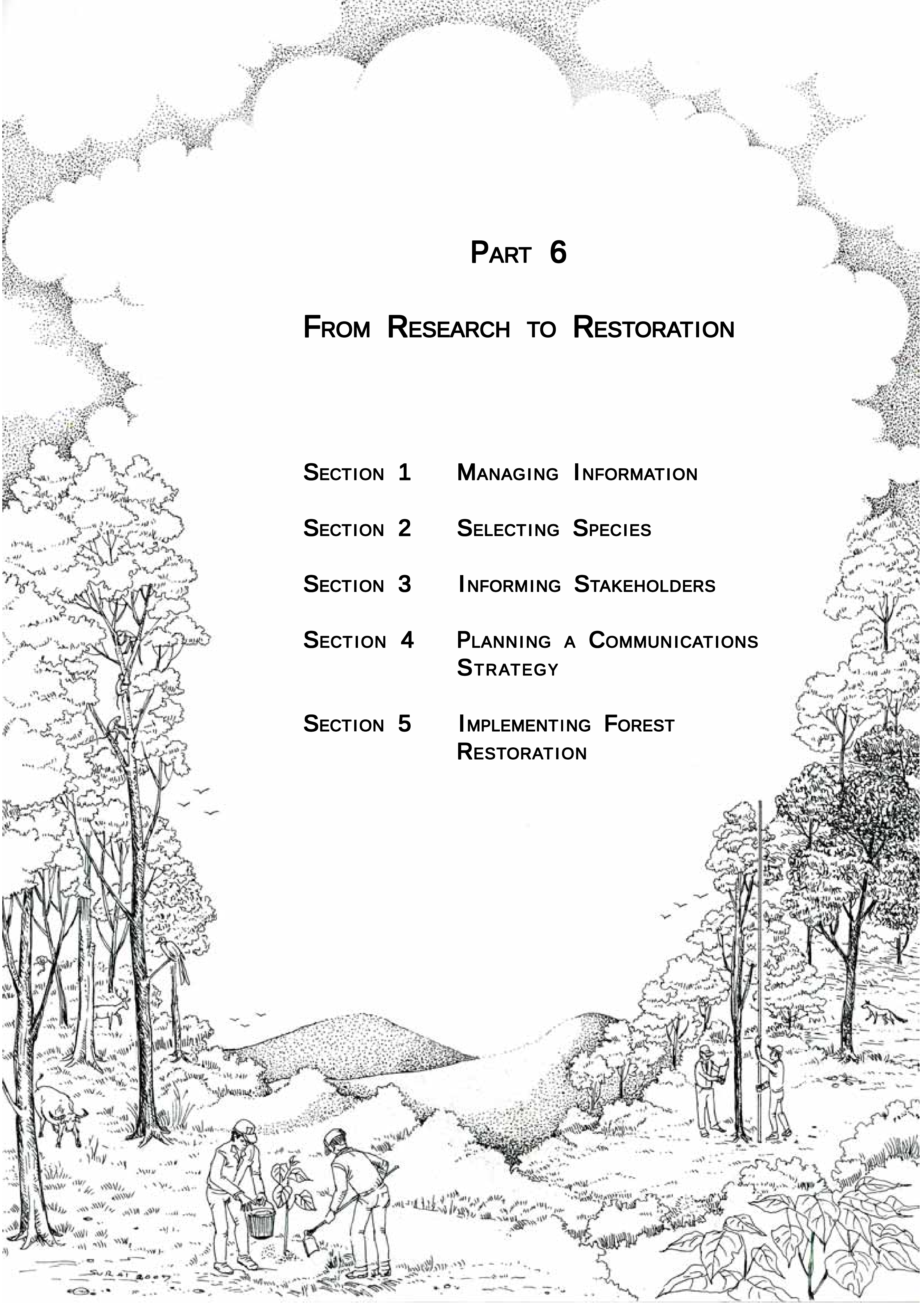
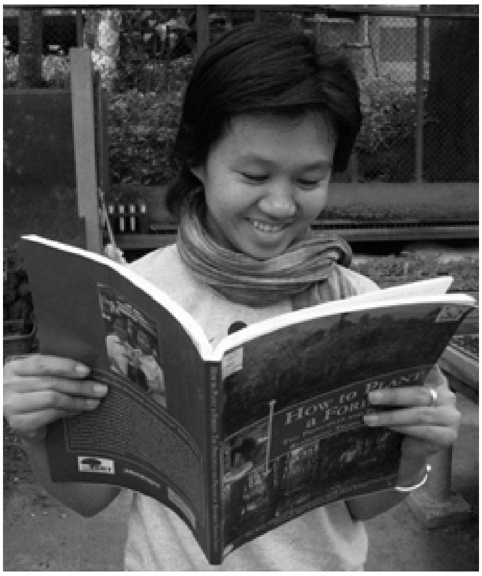
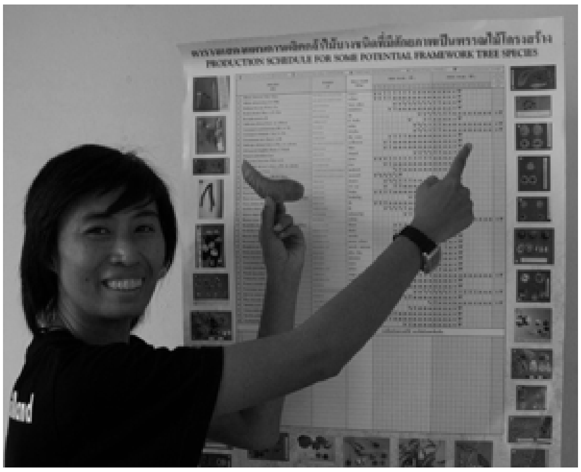


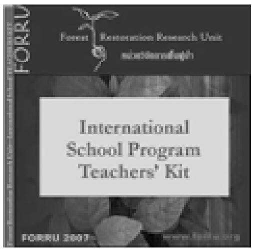
Part 6

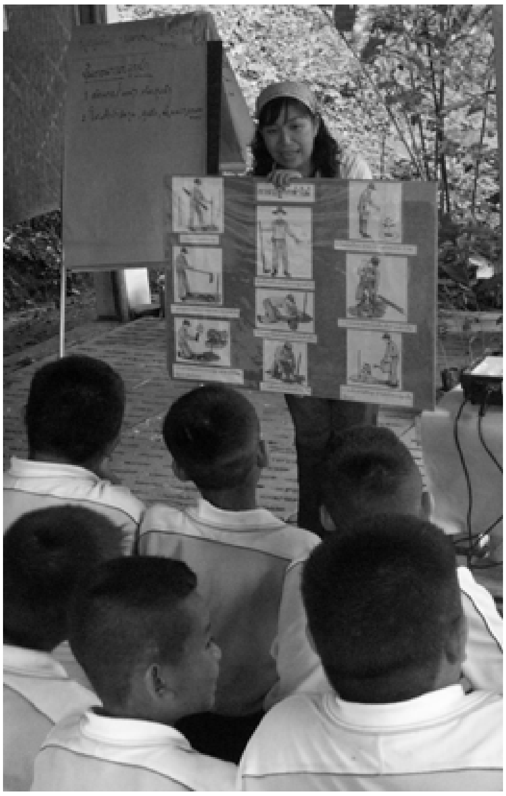
From Research to Restoration



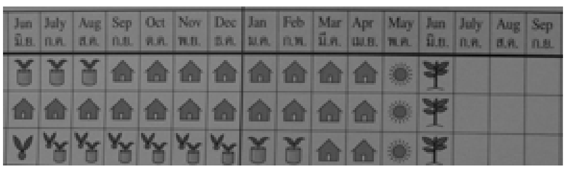


A recognisable logo helps to build a sense of unit identity and project recognition. Educational materials such as manuals, worksheets, posters and videos can help to spread the original knowledge and new skills developed by a FORRU to all those interested in forest restoration.





Ultimately, scientific data and graphs (above) must be converted into user-friendly materials, easily understood by villagers and government officials and also children (below).



From Research to Restoration

The experiments described in Parts 3-5 will quickly result in large amounts of data. Whilst the spreadsheets, described previously, are useful for storing the results of individual experiments, all data must eventually be combined to produce comprehensive overviews of every species studied. Only then can objective decisions be made as to which of them qualify as framework species and how best to grow, plant and take care of them.

The data must be organized into a single, but flexible, database structure, which can then be interrogated in various ways: i) to reveal the most suitable species for planting on any particular site and ii) to aid development of effective forest restoration strategies for particular sites.

Section 1 – Managing Information

Why make a computer database?

Computer databases are the most appropriate way to i) store large diverse data sets and ii) analyse them to answer a wide range of different questions. For example, let's say a site at 1,300 m elevation becomes available for forest restoration, the questions to ask might include...

- What tree species grow at an elevation of 1,300 m?
- Of those species, which ones have fleshy fruits that attract seed-dispersing animals?
- Of those species, which ones are fruiting this month so seeds can be collected?
- Of those species, which ones have previously germinated well in the nursery?
- Of those species, which ones would be ready for planting next June?

To generate species lists, matching such a set of criteria, it is necessary to construct a database, which integrates all data produced by a FORRU, together with published data and indigenous local knowledge. Excel spreadsheets do not allow the sophisticated search and sort facilities of advanced database programs, and, the larger spreadsheets become, the more difficult they are to work with. Therefore, the most critical data must be extracted from the spreadsheets, already described in Parts 3-5, and re-entered into a database system.

Who should set up the database system?

Setting up a database system involves intensive collaboration between the FORRU research staff, who have first-hand knowledge of the data being generated and how they would like to analyse it, and a hired IT consultant, with specific experience of working with the particular database programme selected.

How should the database be structured?

Databases are like sophisticated card index systems. A "database file" is the equivalent of one box, containing many cards. A "record" is the equivalent of one card and a "field" represents one of the headings on the card and the information associated with it. It is not practical to store all information about a species in a single record, since, for some types of information, there will be a single entry (e.g. the name and characteristics of a tree species, which do not change) and for other types of information there may be many entries (e.g. germination trial results for each seed batch collected). Therefore, the database consists of several database files, each one storing a particular category of information.

In addition, records referring to a particular species in each database file should be linkable with records referring to the same species in all other database files. Links are achieved by assigning link codes to each record, which enables records referring to the same species to be joined, regardless of which database file they are in. The most convenient link codes are the species number (S. no.) and seed batch number (b. no.). The database system must be able to recognise these codes and group together all records with the same codes, from all database files. Thus, the database should be able to generate species reports, listing all information about each species. It is not a good idea to use the species name as a link code, since taxonomists are constantly changing scientific plant names.

On the following pages, we suggest some record structures to contain the most basic information generated by a FORRU. This basic database structure can be expanded with new fields and database files as required. Consider adding files to hold summary data on seed storage experiments, attractiveness of each species to wildlife, or indigenous knowledge about the uses of each tree species. But be aware that data entry is time consuming, so before embellishing the database with extra fields or files, first consider whether the data entered will actually be used to support decision making – whether the outputs really justify the data input time.

Which database software?

Database programmes vary in terms of their sophistication and ease of use. Unfortunately the more sophisticated the program is, the less user-friendly it is.

At FORRU-CMU, we opted to use FoxPro for our database, because this package allows intricate and complex questions to be answered. Using the program requires some training, since building queries requires familiarity with some programming procedures. However, the program does provide for the construction of user-friendly interfaces to enable anyone to access and analyse the data easily, although construction of such an interface would require the services of a specialist.

If you consider complex software like FoxPro too difficult to use, there are plenty of other simpler but less powerful database programs on the market from freeware to expensive packages costing hundreds of dollars. So browse the web for reviews and select the package that matches both your information requirements and your tolerance of computer technology.

Whichever package you select, make sure that it supports the following essential features:

- The ability to link records in different database files that refer to the same species.
- Searches within fields for text occurring in any position in the field (e.g. find “September” = sp, occurring *anywhere within* a list of fruiting months....”jl ag sp oc nv”).
- The ability to generate information in one field, from calculations on numbers stored in other fields e.g. MLD by subtracting the date of seed collection from the date on which the median seed germinated.

Also consider whether the database package supports the script of your language and/or insertion of images (if needed). Database technology has other applications for a FORRU besides storing experimental data. Consider constructing a database of everyone who contacts with the unit, so that you can easily organize invitations to workshops and other educational events, as well as a circulation list for the unit’s newsletter. Another database could be used to catalogue books kept in the unit’s library or photographs taken by the unit’s staff.

Suggested Files, Records and Fields

DATABASE FILE – “SPECIES.DBF” – basic information about each tree species studied, which can be linked to records in other database files through the “**SPECIES NUMBER:**” field. Most of this information can be retrieved from a flora. Modify the list of flowering and fruiting months, as data from the phenology survey become available (Part 3, Section 2).

SPECIES NUMBER: *e.g. S71*

SCIENTIFIC NAME: *e.g. Prunus cerasoides* **FAMILY**: *Rosaceae*

LOCAL NAME: *Nang Praya Seua Krong*

EVERGREEN/DECIDUOUS: *D*

ABUNDANCE: *e.g. 0 = Probably extirpated; 1= Down to a few individuals, in danger of extirpation; 2= Rare; 3 = Medium abundance; 4 = Common, but not dominant; 5 = Abundant.*

HABITAT: *develop your own codes for forest types e.g. egf = evergreen forest; species may occur in more than one forest type, list them all in any order.*

LOWER ALTITUDE: **UPPER ALTITUDE**: *from direct observations*

FLOWERING MONTHS: *ja fb mr ap my jn jl ag sp oc nv dc*

FRUITING MONTHS: *ja fb mr ap my jn jl ag sp oc nv dc*

LEAFING MONTHS: *ja fb mr ap my jn jl ag sp oc nv dc*

FRUIT TYPE: *e.g. dry/fleshy drupe/nut/ samara etc.*

DISPERSAL MECHANISM: *e.g. wind/animal/water etc.*

NOTES:

ENTRY INTO DATABASE CHECKED BY: **DATE:**

DATABASE FILE – "SEED COLLECTION.DBF" - one record for each batch of seeds collected. Records for several seed batches for each species are linked to a single record in "**SPECIES.DBF**" by the **"SPECIES NUMBER:"** field. Transcribe information from seed collection data sheets (page 48).

SPECIES NUMBER: *e.g. S71* **BATCH NUMBER:** *e.g. S71b1*

COLLECTION DATE: **TREE LABEL NUMBER:** **TREE GIRTH:**

COLLECTED FROM: *e.g. ground/tree*

LOCATION: *e.g. Rusii Cave* **GPS CO-ORDINATES:**

ELEVATION:

FOREST TYPE: *develop your own codes for forest types e.g. egf = evergreen forest.*

NO. SEEDS COLLECTED: **STORAGE/TRANSPORT DETAILS:**

SOWING DATE:

VOUCHER SPECIMEN COLLECTED: *e.g. Yes/no*

NOTES FOR HERBARIUM VOUCHER LABEL:

ENTRY INTO DATABASE CHECKED BY: **DATE:**

DATABASE FILE – "GERMINATION.DBF" - one record for each treatment applied to each sub-batch of seeds. Multiple records for each species or each batch, respectively, are linked to a single record in "**SPECIES.DBF**" by the **"SPECIES NUMBER:"** field, and to a single record in "**SEED COLLECTION.DBF**" by the "**BATCH NUMBER:**" field. Extract data from germination data sheets (page 53). Use mean values from all replicates.

SPECIES NUMBER: *e.g. S71* **BATCH NUMBER:** *e.g. S71b1*

PRE-SOWING TREATMENT: *enter only one treatment (or control) e.g. scarification.*

MEDIAN SEED GERMINATION DATE: *date on which half the seeds germinated.*

MLD: = GERMINATION.DBF/MEDIAN SEED GERMINATION DATE: *minus* **SEED COLLECTION.DBF/SOWING DATE:**

MEAN FINAL PERCENT GERMINATION:

MEAN FINAL PERCENT GERMINATED BUT DIED: *as a percent of the number of the number of seeds that germinated.*

ENTRY INTO DATABASE CHECKED BY: **DATE:**

DATABASE FILE – "SEEDLING GROWTH.DBF" - one record for each treatment applied to each batch. Multiple records for each species or each batch, respectively, are linked to a single record in "**SPECIES.DBF**" by the **"SPECIES NUMBER:"** field, and to a single record in "**SEED COLLECTION.DBF**" by the "**BATCH NUMBER:**" field. Extract data from seedling growth data sheets (page 62).

SPECIES NUMBER: *e.g. S71* **BATCH NUMBER:** *e.g. S71b1*

POTTING DATE:

TREATMENT: *enter only one treatment (or control) e.g. Osmocote once every 3 months.*

NO. OF SEEDLINGS: *total number of seedlings subjected to treatment (combined replicates).*

SURVIVAL: *as a percentage, between potting and just before planting out.*

TARGET DATE: *date on which mean seedling height reaches target value (e.g. 30 cm for fast- growing pioneers and 50 cm for slower growing climax tree species). Derived from interpolation between points on the seedling growth curve (Part 3 Section 3).*

OPT. PLANTING DATE: *first optimum planting out date after the target date (usually 4-6 weeks after the first rains).*

TNT: *total nursery time* = **SEEDLING GROWTH.DBF/OPT. PLANTING OUT DATE:** *minus* **SEED COLLECTION.DBF/COLLECTION DATE:.**

OST: *over storage time* = **SEEDLING GROWTH.DBF/OPT. PLANTING OUT DATE:** *minus* **SEEDLING GROWTH.DBF/ TARGET DATE.** *This value is useful for identifying species for seed storage experiments.*

RGR HEIGHT: *relative growth rate, based on height measurements from just after potting to just before planting out.*

RGR RCD: *relative growth rate based on root collar diameter measurements from just after potting to just before planting out.*

ROOT/SHOOT RATIO: *from sacrificed plants just before planting out.*

NOTES ON HEALTH PROBLEMS: *descriptions of pests and diseases etc*

ENTRY INTO DATABASE CHECKED BY: **DATE:**

DATABASE FILE – "FIELD PERFORMANCE.DBF" - one record for each silvicultural treatment applied to each batch. Multiple records for each species or each batch can be linked to a single record in "**SPECIES.DBF**" by the **"SPECIES NUMBER:"** field, and to records in the other database files by the "**BATCH NUMBER:**" field. Extract data from the field data analysis spreadsheets (page 86). Insert mean values for combined replicates for a single silvicultural treatment.

SPECIES NUMBER: *e.g. S71* **BATCH NUMBER:** *e.g. S71b1*

PLANTING DATE:

FTPS LOCATION: **PLOT NUMBER(S):**

TREATMENT: *enter only one treatment (or control) e.g. cardboard mulch.*

NO. OF TREES PLANTED: *total number of trees planted and subjected to treatment (combined replicates).*

MONITORING DATE 1: *just after planting.*

SURVIVAL 1: *as a percentage.*

MEAN HEIGHT 1: **MEAN RCD 1:** **MEAN CANOPY WIDTH 1:**

MONITORING DATE 2: *after first rainy season.*

SURVIVAL 2: *as a percentage.*

MEAN HEIGHT 2: **MEAN RCD 2:** **MEAN CANOPY WIDTH 2:**

MEAN RGR HEIGHT 2: **MEAN RGR RCD 2:**

MONITORING DATE 3: *after second rainy season.*

SURVIVAL 3: *as a percentage.*

MEAN HEIGHT 3: **MEAN RCD 3:** **MEAN CANOPY WIDTH 3:**

MEAN RGR HEIGHT 3: **MEAN RGR RCD 3:**

MONITORING DATE 4: *add additional fields as needed for each subsequent monitoring event.*

ETC….

NOTES: *descriptions of pests and diseases etc. observed.*

ENTRY INTO DATABASE CHECKED BY: **DATE:**

SECTION 2 – SELECTING SPECIES

Once all data have been collated, a rational, objective method of interpreting the data is required to select trees which will perform well as framework species.

This process can be carried out in two ways: i) determine which species exceed certain standard minimum values of performance parameters or ii) apply a scoring system to each performance parameter and calculate an overall suitability score for each species.

Minimum Standards

Minimum standards can be applied to field data to determine which species exceed pre-defined minimum values of those parameters, which define a framework species i.e. high survival and growth, shading out of weeds etc. They can be based on absolute tree size achieved by a certain time (usually 18 months) after planting (height, RCD or GBH), growth rates (RGR's for height and/ or girth), canopy width, reduction in weed cover scores etc.

Setting the values for the minimum standards is subjective, although sensible values can usually be decided upon by scanning the data sets and looking for the divisions that set the species apart – particularly values that will lead to successful canopy closure within the desired timeframe. Bear in mind that whether or not a species exceeds the minimum standard will depend on i) the silvicultural treatments applied, ii) climatic variability (some species may exceed the standard in one year but not the next) and iii) site conditions. So a species need not necessarily be rejected if it marginally fails to achieve the standards in a single trial.

The process usually results in three classes of species i) those that fail most or all standards by a long way (rejected); ii) those that exceed some standards but fail others, (replant with different silvicultural treatments in subsequent years for further study) and iii) those that greatly exceed most or all standards. The latter can be confirmed as "acceptable" or "excellent" framework species, once their attractiveness to wildlife has been determined.

Once minimum standards have been applied to the quantifiable parameters of field performance, the most subjective characteristic of framework species, "attractiveness to wildlife", needs to be taken into consideration. This may not be known until several years after planting. It can be measured in terms of direct observations of wildlife i.e. numbers of individuals/species of frugivorous birds (or other species) visiting the trees or by quantifying the effects of wildlife visitations on natural regeneration i.e. numbers of individuals/species of recruit tree species establishing beneath the tree species (excluding wind-dispersed species). Another approach is to determine the age at which tree species first produce flowers or fruits (or other resources for wildlife e.g. nesting sites), by regular observations throughout the FTPS.

In practice, it is unlikely that any tree species will meet all the standards set for a framework species, but some may meet the majority of them. Among a mixture of 20-30 species planted on a particular site, all framework characteristics should be well represented.

Example of standards applied to evaluate candidate framework species for restoration of evergreen forest above 1,000 m elevation in N. Thailand (Elliott et al., 2003).

"To assess the extent to which planted tree species met framework criteria, minimum acceptable standards were proposed. Trees were planted at the start of the wet season and grew rapidly until November. In the first dry season after planting (November – April), growth slowed and those trees that failed to survive succumbed to drought stress resulting from failure to develop an adequate root system. By the end of the second wet season, planted trees had either established well or had died. This was therefore the optimal time to judge performance.

The acceptable survival rate for any species was considered as 50% or more by the end of the second growing season, excellent survival being considered as 70% or more. Species with survival rates of 45-49.9% were considered to be marginally acceptable. We considered that a mean height of 1.5 m or more by the end of the second growing season was acceptable, as this amounted to a more than doubling of height within 17 months. A mean height of 2 m or more by the end of the second growing season was classed as exceptional growth, whilst 1.25-1.49 m was considered marginally acceptable.

Canopy closure is an crucial milestone in forest restoration, creating shadier conditions on the forest floor and suppression of weeds, which encourage establishment of forest tree seedlings. Since trees were planted 1.8 m apart, a crown width of 1.8 m or more, by the end of the second growing season, should enable a tree to close canopy with its nearest neighbours. We, therefore, considered a mean crown width of 1.8 m by the end of the second growing season after planting as excellent, 1.5-1.8 m as acceptable, 1.0-1.5 m as marginal and less than 1.0 m as unacceptable.

The reduction in weed cover score between the end of the first growing season after planting and the end of the second growing season was used to compare species' abilities to suppress growth of herbaceous weeds. A reduction in mean weed score of 1.0 or more was considered excellent, 0.5–1.0 acceptable, 0.40-0.49 marginal and less than 0.40 unacceptable.

Standards of survival after a single fire event in early 2000 followed those for overall survival: 70% survival or higher was considered to indicate excellent fire resilience; 50-69.9% acceptable; 45-49.9% marginal and less than 45% unacceptable."

Measurement	Excellent	Acceptable	Marginal	Rejected
Survival (%)	>70	50-69.9	45-49.9	<45
Height (m)	>2	1.5-1.99	1.25-1.49	<1.25
Crown width (m)	>1.8	1.5-1.79	1-1.49	<1
Reduction in weed cover (score)	>1	0.5-0.99	0.4-.49	<0.4
Survival after fire (%)	>70	50-69.9	45-49.9	<45

A similar system of standards can be applied to the propagation of trees in nurseries:-

Measurement	Excellent	Acceptable	Marginal
Germination %	>80%	50-79%	30-49%
Total Nursery Time (TNT)[1]	<1 year	1-2 years	>2 years
Seedling Survival[2]	>80	60-79	40-59

[1]Time from seed collection to planting out of trees of target size.
[2]From potting to optimal planting date

What if too few species achieve the standards?

There are several options:-

- Improve planting stock quality – review the nursery data and check to see if there is anything that can be done to increase the size, health and vigor of the planting stock.
- Experiment with improved silvicultural treatments, particularly if you think site conditions may be limiting.
- Try new species - update and expand the list of candidate or potential framework species (Part 3, Section 1) by reviewing more information from the FORRU's database, indigenous knowledge and literature/web and start collecting seeds of species that have not already been tested.

A scoring system can also be used to assign a "suitability index" to each species tested. Species can then be ranked in descending order of suitability to prioritize those species most likely to respond to more intensive nursery or silvicultural treatments.

Set up a spreadsheet with species names in the left-hand column and the parameters that you want to contribute to the suitability index in the top row. Use field data from the end of second rainy season to calculate scores for each species. Enter the value for percent survival. Find the species with the highest mean height. Assign a value of 100% to that maximum mean height and convert the mean heights of all other species to percentages of the maximum. Do the same for canopy width and any other quantitative performance parameters that you want to contribute to the suitability index, including nursery performance parameters as required (% germination/survival, TNT etc.).

Assigning scores for "attractiveness to wildlife" is more subjective. Give high positive scores (0-100) for species that produce fleshy fruits; higher scores if they also have flowers with nectar and increase the score further if attractiveness to wildlife is confirmed by observations in the forest. If you have long-term monitoring data from the plots, increase the score depending on how rapidly the species flowers/fruits are produced after planting or base a score on the numbers of individuals/species of frugivorous birds observed visiting the trees.

Next, consider the relative importance of each score and multiply the scores by a weighting factor. For example, growth or canopy closure are irrelevant if a species has very low survival after planting out, so multiply survival scores by 2 or more. Finally sum all scores and sort the species in descending order of total score.

SPECIES SUITABILITY SCORING SYSTEM - EXAMPLE

Enter mean values of the most critical performance parameters after 2 growing seasons. Use values from the planted control plots or select the highest values from whichever silvicultural treatment produces the best results.

Before biodiversity data are available, fleshy fruits can be used as an indicator of attractiveness to seed dispersers.

Total nursery time, as an indicator of "ease of propagation". Could also use % germination or seedling growth rates.

Species	% Survival	Mean Height (cm)	Crown width (cm)	Fleshy Fruits	TNT
S01	89	450	420	Yes	<1 yr
S15	45	198	255	Yes	<1y
S43	38	102	20	No	1-2y
S67	78	234	287	Yes	1-2y
S72	90	506	405	No	<1y
S79	65	78	63	Yes	1-2y
S80	48	98	78	Yes	>2y

Convert mean values into scores, all with potential values ranging from 0 to 100. Add extra weight to the parameters you feel are most important by multiplying them by a weighting factor (e.g. survival x2 in the example below). Sum the scores and calculate a mean score. Then rank the species in order of declining overall score.

Use mean value directly

100 = fleshy fruits; 0 = dry fruits

TNT <1y = 100; 1-2y = 75; >2y = 50

Total score/6

	Survival score	Height Score	Crown Score	Attractive-ness Score	Ease of Propagation Score	Total Score	Adjusted Score	Rank
Max Score	200	100	100	100	100	600	100	
S01	178	89	100	100	100	567	94	1
S15	90	39	61	100	100	390	65	4
S43	76	20	5	0	75	176	29	7
S67	156	46	68	100	75	446	74	3
S72	180	100	96	0	100	476	79	2
S79	130	15	15	100	75	335	56	5
S80	96	19	19	100	50	284	47	6

Assign 100 to the highest mean value and calculate the other scores as a percentage of the maximum mean

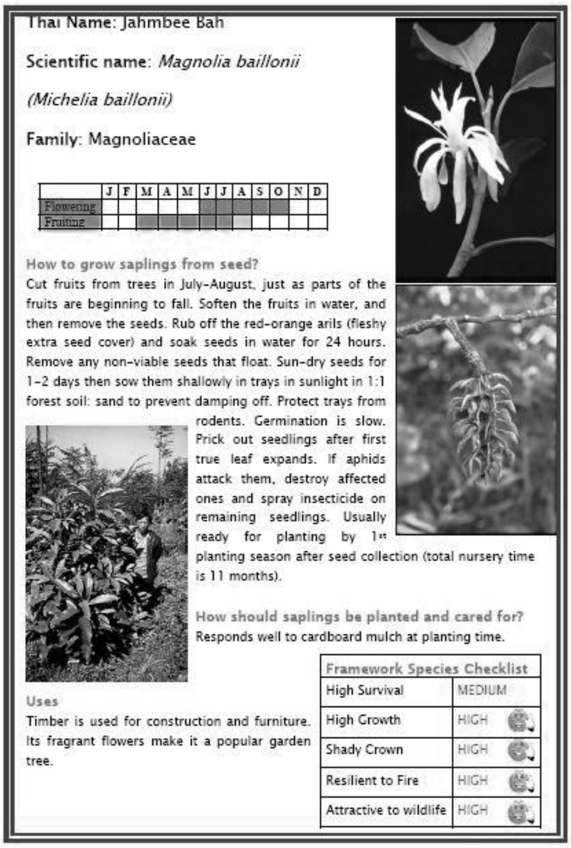
Deciding on the species mix

One of the disadvantages in applying standards or a scoring system too rigorously is that it may end up in the selection of all fast-growing pioneer species, producing a uniform forest canopy. The framework species method involves planting mixtures of both pioneer and climax forest tree species, and the creation of structural diversity, so retain a certain amount of flexibility when compiling the final mixture of species to be planted each year.

For example, a few slower growing climax tree species may be acceptable for planting if most of the other species being planted are fast-growing pioneers. Similarly, a few species with narrow crowns may be desirable, to add to the structural diversity of the forest canopy, provided they are planted alongside other species which score highly for canopy width.

Adaptive management

Ideally final species selection would not be made until all the data had been collected and analysed. However, it may take many years before some of the field data are produced, so it is inevitable that decisions in the first few years of a FORRU will have to be made on the basis of the data that becomes available early in the project - e.g. observations during phenology and seed collection and nursery data; with field data from the 1st year and 2nd year following and finally, data on biodiversity recovery and establishment of recruit tree species after many years. Therefore, systems for calculating standards and/or suitability must be continually updated and modified as new data become available. Maintaining and updating the FORRU database is critical to this process. Decisions on which species to plant in field trials each year are then re-evaluated in response to the new incoming data from the nursery and FTPS. This is “adaptive management” - one of the principle concepts of forest landscape restoration (see chapter 4 in Rietbergen-McCracken, et al., 2007).


Thai Name: Jahmbee Bah

Scientific name: *Magnolia baillonii*

(Michelia baillonii)

Family: Magnoliaceae

	J	F	M	A	M	J	J	A	S	O	N	D
Flowering												
Fruiting												

How to grow saplings from seed?
Cut fruits from trees in July–August, just as parts of the fruits are beginning to fall. Soften the fruits in water, and then remove the seeds. Rub off the red-orange arils (fleshy extra seed cover) and soak seeds in water for 24 hours. Remove any non-viable seeds that float. Sun-dry seeds for 1–2 days then sow them shallowly in trays in sunlight in 1:1 forest soil: sand to prevent damping off. Protect trays from rodents. Germination is slow. Prick out seedlings after first true leaf expands. If aphids attack them, destroy affected ones and spray insecticide on remaining seedlings. Usually ready for planting by 1st planting season after seed collection (total nursery time is 11 months).

How should saplings be planted and cared for?
Responds well to cardboard mulch at planting time.

Uses
Timber is used for construction and furniture. Its fragrant flowers make it a popular garden tree.

Framework Species Checklist	
High Survival	MEDIUM
High Growth	HIGH
Shady Crown	HIGH
Resilient to Fire	HIGH
Attractive to wildlife	HIGH

Once the decision on species selection has been made, convert information on the most suitable species into user-friendly formats, such as this species profile card for *Magnolia ballonii*

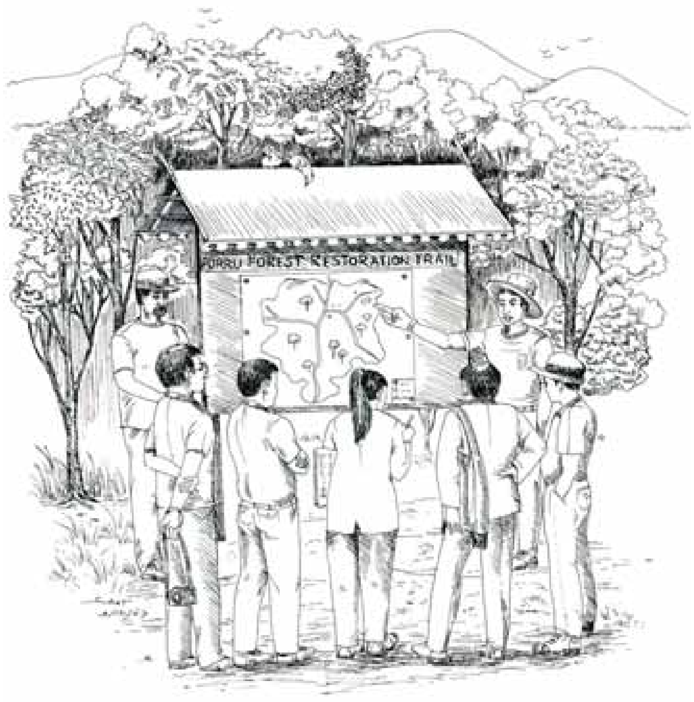
Section 3 – Informing Stakeholders

A FORRU is only beneficial if the original information and new skills developed by it are made easily accessible to all stakeholders that may become involved in restoring forest ecosystems, including government officials, NGO officers, villagers, teachers, school children etc. A FORRU should therefore provide comprehensive education and extension services to build capacity amongst stakeholders to enable them to implement effective forest restoration initiatives. These may include training programs, workshops, extension visits etc. as well as the production of publications and other educational materials.

Education Team

To begin with, a FORRU's research staff may be called upon to provide ad hoc training sessions or workshops for villagers, school children or local forest officers. However, if the experiences of FORRU-CMU are anything to go by, this will lead to a rapid increase in demand for education and training services that will overwhelm research staff, distracting them from the vital research activities. Therefore, it is better to recruit a team of education officers, with specialized experience of environmental education techniques, dedicated to providing stakeholders with the knowledge and technical support they need to start forest restoration initiatives (or improve existing ones).

Bear in mind that newly recruited education staff will not have the knowledge-base acquired by the research staff, so an education program must begin with intensive training of the education team members by the research staff, followed by frequent updates, as the research program produces new information.



A trail with sign boards through the FTPS turns a research facility into an educational resource of immense value.

Education Program

Once the educators are familiar with the FORRU's knowledge-base, they must design curricula to meet the very different needs of the various stakeholders involved in forest restoration. A modular system is best, with basic subject material presented in different ways to match: i) the location where the module will be taught and ii) the target audience. For example, teaching forest officers about the framework species concept in a field plot requires a very different approach to teaching school children about the same concept in a classroom, although the information content would be very similar.

An education program should include the following activities:-

- Workshops to introduce the general concepts of forest restoration and present techniques and results – usually for government officers, and community groups considering forest restoration initiatives (1-2 days).
- Longer and more detailed training in forest restoration best practices for officers responsible for running nurseries and implementing planting programs (3-10 days).
- Extension visits to the locations of forest restoration projects – to provide onsite advice and technical support directly to the people involved in implementing initiatives (1-3 days).
- A schools program, including events for school children and a train-the-teachers program – since children have the most to gain from forest restoration (1/2 day to several days, for camps and teacher training).
- Dealing with ad hoc visitors to the unit – visiting scientists, donors, media etc. (a few hours to one day).
- Training student interns (several weeks).
- Representation of the FORRU at international conferences etc. (a few days).

Educational Materials

A FORRU education team should produce a wide range of educational materials to satisfy the needs of all stakeholders. Teaching aids will be needed for each module.

A video can provide a concise overview of the FORRU and its work for the opening sessions of workshops and training programs, whilst a newsletter and a website can keep all stakeholders informed of a FORRU's outputs on a regular basis.

Publications are important educational outputs of a FORRU. Producing them can include a participatory component, involving consultations with, and inputs from workshop participants. This ensures that the information provided by the FORRU is of maximum benefit for local people, and also that it makes best use of local and indigenous knowledge. Most of this material can be designed and laid out in house easily with the aid of computers with desktop publishing software, particularly if someone with experience of graphic design is recruited to join the education team.

Poster being used to teach good tree planting practices.

Pamphlets and handouts

Handouts and pamphlets are one of the first outputs of a FORRU. They are useful for the unit's staff and visitors (particularly existing and potential funders). They may be both informative and educational, and help to publicize the unit. One of the first pamphlets produced could simply describe the FORRU's research program to visitors. As the research program develops, more technical literature should be produced, such as species data sheets and production schedules. Once this material has been written up, it can be used in other ways, such as posters displayed in prominent places in the research unit for educational purposes.

Manuals

A best practices manual should provide a comprehensive overview of all techniques developed by a FORRU. The manual becomes a text book for training stakeholders during workshops and extension events as well as interns and newly recruited staff. It may also inspire people working more distantly from the unit.

Typically, a manual should contain the basic principles and techniques of forest restoration in a form, which is accessible to a broad readership. The manual should also contain descriptions and propagation methods for framework species for the region.

For an example, see FORRU-CMU's "How to Plant a Forest", which is available in English, Thai, Vietnamese, Lao, Khmer and Chinese. It provides a model for other countries to adapt and modify using results generated from FORRU research programs.

Research papers and an international audience

Original scientific results produced by the unit should be published in international journals or presented at international conferences and published in proceedings. The purpose of publications aimed at an international audience is to share research results with other people working in a similar field. Research papers promote correspondence, discussion and exchange visits. They assist other researchers to develop their own research programs. Furthermore, international publications enhance the status of the research unit, both at home and abroad. If such publications are to be produced, it is important to ensure that experimental designs are sufficiently robust to withstand peer review.

Acceptance of papers by international journals and conference proceedings is important for the careers of the scientific staff (since job security in the academic world now increasingly depends on publication record) and raises the profile of the FORRU in the eyes of donor agencies.

A class from a Visting International Schools Program learn tree propogation techniques in FORRU-CMU's research nursery.

Section 4 – Planning a Communications Strategy

In addition to informing and training stakeholders directly involved with forest restoration, the education team should also be responsible for reaching out to the broader general public by engaging the mass media. Public recognition for the work of a FORRU helps to build public acceptance of forest restoration and attracts support and funding. It also helps to establish a network of contacts with other organizations that might otherwise be unaware of the FORRU's work. So it is worthwhile to invest some time in planning an effective "communications strategy" to ensure that appropriate media are used to communicate appropriate information to the appropriate audience.

Landcare NSW in Australia has developed a comprehensive support package to help environmental community groups, in the publications section at http://www.landcarensw.org. This is a detailed online resource that provides lots of practical recommendations on developing all aspects of a communications strategy, including how to write media releases and design promotional material. The following content is summarised from this source to help you start thinking about what to include.

What questions should a communication strategy answer?

Firstly determine what the purpose of the communication is, what resources are available, and how to evaluate whether the message has been effectively communicated. Decide on who is the intended target audience. For example it could be the general public, landholders, staff from government agencies, environmental organisations, teachers and students, sponsors and potential sponsors, industry organisations and so on. Be clear on what issues concern the audience, what message to communicate to them, what tools will be used, who in the FORRU will be responsible for the communication, and by when.

Writing for an audience

Develop the skills needed to present information in a clear, concise manner. Articles in newspapers, brochures, newsletters and on displays will be read by people from a wide variety of backgrounds with different levels of technical expertise and language skills.

Developing a logo and promotional style

Develop a FORRU logo and a signature style (colour scheme, font style etc.) for presentations, publications, uniforms and so on. This will help audiences to recognise the FORRU.

Forest
Restoration
Research Unit

Photography

Good photographs can be used for a wide range of communication activities. Good clear photos will increase the chance of getting articles published. Use a database to catalogue and organize the photo collection to easily select the most appropriate photographs for each purpose.

What communication tools can be used?

The online support package provides detailed recommendations about using various communication tools. Direct correspondence may be cheap, quick and easy. These days, email makes it easy to communicate personally with large numbers of people, but do not allow your FORRU to gain a reputation for generating junk mail.

Open days, workshops and other events are another good way to communicate, provided there is a clear objective. Never turn down the opportunity to speak at conferences and other meetings. Tailor the presentation to the interests of each target audience. Conferences also provide opportunities for displays and posters. These can be very useful for boosting a FORRU's public image and they can be displayed around the FORRU after the conference is over. Keep posters short and simple with more pictures than text. Develop handouts for more detail.

Use the media. Invite journalists to planting events and the opening of workshops etc. Write a press release or prepare information packs for journalists in advance so they have accurate facts and figures at their fingertips when writing articles.

Ask a TV company to make a VDO about the unit, which can then be used as an introductory VDO at workshops and training events etc.

Make a website to maintain regular communications with a network of interested organizations and individuals. Anyone making enquiries about the unit can simply be referred to the website for further information. In addition to a general description of the unit and its research and education activities, include pages with announcements of forthcoming events, a picture gallery of recent events and an interactive bulletin board. Publications and educational materials can be also posted on the website for ease of access (and to save on postage costs).

For those unable to access the web, a quarterly printed newsletter serves a similar function. Maintain a mailing list for the newsletter and also post copies on the website.

TV documentaries are the best way of becoming better known in the national or international community.

Section 5 - Implementing Forest Restoration

A FORRU's role is not to implement large-scale forest restora-tion programs. Decisions on restoration policies are made by na-tional and local governments and the communities they serve, whilst funding and implementing them is the responsibility of national agencies such as forestry departments and the private sector. The role of a FORRU is to provide all those institutions with the best possible information to enable them to achieve desired outcomes. However, when establishing a FTPS and building local partnerships, it is inevitable that FORRU staff will become involved in the logistics of implementing both small- and large-scale restor-ation projects.

From the start of its research programme, FORRU-CMU worked closely with a local village community and with a national park authority (Ban Mae Sa Mai in Doi Suthep-Pui National Park). So in-volvement in logistical and socio-economic aspects of forest restor-ation commenced very early on. Many lessons were learnt, and the community quickly became an important partner of the unit and a model for others to follow. The next stage in FORRU-CMU's devel-opment was to transfer lessons learned from the model developed at Ban Mae Sa Mai to a small number of villages across the north of Thailand, as part of a project called "Trees for Thailand" funded by the UK's Eden Project. FORRU-CMU also provided input into other projects in Thailand where relatively small scale forest restoration was required, for example a project to restore forest in Khao Pra Bang Kram National Park in southern Thailand, home of the critically endangered Gurney's Pitta bird species.

FORRU-CMU was then approached by government organiza-tions to provide advice and training for national-level restoration projects. FORRUs are particularly useful in these projects as tech-nical advisors, as often what is required is a refinement of methods already being used, for example expanding the list of local trees in the species mix, and advising on planting techniques.

Finally, with sponsorship from the UK's Darwin Initiative, FORRU-CMU began to export its generic concepts and research method-ologies to forestry agencies in other countries, to enable them to establish their own FORRU's and develop appropriate forest restoration technologies suited to local environmental and socio-economic conditions. This manual is part of that process.

Small scale projects

Test ideas with a small-scale model project and use lessons learned to generate meaningful inputs into large-scale, national or international restoration programs.

Left: An Australian scientist (right), national park chief (centre) and village leaders (left) meet at FORRU-CMU's model site in Doi Suthep-Pui National Park, N. Thailand to confirm sites for planting, after jointly planning restoration plots with aerial photos and the latest GIS technology (geographical information system).

Typically small scale projects are located in villages. There may be one enthusiastic individual who drives the project, or possibly a local school that is involved. Encouraging the whole community to be involved will provide an opportunity not just to plant trees but get young and old working together on the restoration project. FORRU-CMU's experience is that even for small scale projects, external funding for the community is just as essential for the work to progress, as is technical support. A FORRU can be instrumental in helping local communities to raise small amounts of funding as a start up grant. However, even a small number of small scale extension projects can place a significant workload burden on the FORRU, especially if they are distant from the FORRU, and distant from each other. Working with existing environmental networks, and developing clusters of small scale projects in small geographic areas that can meet and support each other, may help reduce the support requirements.

Large scale projects

Involvement in large scale planting is something which the FORRU must be prepared for. FORRU-CMU had extensive research experience, and worked with a range of small scale projects before it became involved in larger scale forest restoration schemes. Other FORRU's may be required to help with larger scale projects much earlier in their evolution.

One of the biggest problems with working with national agencies is the tendency for governments to set unrealistically ambitious targets to achieve impressive results before their term of office expires. This often conflicts with the proven, methodical approaches developed by scientific research. Under such circumstances a FORRU's role is to make sure that all agencies involved fully understand the time, labour and funding needed for effective restoration using proven techniques. The implementing agencies must then weigh up these practical considerations against political pressure to achieve rapid results.

Training manual based on initial research, 1997.

Identification book for seeds and seedlings, including propagation tips, 2000

A comprehensive practical manual, 2006

Proceedings of a conference hosted by FORRU-CMU in 2000

Published vegetation survey of the national park where tree species were tested, 2001