on bird species richness

A similar approach was used to collect baseline data on the bird communities of the area. Mr Somboon Kamtaeja (MSc student in ornithology

at CMU) was engaged by the project to record birds present both in nearby natural forest and in the planted plots. He carried out a total of 96 hours observations spread between 6 observation points in forest 6 more scattered evenly across the planted plots. Bird species richness was surprisingly similar in both planted plots an adjacent forest, although the species composition differed. This contrasts with results obtained after forest restoration activities at upland evergreen sites, where tree planting resulted in a temporary decline in bird species richness immediately following tree planting and weeding. Mr. Somboon's detailed report is appended.

Use of the Plots for Education and Training

The plots were used during a training course for 15 participants in a workshop, organized for World Wildlife Fund over April 8-10th, to train villagers near Khao Yai National Park how to carry out forest restoration.

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Action Plan

“Propagation and performance trials of framework tree species for restoration of deciduous forest ecosystems”

	Year 1		Year 2		Expected outputs
	Apr - Sep	Oct - Mar	Apr - Sep	Oct - Mar	
Activities					Expected outputs
Seed Collection	X	X	X	X	Up to 20,000 trees of at least 20 tree species.
Germination Experiments	X	X	X	X	More rapid and higher germination
Seedling Growth Experiments in Nursery		X	X	X	Improved planting stock quality
Site Preparation	X		X		Plots cleared ready for planting
Planting field experiments	X		X		24 rai of experimental plots
Weeding fertiliser application, fire prevention etc		X	X	X	Maximal survival and growth of healthy trees.
Monitoring of planted trees	X	X	X	X	Identification of best silvicultural treatments to apply.
Ground flora surveys	X	(X)			Delayed till November - Data on site capture effectiveness
Observational study on use of trees by wildlife	X			X	Bird survey underway
Data analysis and reporting	X	X	X	X	Biannual reports to BRT