13.3. Enrichment planting using native species (*Dipterocarpaceae*) with local farmers in rubber smallholdings in Sumatra, Indonesia

Hesti L. Tata,[1,2] Ratna Akiefnawati[2] and Meine van Noordwijk[2]

[1] Forest Research and Development Agency, Indonesia
[2] World Agroforestry Centre (ICRAF), South East Asia Regional Office, Indonesia

Indonesia has the world's third largest area of tropical forest. An estimated 50 percent of the country's total land area still has forest cover (FAO, 2005). Natural forests in the lowland of Sumatra and Borneo are dominated by *Dipterocarpaceae*, which is one of the most important families for good-quality timber. Some species provide non-timber forest products, such as dammar resin, camphor and illepe nuts. The family consists of 16 genera and is widely distributed from Africa (Congo, Côte d'Ivoire, Ghana, Guinea, Madagascar and the Seychelles), to Asia (the Andaman Islands, India, Indonesia, Malaysia, Nepal, Pakistan, Sri Lanka, Papua New Guinea and the Philippines) and South America (Colombia, Ecuador and Venezuela) (Ashton, 1982; Maury-Lechon and Curtet, 2005). In Sumatra alone, 106 species of *Dipterocarpaceae* have been recorded. Construction timbers derived from *Dipterocarpaceae* include red meranti, white meranti, yellow meranti and bangkirai (Ashton, 1982).

The nature of forest in Indonesia is rapidly changing, even if cover is being maintained. Indonesia has become the global leader in carbon-dioxide emissions from land-use change as a result of the rapid loss of forest biomass and destruction of peatlands (Archard *et al.*, 2002; de Fries *et al.*, 2002). The overall loss of forest cover in Indonesia from 2003 to 2006 was 1.2 million ha/year (MoFor, 2010). In the Bungo district of Jambi province alone, forest cover decreased by 9964 ha/year in the period of 1988–1993, but by only 1211 ha/year in the period of 2002–2005. Between 1988 and 2005, almost 40 percent of the Bungo area was converted to intensive agriculture, such as rubber and oil palm plantations. Rubber trees are planted in both monoculture and agroforestry systems. Between 1973 and 2005, the area under rubber agroforest in Bungo decreased from 15 to 11 percent, while the area under monoculture plantations increased from 3 percent to over 40 percent (Ekadinata and Vincent, 2011).

Although rubber monoculture systems using clonally propagated rubber trees can produce large amounts of latex, agroforests can provide multiple environmental services while ensuring farmer livelihoods (Tomich *et al.*, 2002; Schroth *et al.*, 2004). Rubber agroforest consists of mixtures of rubber trees with other species that regenerate naturally from seed banks or dispersal agents. Some important species, such as fruit trees, are deliberately planted (Joshi *et al.*, 2002). Rubber agroforests range in intensity from secondary forests with some rubber (e.g. 5–10 percent of tree basal area) to vegetation dominated by rubber with a complement of native forest trees. So-called "complex agroforest" systems are characterized by a substantial (but less than 50 percent) proportion of rubber trees in the total biomass and a high diversity of native forest trees and understorey plants (Gouyon, de Foresta and Levang, 1993).

To counterbalance the high rate of deforestation, the Government of Indonesia has initiated tree-planting efforts during the last three decades. Tree plantings using exotic and fast-growing species, such as brown salwood (*Acacia mangium* Willd.) and *Eucalyptus* spp., would provide resources for pulp and paper industries. Some forest rehabilitation is based on enrichment planting with native tree species, such as *Dipterocarpaceae* species (Nawir, Murniati and Rumboko, 2007). Dipterocarp seedlings tend to be shade-tolerant, so are suitable to be planted in an agroforestry system with rubber trees. Planting dipterocarp trees helps to meet the challenge posed by domestic demand for timber, despite being constrained by rules and regulations on extracting hardwood from farm-forests.

Several studies have been conducted on enrichment planting in rubber plantations with *Dipterocarpaceae* in various areas of Bungo and Tebo districts, Jambi province (Anonymous, 2004; Tata *et al.,* 2010). These have shown that dipterocarp species grow well in rubber plantings and do not suffer from mycobionts and abiotic factors such as soil and microclimate (particularly light availability).

Here we report on the early growth of meranti in rubber agroforests in three villages in Bungo district and farmers' participation in tree enrichment planting in rubber smallholdings.

Activities of enrichment planting

Study site

Bungo district is located in western Jambi Province, Sumatra, Indonesia. Bungo has the third largest area of rubber agroforest in Indonesia. The sites were selected based on degree of land intensification: (i) low intensification (with forest and complex rubber agroforests dominating the landscape) was represented by Lubuk Beringin village; (ii) intermediate intensification (with complex to simple rubber agroforests dominating) was represented by Tebing Tinggi village; and (iii) high intensification (with simple rubber agroforests, monoculture rubber and oil palm) was represented by Danau village (Therville, Feintrenie and Levang, 2011) (Figure 13.4).

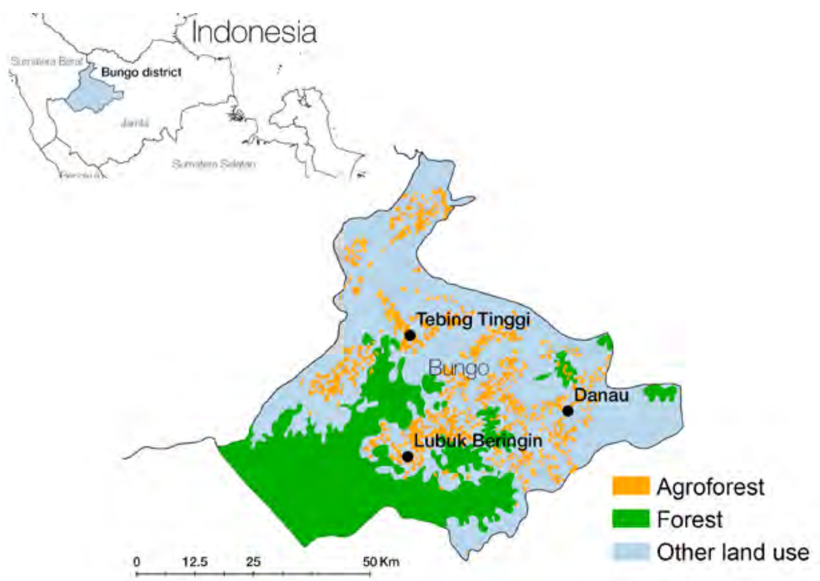
Farmer selection

One farmer was selected at each site based on willingness to collaborate. The farmers are aware that wood stocks are getting scare, owing to few remnant natural forests and lack of wood supplies from plantations to meet local demand. Staff from the World Agroforestry Centre (ICRAF) provided technical support to farmers to familiarize them with the different character and silvicultural requirements of dipterocarp species compared with rubber trees. An earlier study showed that very few rubber farmers (about 12.5 percent of respondents) had experience in planting forest-tree species (Tata and van Noordwijk, 2012). Farmers were responsible for regular seedling maintenance in the plots.

Rubber agroforest development and maintenance

Establishment of rubber agroforests begins with slashing the forest cover and burning it during the dry season. This method is relatively cheap and commonly applied by farmers in the area, in part because they believe that ash improves soil fertility (Ketterings *et al.*, 1999). The plots in the three sites were established 10–12 years ago, at a planting distance of 6 × 3 m or 6 × 5 m. Rubber trees were being tapped by the time *Shorea leprosula* seedlings were being interplanted in the rubber plots.

Figure 13.4.
Sites where dipterocarp species were planted in rubber agroforests in Bungo district, Jambi



Tree species and planting

Shorea leprosula is a native species that grows in the lowland forest of Sumatra. It is known locally as *meranti batu*. *S. leprosula* wood is sold as red meranti, and is used for light construction, furniture and moulding. The species can be grown in various soil types, from fertile to poor. It has a long life cycle; wood can be harvested 20–25 years after planting. *Shorea leprosula* grown on Ultisol soil in central Kalimantan grows by about 3.2 cm/year, and hence is classified as a fast-growing meranti (Soekotjo, 2009).

Seedlings were bought from an uncertified vendor in Sungai Duren village, Jambi. Wildings were collected from the surrounding remnant forest areas. Therefore the age and the origin of mother trees of the wildings were unknown. The seedlings were planted between rubber trees in the rubber gardens at a spacing of 10 × 7 m. The number of *S. leprosula* seedlings planted depended on the area of the rubber garden, ranging from 48 to 70 trees per plot. All farmers actively maintained the *S. leprosula* seedlings, weeding an area around them, but applied no fertilizer.

Dipterocarps form symbioses with ectomycorrhizal fungi, but meranti do not need to be inoculated with the fungi to establish in tropical forest (Lee, 2006; Tata *et al.,* 2010). This proved to be the case in this study; *S. leprosula* seedlings were not manually inoculated with ectomycorrhizal fungi but most of the roots of seedlings were naturally inoculated by unidentified ectomycorrhizal fungi.

Monitoring and experiences

Survival of* S. leprosula *in rubber plots

Survival rate of *S. leprosula* six months after planting ranged from 46.5 percent to 59.2 percent in the three plots and remained the same at 12 months after planting (Figure 13.5). Survival rate was lowest at the Tebing Tinggi site because wild pig (*Sus scrofa*) attacked both rubber trees and *S. leprosula* trees in the plots. Similar attacks on *Shorea* seedlings in other plots in Bungo and Tebo district were also reported by Tata *et al.* (2010).

Figure 13.5.
Survival rate of *S. leprosula* in three sites in Bungo District, Indonesia

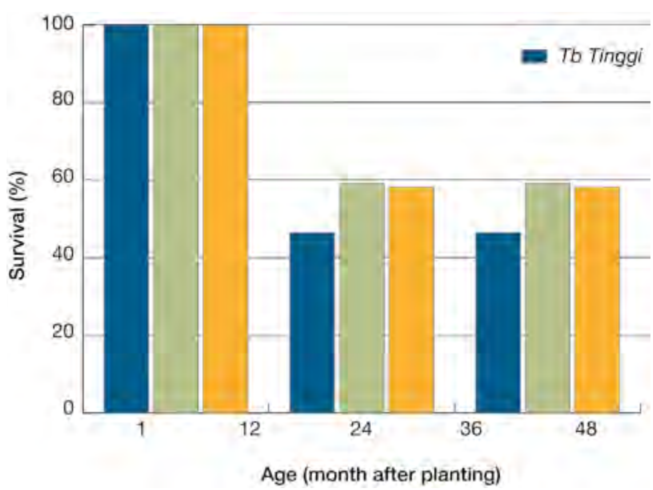
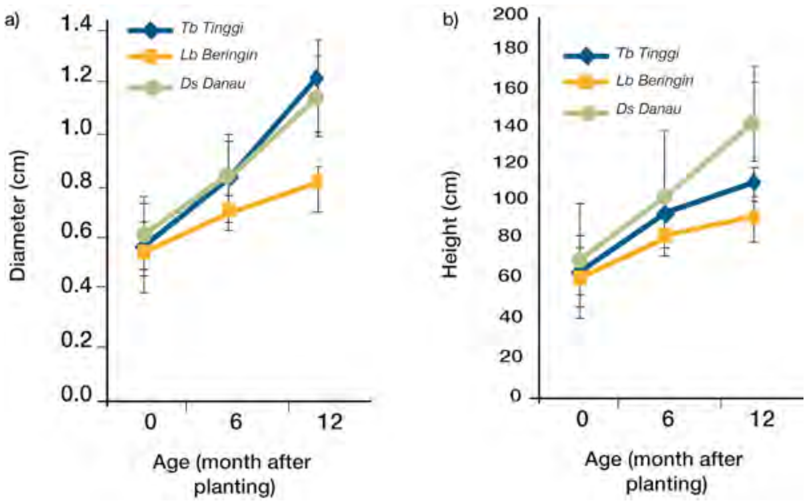


Figure 13.6.
Early growth of *S. leprosula* in three different plots in Bungo districts: Tebing Tinggi, Lubuk Beringin and Dusun Danau: (a) diameter growth, (b) height growth



Note: vertical line shows standard error.

Early growth of S. leprosula *in rubber plots*

Height growth was greatest in Dusan Danau while growth in stem diameter was greatest in Dusan Danau and Tebing Tinggi (Figure 13.6). The poor growth of *S. leprosula* in Lubuk Beringin was the result of poor maintenance, particularly lack of weeding, by the farmer at that site.

Farmer participation

Many rubber farmers are reluctant to plant forest-trees in rubber plots because they believe that rubber and timber trees compete for soil nutrients and light, which reduces production of latex. The farmers who took part in the current study were willing to do so because: (i) they received free seedlings and technical assistance, (ii) they were aware of the shortage of timber in their areas, (iii) they could use the planted trees as a means of saving and as collateral for credit, (iv) they were innovators and (v) because they received recognition from others (Tata and van Noordwijk, 2012).

The participating farmers also planted other trees, including *Litsea* sp., bitter bean (*Parkia speciosa* Hassk.) and *Archidendron jiringa* (Jack) I. C. Nielsen. *Litsea* sp., which produce light timber and usually regenerate naturally, while *P. speciosa* and *A. jiringa*, which are grown for their fruit, are usually planted but can regenerate naturally in rubber plots during the fallow period. Although *S. leprosula* is a native species and produces good timber, it is not commonly planted by the farmers in rubber plots. Farmers are mostly interested in planting exotic species, such as teak (*Tectona grandis* L.f.) and big leaf mahogany (*Swietenia macrophylla* King) because of their market value. Market access is one of the key reasons why a farmer will plant a commodity tree. Farm forests of teak, albizia *(Paraserianthes falcataria* (L.) Nielsen) and some other timber species are already well established and supported by the Government of Indonesia. In contrast, dipterocarps such as *Shorea* spp. can be harvested for sawn wood only in forest-concession areas, that is, industrial plantation forest (*hutan tanaman industri*) and community plantation forest (*hutan tanaman rakyat*), and not from farm forests (*hutan rakyat*). This restriction on harvesting, transporting and marketing timber of dipterocarps from farm forests, such as rubber agroforest, hampers forest restoration using native species.

Conclusions

Dipterocarp species native to Indonesia are recommended for use in ecosystem restoration in Sumatra. Red meranti (*S. leprosula*) grows well in the rubber agroforestry systems in Bungo district, Jambi province. However, active participation of farmers in restoration activities is essential to achieve high survival rate and performance of the planted seedlings. Changes to government regulations are required to permit harvesting, transport and marketing of red meranti from farm forests, such as rubber agroforests.

Acknowledgements

The authors acknowledge Landscape Mozaics Project funded by the Swiss Agency for Development and Cooperation (SDC). We thank two anonymous reviewers for their critical reviews of the manuscript.

References

Anonymous. 2004. Development of tropical reforestation techniques. Report of joint study. Kansai Electric Power Co., Gadjah Mada University and Kanso Technos Co. Ltd.

Archard, F., Eva, H.D., Stibig, H.J., Mayaux, P., Gallego, J., Richards, T. & Malingreau, J.P. 2002. Determination of deforestation rates of the world's humid tropical forests. *Science*, 297: 999–1002.

Ashton, P.S. 1982. Dipterocarpaceae. *In* van Steenis, C.G.G.J., ed. *Flora Malesiana*, Series 1, Vol. 9, part 2, pp. 237–552. The Hague, Martinus Nijhoff.

de Fries, R.S., Houghton, R.A., Hansen, M.C., Field, C.B., Skole, D. & Townshend, J. 2002. Carbon emissions from tropical deforestation and regrowth based on satellite observations for the 1980s and 1990s. *P. Natl Acad. Sci. USA*, 99: 14256–14261.

Ekadinata, A. & Vincent, G. 2011. Rubber agroforests in a changing landscape: analysis of land use/over trajectories in Bungo District, Indonesia. *Forest, Trees and Livelihoods*, 20: 3–14.

FAO (Food and Agriculture Organization of the United Nations). 2005. *State of the world's forests 2005*. Rome.

Gouyon, A., de Foresta, H. & Levang, P. 1993. Does "jungle rubber" deserve its name? An analysis of rubber agroforestry system in Southeast Asia. *Agroforest. Syst.*, 22: 181–206.

Joshi, L., Wibawa, G., Vincent, G., Boutin, D., Akiefnawati, R., Manurung, G., van Noordwijk, M. & Williams, S. 2002. Jungle rubber: a traditional agroforestry system under pressure. Bogor, Indonesia, International Centre for Research in Agroforestry, Southeast Asia Regional Office.

Ketterings, Q.M., Wibowo, T., van Noordwijk, M. & Penot, E. 1999. Farmer's perspectives on slash-and-burn as a land clearing method for small-scale rubber producer in Sepunggur, Jambi Province, Sumatra, Indonesia. *Forest Ecol. Manag.*, 120: 158–169.

Lee, S.S. 2006. Mycorrhizal research in Malaysian plantation. *In* K. Suzuki, K. Ishii, S. Sakurai & S. Sasaki, eds. *Plantation technology in tropical forest science*, pp. 157–166. Tokyo, Springer.

Maury-Lechon, G. & Curtet, L. 1995. Biogeography and evolutionary systematics of Dipterocarpaceae. *In* S. Appanah & J.M. Turnbull, eds. *A review of dipterocarps: taxonomy, ecology and silviculture*, pp. 6–44. Bogor, Indonesia, Center for International Forestery Research.

MoFor (Ministry of Forestry). 2010. *Statistics of forestry 2010*. Jakarta, Ministry of Forestry of Indonesia.

Nawir, A.A., Murniati & Rumboko, L. 2007. *Forest rehabilitation in Indonesia: where to after more than three decades?* Bogor, Indonesia, Center for International Forestry Research.

Soekotjo. 2009. *Teknik silvikultur intensif*. Yogyakarta, Indonesia, Gadjah Mada University Press.

Schroth, G., da Fonseca, G.A.B., Harvey, C.A., Gascon, C., Vasconcelos, H.L. & Izac, A.M.N. 2004. *Agroforestry and biodiversity conservation in tropical landscapes*. Washington, DC, Island Press.

Tata, H.L. & van Noordwijk, M. 2012. Farmers participation on dipterocarp trees planting in smallholder rubber plantation. *In* E.B. Hardiyanto, M. Osaki & S. Solberg, eds. *Proceeding of International Conference on New Perspectives of Tropical Forest Rehabilitation for Better Forest Functions and Management*, pp. 38–41. Yogyakarta, Indonesia, Gadjah Mada University.

Tata, H.L., van Noordwijk, M., Summerbell, R. & Werger, M.J.A. 2010. Limited response to nursery-stage mycorrhiza inoculation of *Shorea* seedlings planted in rubber agroforest in Jambi, Indonesia. *New Forest.*, 39: 51–74.

Therville, C., Feintrenie, L. & Levang, P. 2011. Farmers' perspectives about agroforests conversion to plantations in Sumatra. Lessons learnt from Bungo district (Jambi, Indonesia). *Forests, Trees and Livelihoods*, 20: 15–33.

Tomich, T.P., de Foresta, H., Dennis, R., Ketterings, Q.M., Murdiyarso, D., Palm, C.A., Stolle, F., Suyanto, S. & van Noordwijk, M. 2002. Carbon offsets for conservation and development in Indonesia? *Am. J. Alternative Agr.*, 17: 125–137.