M.G. Bertomeu and **R.L. Sungkit**. International Centre for Research in Agroforestry (ICRAF), Claveria Research Site, Claveria, 9004 Misamis Oriental, The Philippines.

Propagating *Eucalyptus* Species- Recommendations for Smallholders in the Philippines

Since the recent emergence of an attractive market-driven demand for fast-growing timber trees in the Philippines, a great number of small upland farmers are moving into the production of timber trees as a major self-financed enterprise (Garrity and Mercado 1994). Smallholder strategies for the propagation and establishment of trees are diverse. Easy-to-propagate trees such as *Gmelina arborea* Roxb. and *Swietenia macrophylla* King. are being extensively planted by direct sowing or transplanting wild seedlings. Propagation of small-seeded trees, such as Eucalyptus species, require extra-care during the early stages of propagation involving the establishment of household or small-scale nurseries.

Although much information already exists on the propagation of the most commonly used fast-growing timber trees, there is lack of knowledge and proper information regarding the production of quality planting stock under the circumstances of smallholders. The case of *Eucalyptus deglupta* Blume., a species indigenous to the Philippines, sets a good example. Although highly appreciated by farmers for its fast growth, easy management (pruning) and high market value, propagation in household or small-scale nurseries has been very limited, mainly due to farmers' inability to prevent and control the occurrence of pest and diseases during early stages of propagation.

This paper was written in response to the many inquires received from Filipino farmers, extension agents and NGO workers on how to raise Eucalyptus seedlings, in particular *Eucalyptus deglupta*, with locally available and low-cost materials. Our objective was twofold: (1) to test the suitability of inexpensive local materials readily available to smallholders, and (2) to devise simple, farmer-appropriate recommendations for easy propagation of these species at minimum cost. Our starting point for investigating both objectives was the advice of the nursery caretaker at the PICOP Resources Inc. in Surigao and the experiences of our staff and farmers in household, community and researcher-managed nurseries. The procedures described are not the only possible and should be modified according to local conditions.

Materials and methods

In 1996 members of the Claveria Landcare Association (CLCA), a farmer self-help organization working on soil conservation and agroforestry, decided to establish small-group and individual nurseries to propagate *Eucalyptus deglupta* seedlings. They requested our assistance. Since at that time germplasm was not available in Claveria, seeds were procured from PICOP nursery in Surigao, Mindanao. Results were mixed but never encouraging. While some groups and individuals were able to raise few dozen seedlings, most completely failed. We visited the nurseries and interviewed farmers in order to determine the reasons behind the failure. Subsequently, we visited PICOP nursery in Surigao to learn from their experience in propagating *E. deglupta,* and then we established our own nursery to test the PICOP methods under smallholder conditions.

Our nursery was located at the Misamis Oriental State College of Agriculture and Technology (MOSCAT), Claveria, Mindanao. Elevation is 600 m; average rainfall is 2500 mm per year, well distributed during a 9-month period from May to January. Annual average temperature is 21.3 C. The soils are deep and acidic with pH ranges from 4.2 to 5.2, are low in available phosphorus, and have low cation exchange capacity (CEC) and low to moderate organic matter content (Magbanua et al. 1986).

Wooden boxes (35 x 45 x 8 cm) available at the local market were used as germination trays. The trays were filled with 1 inch of a 1:1 topsoil and river sand. Before

use, the mix was sterilized on a galvanized iron sheet over a fire for 45-60 minutes. The mix in the tray was topped with 0.5 inch of weathered rice hulls, available at local mills. The trays were watered before sowing. Seeds of five species (eight provenance) of *Eucalyptus* were sprinkled evenly over the surface of the trays using a can with punched, scattered holes to avoid sowing them too densely. Sowing rates used, indicated in Table 1, followed PICOP recommendations to produce 500 healthy seedlings per tray, from which the healthiest 200-300 will be removed and transplanted. No pre-treatment was applied to the seeds, as the seeds of most *Eucalyptus* species, except those of species from high elevations, germinate readily without preliminary treatment (Kleinig and Doran 1981). After sowing, seeds were covered with a thin layer (just thick enough to hide them from view) of fine rice hulls to keep the seed moist.

Two germination trays per provenance and four for *E. deglupta* were established. Once a day, or twice in very hot weather, the boxes were watered using a fine spray. The water was not sterilized. Trays were placed in a sheltered spot, having both overhead and lateral shade, with good ventilation and gentle light to reduce the likelihood of fungal disease. During cloudy days, more light was allowed to penetrate by removing lateral shade cloth. Two days after sowing Carbaryl 85 WP, at a rate of 4 tablespoons per 16 liters of water, was sprayed on all germination trays to control ants. Seven to 10 days after sowing, germination was widespread for all species except for *E. torrelliana* 15888, which was damaged by ants. A third germination tray of this seedlot was sown. Because seed supply was limited and weather condition unusually wet due to La Niña phenomenon, fungicide (Captan 50 WP) was applied to all trays at a rate of 3 g/liter of water 15 days after sowing as a preventive measure against damping-off. Thirty days after sowing, when the first to second pair of leaves appeared, healthy seedlings showing good growth were pricked from the trays. A complete fertilizer (14-14-14) at a rate of 2 g/tray was applied to all trays after the healthiest seedlings were removed (40 days after sowing). Ten days later (50 days after sowing) a second pricking operation was conducted using the same selection criteria, healthy seedlings having two pairs of leaves. Pricking operations, conducted only once in industrial or government nurseries, was done twice under these smallholder conditions to make efficient use of seed and other nursery resources, and to maximize seedling production. During both pricking operations, seedlings were transplanted into 3 x 5 inch polyethylene bags filled with a mix of topsoil, rice hulls and river sand at ratio of 6:3:1. The seedlings were shaded for 4-5 days after transplanting. Afterward, they grew under full sunlight. Fertilizer was applied twice to the potted seedlings, 15 days and 30 days after transplanting, at a rate of 10g/liter of water. Water was applied until the soil was saturated. Root pruning was done 3 weeks before outplanting. Seedlings were plantable 3-4 months after sowing. Table 2 provides a nursery operation schedule for *Eucalyptus* seedlings under our conditions.

Results and discussion

The evaluation of six farmers' group nurseries and individual interviews revealed that failure to raise *Eucalyptus deglupta* seedlings was mainly due to the occurrence of damping-off disease after germination or seedling mortality after transplanting. Reasons behind this are as follows:

- The use of a soil mix with high clay content and poor drainage capacity encouraged fungal diseases and caused root damage during pricking.
- Excessive sterilization of soil media killed beneficial soil organisms, which aid plants, and may also have harmed soil structure and chemistry (Doran and Gorrie undated).
- Germination trays were placed in conditions of excessive shade or poor ventilation, producing weak seedlings and encouraging fungal disease.
- Sowing was too dense (in some cases several grams per box) resulting in weak seedlings and easy spread of diseases.
- Over-watering aggravated by heavy soil media caused disease.

Based on our experience (see Table 3) it is reasonable to state that at the sowing rate indicated in Table 1, considering a 5-10% rate of post-germination mortality and discarding

of inferior seedlings, an average of 150-200 good-quality plantable seedlings per germination tray can be easily produced in smallholder conditions. Seedlings in the germination trays grow steadily without fertilizer, but if needed a complete water-soluble fertilizer can be sprayed at a rate of 2 g/box. If a foliar fertilizer is used, spray during early morning or late afternoon to avoid burning the leaves (Doran and Gorrie undated).

In this study, an insecticide and fungicide were each applied once to control ants and prevent damping-off. Our previous experience with *Eucalyptus deglupta* in similar nursery conditions showed that if cultural preventive measures are followed, the spread of pest and diseases can be greatly reduced and thus the use of chemicals avoided. Aside from being costly, repeated and widespread application of pesticides and fungicides has resulted in problems, such as increasing pest or disease resistance, toxicity to non-target organisms, environmental contamination and other unforeseen effects (ERDB 1988). In smallholder circumstances, prevention and control of pest and diseases by cultural means may be a more appropriate and feasible approach. Recommended procedures are the following:

1. Use a friable, light, free-draining locally available soil mix. Aside from rice hulls, coffee pulp is another inexpensive and locally available alternative that gave us excellent results with *E. deglupta*.
2. Long sterilization times are unnecessary and undesirable. Heating germination media over a fire for 30-60 minutes is enough to kill weed seeds and disease-causing pathogens (Agpaoa et al. 1975, Doran and Gorrie undated). ERDB (1998) even recommends a heating time of 15 minutes, or simply pouring boiling water over the soil mix.
3. Place germination trays in a sheltered but well ventilated and gently lighted spot.
4. Insect attacks (i.e., ants) can be avoided if the legs of the seed trays are set in cans of water (ATIK. 1992).
5. Sow only a small amount of seeds per tray. As a rule of thumb, between 0.25 and 1 teaspoon of seeds per tray is enough to obtain around 200-300 good-quality plantable seedlings.
6. Watering should be controlled but enough to ensure germination and growth (PCARRD and DENR 1995). Use a sprayer, and water once a day (preferably early in the morning) or twice in hot weather.
7. Diseased seedlings must be removed and burned (PCARRD and DENR 1995).
8. Prick only healthy seedlings (Quimio and Eusebio 1990).

If damping-off problems persist, spray germination trays once with an appropriate fungicide such as Benlate or Captan (Kleinig 1981, Quimio 1990).

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Table 1. *Eucalyptus* species and provenance used and sowing rate per seed tray.

Seedlot no.	*Eucalyptus* sp	Viable seeds/10g*	Sowing rate (g/tray)	Supplier
18955	pellita F. Muell	3100	1.6	CSIRO
19207	pellita F. Muell	3710	1.3	CSIRO
15937	robusta Smith	3500	1.4	CSIRO
15940	robusta Smith	5000	1	CSIRO
15265	torrelliana F. Muell	4100	1.2	CSIRO
15888	torrelliana F. Muell	2900	1.7	CSIRO
17567	urophylla S.T. Blake	3400	1.4	CSIRO
17841	urophylla S.T. Blake	5900	0.9	CSIRO
	deglupta Blume*	42000**	0.5	PICOP

*Data source: Australia Tree Seed Centre, CSIRO Forestry & Forest Products. **Data source:Hensleigh and Holaway 1988. Note that the number of seeds per 10g ranges within wide margins. Therefore, the sowing rates proposed above should be considered as a guide only.

Table 2. Nursery operation schedule, days after sowing

Activity	Germination trays	Potted seedlings	
		1st pricking	2nd pricking
Sowing	0		
Carbaryl application*	2		
Germination	7-10		
Captan application*	15		
Pricking & transplanting	30	30	
Remove shade		35	
Fertilization*	40	45-50	
Pricking & transplanting	50		50
Remove shade			55
Fertilization		60-65	65-70
Root pruning		75-80	
Fertilization			80-85
Root pruning			90-95
Outplanting		100-120	

*Only if needed.

Table 3. Number of seedlings pricked per germination box and number of plantable seedlings raised for each provenance.

Seedlot no.	*Eucalyptus* sp.	No. pricked*					No. plantable* raised
		Box 1	Box 2	Box 3	Box 4	Total	
18955	pellita	190	154			344	318
19207	pellita	220	150			370	348
15937	robusta	210	190			400	378
15940	robusta	270	130			400	379
15265	torrelliana	394	408			802	801
15888	torrelliana	19	11	104		134	131
17567	urophylla	175	225			400	396
17841	urophylla	198	92			290	270
	deglupta	300	320	60	120	800	766

*Plantable seedlings are those at least 25-30 cm tall, healthy and showing good growth rate and form.