

RESTORING ABANDONED AGRICULTURE AND AGROFORESTRY- DEGRADED LAND AT ROYAL PROJECT NONG HOI

Project Name:	Restoring Abandoned Agriculture-Degraded Land at Royal Project Nong Hoi (RPNH25)
Sponsor:	Plant Genetic Conservation Project Under the Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn – Chiang mai University (RSPG-CMU)
Project Duration:	May 2025 – December 2025
Project Organizer:	Forest Restoration Research Unit (FORRU-CMU), Department of Biology, Faculty of Science, Chiang mai University
Prepared by:	Pornpawee Laohasom

SUMMARY

The report details a forest restoration initiative titled "Restoring Abandoned Agriculture-Degraded Land at Royal Project Nong Hoi (RPNH25)," executed by the Forest Restoration Research Unit (FORRU-CMU) between May and December 2025. Sponsored by RSPG-CMU. The project aimed to restore upland evergreen forest across two degraded watershed sites in Doi Suthep-Pui National Park. A total of 3,707 framework trees were planted to recover local biodiversity.

Plot 1 (Phu Morin) - evaluated the efficacy of cardboard mulch mats versus a non-mulched control group across 3.5 rai using 13 framework species. Survival: After the first rainy season (R1), the site achieved an excellent overall survival rate of 93.8% (932 trees alive). The survival variation between the cardboard group (94.6%) and the control group (93.1%) was minimal. Six species achieved a 100% survival rate in at least one treatment. Growth: Four species (*Eriobotrya bengalensis*, *Prunus cerasoides*, *Garcinia xanthochymus*, and *Acrocarpus fraxinifolius*) displayed excellent Relative Growth Rates of Root Collar Diameter (RGR-RCD) exceeding 70%/y. Cardboard mulching only accelerated growth for two species (*Ficus capillipes* and *A. fraxinifolius*), while substantially reducing growth for seven others. Conclusion: Cardboard mulch is not recommended for upland restoration. It failed to significantly reduce weed scores compared to the control group and likely caused stem abrasions that introduced pathogens.

Plot 2 (Mon Cham Orchard) Data-Deficient Species Trial. Compared performance among 15 "data-deficient" local forest tree species, across 4.7 rai to evaluate their suitability as framework trees. Survival: The R1 monitoring revealed an excellent overall survival rate of 95.6%. All 15 tested species-maintained survival rates above 80%, with *Gluta usitata*, *Dracontomelon dao*, and *Beilschmiedia assamica* achieving 100% survival. Growth: Every tested species met or exceeded acceptable growth criteria, with 10 species (66%) demonstrating excellent growth (RGR-RCD >69.3%/y). *Dalbergia ovata* emerged as the top-performing species overall. Conclusion: All 15 data-deficient species met the initial performance requirements to be considered candidate framework tree species. *D. ovata* is

highly recommended for similar upland sites due to its nitrogen-fixing capabilities and resilience.

Introduction

Doi Suthep-Pui national park is a watershed area in Chiang Mai Province, rich in biodiversity and deeply intertwined with the local community's ecology, traditions and way of life. However, certain forest areas within Suthep–Pui National Park—particularly around Royal Project Nong Hoi, Moo 7, Mae Raem Subdistrict, Mae Rim District—have suffered from inappropriate land use, recurring wildfires and increasing human pressures. These disturbances have led to ecosystem degradation and a marked decline in ecosystem services.



Figure 1 Planting Day on 12th June 2025 – low terraced plot testing cardboard mulching

In response, a collaborative forest-restoration project has been launched, through the joint efforts of the Royal Project Nong Hoi, Suthep–Pui National Park and Chiang Mai University's Forest Restoration Research Unit (FORRU). The project promotes natural science knowledge, as a foundation for effective and sustainable natural resource management. This initiative serves as a model for collaboration among government agencies and academic institutions, focusing on integrating science-based restoration with community participation, to revitalize degraded forest ecosystems—ecologically, socially and economically.

Objective

The project objective was to restore upland evergreen forest to 8.2 rai of deforested and degraded upper watershed land, following fire focusing on biodiversity recovery and creating opportunities for community members, students and the general public to engage in long-term forest stewardship. The project involved planting 3,707 trees in the rainy season of 2025 and maintaining the planted trees for at least two years.

Plot 1 – The lower plot near Phu Morin - testing cardboard mulching

Characteristics of the restoration site, area survey and map

The site was a terraced steep slope (>30°) formerly used as an agroforestry demonstration site, accessed via Phu Morin Resort (18.929689° N, 98.828132° E) at 1,285 m above sea level.

A [rapid site assessment](#), conducted 30 May 2025, recorded dense cover of grasses and herbs 1–2 m tall. There were very few saplings of *Persea americana*, *Prunus cerasoides* and *Fraxinus floribunda*. Soil erosion was evident. Natural regenerant density was estimated at 37/rai (± 1.2 , 95% c.l.), requiring enrichment planting at 462 saplings/rai—approximately 1,607 trees for the 3.5-rai site.

An aerial survey by drone (Figure 3) located small forest patches nearby that may provide seed sources. The surrounding landscape functions as both a headwater catchment and an ecological corridor. Past land use has heightened erosion risk. The study boundaries were defined as shown in Figure 2.



Figure 2 Target site on Rapid site assessment

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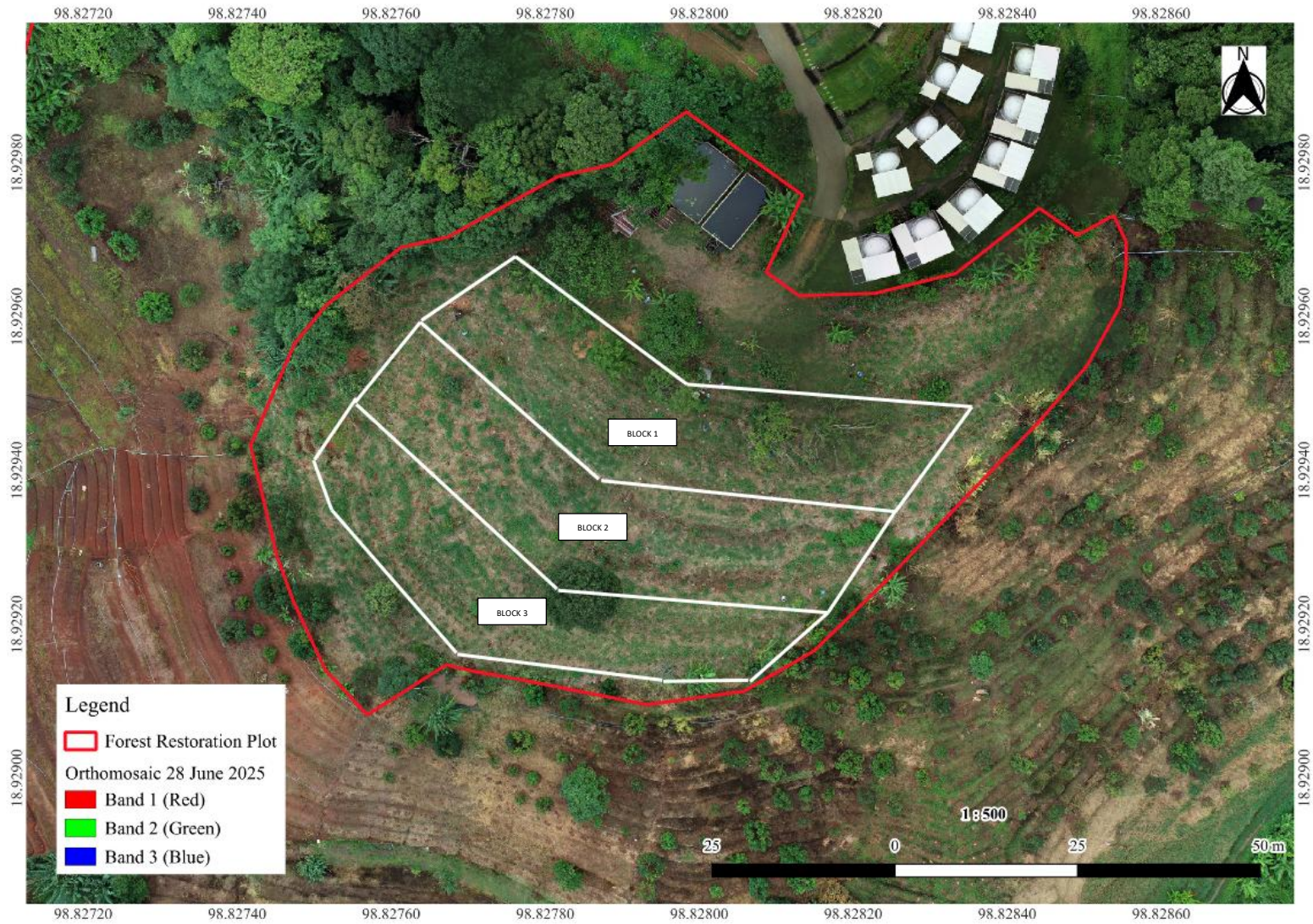


Figure 3 Map of lower restoration plot

Planting Preparation

1. Site Preparation

Royal Project staff joined FORRU-CMU staff to perform manual weeding was performed on 2-4th June 2025, leaving cut dried grass as a light mulch over the whole area. On 7th July 24, 2025 experimental plots were delineated and colored bamboo stakes placed, to mark planting spots (blue=cardboard; red=no cardboard) spaced 1.8 meter apart. Holes were dug, twice the size of sapling containers (plastic bags 9x2.5”). Planting equipment and materials were transported to the site on planting day.



Figure 4 - Site preparation by Royal Project and FORRU staff. Laying out the experiment with different coloured bamboo poles: red (control) and blue (cardboard)

Species selection

Framework tree species were selected to plant this site, matched with the site elevation. A total of 1,607 trees were planted across 3.5 rai. Thirteen species (1,002 trees) were planted for the cardboard-mulch experiment (Table 1) in 3 replicates (white polygons in Figure 3). Half were planted with the cardboard mulch and half without cardboard (control). The remaining 605 trees (24 species) were planted to fill in the area around the experimental zone. (Table 2)

Table 1 - Species selected for experimental blocks

S#	Species	Family	Successional guild	Low elev	High elev	No. seedlings	Tag no. Control (red)	Tag no. Cardboard (blue)
3	<i>Garcinia xanthochymus</i>	Clusiaceae	Climax	200	1,100	42	3 (1-21)	3 (22-42)
13	<i>Sapindus rarak</i>	Sapindaceae	Intermediate	200	1,620	90	13 (1-39)	13 (40-78)
31	<i>Acrocarpus fraxinifolius</i>	Fabaceae	Pioneer	500	1,250	90	31 (1-39)	31 (40-78)
71	<i>Prunus cerasoides</i>	Rosaceae	Pioneer	1,050	1,685	90	71 (1-39)	71 (40-78)
74	<i>Cryptocarya amygdalina</i>	Lauraceae	Climax	700	1,320	78	74 (1-39)	74 (40-78)
105	<i>Sarcosperma arboreum</i>	Sapotaceae	Climax	550	1,500	78	105 (1-39)	105 (40-78)
110	<i>Elaeocarpus prunifolius</i>	Elaeocarpaceae	Climax	1,050	1,500	78	110 (1-39)	110 (40-78)
161	<i>Alangium kurzii</i>	Cornaceae	Climax	600	1,400	90	161 (1-39)	161 (40-78)
186	<i>Ostodes paniculata</i>	Euphorbiaceae	Climax	500	1,500	60	186 (1-30)	186 (31-60)
272	<i>Eriobotrya bengalensis</i>	Rosaceae	Climax	60	1800	78	272 (1-39)	272 (40-78)
293	<i>Podocarpus neriifolius</i>	Podocarpaceae	Climax	1,050	1,850	78	297 (1-39)	297 (40-78)
317	<i>Erythrina subumbrans</i>	Leguminosae	Pioneer	200	1,680	60	317 (1-30)	317 (31-60)
376	<i>Ficus capillipes</i>	Moraceae	Climax	1,050	1,100	90	376 (1-45)	376 (46-90)
					Total trees	1,002		

Table 2 - Species selected for non-experimental areas

S.no	Species	Family	Successional guilds	Low elev	High elev	Total
5	<i>Melia toosendan</i>	Meliaceae	Pioneer	500	1,450	25
18	<i>Hovenia dulcis</i>	Rhamnaceae	Pioneer	1,025	1,300	40
22	<i>Ficus capillipes</i>	Moraceae	Pioneer	1,050	1,100	40
129	<i>Artocarpus lakoocha</i>	Moraceae	Pioneer	200	1,500	15
74	<i>Cryptocarya amygdalina</i>	Lauraceae	Climax	700	1,320	15
101	<i>Alseodaphne andersonii</i>	Lauraceae	climax	1,000	1,400	40
105	<i>Sarcosperma arboreum</i>	Sapotaceae	Climax	550	1,500	15
110	<i>Elaeocarpus prunifolius</i>	Elaeocarpaceae	Climax	1,050	1,500	20
158	<i>Garuga pinnata</i>	Bursaceae	Pioneer	3,500	1,200	40
163	<i>Machilus bombycina</i>	Lauraceae	climax	550	1550	20
181	<i>Styrax benzoides</i>	Styracaceae	climax	550	1,650	15
187	<i>Bridelia glauca</i>	Phyllanthaceae	climax	525	1,575	50
263	<i>Michelia floribunda</i>	Magnoliaceae	climax	875	1,750	20
286	<i>Antidesma bunius</i>	Phyllanthaceae	climax	725	1,450	50
293	<i>Podocarpus neriifolius</i>	Podocarpaceae	Climax	1,050	1,850	20
333	<i>Eugenia albiflora</i>	Podocarpaceae	climax	800	1,525	20
364	<i>Ficus auriculata</i>	Moraceae	climax	525	1,400	40
186	<i>Ostodes paniculata</i>	Euphorbiaceae	Climax	550	1,500	10
195	<i>Terminalia bellirica</i>	Combretaceae	Pioneer	200	1,150	40
36	<i>Phyllanthus emblica</i>	Phyllanthaceae	Pioneer	60	1,700	3
133	<i>Afzelia xylocarpa</i>	Leguminosae	Climax	350	500	40
78	<i>Gmelina arborea</i>	Lamiaceae	Pioneer	200	1,475	5
-	<i>Eugenia sp.</i>	Myrtaceae	Climax			20
-	<i>Bauhinia sp.</i>	Leguminosae	Pioneer			2
						605



Figure 5 - Pickup and transfer of trees from Ban Mae Sa nursery to the plot.

3. Experimental Design

A total of 3 blocks (replicates) were used for the cardboard mulching experiment, trees were planted randomly among the 2 treatments within each block: Treatment 1 (Control): non-mulching (red); Treatment 2: Cardboard mulching (blue)



Figure 6 - Applied cardboard mulching (Blue bamboo) on 12th June 2025

Thirteen species were selected for the experiment, with 501 saplings per block, as shown in Table 1, but with different numbers of individuals for each species.

Planting events

The first planting day was on 12th June 2025, when the 3 experiment blocks were planted with 1,002 saplings of all of 13 species by children from Christian German School Chiang Mai (CDSC), Cross Chiang Mai Riverside (hotel group), Away Chiang Mai Thapae Resort, Doi Suthep Nature

Centre, Royal Project, Nong Hoi local villagers and FORRU staff, totally 130 people. Participants were instructed on planting methods and how to apply the cardboard mulch mats and fertilizer by FORRU staff in each separate group.

Planting equipment:

- Baskets for sapling transport across the site
- Hoe
- Box cutters to open plastic bags
- Gloves
- Fertilizer, bucket for fertilizer and measuring cup
- Bamboo poles



Figure 7 - Planting days: 12th June (lower)) and 13th June (lower).

The following day, 13th June 2025, planting continued in the fill-in areas with 120 participants from Yupparaj and Varee schools (from the Young Forest Restorers project (YFR)). Also joining were participants from SIG company and Ratchapreuk foundation, the Chief and officers from the National Park Protection Unit 6 (Tat Mok Waterfall) of Doi Suthep–Pui National Park and FORRU staff. A total of 605 saplings were planted in non-experiment (non-monitored) parts of the study site (Table 2) (Figure 8). The planted trees effectively formed a buffer zone around the experimental plots.

Site Maintenance

Weeding and fertilizer application were performed 3 times during the subsequent rainy season on 13th June, 4th August and 8th October. Fifty grams of fertilizer was applied to each sapling under the cardboard mulch mats.



Figure 8 – FORRU volunteer on 4th August apply fertilizer.

Tree Monitoring

Monitoring tree survival and growth was performed with volunteers, supervised FORRU-CMU staff on 28th June 2025 (baseline data BL) and again on 5th November 2025 for after rainy season (R1). Measurements included tree height (cm) and root collar diameter (RCD, mm) to assess tree growth. For the small trees, Vernier calipers were used to measure RCD at the widest point. Tape measures were used to measure tree height from the root collar to the highest shoot tip and to measure crown width at the widest point. A simple health score of 0 to 3 was assigned to each tree and a descriptive note made of any health problems observed. The same scoring system was applied to weed cover (within 1 m of the tree stem) and for shade over the planted trees. Monitoring will be repeated, using same methods at the end of the second rainy season, to calculate survival and relative growth rates and to detect any differences between the experimental treatment.



Figure 9 – Baseline monitor on 28th June 2025 with FORRU staffs and volunteers.

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Planting Plan at Royal Project Nong Hoi Plot 1 – Phu Morin

May 27,2025	Rapid site assessment and Drone survey	FORRU and Royal Project
June 4, 2025	Staking regenerants and weeding	FORRU and Royal Project
June 6, 2025	Site preparation (bamboo stake sand digging planting holes)	FORRU and Royal Project
June 9, 2025	Transferred saplings, equipment to the 1st planting area and distributed saplings to holes. Transfer fertilizer to planting site	FORRU and volunteers
June 12, 2025	Planting Day 1 - YFR	FORRU, YFR, Hotel and Royal Project
June 13, 2025	Planting Day 2 - SIG	FORRU, YFR, SIG, Hotel and Royal Project
June 28, 2025	Baseline Monitoring in experimental plots	FORRU and Volunteers
July 13, 2025	1 st Site Maintenance	FORRU and Volunteers
August 4, 2025	2 nd Site Maintenance	FORRU and Volunteers
October 8, 2025	3 rd Site Maintenance	FORRU and Volunteers
November 5, 2025	The end of 1 st rainy season monitoring	FORRU and Volunteers
To be continued		
December 31, 2025	Report for the end of 1 st Rainy season	FORRU
February 12, 2026	Fire Prevention	FORRU
Rainy season 2026	4 th Site Maintenance	FORRU
Rainy season 2026	5 th Site Maintenance	FORRU
Rainy season 2026	6 th Site Maintenance	FORRU
Late November – Early December 2025 (after the 6 th maintenance of the site)	The end of 2 nd rainy season monitoring	FORRU
Dec-26	Report for the end of 2 nd Rainy season	FORRU

Post-planting baseline (BL)

Nine saplings were not detected in either the baseline nor the R1 (end-first-rainy-season) monitoring and were assumed “not planted”. This left a cohort of 993 planted trees for calculation of mortality: 500 with cardboard mulch and 493 in the control group.

Only two control saplings were recorded as dead in the baseline survey, probably due to rough handling or trampling during the planting process. Of the 62 saplings not found during the baseline survey, all were subsequently found alive during the R1 survey. Therefore, the BL mortality rate was 0.2%. The two trees that died were *Alangium kurzii* and *Erythrina subumbrans*.

End-first-rainy-season monitoring – R1

Trees that were not found during the R1 survey were assigned as “not found probably alive (NFPA)”, if they had been recorded as alive during the baseline survey with a health score of 1.5 or higher, whereas those with a BL health score lower than 1.5 were assigned as “not found probably dead (NFPD)”. These status assignments may be readjusted retrospectively according to the R2 survey results at the end of 2025.



Figure 10 – FORRU staff, interns and volunteers performing R1 monitoring 5/11/25

A total of 932 trees were recorded as alive (including 115 NFPA), resulting in an overall estimated survival rate of 93.8%. The overall difference in survival rates between the cardboard treatment (94.6%) and the control trees (93.1%) was minimal. All species achieved higher than 80% survival rates (considered “excellent”) and six (almost half of the species attained 100% survival, with at least one of the treatments. Species-specific survival rates are shown in Figure 11.

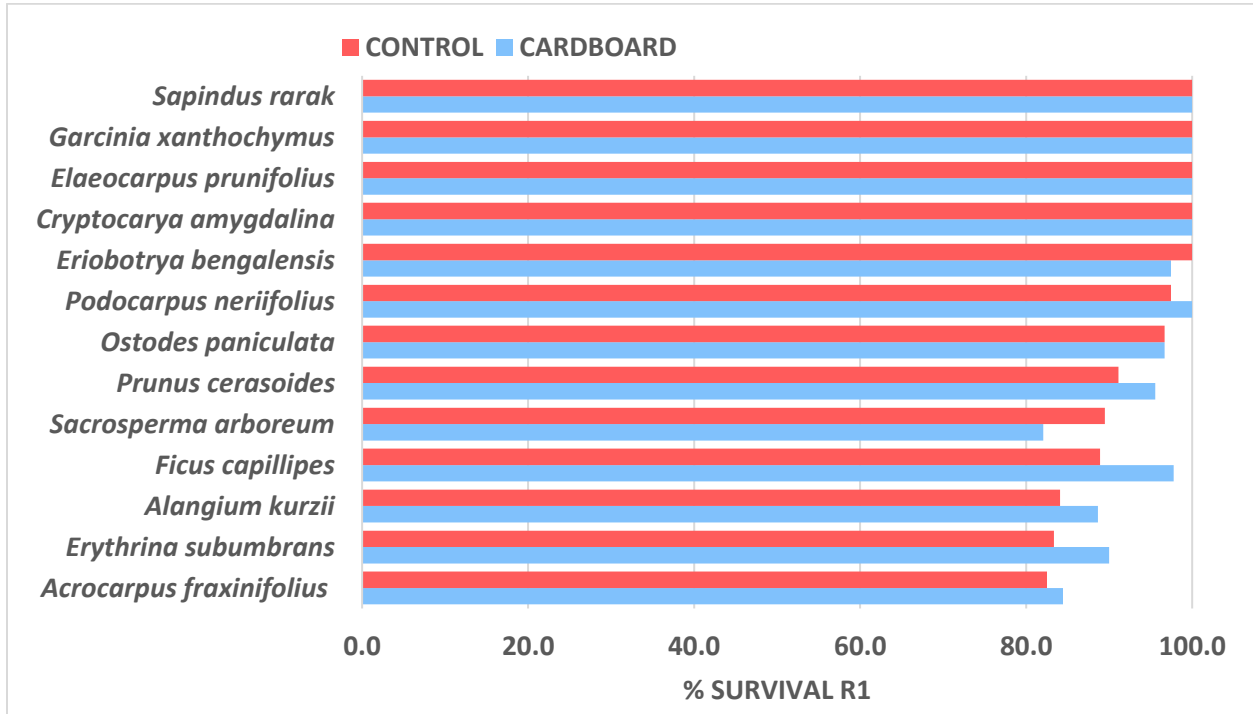


Figure 11– Species-specific estimated survival rates (including NFPA) after one rainy season - combined data from all 3 replicates.

Four species (*E. bengalensis*, *P. cerasoides*, *G. xanthochymus* and *A. fraxinifolius*) achieved RGR-RCD values above 70%/y, indicating a potential annual doubling in size (considered “excellent”). Six additional species (*E. subumbrans*, *O. paniculata*, *C. amygdalina*, *E. prunifolius*, *S. arboreum* and *F. capillipes*) achieved RGR-RCD values equivalent to a projected annual increase in size of 50% (considered acceptable). The remaining 3 species (*S. rarak*, *P. neriifolius* and *A. kurzii*) failed to achieve acceptable growth on this site. Cardboard mulch appreciably accelerated growth of only two species (*F. capillipes* and *A. fraxinifolius*), whereas it substantially reduced growth of seven species: *E. bengalensis*, *P. cerasoides*, *G. xanthochymus*, *E. subumbrans*, *O. paniculata*, *E. prunifolius* and *S. rarak*).

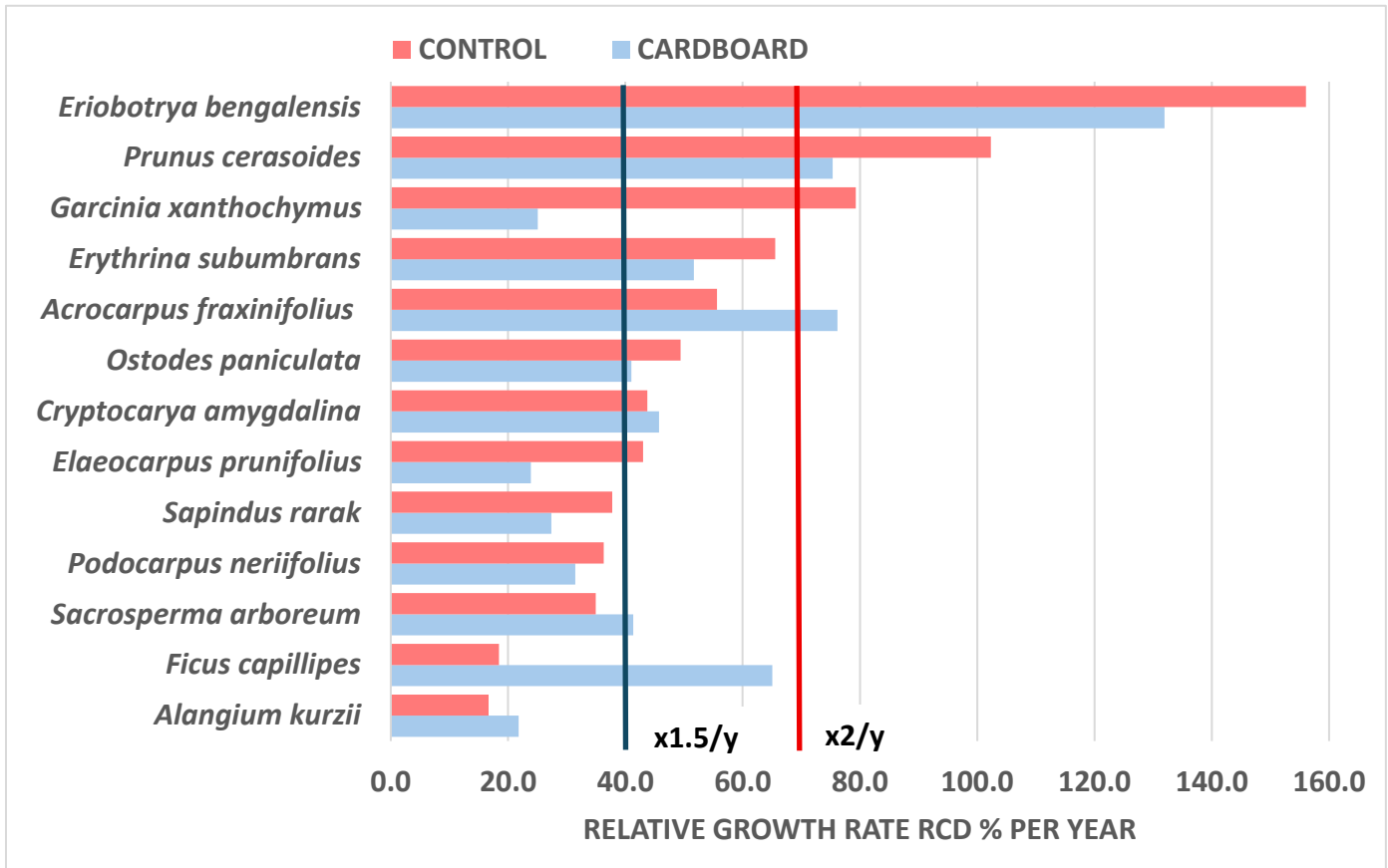


Figure 12 - Species-specific mean relative growth rates from planting to R1 survey 5th November. An RHG-RCD of 69.3%/y represents an annual doubling in size (red line), whilst 40.0% represents an annual size increase of 50% (blue line).

A performance index was calculated by multiplying % survival and standardize RGR-RCD (converted to a scale of 0-100%) – giving equal weight to growth and survival. The raw performance score was converted to a percentage of the highest species score, to create a relative performance score, enabling fair comparisons among species (Figure 13). *E. bengalensis*, *P. cerasoides* and *G. xanthochymus* achieved the highest performance. Most of the other species achieved moderate performance, but the 1st-year performance of *A. kurzii* was unacceptable. Cardboard mulch substantially increased the RPIs of *F. capillipes* and *A. fraxinifolius*, but substantially reduced it for *E. bengalensis*, *P. cerasoides*, *G. xanthochymus*, and *E. prunifolius*.

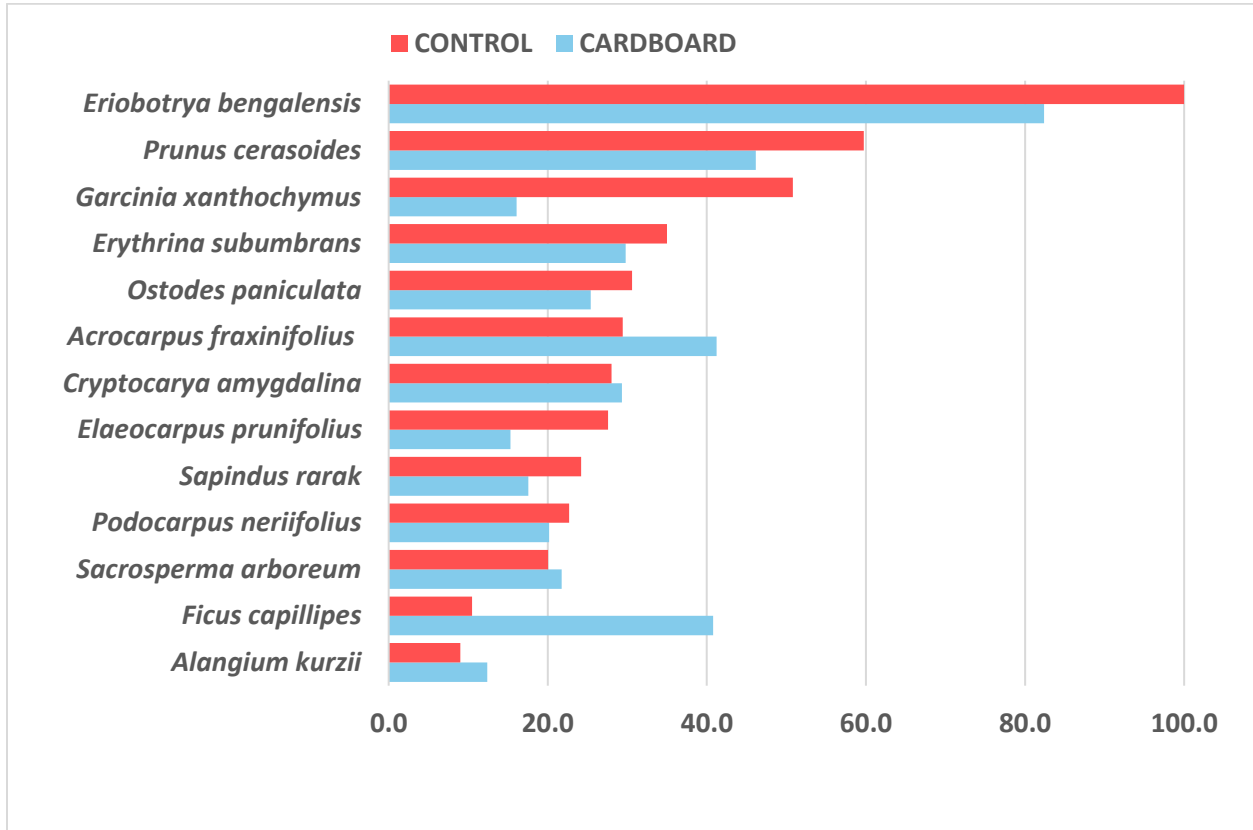


Figure 13 - Species-specific relative performance indices BL to R1 (surveyed 5th November)

Conclusion

We conclude that cardboard mulch cannot be recommended for forest restoration projects on upland sites. This confirms the finding of previous FORRU-CMU experiments, which found that cardboard mulch mats work best on lowland sites with poor soils, but have little effect on upland sites with more fertile soils. The hypothesis is that cardboard suppresses weed growth around planted trees, reduces competition and thus increases growth. However, averaging across all species, we found very little difference in mean weed-score reduction from BL to R1: -0.20 for cardboard-mulch trees and -0.27 for control trees (max of -3.0). The overall negative effects of cardboard mulch mats on most species may have been due to damage to the base of the tree stems, when applying the mat or when the mats are blown by the wind, perhaps allowing entry of pathogens via stem abrasions.

Overall cardboard mulch mats remain **not recommended for upland sites**, although they have been shown to be **useful on lowland or mine sites** with poor soils of for boosting performance of a few individual tree species (such as *Ficus* spp).

Plot 2 – The orchard site near Mon Cham view point – testing data-deficient species

Characteristics of the restoration site, area survey and map

The site was a steep slope (>40°) formerly used as a highland agroforestry plot and fruit tree orchard (apples, plums, maple and avocados), accessed via the car park of the Mon Cham view point (18.936389° N, 98.823400° E) at 1,301 m above sea level. RIF volunteers had previously planted a few trees of framework species on this plot back in 2013 (June 16th). However, the trees were not subsequently maintained and none were found in the current rapid site assessment (RSA). The

[RSA](#), was conducted on 5th July, recorded dense cover of grasses and herbs 1–2 m tall. A few trees of domestic species (avocado and cherry) were recorded from previous agroforestry attempts. Soil erosion was evident, but there were no signs of cattle damage or burning. The site was close to reference forest and FORRU restoration plots, planted in 2012 and 2022-23, as seed sources. Natural regeneration on the site was estimated at 58.6/rai (± 0.8 , 95% c.i.), requiring supplementary planting at 441 tree/rai—approximately 2,100 trees for the entire 4.7-rai site .



Figure 14 - Restoration site in Mon Cham area on 5th July 2025

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Figure 15 Maps of 4.7 rai restoration plot.

1. Site Preparation

Weeding was challenging at this site since grasses had grown above head height (Figure 14). Hand weeding was performed on 14th July 2025



Figure 16 – Staking out the site – planting spots 1.8 m apart (top) and shifting the trees from Ban Mae Sa nursery (below) on 21st and 22nd July.

The experiment (data-deficient) trees were planted in three replicated blocks (red, blue and yellow bamboo poles). The rest of the site was also planted with non-monitored trees.

Bamboo poles were installed 1.8 m on 21st July and holes were dug twice the size of sapling containers (9 x 2.5”).

Saplings were prepared and labelled at Ban Mae Sa nursery, then transfer to plot on 22nd July (Figure 16). Planting equipment and material were transported to site on planting day.

2. Species selection

The objective of this site was to test the performance of data-deficient species – those for which no field data were present in FORRU-CMU database system. Species were also selected on the basis of matching elevational distribution. A total of 4.7 rai was planted with 2,100 trees. Seven hundred and ninety trees of 15 data-deficient species were selected for testing standard performance in 3 replicated blocks (Table 3). The remaining 1,310 trees of 21 species were planted in the non-experimental area to fill in the rest of the site, including 500 trees from Royal Project (Table 4).

Table 3 Data deficient species for standard performance testing

S.no	Specie	FAMILY?	Successional guilds	Low elevation	High elevation	Total	Tag. (Block1, Block2, Block3)
67	<i>Engelhardia spicata</i>		climax	850	1,650	60	67-(1-20, 21-40, 41-60)
76	<i>Beilschmiedia assamica</i>		Climax	1025	1685	60	76-(1-20, 21-40, 41-60)
89	<i>Micromelum hirsutum</i>		Climax	1050	1050	60	89-(1-20, 21-40, 41-60)
91	<i>Gluta usitata</i>		climax	350	1,240	45	91-(1-15, 16-30, 31-45)
144	<i>Meliosma simplicifolia</i>		Pioneer	200	1200	60	144-(1-20, 21-40, 41-60)
170	<i>Canarium subulatum</i>		Climax	60	1300	45	170-(1-15, 16-30, 31-45)
187	<i>Bridelia glauca</i>		climax	525	1,575	60	187-(1-20, 21-40, 41-60)
217	<i>Dalbergia ovata</i>		climax	650	1,350	60	217-(1-20, 21-40, 41-60)
263	<i>Michelia floribunda</i>		climax	875	1,750	30	263-(1-10, 11-20, 21-30)
284	<i>Dracontomelum dao</i>		climax	500	1,025	60	284-(1-20, 21-40, 41-60)
286	<i>Antidesma bunius</i>		climax	725	1,450	60	286-(1-20, 21-40, 41-60)
334	<i>Harpullia arborea</i>	SAPINDACEAE	climax	500	1025	40	334-(1-13, 14-26, 26-40)
483	<i>Anogeissus acuminata</i>			60	1500	45	483-(1-15, 16-30, 31-45)
X1	<i>Utania racemosa</i>					60	S1-(1-20, 21-40, 41-60)
X2	<i>Clusia rosea</i>					45	S2-(1-15, 16-30, 31-45)
						790	

Table 4 Species selected for the non-experiment plot

S.no	Species	Family	Successional guild	Low elevation	High elevation	Total
12	<i>Diospyros glandulosa</i>	Ebenaceae	climax	650	1,650	20
13	<i>Sapindus rarak</i>	Sapindaceae	Intermediate	200	1,620	80
36	<i>Phyllanthus emblica</i>	Phyllanthaceae	Pioneer	60	1,700	50
66	<i>Spondias axillaris</i>	Anacardiaceae	Pioneer	460	1,600	30
71	<i>Prunus cerasoides</i>	Rosaceae	Pioneer	1,050	1,685	250
76	<i>Beilschmiedia assamica</i>	Lauraceae	Climax	1025	1685	50
83	<i>Artocarpus lanceolata</i>	Moraceae	climax	200	1,500	40
123	<i>Aglaiia lawii</i>	Meliaceae	climax	550	1,575	50
146	<i>Nyssa javanica</i>	Nyssaceae	Climax	550	1400	50
180	<i>Pittosporum nepaulense</i>	Pittosporaceae	Climax	852	1400	15
186	<i>Ostodes paniculata</i>	Euphorbiaceae	climax	500	1,500	30
284	<i>Dracontomelon dao</i>	Anacardiaceae	climax	500	1,025	30
293	<i>Podocarpus neriifolius</i>	Podocarpaceae	climax	1,050	1,850	50
296	<i>Chionanthus ramiflorus</i>	Oleaceae	climax	550	850	30
337	<i>Lithocarpus fenestratus</i>	Fagaceae	climax	800	1,300	27
344	<i>Ficus callosa</i>	Moraceae	climax	790	1,100	18
364	<i>Ficus auriculata</i>	Moraceae	climax	525	1,400	35
475	<i>Litsea glutinosa (Lour. C.B.)</i>	Lauraceae	-	75	1,225	35
365	<i>Ficus racemosa L. var. racemosa</i>	Moraceae	climax	60	650	40
158	<i>Gurga pinnata</i>	Burseraceae	Pioneer	350	1,200	40
320	<i>Bauhinia purpurea</i>	Fabaceae	Pioneer	350	900	40
	<i>Fraxinus griffithii</i>	Oleaceae				100
	<i>Liquidambar formosana</i>	Hammamedaceae				100
	<i>Cinnamomum camphora</i>	Lauraceae				100
					Total	1,310

3. Experimental design

We tested the performance of data-deficient species in three blocks, with each block color-coded with painted bamboo stakes. Within each block, saplings were randomly assigned, and each block contained the same number of saplings, as shown in Table 3. Species were classified as data-deficient if they had fewer than five field-test records (including zero) in the FORRU database. Planting species were selected from the list both Ban Mae Sa and Doi Suthep nurseries.

Planting event

The first planting day was 18th July, when the fill in (non-experimental) area was planted with 500 trees organized by the Royal Project, to celebrate the birthday of King Rama X birthday, together with National Park officers, Nong Hoi villagers local school children and participants from nearby resorts. The second planting day was 27th July and was organized by the FORRU team (Figure 17). Around 200 participants from the Royal Project, National Park, CMU's Agriculture Faculty, Doi Suthep Nature Center and Marriott hotel planted 1,600 trees, including 790 for experiment (testing data-deficient species) and 810 trees in the non-experiment area. FORRU staff divided participants into 4 groups and provided instruction on the plot layout and tree-planting techniques in each plot. In total, 2,100 trees were planted across the two events.



Figure 17 - Planting days: 18th July 2025 (top) and 27th July 2025 (below)

Site Maintenance

Weeding and fertilizer application was done on 6/9 and 8/10. Fifty grams of fertilizer was applied around all saplings in plot. Weed was performed by hand.

Monitoring

Monitoring of tree survival and growth was performed with volunteers, supervised FORRU-CMU staff, shortly after planting (baseline data) on 13th August 2025 and after 1st rainy season on 7th November 2025. Measurements were the same as previously described.



Figure 18 - FORRU staff with volunteers from Mae Jo University, Faculty of Economics helped with baseline monitoring on 13th August 2025.

Planting plan for Royal Project Nong Hoi plot2 – Mon Cham Orchard

June 28,2025	Rapid site assessment and Drone survey	FORRU
July 14, 2025	Staking regenerants and weeding	FORRU and Royal Project
July 21,2025	Sapling preparation in nursery, labelling	FORRU and volunteers
July 22, 2025	Transferred saplings, equipment to the area and distributed saplings to holes. Transferred fertilizer to planting site.	FORRU and volunteers
July 27, 2025	Planting Day	FORRU
August 13, 2025	Baseline Monitoring in experimental plots	FORRU and Mae Jo students
July 27, 2025	1 st Site Maintenance	FORRU and volunteers
September 6, 2025	2 nd Site Maintenance	FORRU and volunteers
October 8, 2025	3 rd Site Maintenance	FORRU and volunteers
November 7, 2025	The end of 1 st rainy season monitoring	FORRU and volunteers
December 31, 2025	Report for the end of 1 st Rainy season	FORRU
To be continued		
February 12, 2026	Fire Prevention	FORRU
Rainy season 2026	4 th Site Maintenance	FORRU
Rainy season 2026	5 th Site Maintenance	FORRU
Rainy season 2026	6 th Site Maintenance	FORRU
Late November – Early December 2025 (after the 6 th maintenance of the site)	The end of 2 nd rainy season monitoring	FORRU
Dec-26	Report for the end of 2 nd Rainy season	FORRU

Post-planting baseline (BL)

Two trees were not found in both the BL and R1 surveys and were assumed “not planted”. Therefore, the cohort size, used for calculation of survival, was reduced to **788**.

Only one tree (*Canarium subulatum*) was recorded as dead in the baseline survey most probably due to rough handling during transportation and planting.

Species specific mean tree heights at planting time were within the recommended range (30-60 cm tall) for most species (Figure 19). *Meliosma simplicifolia* trees were a little too small whilst *Harpullia arborea* and *Bridelia glauca* exceeded the upper recommended limit but not excessively so.

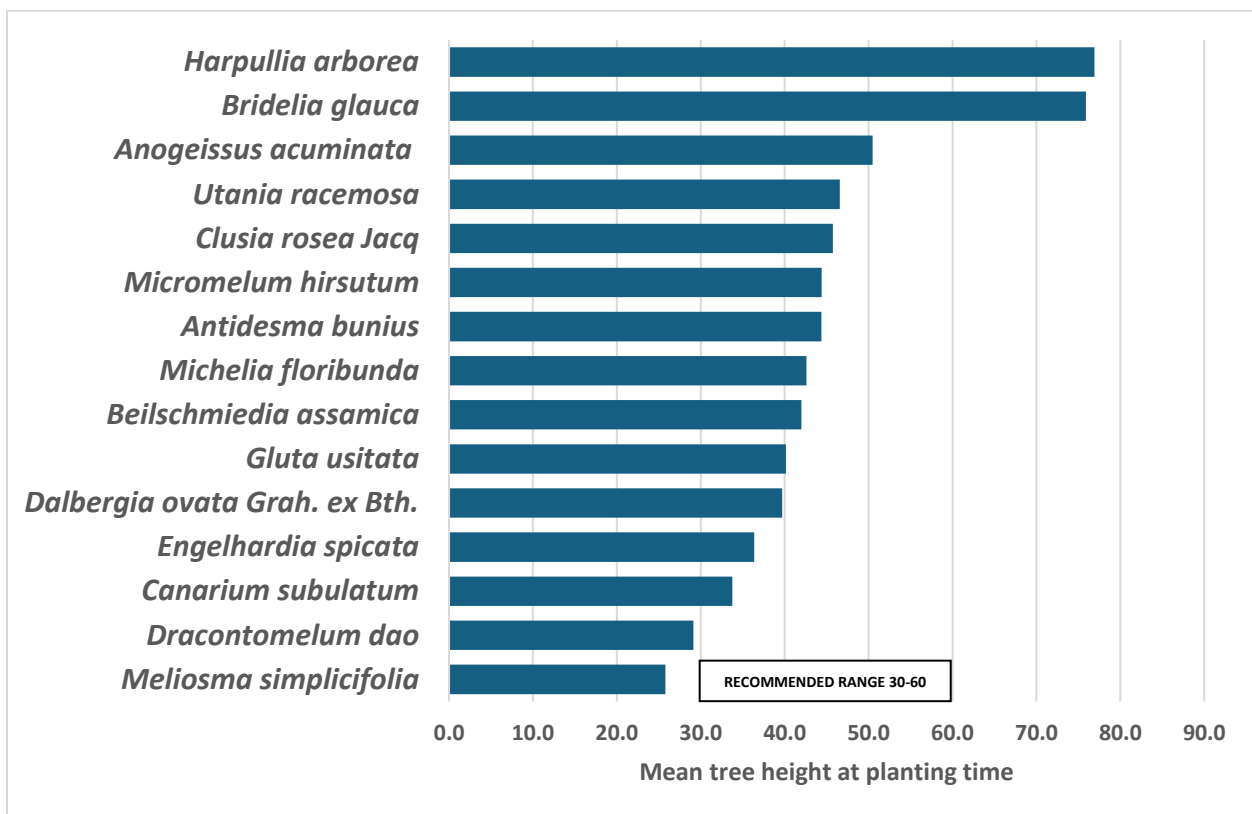


Figure 19 - FORRU staff with volunteers from Mae Jo University, Faculty of Economics helped with baseline monitoring on 13th August 2025.



Figure 20 – on 7th November 2025, R1 monitoring; FORRU team, interns and volunteers.

1st rainy season monitoring

Overall survival was excellent at 95.6%. All species-maintained survival rates above 80% (excellent) with three species attaining 100% survival (*Gluta usitata*, *Dracontomelon dao* and *Beilschmiedia assamica*) (Figure 21).

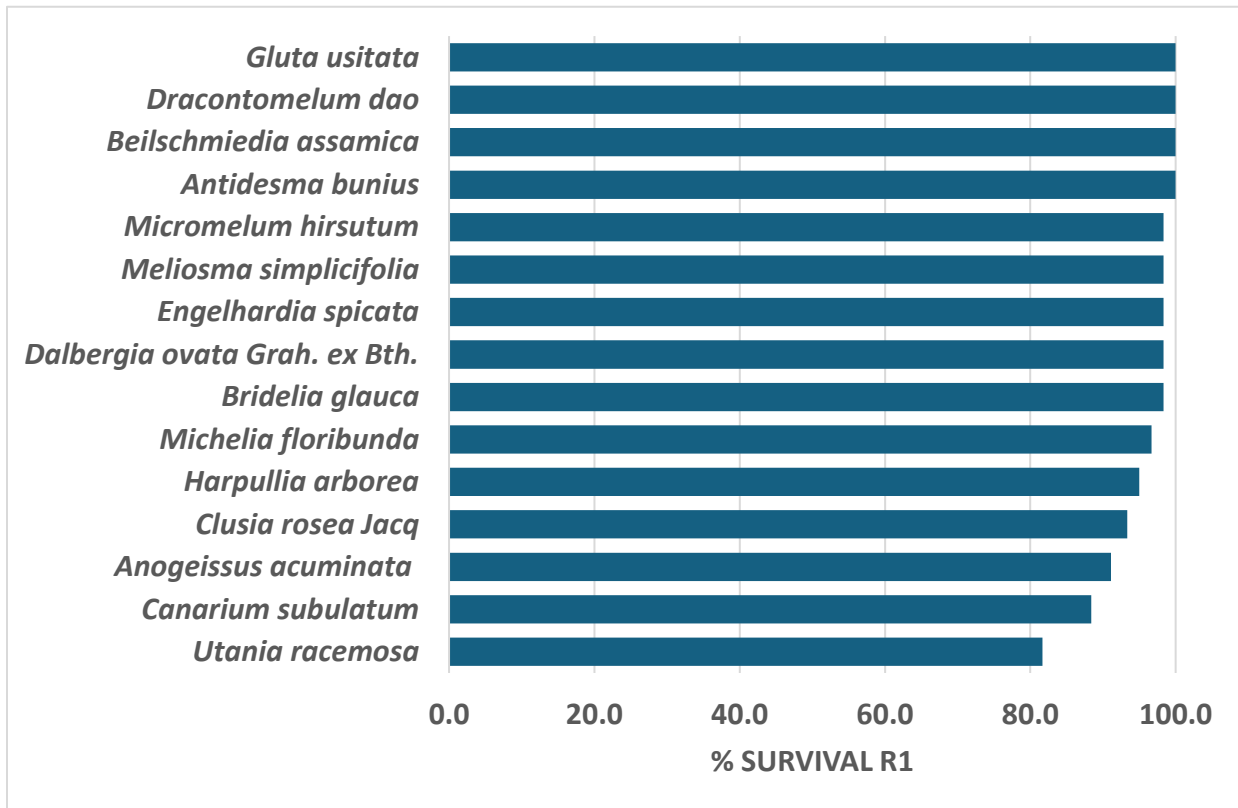


Figure 21 Species-specific survival between baseline and R1 survey 5th November.

The growth metric used was relative growth rate of root collar diameter (RGR-RCD). In Figure 22 a value of >69.3 indicates a projected, annual doubling in RCD whereas >40% projects an annual RCD increase of 50%. All species were ranked as having above acceptable growth rates, with 10 of the species (66%) attaining excellent growth.

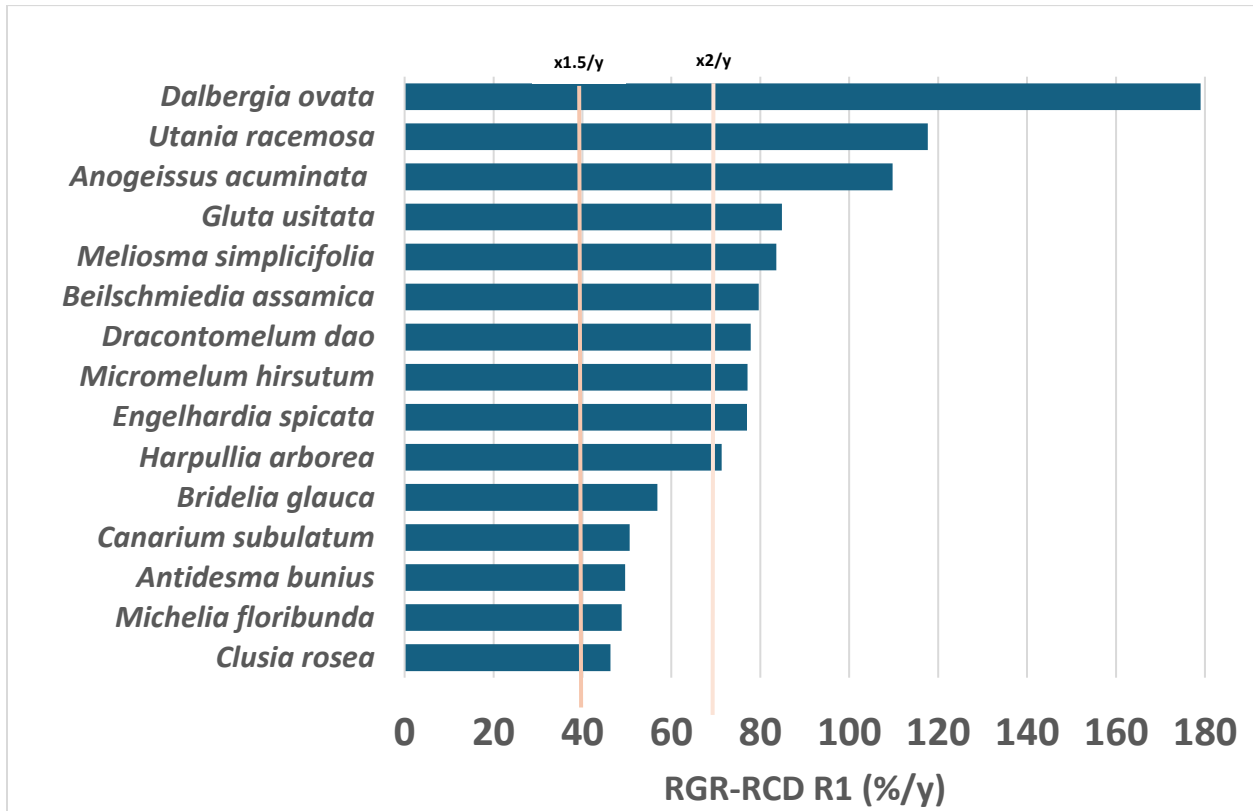


Figure 22 - Projected annual species-specific mean relative growth rates of RCD (%/y) (survey 5th November). A value of >69.3 indicates a project annual doubling in RCD whereas >40% projects an annual RCD increase of 50%

Relative performance indices were calculated for each species as previously described. The top performing species was *Dalbergia ovata* and the bars in Figure 23 are the species performance indices as percentages of that of *D. ovata*.

The high performance of *D. ovata* diminished the RPIs of the other species. However, looking at the raw performance indices against acceptable and excellent values, we see that all species achieved a raw performance index above 2000 considered “acceptable” (40 RGR-RCD x 50% survival), whilst the top three species achieved “excellent” performance (>69.3/ RGR-RCD x 75% survival = 5,197).

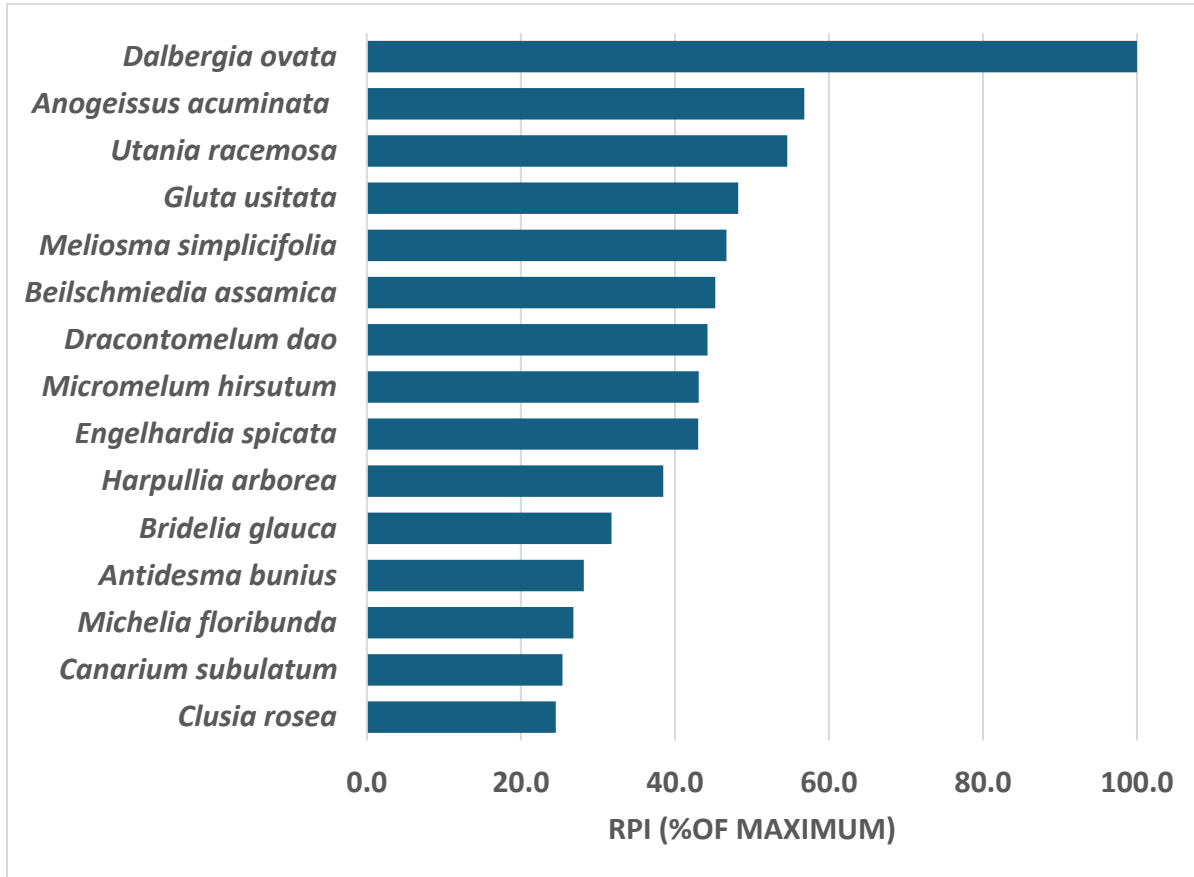


Figure 23 – Species performance indices, relative to the top-performing species (*D. ovata*), combining survival with RGR-RCD over first rainy season (R1) (5/11/25)

Conclusions

This trial of data deficient species produced valuable data suggesting that all the species tested achieved initial performance levels required as a prerequisite for consideration as framework tree species. They should be further investigated for the other essential framework traits i.e. attractiveness to seed dispersers, weed suppression and fire resilience.

D. ovata emerged as an exceptionally high-performing species and is highly recommended for sites with similar conditions. It is well known as a resilient species, and grows well on limestone, making it also a candidate for restoration of open cast limestone quarries. It's nitrogen-fixing capability also makes it useful for maintaining soil fertility. Like many members of the *Dalbergia* genus (the rosewoods), its wood is highly valued. Being close-grained, and moderately durable the wood is used for making high-quality furniture. The high performance of *G. usitata* is surprising as it usually grows at lower elevations (<800 m

Appendix I

Rapid site assessment

Planting Report RPNH25

RAPID SITE ASSESSMENT									
Site: RPHN25.1 – cardboard mulch testing on terraced slope						Recorder: Aom, Gawmai	Date: 2025 May, 30th		
Circle#	Latitude (N)	Longitude (E)	Livestock signs	Fire signs	Weeds - %cover/mean height/ ± tree seedlings	No. trees >50 cm tall (<30 cm gbh)	No. live tree stumps	No. trees >30 cm gbh	Total No. regenerants
1	18.92936	98.827530	Not found	Not found	60% ± 50 cm.	1	0	1	2
2	18.929470	98.827610	Not found	Not found	60% ± 50 cm.	0	0	0	0
3	18.929520	98.827730	Not found	Not found	60% ± 50 cm.	0	0	0	0
4	18.929610	98.827850	Not found	Not found	60% ± 50 cm.	3	1	1	5
5	18.929590	98.827950	Not found	Not found	60% ± 50 cm.	2	0	1	3
6	18.929393	98.827815	Not found	Not found	60% ± 50 cm.	2	0	0	2
7	18.929358	98.828111	Not found	Not found	60% ± 50 cm.	0	0	0	0
8	18.929490	98.827864	Not found	Not found	60% ± 50 cm.	1	0	0	1
9	18.929500	98.828286	Not found	Not found	60% ± 50 cm.	1	0	1	2
10	18.92960	98.828230	Not found	Not found	60% ± 50 cm.	2	0	1	3
TOTALS						12	1	5	18
Site description – terraced former demo site for agroforestry – steep and erosion prone							(= total/10)	Mean	1.8
							(= mean x 1,600/78.5)	Average /Rai	36.7
							95% c.l.		1.2
							จำนวนที่ต้องปลูกไร่(500-Average/Rai)		463

Planting Report RPNH25

RAPID SITE ASSESSMENT									
Site: RPNH25.2						Recorder: Aom		Date: 2025 July, 21st	
Circle	Latitude (N)	Longitude (E)	Livestock signs	Fire signs	Weeds - %cover/mean height/ ± tree seedlings	No. trees >50 cm tall (<30 cm gbh)	No. live tree stumps	No. trees>30 cm gbh	Total No. regenerants
1	18.93606	98.823670	Not found	Not found	0%	0	0	2	2
2	18.93620	98.823800	Not found	Not found	10% ± 50 cm.	2	0	0	2
3	18.93629	98.82354	Not found	Not found	10% ± 50 cm.	2	0	0	2
4	18.936510	98.823470	Not found	Not found	20% ± 100 cm.	2	0	0	2
5	18.936460	98.823280	Not found	Not found	5% ± 50 cm.	4	0	0	4
6	18.936580	98.823090	Not found	Not found	20% ± 100 cm.	4	0	0	4
7	18.936060	98.823670	Not found	Not found	5% ± 50 cm.	3	0	0	3
8	18.936910	98.822930	Not found	Not found	10% ± 100 cm.	4	0	0	4
					TOTALS	21	0	2	23
Site description: 1,284 m. 40-degree slope, abandoned agroforest (avocado, plum, maple)							(= total/10)	Mean	2.9
							(= mean x 1,600/78.5)	Average /Rai	58.6
							95% c.l.		0.8
							จำนวนที่ต้องปลูก/ไร่(500-Average/Rai)		441

Appendix II

Photo monitoring

Plot 1 – Phu Morin

Circle 1



Circle 2



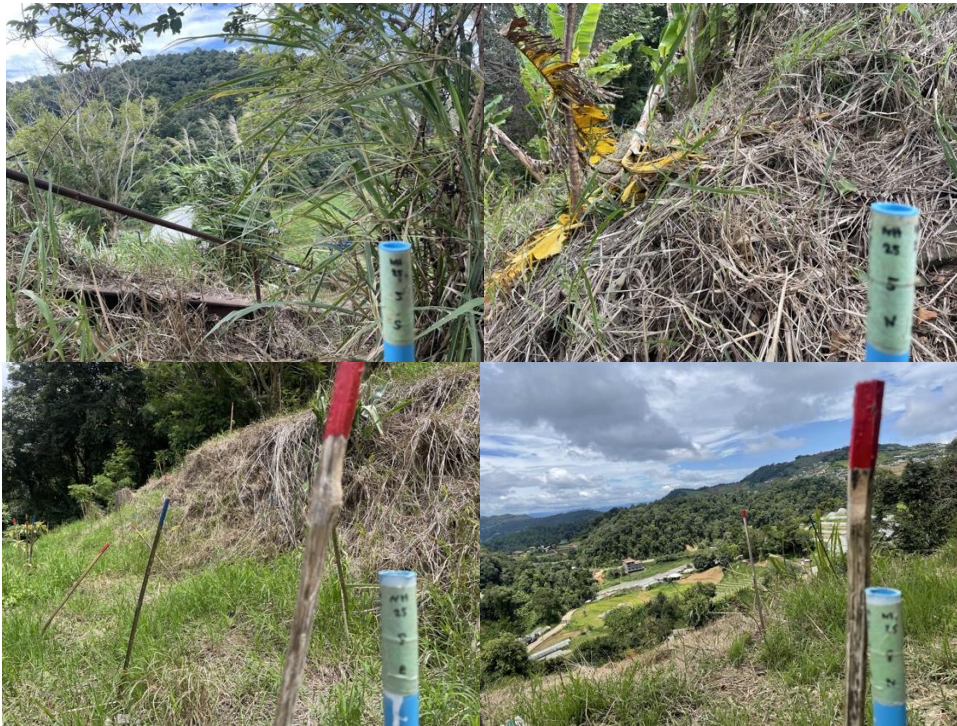
Circle 3



Circle 4



Circle 5



Circles 6-10??

Planting Report RPNH25

Plot 2 – Mon Cham Orchard
Circle 1



Circle 2



Circle 3



Circle 4



Circle 5



Circles 6-8

Appendix III

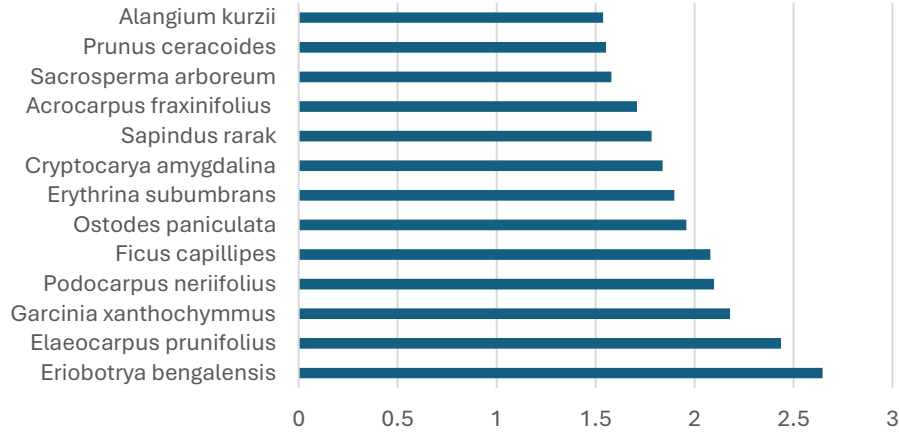
BL and R1 Data in Detail

Planting Report RPNH25

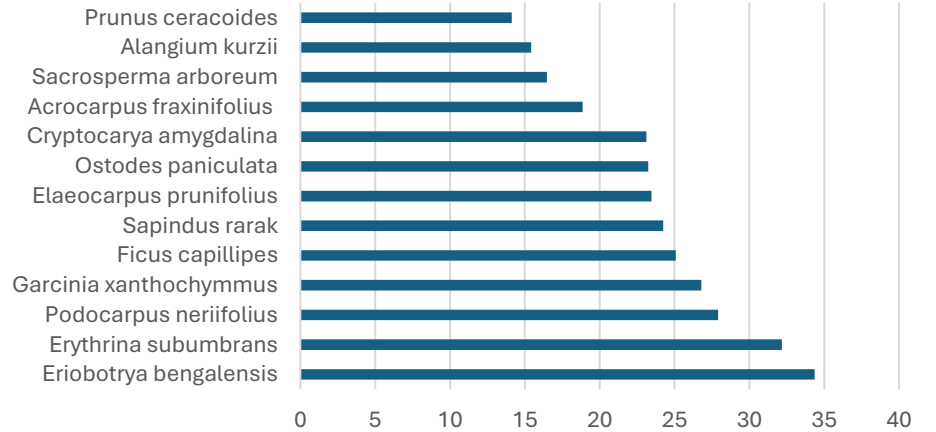
Plot 1 – Phu Morin



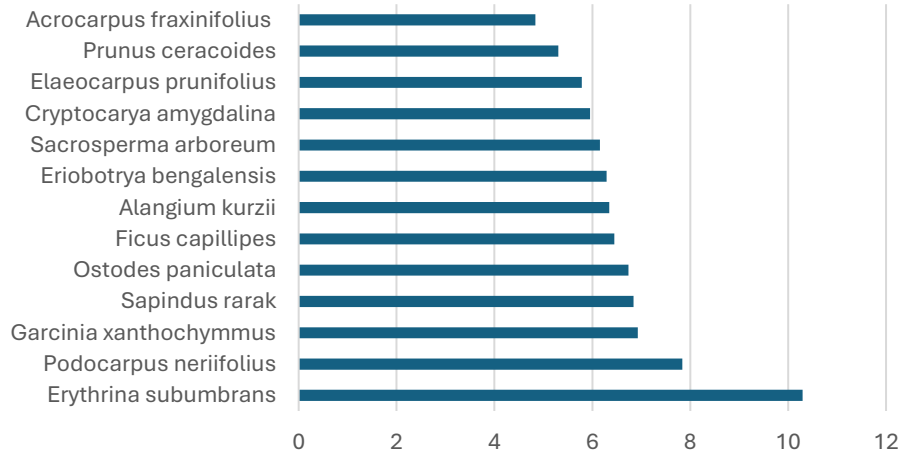
Average of Health score R1 (0-3)



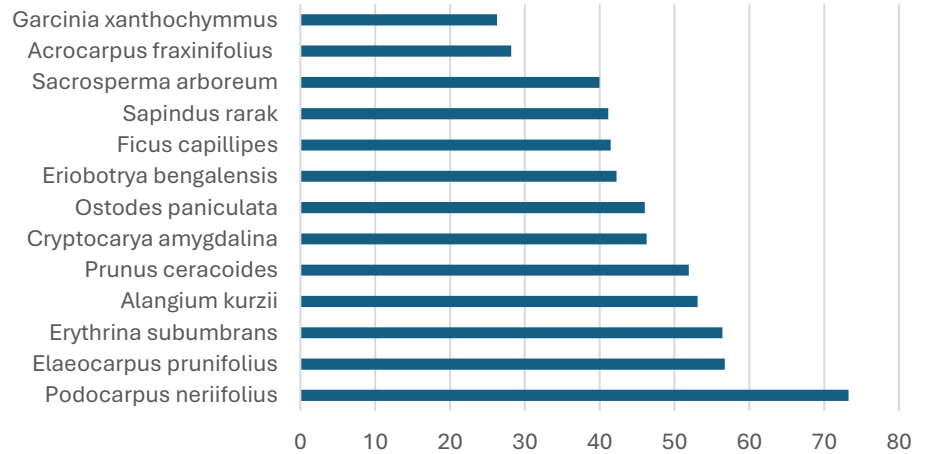
Average of crown width R1 (cm.)



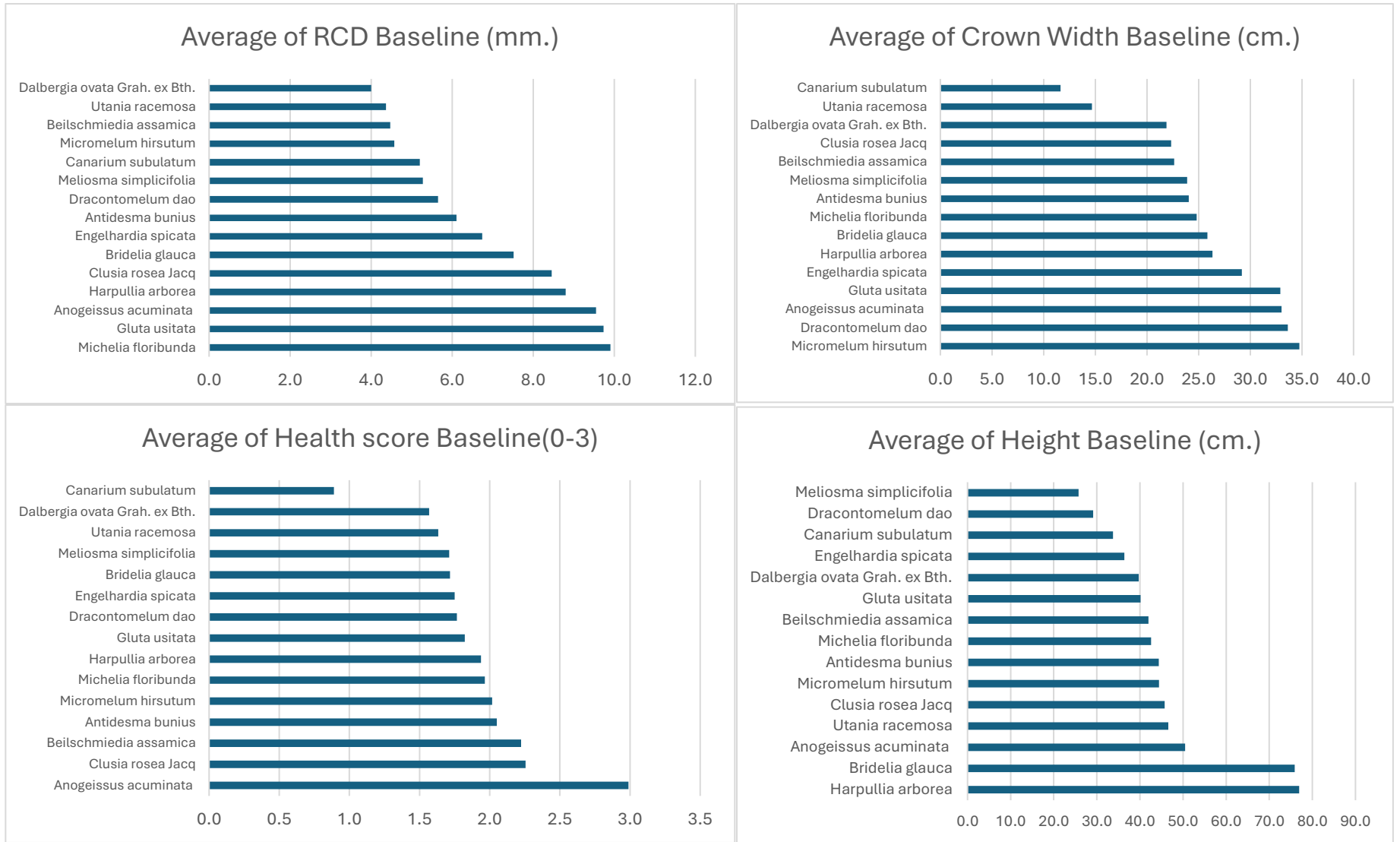
Average of RCD R1 (mm.)



Average of Height R1 (cm.)



Plot 2



Planting Report RPNH25

Plot 2

