Some Observations on Seedling Production and Reforestation Initiatives of Research Partners of the ACIAR Project in Papua New Guinea

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INTRODUCTION

The University of the Sunshine Coast in partnership with the Forestry Department in Papua New Guinea (PNG) and Ramu Agri Industries Ltd (RAIL) is implementing a research project to promote community forestry in PNG. This project is implemented with support from the Australian Centre for International Agricultural Research (ACIAR). Pilot research sites were identified including at Ramu in the province of Madang. A three-day field trip was undertaken to observe the seedling production and tree planting activities at research sites of the ACIAR Project in Ramu. This report outlines the key observations from the field trip. The nurseries are described based on the purpose of operation, set-up and construction, species diversity, and management practices. Key aspects for improving the nursery effectiveness are suggested, and the potential of the nursery for promoting community forestry is discussed.

METHODS

Visits to villages in Waret, Rais, Ragi and Mara were undertaken to observe the forest nurseries in these areas that were established as part of the implementation of the ACIAR project. A visit to the RAIL nursery was also undertaken. RAIL has been producing seedlings of timber trees for the company’s reforestation initiatives. The company has been working with various villages to support the promotion of community forestry in the region. The visits were made on the 3rd and 4th of September, 2015. Researchers from the ACIAR project and staff members of RAIL obtained permission from village gatekeepers prior to the visit. Gatekeepers were leaders of the villages or clans within the village.

Informal unstructured interviews with clan representatives were conducted to gather information regarding the interest of the clan in tree farming and reforestation, and perceived and realised constraints for the successful implementation of tree farming and reforestation activities (Figure 1). Information on species preferences and the basis of species selection, and sources of germplasm were also gathered. A rapid assessment of seedling physical quality was undertaken by observing seedling sturdiness and health. The nursery set-up including the structure and location was noted. Nursery silvicultural practices, as observed during the visit and those revealed by respondents, were also recorded.
INFORMATION GATHERED AND SOME CRUCIAL OBSERVATIONS

Five nurseries were visited, namely the RAIL nursery and nurseries in the villages of Waret, Rais, Ragi and Mara. These nurseries were established with varying objectives, operation schemes, and with corresponding constraints and opportunities.

THE RAIL NURSERY

Purpose: The RAIL nursery is producing seedlings to supply the requirements for the company’s research and reforestation programs.

Nursery set-up and construction: The RAIL nursery is located inside the company’s compound in Ramu. The structure of the nursery was semi-permanent, using concrete blocks and lumber for germination beds, steel bars as frames for germination and transplant sheds, and nylon netting as shade material (Figure 2a). Elevated hardening beds made of steel were also used (Figure 2b). The nursery set-up generally followed the standards required for producing high-quality seedlings. There was a potting shed, which also served as a storage space for the potting medium. The potting shed had a roof to prevent the potting medium from being soaked during rain events. The production capacity based on the size of the nursery was approximately 20,000 seedlings. The nursery was managed by a permanent staff member of RAIL.

Seedling species diversity: The nursery is producing a variety of tree species including Eucalyptus pellita, Intsia bijuga, Pterocarpus indicus, Tristiropsis acutangula, Pinus spp., Azadirachta indica, Gnetum spp. and Aleurites moluccana.
Nursery management practices: The nursery uses the germination medium of soil plus sand. This mixture was found appropriate based on trials undertaken by the previous ACIAR Q-seedling Project in the Philippines. Black polybags were largely used as the seedling container, although a few seedlings were grown in plug trays and hyko trays (Figure 3). These trays are excellent seedling containers because they possess root trainers, which prevent root curling or pot-bounding. Seedlings were sun-hardened on elevated hardening beds, which is an ideal practice for high-quality seedling production. Seeds rather than wildlings were mostly used for seedling production, indicating that RAIL has ready access to mother trees of various tree species. Several studies have indicated that using seeds will promote high seedling survival and facilitate the development of good seedling root systems.

Seedling quality: In general, the physical quality of seedlings at the RAIL nursery was good with minimal signs and symptoms of pests and diseases. Some seedlings of *E. pellita* have damaged leaves caused by leaf-feeding insects, however, the degree of infestation is minor. Seedlings in plug trays and hyko trays developed a desirable root form and those grown in polybags have not exhibited root systems growing outside the container. Sun-hardening was practiced although some seedlings appeared etiolated because of unregulated watering.
Possible improvements: While the RAIL nursery essentially follows the ideal practice for high-quality seedling production, there are some aspects in the nursery set-up and management practices that can be improved in order to increase the efficiency and effectiveness of the nursery in producing high-quality planting stock. These improvements include the following:

**Use of polybags with appropriate size.** It was noted that several seedlings were grown in large polybags (Figure 4a). While large polybags will contain a high volume of potting medium, which is good for seedling growth and development, this will result in a high seedling transport cost. Also, large polybags require a high volume of potting medium, which can also increase costs. Further, large polybags with a high amount of potting medium will produce tall seedlings, which are not ideal for reforestation activities. Large polybags are appropriate for growing trees for urban forestry and landscaping but not for watershed rehabilitation projects.

While some tree species have large seeds, sowing them in germination beds rather than direct seeding to pots minimizes the use of large polybags. Young seedlings can be potted in smaller pots. The 3in x 7in sized polybag (Figure 4b) is commonly used in reforestation programs in the tropics.

![Figure 4. (a) Large polybag used at the RAIL nursery, and (b) the 3in x 7in polybag commonly used in reforestation programs in the tropics](image)

**Timely potting of seedlings.** It was observed that some seedlings were left growing in germination beds (Figure 5). Ideally, seedlings are potted once they have developed two pairs of leaves beyond the cotyledon (if any). The sooner the seedlings are potted, the lesser is the occurrence of seedling mortality. This is the reason why seedling mortality is high when wildlings are used. Also, potting mature seedlings will require large containers because using small containers will usually cause the formation of J-roots and other root deformities.
Grading seedlings on hardening bed. Grading seedlings is a simple activity that has a profound effect on development of seedlings in the nursery. Grading facilitates short seedlings to receive ample sunlight. Without grading, short seedlings will remain overtopped and become inappropriate for planting. At the RAIL nursery, there is a need to grade seedlings on hardening beds to achieve uniform seedling growth. This can be done by arranging the seedlings according to their height, usually about two months after potting or when they are subjected to sun-hardening.

Unnecessary use of steel screen as seedling spacer. It is ideal to arrange seedlings with substantial space to allow sufficient sunlight to reach the nursery bed. The use of a steel screen on hardening beds as a seedling spacer is ideal for creating space between seedlings (Figure 6a). However, it has the disadvantage of being expensive and it reduces the volume of seedlings that can be placed on the hardening bed. Instead of using this kind of spacer, seedlings can be arranged in groups of five rows per group and leaving a space of about 6in in between groups (Figure 6b).

Use of an appropriate recovery chamber. The use of a recovery chamber has been found to be effective in facilitating recovery and improving the survival of newly-potted seedlings, wildlings and cuttings. A recovery chamber is used at the RAIL nursery (Figure 7a). However, the construction of this recovery chambers is inappropriate, which
could be the reason for the considerable mortality of newly-potted seedlings. The design of the chamber may protect seedlings from wind but it will not create the optimum environment (i.e. humidity) necessary for the recovery and development of newly-potted seedlings. There is a need to re-design the seedling recovery chamber used at the RAIL nursery. An example of a simple and low-cost but effective recovery chamber is presented in Figure 7b.

Figure 7. (a) The recovery chamber at the RAIL nursery, and (b) the one used in a community nursery in the Philippines

**Improved nursery design.** The RAIL nursery complies with the basic design and set-up of a nursery to produce high-quality seedlings. However, the efficiency of operation can be improved if transplant beds can also serve as hardening beds. With the relatively high number of seedlings produced in each production schedule, refraining from moving seedlings from transplant beds to hardening beds will minimise the nursery's operational costs. With this set-up, it is necessary to make the shade material on the transplant shed readily removable when seedlings are ready for hardening. Also, unlike the present practice in which seedlings on the transplant beds are placed on the ground, the suggested set-up will use elevated transplant beds because these will eventually become hardening beds.

**Appropriate frequency of watering.** It is important that seedlings are hardened not only by providing full sun exposure but also by reducing the uptake of moisture to accustom them to field conditions. Regulating the watering frequency and placing seedlings on elevated hardening beds largely achieves the reduced uptake of moisture. While hardened seedlings at the RAIL nursery were placed on elevated hardening beds, it was revealed that nursery workers water the seedlings twice a day due to a fear that the seedlings will desiccate. The frequent watering defeated the use of the elevated hardening bed and produced seedlings that were lanky (Figure 8). Although root systems did not absorb moisture from the soil, frequent watering provided regular moisture and nutrient supply to seedlings that were meant to be water-hardened, resulting in their rapid height growth. Lanky seedlings are unlikely to survive in moisture-stressed conditions at the planting site.
**Potential for promoting community forestry:** The RAIL nursery can play a supporting role to village nurseries in promoting community forestry. Recognising that the operation of the RAIL nursery is permanent and is backed by substantial resources, this nursery could serve as an extension facility, providing technical support to managers of village or clan nurseries. It can also serve as a tree seed centre, distributing seeds of species with limited germplasm availability. RAIL could collate information regarding location and phenology of mother trees and develop a database of germplasm sources. RAIL could also undertake nursery and field trials to develop new silvicultural technologies to support the success of community forestry. Hedge gardens of selected species with limited germplasm supply that can be propagated using macro-somatic propagation techniques could also be established at the RAIL nursery.

**THE WARET NURSERY**

**Purpose:** The nursery was established to produce seedlings for use by members of the Waret clan and other clans in the village in establishing a tree plantation on clan(s)-owned land to help address the dramatically declining supply of timber for domestic construction purposes. The clan, as a group, has started planting trees on their clan-owned land.

**Nursery set-up and construction:** The nursery was fairly new and smallholder-based, using indigenous materials and netting for fencing and shade (Figure 9). The construction of the nursery was temporary. Some necessary structures including a potting shed and elevated hardening beds were absent. The germination shed also served as a transplant shed. The production capacity was low, limited to approximately 1,000 seedlings. The nursery was established with support from the ACIAR project. Support was in the form of technical advice and provision of nursery materials including polybags, a sterilizing pan, nylon netting, shovels.

Figure 8. Etiolated or lanky seedlings of *E. pellita* placed on the elevated hardening bed
and a wheelbarrow. The location of the nursery was appropriate as it was fully exposed to the sun and near a creek for a ready water supply.

Figure 9. The smallholder-based nursery at Waret

**Seedling species diversity:** During the visit, seedlings of *E. pellita* (approx. 300) and *I. bijuga* (approx. 100) were found in the nursery. Some seedlings of *Theobroma cacao* (approx. 50) were also propagated. Members of the Waret community preferred *E. pellita* because of its high wood quality and fast growth. However, they also indicated their willingness to propagate and plant other timber species.

**Nursery management practices:** The clan members sterilised the germination medium by heating over fire (Figure 10). This is a good practice to kill pathogens and weed seeds. However, it was observed that the pasteurisation method was incorrect because the medium was cooked for too long over a strong fire. Prolonged cooking in a high temperature will result in excessive release of ammonia, manganese toxicity, elevated salt levels, and the destruction of organic matter and beneficial organisms.
It was noted that seedlings were arranged and graded according to height. However, one distinct observation was the leaning position of polybags as they were placed on the ground (Figure 11a). The pots were not standing upright because the corners of the polybags were not adequately poked out during bagging, hence not producing a round bottom (Figure 11b). Pots that are not upright will produce seedlings with bent stems, eventually resulting in a tree with a bent stem or multiple stem leaders. The seedlings were also arranged without sufficient spacing to allow ample sunlight to reach individual seedlings.

The clan was also provided with a sieve for processing the potting medium. It was made from steel, the size was quite small and the mesh was larger than the ideal mesh size for sieving potting medium (approximately 5mm). During the visit, the sieve was found in the kitchen of one of the members of the clan and was being used for another purpose (Figure 12).
Figure 12. The sieve provided by the ACIAR project to the Waret clan for preparing potting medium

**Seedling quality:** The quality of seedlings is generally low. Most of the seedlings were etiolated because there was no appropriate spacing of seedlings. The seedlings were not sun-hardened and watering frequency was not regulated. The presence of pests and diseases was also evident. Many seedlings were attacked with leaf-feeding insects and some exhibited symptoms of pathogen infestations and nutrient deficiency (Figure 13).

![Image](image.png)

Figure 13. Seedlings showing signs of insect damage and symptoms of pathogen infestation

**Possible improvements:** The pasteurisation method can be improved to follow the appropriate practice. A potting shed and elevated hardening beds can be established. The potting shed can also serve as a storage space for the potting medium. This shed needs to have a roof to protect the medium from getting wet during rain events. The seedlings on transplant beds should be placed upright to minimize seedlings developing bent stems. This can be done by correctly poking out the corner of polybags during bagging to create a circular bottom, which helps the pot to stand upright. Adequate spacing of seedlings should also be practiced to minimise the development of etiolated seedlings. Sun-hardening of seedlings should be carried out and the frequency of watering seedlings should also be regulated. The occurrence of diseases can be minimised by exposing seedlings to full sunlight and regulating the frequency of watering. Improved knowledge of disease and pest identification and appropriate control measures is necessary.
Potential for promoting community forestry: The nursery at Waret is an example of a clan-based nursery, established by a few members of the clan who are interested in undertaking tree farming. They are carrying out the task without receiving monetary compensation, which results in other clan members refraining from participating. The few clan members who have established the nursery have begun planting *E. pellita* on a piece of land that is owned by several clans. There is no legal arrangement in regards to managing the plantation and the sharing of future benefits. Whether the few clan members will maintain their motivation to grow seedlings and establish and manage the plantation eventually enticing more clan members to participate, or their enthusiasm will wane because of various constrains, remain unanswered questions. However, the initiative of the few members of a single clan is a manifestation that there are smallholders willing to venture into tree farming without receiving immediate monetary benefits. On the other hand, the reluctance of most community members to participate because of the absence of direct monetary benefits is also an important observation. There may be a need to investigate further the varying views, attitudes and interests among members of the clan - e.g. what drove the few to get involved and why did the majority not get involved? Answers to questions like these could be used as input for designing an effective community forestry program.

THE RAIS NURSERY

Purpose: The nursery at Rais was established to serve as a teaching facility for secondary school students to learn skills in nursery seedling production as a means of livelihood. It is also envisaged to supply seedlings for a buffer planting of an oil palm plantation that will be established by RAIL on land owned by the clan that also owns the land where the school is established.

Nursery set-up and construction: The nursery was inside the school complex, fairly new and established with the support from the ACIAR Project. The support was mainly technical advice and provision of nursery materials. The nursery set-up was fairly good. It was fully exposed to the sun, had a permanent supply of water and was highly accessible as it was next to the main road. However, the design of the nursery needs considerable improvement. The nursery was temporary, made of local materials and used netting for fencing and shade (Figure 14). The design of the nursery, and its size and production capacity were similar to the Waret nursery. As with the Waret nursery, it did not have a potting shed or hardening bed.
Seedling species diversity: The nursery was fairly new and had not started producing planting stock during the visit. It was not yet decided what species to produce but it was mentioned by the head of the clan that *E. pellita* would be one of the species that will be produced because this is the species that will be planted in the buffer zone of the oil palm plantation.

Nursery management practices: There was no information regarding nursery cultural practices because the nursery had not yet started seedling production. However, it was mentioned that two teachers from the school with the help of secondary students would manage the nursery.

Seedling quality: There were no seedlings produced in the nursery during the visit. There were some newly-potted *E. pellita* seedlings but those were taken from another nursery.

Possible improvement: The design of the nursery can be improved to include a potting shed and hardening beds. The hardening beds should be fully exposed to the sun and elevated to promote aerial root pruning. It was not known if the school teachers have the technical knowledge in nursery management and production of high-quality seedlings. Training might be needed to improve the technical skills of the teachers. A formal agreement between the school, the clan, RAIL and the ACIAR project might be necessary to legalise the collaborative undertaking and define the roles and responsibilities of each party.

Potential for promoting community forestry: Considering its strategic location, the nursery in Rais has the potential to serve as a demonstration nursery to showcase smallholder-based best management practices for high-quality seedling production. It could also serve as a training facility and focal point for providing technical support and extension materials. This nursery may complement the function of the nursery at Mara and develop into a permanent nursery for distributing seedlings to tree farmers. The teachers have a crucial role in sustaining the operation of the nursery.
THE RAGI NURSERY

**Purpose:** The nursery at Ragi was established to produce seedlings of trees to provide shade to cacao trees that will be planted on individual farms of clan members. It will also produce seedlings of trees that will serve as future sources of timber for domestic construction purposes.

**Nursery set-up and construction:** The design of the nursery in Ragi is the same as the nurseries at Rais and Waret (Figure 15). The structure was temporary and the production capacity was only about 1,000 seedlings. As with the Rais and Waret nurseries, the Ragi nursery received support from the ACIAR project in terms of technical advice and nursery materials including polybags and nylon netting. The forest nursery was established within the main clan-managed cacao nursery, which during the visit was producing 20,000 seedlings of cacao. The nursery was centrally located, being near the meeting place of the clan. The nursery location was quite shaded by coconuts and branches of neighbouring trees. Clan members had to fetch the water for the nursery because the source of water was relatively distant.

![Figure 15. The newly-established forest nursery at Ragi](image)

**Seedling species diversity:** The seedling production had not yet commenced because the forest nursery construction had only just been completed. However, it was mentioned by clan members that they prefer *E. pellita* as a shade tree for cacao because it can also provide high-quality timber for their domestic construction needs.

**Nursery management practices:** Several members of a single clan initiated the nursery but eventually the participation increased to include some members of other clans. Members of the initiating clan belong to the Seventh Day Adventist religion, which could be a major factor for the cohesion of the clan in undertaking the nursery endeavour. The youth members of the clan were largely involved in the nursery operation. There was a clan member who has vast knowledge and experience in cacao production, but not in forest tree seedling production. This person was leading the clans in nursery seedling production of cacao and in establishing the forest nursery.

There was no information regarding nursery cultural practices because the nursery had not yet commenced production of tree seedlings.

**Seedling quality:** During the visit, there were no seedlings of forest trees to judge the quality of planting stock. However, it was observed that seedlings of cacao were of a high quality. There
was no occurrence of pest or pathogen infestations. The seedlings were placed on the ground but the occurrence of root systems growing outside the polybag was not evident.

**Possible improvements:** Similar to the Waret and Rais nurseries, the design of the Ragi nursery could be improved to include a potting shed and hardening beds. The hardening beds should be fully exposed to the sun and elevated to promote aerial root pruning and development of sturdy seedlings. Irrigation piping could be installed from the water source to provide a reliable supply of water to the nursery. There may be a need to trim some branches of adjacent trees that were shading the nursery. Further, there may be a need to reconsider the preference of *E. pellita* as a shade tree because this species does not produce a wide and thick crown to provide substantial shade to cacao. The planting design for integrating cacao and shade trees may also need to be further considered.

**Potential for promoting community forestry:** The multi-clan scheme of managing the nursery and individual/family member-based planting of cacao and forest trees could be a potential model for implementing community forestry in Ragi and other villages within and outside Ramu. The group was organised and presumably cohesive as shown by high level of clan member participation and involvement of members of other clans. The participation of community members was voluntary and motivated by their interest to obtain cacao seedlings for their own farms. This is a manifestation that farming is an important livelihood for smallholders in the area and a potential means of promoting tree farming might therefore be to integrate trees that will complement the growth of agricultural crops. A multiple-use mixed-species plantation incorporating trees and agricultural crops might be a good approach to encourage these people to plant more trees. Strong leadership is one of the keys to promoting successful community forestry and the clan has a strong leader who was able to mobilise many members to participate in the seedling production endeavour.

**THE MARA NURSERY**

**Purpose:** The nursery at Mara was established during the previous ACIAR project and is currently managed by RAIL. When the nursery was established, seedlings were produced for distribution to members of clans within the village. The nursery continues to operate with a similar purpose but the free seedlings are now also distributed to individuals who are not members of clans within the village.

**Nursery set-up and construction:** The nursery construction was permanent and possessed the basic structures for producing high-quality seedlings (Figure 16a). It has a transplant shed using netting as a shade and fencing material. It has an appropriate germination shed. The hardening beds provided full exposure of seedlings to sunlight but beds were not elevated. Also, transplant beds and hardening beds have metal screens to space out the seedlings for ample sun exposure. The nursery has a storage shed for seeds, fertilisers and nursery instruments (Figure 16b). It was constructed near a creek for a ready supply of water to the nursery. The production capacity was quite high but the nursery was producing only a small quantity of seedlings because the seedling uptake was low.

The nursery was constructed a relatively long distance from the main road (approximately 1.5km). The nursery is accessible from an unpaved road that is difficult for motorised vehicles to pass through during the rainy season. The nursery was surrounded by stands of trees of various species that were established to become sources of germplasm.
Seedling species diversity: The nursery was mainly producing seedlings of *E. pellita* because this species had the highest local demand.

Nursery management practices: A permanent RAIL staff member managed the nursery. This person has considerable experience in nursery seedling production. Black polybags were used and the size was optimum for growing *E. pellita*. Polyethylene sheets and plastic sacks were laid on the hardening and transplant beds (Figure 17). Unlike at the RAIL nursery where seeds of *E. pellita* were sown in germination beds, germination trays were used (Figure 18), which is ideal for small-seeded trees including *E. pellita*. The appropriate sub-irrigation method for watering sown seeds of *E. pellita* in germination trays was used. Metal screen spacers were used to space out seedlings. Grading of seedlings was not carried out.
Seedling quality: The physical quality of seedlings was relatively high. There was no evidence of considerable presence of pests and diseases. The seedlings were sturdy because of appropriate sun-hardening. Although the use of polyethylene sheets on hardening and transplant beds is not ideal, seedling root penetration into the ground was not observed. This was because seedlings did not stay long in the nursery, they were taken away for planting before significant growth of roots outside of the polybag could develop.

Possible improvements: The following measures could help to improve the set-up and operation of the Mara nursery:

*Use of elevated hardening beds to prevent growth of roots outside the container.* Roots growing into the ground will produce lanky seedlings that are not water-hardened. Also, when seedlings are not planted on time, they will become overgrown and not appropriate for planting after just a short period of overstay in the nursery.

*The use of screen spacers in Figure 17 can be avoided.* Aside from incurring additional production costs, the use of metal screen spacers will actually make the arrangement of seedlings difficult. Also, seedlings will not stand upright when the size of the bag is smaller than the mesh. Leaning polybags will result in seedlings with bent stems that eventually develop into trees with poor stem form including multi-leaders. Figure 6b is a good alternative arrangement.

*Grading seedlings to avoid overtopping.* Arranging seedlings based on height will result in seedlings with almost the same height at the end of each production schedule.

*Avoid using polyethylene sheets and sacks to line the transplant and hardening beds.* The polyethylene sheets will result in localised water pools which could be favourable for the growth of pathogens. Also, collected water will provide an abundant supply of moisture and nutrients to growing seedlings, thereby preventing the necessary water and nutrient-hardening. Collected water will also promote a concentration of root growth outside of the container, which is detrimental for the survival of seedlings in the field.
To minimise the labour cost, it is possible to use the transplant beds as hardening beds. This can be achieved by gradually removing the nylon net roof as the seedlings grow. In this approach, it is important that transplant beds are elevated as they will also serve as hardening beds.

Potential for promoting community forestry: It was revealed by the nursery manager that the Mara nursery did not achieve its purpose of providing planting stock to the greater membership of clans in the village. Only a few members of the clan obtained seedlings from the nursery. Lack of information about the availability of free seedlings was identified as the main reason for more community members not accessing seedlings. Even after the completion of the previous ACIAR project and when RAIL took over the management of the nursery, seedling uptake has remained low. The location of the nursery could be a factor for the limited seedling uptake. The nursery is remote and the road is difficult to traverse during the rainy season, which is the appropriate period for tree planting. With farmers having to pay the cost of seedling transport, the location of a nursery and its accessibility are major considerations in selecting an appropriate site for a nursery.

Being less accessible, the Mara nursery might serve as a satellite set-up for the school nursery at Rais. The seedling distribution function could be transferred to Rais nursery considering that it is adjacent to the main road. The Mara nursery could potentially be used as a seed processing centre considering the presence of planted stands of forest trees that will become useful future sources of germplasm. It could also be used as a research facility to develop nursery cultural technologies that will be useful in promoting tree farming and reforestation throughout the region.

CONCLUSION

The visit to five nurseries in Ramu provided insights into seedling production systems that are potentially useful in promoting tree farming and reforestation programs in the current ACIAR research project’s focus areas and possibly other areas in PNG. Although these nurseries are located at various sites and established without direct connections in terms of their operation, they are being linked to form a network of nurseries through the ACIAR research project. With proper organisation of their operations, there is a high potential for this network of nurseries to significantly contribute to satisfying the planting stock requirements for community forestry in Ramu and adjacent areas. This ‘proper organisation’ means using the strength of one nursery to complement the weaknesses of the others. For example, the RAIL nursery may serve as a training centre to improve the skills of the managers of the other nurseries, while other nurseries will facilitate seedling distribution to tree farmers especially those who do not have access to the RAIL nursery. The nursery at Mara might be used as a research and seed centre to develop improved seedling production technologies. It can also serve as a conduit for an improved germplasm pathway by distributing seeds to other nurseries, especially those that are readily available in one nursery but wanting in others. Nursery managers in villages including Waret and Ragi may identify suitable mother trees from their community’s forests and farms, and provide seeds from these trees to the Mara and RAIL nurseries for research purposes.

It is apparent that considerable support is necessary to improve the design and management practices of the above-noted network of forest nurseries in the Ramu region of PNG. The
organisation and improvement of the current seedling production systems of the nurseries requires considerable efforts and resources. The ACIAR research project plays a crucial role in helping to realise this.