Potential Forest Plantation Species: *Leucaena Leucocephala*

Wan Mohd Nazri Wan Abd Rahman
Jamaludin Kasim
Mohd Saiful Akbar Mohd Sahal
Fairuz Khalid

ABSTRACT

Fast growing and high yielding tree plantations are becoming an important source of wood in tropical countries. The future supply of wood will be met from these planted forests as opposed to managed natural forests. In Malaysia, Leucaena leucocephala is widely regarded as a shade tree because of its fast growth (lead tree) compared to other commercial tropical trees. The Malaysian Agricultural Research Development Institute (MARDI) has used this species for shade and wind protection for a variety of crops, especially during early growth and for animals feed. The objectives of the paper were to compare the stem yield of leucaena leucocephala with rubber wood and acacia mangium. This study revealed that stem yield of leucaena leucocephala ranged from 30.83 to 134.23 tons ha^{-1} for the tree age of 3 years-old to 16 years-old. Based on data comparison with Acacia and rubber wood, leucaena leucocephala was found to be a suitable alternative for forest plantation species with a better stem yield recovery.

Keywords: *forest plantation, yield, Acacia, rubber wood*

Introduction

Forest resources, particularly in the developing countries, have shrunk at an alarming rate during the last decade. Among the causes of deforestation is the need for more agriculture land and demand for timber from the growing population. This does not offer bright prospects for the future of forest cover. Therefore, the introduction of multipurpose trees is to cater to both the basic needs of people as well as environmental benefits. In fact, it may be looked upon as the only alternative to safeguard the ecological balance in many parts of the world (Carlowitz, 1984). On the other hand, the use of fast-growing species for wood industry could have a great advantage as they provide remediation for the environmental problems associated with the industrial use of wood species. Moreover, the use of fast-growing species for wood industry may offer some advantages in terms of the shorter time required to activate production in comparison with natural forest plants (Oggiano et al., 199. In this way, short rotation coppice is based on the harvest of fast-growing species every few years and their fast resprouting from stump after harvest (Kauter et al., 200.

The trends of industrial round wood consumption significantly show that the future supply of wood would be met from planted trees as opposed to managed natural forest and this trend towards increasing reliance on planted forests for wood production will continue (Apsey & Reed, 1996; Kanowski, 1997; Pandey & Ball, 1998). This trend is seen to follow the pattern in farming and food production, of domestication and development of ever more intensive systems, especially in the past 30 years (Evans, 1999). In the future, the manufacture of wood composites will increase even more because it is expected that the forest resources will provide fewer larger trees (Maloney, 1996).

Wood composites in Malaysia are developed from the materials that are direct result of declining availability of large diameter logs and tend to use material such as rubber wood, which is a by-product of rubber plantation. The currently raw material usage of rubber wood and other tropical timbers (wastage / off cuts) will not be able to support the highly demand by industries and will lead to bleak and a pressure for the industry players in finding the alternatives. Diminishing of raw materials in Malaysia for wood based panel (WBP) industries for Particleboard and MDF is one of the major threats for industries to sustain growth and competitive. Currently, wood based panel (WBP) industries are generating the income of RM 20 billion/year for the country. The industries had been through difficulties on maintaining the raw material supply. Therefore, the fast growing species needs to be introduced in order to sustain the demand from the wood industry sector in Malaysia.

Rubber Plantation

Rubber wood plantations were introduced in Malaysia during the 20th century (1925) by the British to extract latex for industrial/consumer rubber (Lim, 2000). In 1997, about 1.6 million ha of rubber wood plantations existed in the country (Norini et al., 2000). After the economic life span for latex production efficiency begins to decrease in the rubber wood trees (25-30 years), the trees are felled (historically, were burned) and the plantation is replanted (Hong and Sim, 1994). In recent years, it was discovered that the rubber wood tree stems could be salvaged for lumber suitable for furniture and other products, if proper harvesting, immediate drying and other processing steps were taken. Malaysia has made tremendous progress in utilizing rubber wood since its potential was realised and tapped in the late 70's. It has successfully substituted forest timbers in a number of uses due to extensive promotion, research and development activities. In mid 1980s, rubber wood was one of the most popular timbers for making furniture and other wood-based products and was an important resource for the Malaysian timber industry (Rajan, 2000).

The rubberwood supply to sustain the booming industry is now declining seriously. The scenario may become worse as many rubber plantation areas are turning into other crops such as oil palm (Mohd Nor et al., 2000). Norini et al. (2000) reported that at the early stage of using rubber wood as raw material, entrepreneurs are operating in what may be considered as a perfectly competitive market; the excess profits enjoyed by a few producers at the beginning encouraged other potential produces to jump in. This is when new types of wood industries entered the scene, such as MDF, particleboard, and newly developed products such as OSB. As a result of these new entries, the excess profits slowly disappeared and the supply of rubber wood is expected to be unable to meet the demand of these newcomers which used large volume of raw material. Many manufacturers have expressed concern over the decreasing area under rubber cultivation. From an estimated 1.8 million hectares of rubber plantation land in 1980's, the area under rubber cultivation has gradually reduced to 1.15 million hectares in 1998 for Peninsular Malaysia. This follows the government's policy of reducing the replanting grant. The assurance of quick and better returns and relatively lower labour input for oil palm cultivation have also contributed to small holders gradually replacing rubber with oil palm (Rajan, 2000). According to MTIB (2006), the total area of rubber plantation in Peninsular Malaysia for the year 2005 is 958,000 hectares, a decrease of 3.8% compared to 995,000 hectares in 2004.

Acacia mangium

Acacia mangium is one of the major fast growing species used in plantation forestry programmes throughout Asia and the Pacific. Due to its rapid growth and tolerance of very poor soils, *A. mangium* is playing an increasingly important role in efforts to sustain commercial supply of tree products while reducing pressure on natural forest ecosystems. In Malaysia, the Forestry Department of Peninsular Malaysia and private forest plantation companies consider *A. mangium* as a useful early pioneer species on open and degraded areas where most other plants or trees are unable to grow. *A. mangium* is able to regenerate marginal and degraded areas, thereby, improving the site for subsequent colonisation by other plant and animal species. Furthermore, *A. mangium* plantations have been located in natural forests in Malaysia, yet, there have been no incidences where the species has been found to invade undisturbed sites. In Sabah, *A. mangium* represents one of the most important species planted on the clear-felled areas (Nykvist et al., 1996). *A. mangium* belongs to diffuse porous species with a medium-quality wood of light density. A standing average tree diameter can reach more than 20 cm and a height of 25 m in less than 10 years (Peh & Khoo, 1984).

There have been some concerns about the weedy nature of *A. mangium* and its potential to become an invasive species. Its ability to rapidly colonise roadsides, abandoned, degraded or open areas and marginal lands is well known, and like its close relative *A. auriculiformis*, *A. mangium* is now a common feature of the landscape in Malaysia and many other Southeast Asian countries. As a result, some sources have described *A. mangium* as an alien weed and invasive species, believing that it will diminish the rejuvenation potential of the original biota and invade highland secondary forests and rain forests (Certified Source Timber Programme, 2004).

A. mangium appeared as the most promising species partly because of its superior growth, wide site suitability, multiple uses and lack of serious pest problems. Fast growing characteristic of *A. mangium* had made it easy to plant in large areas as planting material and was not difficult to obtain. *A. mangium*, planted on a 15-year rotation for production of general-utility timber, came to constitute the largest area of forest plantations in the country. While these *A. mangium* plantations are young, there are no detectable disease problems. However, as the plantations grow, they turn out to be prone to a number of diseases. The most publicised of these is heart rot. Other diseases such as root rot and phyllode rust have turned out to be far more threatening. Partly as a result of the heart rot problem, *A. mangium* is no longer a popular forest plantation species in Peninsular Malaysia, although it is still planted for pulp and paper production in the eastern Malaysian states of Sabah and Sarawak (Lee, 2004).

Leucaena leucocephala

Leucaena is a fast-growing species from leguminous shrub. *Leucaena* is widely used as livestock forage, fuel wood, reforestation material, and green manure consumption. Its uses have also been expanded to gum production, furniture and construction timber, pole wood, pulpwood, shade and support plants in agroforestry systems. In Southeast Asia, large growing trees are used to shade coffee and cocoa plantations (NAS, 1979; Brewbaker, 1987; Diaz et al., 2007).

In Malaysia, it is locally known as "petai belalang". Petai belalang (*L. leucocephala*) is one of the fast growing tropical species which has the potential to be developed as a raw material. *L. leucocephala* is widely used as a shade tree because of its fast growth (lead tree) compared to other commercial tropical trees. The Malaysian Agricultural Research Development Institute (MARDI) has used this multipurpose tree for shade and wind protection in a variety of crops, especially during early growth and food for some animals. At present, the trees are normally felled and burnt or left to decay when the plantation crops gain their maturity to survive (Aminah, 2006).

The relation between wood quality and growth rate is always a central focus to combine high wood qualities with fast growth. The wood qualities of *Leucaena* are not negatively correlated with yield, and there is opportunity to combine high yield with good qualities (Pottinger et al., 1999). Stewart et al. (1991) reported that *Leucaena* also produces high wood biomass with high wood density. Hughes (1998) concluded that it is possible for *Leucaena* species to have both high wood yields and high wood densities. Tewari et al. (2004) reported that *Leucaena* maintained progressive increase in biomass production by better regeneration and survival of sprouts. The survival of coppiced stumps after second and third harvest ranges between 90.8% and 98.9%, and does not vary significantly with the season of harvest. Brewbaker (1987) reported that *Leucaena* grows remarkably fast reaching up to 3-4 meters per year.

L. leucocephala has been the focus of a great deal of research in the past few decades (National Research Council, 1977; International Development Research Centre, IDRC, 1983). This species is native to Central America and it has been planted in many tropical countries, including south-east Asia (Tewari et al., 2004), Africa (Okigbo, 1984) and South America (Dobereiner, 1984), as a shade tree for commercial crops, alley cropping or agroforestry for wood production.

The survival and regeneration of *L. leucocephala* are excellent and the shoots emerging from coppiced stumps show progressive increase in their average height and diameter (Misra et al., 1995). According to Tewari et al. (2004) *L. leucocephala* shows excellent survival of stumps (>96%) up to 36 months of age in the original stand. The yield per stump shows continuous increase with increase in age of harvesting from 10 to 36 months. The results of the study indicate that growth and biomass production of *L. leucocephala* is significantly influenced by the age of harvesting.

Comparisons of Yield

Table 1 shows the stem yield of the plantation species according to age and tree density. *Luecaena* trees planted with a density of 1111 per hectare show increasing tree stem yield with increasing age. 16- year-old trees have the highest stem yield (134.23 tons/ha) while 3-year-old have the lowest stem yield (30.83 tons/ha). Yield of 16-year-old trees shows a 335% higher yield, while 8-year-old trees shows a 291% better yield than 3-year-old plantation. Therefore, eight year old plantation have better tonnage yield in terms of productivity. In contrast, rubber wood plantations only yield about 87 tons/ha after 25-30 years. *A. mangium* with approximately 7 years old plantation had a yield of about 97 tons/ha.

Table 2 shows the production and consumption of rubber wood logs from 2001 to 2005. Norini et al. (1990) and Ismariah & Norini (1994), projected that consumption of rubber wood would exceed production from 2001 to 2015. If the total operating capacities of demand of all industries processing rubber wood remained at almost 1.6 million m^3 per year, the deficit situation ranges from 820,000 m^3 to 945,000 m^3.

Table 1. Stem yield according to species, age and tree density

Species/Age (yr)	Density (no. of tree/ha)	Stem (tons/ha)	References
L. leucocephala (3)	1111	30.83	W.M.Nazri et. al (2009)
5	1111	75.51	W.M.Nazri et. al (2009)
8	1111	120.82	W.M.Nazri et. al (2009)
16	1111	134.23	W.M.Nazri et. al (2009)
Acacia (3.5)	1089	54.40	Lim & Mohd. Basri Hamzah (1985)
4	2500	48.00	Yantasath (1992)
6.8	730	97.40	Halenda (1989)
Rubberwood (25-30)	240	87.00	Indufor (1993)

Table 2: Production and consumption of rubber wood logs (2001-2005)

Year	Production (m^3)	Consumption (m^3)	Balance (m^3)
2001	682,584	1,1591,000	-908,416
2002	732,069	1,1591,000	-867,931
2003	771,855	1,1591,000	-819,145
2004	645,984	1,1591,000	-945,016
2005	784,782	1,1591,000	-842,218

Source: Norini et al. (2000)

It is clear that the wood processing industries are having difficulty obtaining rubber wood logs. The seriousness of the supply situation can be improved by encouraging more involvement from the private sector in forest plantations. Nonetheless, before they can buy the idea, new incentives such as lower interest rates for loans, subsidization of log prices, introducing alternative species to rubber wood and other incentives need to be implemented. Such incentives will make forest plantation project more attractive and, most importantly, able to sustain the supply of raw materials to the industries (Norini et al., 2000).

Conclusion

Rubber wood plantations with dwindling rubber prices have paved the way for oil palm plantations creating a huge shortage in supply of rubber wood logs to the wood industry. Acacia mangium showed promising growth but is plagued with heart rot diseases giving to low quality logs not meant for the wood industry. *Leuceana*, on the other hand, shows tremendous potential as future plantation species with high yield and fast growth.

References

Aminah, A. (2006). Personal Communication with Research Officer, Malaysian Agricultural Research Development Institute (MARDI).

Apsey, T. M., & Reed, F. L. C. (1996). World Timber Resources Outlook: Current Perceptions with Implications for Policy and Practice. *Commonwealth Forestry Review*, 75, 155-159.

Brewbaker, J. L. (1987). *Species in the genus Leucaena*. (Leucaena Research Report 7(2), pp.7-20). Hawaii.

Carlowitz, P. G. von. (1984). *Multipurpose Trees and Shrubs; Opportunities and Limitations*. (ICRAF pp.45). Nairobi, Kenya.

Certified Source Timber Programme. (2004). *Promoting plantation grown timber*. Retrieved February 12, 2008, from www.certifiedsourcetimber.co.uk/examples.ht.

Diaz, M. J., Garcia, M. M., Tapias, R., Fernandez, M., & Lopez, F. (2007). Variations in Fiber Length and Some Pulp Chemical Properties of *Leucaena* Varieties. *Industrial Crops and Products*, 26 (), 142-150.

Dobereiner, J. (1984). Nodulation and nitrogen fixation in legume trees. *Pesq. Agropec. Bras.*, 19, 83-90.

Evans, J. (1999). *Sustainable of Forest Plantations. The Evidence: A Review Evidence Concerning the Narrow-Sense Sustainable of Planted Forests*. Department for International Development (pp.64). London, United Kingdom.

Hong, L. T., & Sim, H. C. (1994). Rubberwood - Processing and Utilization. Malayan Forest Records No. 39, (pp.249). Forest Research Institute Malaysia.

Hoover, W., Michael, L., O. Hunt, R, Lattanzi, C., Bateman, J. H., & Youngquist, J. A. (1992). Modeling Mechanical Properties of Single-Layer, Aligned, Mixed-Hardwood Strand Panels. *Forest Products Journal*, 42(5), 12-18.

Hughes, C. E. (1998). *Leucaena: A Genetic Resource Handbook*. Tropical Forestry Papers 37, (pp.274). Oxford Forestry Institute. UK: University of Oxford Press.

Kanowski, I. G. (1997). Afforestation and Plantations Forestry: Plantation Forestry in the 21^{st}. Century, in Proceeding of the XI World Forestry Congress Vol. 3 (pp.23-34)., *Food and Agriculture Organization* (FAO). Antalya.

Kauter, D., Lewandowski, I., & Claupeina, W. (200). Quantity and quality of harvestable biomass from Populus short rotation coppice for solid fuel usea review of the physiological basis and management influences. *Biomass Bioenergy*, 24 (6), 411-427.

Lim, D. S. (2000). Rubberwood: Malaysian Takes Steps to Ensure its Sustainability. *Malaysian Timber*, 6(3), 4-5.

Misra, P. N., Tewari, S. K., Singh, D., & Katiyar, R. S. (1995). Effect of coppicing height on the regeneration and productivity of certain firewood shrubs in alkaline soils of north Indian plains. *Biomass and Bioenergy*, 9, 459-63.

Mohd Nor, M. Y, Ab. Rasip, A. G., Ahmad Shakri, M. S, & Mohd Zaki, A. (2000). Availability and Utilisation of Plantation Species. Proceeding of the National Seminar on Alternatives to Rubberwood. 26 Sept. 2000.*Conference on Forestry and Forest Products Research (CFFPR) 2000,* (pp.41-54) Kuala Lumpur.

MTIB. (2006). Supply and demand of rubberwood in Peninsular Malaysia. Retrieved November 20, 2006, from http://www.mtib.gov.my/rubberwood.ph

NAS (National Academy of Sciences). (1979). *Tropical legumes: resource for the future*. Board on Science and Technology. (pp.67).Washington, D.C.: National Academy Press.

Nykvist, N., Liang, S. B., & Malmer, A. (1996). Effects of tractor logging and burning on biomass production and nutrient accumulation in Acacia mangium plantations in Sabah, Malaysia. *Journal of Tropical Forest Science*, 9 (2), 161-183.

Oggiano, Angelini, L. G., & Cappelletto, P. (1997). Pulping and paper properties of some fibre crops. *Ind. Crops Prod.*, 7 (1), 59-67.

Okigbo, B. N. (1984). Nitrogen-fixing trees in Africa: priorities and research agenda in multiuse exploitation of plant resources. *Pesq. Agropec. Bras.*, 19, 325-30.

Pandey, D., Ball, J. (1998). The role of industrial plantations in future global fibre supplies. *Unasylva*, 193, 37-43.

Peh, T. B., & Khoo, K. C. 1984. Timber properties of *Acacia mangium, Gmelina arborea, Paraserianthes falcataria* and their utilization aspects. *Malaysian Forester*, 47, 285-303.

Pottinger, A. J, Gourlay, I. D., Gabunada, F. G., Mullen, B. F., & Ponce, E. G. (1999). *Wood density and yield in the genus of the Leucaena.* Proceeding of the international meeting of the *Leucaena* International Research. (pp.96-102). ACIAR Proc.

Stewart, J. L., Dunsdon, A. J., & Hughes, C. E. (1991). *Early results from a Leucaena species/ provenance trial in Honduras*. (Leucaena Research Reports 12, pp. 101-104). Hawaii.

Tewari, S. K., Katiyar, R. S., Ram B., Misra, P. N. (2004). Effect of age and season of harvesting on the growth, coppicing characteristics and biomass productivity of *Leucaena leucocephala* and *Vitex negundo* .*Biomass and Bioenergy*, 26, 229-234.

WAN MOHD NAZRI WAN ABD RAHMAN, JAMALUDIN KASIM., MOHD SAIFUL AKBAR MOHD SAHAL & FAIRUZ KHALID, Faculty of Applied Sciences, UiTM Pahang. wmdnazri@pahang.uitm.edu.my, djamal@pahang.uitm.edu.my, msaifulakbar@pahang.uitm.edu.my, fairuzdk@pahang.uitm.edu.my.