Potentiality of *Melaleuca cajuputi* Powell Cultivation to Develop for Economic Plantation Purpose

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Abstract

Melaleuca cajuputi Powell, a tree species within the family "Myrtaceae", is an important economic tree in southern Thailand. It is a multipurpose tree that every part is usable and the local people have been recognized its usefulness for a long time. Stems of *M. cajuputi* are used for structural post, fuel wood, charcoal production, fence, platform, fishing rod, agricultural pole and stake etc. Wood is used for construction and bark is for siding, roofing, boat-sealing material and dying etc. Leaves are used as medicinal purposes and sources of cajuputi oil, which is an essential ingredient in the production of balm, shampoo and insect repellant lotion. In addition, young shoot of *M. cajuputi* is edible and an edible mushroom called "Samet" can be harvested from the *M. cajuputi*'s forest. *M. cajuputi* is able to grow in a wide rang of environment disadvantages including high acid soil, saline soil, arid soil and water-locked soil. The species is, therefore, grows very well, with high growth and yield, in the peat swamp areas where most of the agricultural crops and forest trees cannot grow successfully. Recently, it has been recorded that the disturbed peat swamp areas in Thailand covered more than 48,000 hectare. Those disturbed areas have been very difficult to rehabilitate. With its usefulness and its adaptable growing ability in the disadvantageous areas, *M. cajuputi* is considered to be one of the potential trees species for development of the economic plantations in the peat swamp areas.

Keywords: Melaleuca, Tea tree, Cajuputi tree, Peat swamp Forest, Samed

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Introduction

Melaleuca cajuputi Powell, known in Thailand simply as "*White Samet*" (picture B) is a large perennial tree of the Myrtaceae family which can reach heights of up to 40 meters with mature trees having trunks up to 1.2m in diameter. There are about 250 members of the Melaleuca family (Brophy and Doran, 1996), 220 of which can be found in Australian and Tasmania (Southwell and Lowe, 1999). However within Thailand there is only one genus which has the scientific name *Melaleuca cajuputi* Powell (Plengklai, Niyomdham and Ueachirakan,1991, ; Oyen and Dung, 1999. ; Blake, 1968; Elliot and Jones, 1993; Craven and Barlow, 1999; Southwell and Lowe, 1999). *M. cajuputi* has three 3 subspecies: subsp. *cumingiana (Turcz.) Barlow*, subsp. *platyphylla Barlow* and supsp. *Cajuputi*, although in Thailand, only one of these - *cumingiana (Turcz.) Barlow* - is found, reflecting similar conditions to neighboring Burma, Vietnam and Malaysia (Craven and Barlow, 1999; Oyen and Dung 1999 ; Southwell and Lowe, 1999). Within Thailand, *M. cajuputi* is known by different terms depending on the region

and dialect. For example, while in the central region including Bangkok it would be known as "Samet" while in the southern region, where it is most commonly found, it is referred to simply as "met". Similarly, across the Southeast Asian region its name differs, ranging for "gelam" in Peninsular Malaysia and "kayu putih" in other parts of Malaysia and Indonesia. Similarly, the common English name differs from place to place and while often known as the "swamp tea-tree" it is also referred to as the "paperback tea-tree" and the "cajeput" tree. Formerly known as *Melaleuca leucadendron (L.), M. cajuputi Powell* is in the Myrtaceae family of which there are approximately 100 families and 3,000 species to be found on the global scale (Phil, 1978). In Thailand only 14 families and 112 species are to be found, including *Eugenia*, *Baeckea*, *Decaspermum*, *Rhodomyrtus*, *Melaleuca* and *Eucalyptus* which are fast growing and suitable under many of the local conditions to be found in Thailand.

M. cajuputi is found in many areas of the south and east of Thailand and is characteristic of specific soil and topographic conditions. In particular, it is particularly familiar and well known by people of those provinces in which peat swamps are common, notably Narathiwat, Phattalung and Nakhon Sri Thammarat (Nuyim, 1998). Under trial conditions, *M. cajuputi* has been shown to grow fast in comparison to other species and has potential for use by local people to grow where there is space made by otherwise hostile soil conditions to form forest plantations, as has been illustrated by examples of plantations in Thailand's Nakhon Si Thammarat Province. Therefore it is considered to be a species suitable for support and encouragement by the government both for its potential as a natural pioneer species and for its commercial application in plantations.

Distribution and Optimum sites for Plantation

Melaleuca species are tolerant and grow well under a range of environmental conditions including those usually associated with unfavorable to growth including acidic soil, saline soil, flooded soil and even dry lands (Sasaki, *et al*., 1995). While it is tolerant to and can exist next to brackish and saline water (Oyen and Dung 1999) it thrives best in peat lands, waterlogged lowlands and other flooded areas, particularly surrounding swamps. While drier conditions are not a barrier to growth, plants tend to evolve stunted and adopt curved structures.

In Thailand *M. cajuputi* can be found spreading throughout many areas of the south and in southern areas of eastern and western Thailand. In degraded peat swamps, *M. cajuputi* grows and spreads rapidly owing to its tolerance to waterlogged and acidic conditions. Its speed of growth of causes it to become established as pure forest communities (Picture A), giving little opportunity to other species (Tange, et al., 1998), although on the peripheries of such areas, where permanent inundation with water uncommon and conditions are drier, it will grow alongside other species. *M. cajuputi* is able to adapt itself to unfavorable local conditions better than other species, in particular in places where flooding is deep, where *M. cajuputi* will become established more readily than in shallow flooded areas.

Sometimes, such secondary peat swamp forest is known as *M. cajuputi* forest, although since *M. cajuputi* was never been found in original primary peat swamp forests, it is clearly secondary forest occurring after degradation of the primary growth.

From the surveys conducted by Jirasak and his group in 1999, it was reported that of Thailand's 55,523 hectares of *M. cajuputi*, some 54,951 hectares were to be found in Thailand's southern region: 21,992 ha in Narathiwat province, 18,946 ha in Nakhon Si Thammarat province, 3,285 ha in Chumphon province, 1,541 ha in Surat-Thani province, 4,828 ha in Songkhla Province 1,204 ha in Pattani Province, 2,767 ha in Phattalung Province, 189 ha in Yala Province, and 572 ha in Thailand's eastern region.

M. cajuputi forest which replaces such primary forest is quick to establish itself and dominates growth, not allowing other species to become established, including other local and native species, which makes the land incapable of restoring itself to its natural conditions (Plengklai, Niyomdham and Ueachirakan,1991). For this reason, it is not recommended to grow *M. cajuputi* in areas of peat swamp intended for restoration by natural peat swamp forest species, but rather to limit its use for economic forest plantations and community forests (Nuyim, 1995).

In the event of forest fires, *M. cajuputi* is a species with high resistance to effects of flames and high temperatures, particularly the large and mature trees. In cases where forest fires are not strong, the fibrous bark provides heat insulation and plants can survive. However should forest fires become ground fires as can happen in peat land ecosystems, the tree's root system will be burnt and the plant will die.

In other countries, wide spreads of *M. cajuputi* species have been observed, in particular in countries of Southeast Asia and Oceania, including Australia, Burma, Malaysia, Vietnam, New Guinea and on the islands of Borneo and Timor, while it can also be found in India and China (Blake, 1968).

Although often associated with tropical waterlogged lowlands and peat swamps *M. cajuputi* stands have been found at altitudes in excess of 400 m above sea level. It has been observed that while uncommon to certain geographic conditions, such is the natural tolerance of the species that once transferred; *M. cajuputi* often has a good chance of survival under unfamiliar conditions.

Utilization of M. cajuputi

M. cajuputi in Thailand and beyond has a wide range of uses and values for the people that live in and around *M. cajuputi* forests:

Timber

Utilization of *M. cajuputi* timber is of many uses to local people in the communities surrounding *M. cajuputi* forests. In particular, use of timber as fuel wood, and is particularly suitable for and produces high quality charcoal.

Although relatively soft, *M. cajuputi* timber is adapted to anaerobic conditions and resistant more resistant to water damage than other woods. As a result it is also utilized in many forms of construction. On the small scale it is used widely for construction of fences and boundary markers to demarcate land tenure, while it is also use in construction of houses, particularly as supporting columns or piles and for floorboards and frames.

Smaller stems of *M. cajuputi* are also used for a wide range of purposes including for fishing rods, fish trap stakes and supports and stakes for agricultural purposes (Somchai, et al, 1999).

Bark

Since past times, people living around *M. cajuputi* forests have used bark for a range of purposes requiring the durable, waterproof and insulative properties which provide the *M. cajuputi* forest with its resistance against forest fire. Along with a range of uses in, the ability to peel and roll *M. cajuputi* bark into sheets has led it to be used as a roofing material and a sealant material in boat construction. In addition to bark's roll in construction, it is also used in seed propagation, fabrication of water and heat resistant nets for dying materials, and other heat resistant materials. Its softness also sees it used as stuffing material for mattresses and pillows.

In additions to its direct use, the bark is also used as an indicator in order to calculate the age of the trees with layers of bark accumulating with the years of the tree's age

Leaves

M. cajuputi's leaves provide some of the most valuable uses of the species, particularly with respect to its herbal medicinal properties. In Thailand, local people living around *M. cajuputi* forests correct and boll the plant's leaves and drink them as a herbal "tea" in order to relieve pain and treat a number of ailments including asthma, intestinal parasites, viruses and other health problems.

On a wider scale, and throughout other countries, *M. cajuputi* leaves are processed in order to produce cajeput oil - a non-toxic essential oil used as an ingredient in a range of personal hygiene products including shampoo, perfume and skin balm. Cajeput oil is further used in herbal medicinal products to relieve symptoms of coughs, colds, as a laxative and general muscle relaxant and sedative (Oyen and Dung 1999). Beyond this, has been shown that cajeput oil is a strong disinfectant against bacteria (รุ่งระวี , 2544) and can be used as a mosquito and termite deterrent (Kim,et al, 2001). Cajuput oil that is made from *M. cajuputi* is better quality and reaches a higher price, than that extracted from eucalyptus leaves. Studies conducted in Vietnam have shown that a hectare of *M. cajuputi* forest is capable of producing 400 – 600 kg of cajeput oil (Thinh, 1997) while *M. cajuputi* from central Indonesian plantations have production of just 60-65 kg of cajuput oil per hectare. While a fresh leaf yield of 1.2 tones comprises just 0.4-1.2% of cajuput oil (Oyen and Dung 1999) this is sufficient if compared to the cost of maintaining the land and this utilization of *M. cajuputi* in Indonesia is considered a successful example of industrial agronomy (Brophy and Doran, 1996).

Currently, the majority of exported cajeput oil originates from Vietnam and Indonesia and to a lesser extent, Malaysia and utilizes on the subspecies *Melaleuca cajuputi subsp. Cajuputi.* In comparison leaves from the subspecies *M. cajuputi subsp. Cumingiana* (Turcz.) Barlow, which is to be found across Thailand, have lower cineol content (Tassanee. et al1992; Suwanna, 1994), although constituents and amounts of oils found within leaves are highly variable dependant on the local conditions, environment, geography and type of plant ((Kim,et al, 2001 ; Oyen and Dung 1999).

In terms of its indirect use, *M. cajuputi* forest is a natural location for propagating the tasty and valuable local mushrooms known in Thailand as "hed samet", which reach a high market value. *M. cajuputi* is also useful for providing shelter for a number of reasons, including protection of ornamental plant species from direct tropical sunlight, providing soil conservation to protect the soil surface from erosion from rain forces, protecting local communities from forces of strong monsoon winds. Shading wetland

Leperonia articulata grasses from direct sun makes provides longer better quality grass, ultimately giving better quality tatami mats.

M. cajuputi wetland ecosystems also have their own specific high ecological value. While providing habitat to bees and provision of honey to local people, *M. cajuputi* forests, such as that found at Thailand's Thale Noi Noh-hunting Area in Phattalung province, provides habitat to tens of thousands of waterbirds in the Kuan Kii Sian *M. cajuputi* forest.

In Vietnam, *M. cajuputi* forests are used for water quality maintenance. Acidic waters with low pH values are diverted into *M. cajuputi* forest in order to raise the pH before being used for rice cultivation

Seeding propagation and planting techniques

M. cajuputi can be grown in a range of ways including from seed, from small saplings removed from natural habitats and through transplantation of large trees which also proves to have a high survival rate.

For growing from seed:

Soil needs to be prepared simply in a long stretch, upon which *M. cajuputi* seeds are simply broadcast. The area needs to be watered gently, and then covered with transparent plastic to maintain the soil humidity. Once plants have become established and are stronger, they can be removed to plastic bags of size 4x6 or 5x8 inches containing soil prepared by mixing with rice husk. In areas close to peatswamps, native soil can be used mixed together with cattle manure.

This propagation can be achieved within a period of 7 months and will be successful under dark conditions. Propagation under flooded conditions is also possible and 5 cm of standing water is ideal, although in this case, seeds should be inserted manually to protect them from natural forces of the water.

For preparing from young saplings:

Along with propagating saplings for transplantation, saplings can be taken directly from areas of natural *M. cajuputi* forest, where they can be found in abundance. These can simply be pulled out by hand and temporarily transplanted into bags of soil. It is recommended however, that saplings are taken from non-flooded areas as those already established in the more favourable flooded conditions have a lower survival rate on transplantation. Using this method, the total time prior to final planting can be reduced to 2-3 months only, although if done during the rainy season, transplanting can be immediate, without the need for temporary planting in plastic bags.

It is not necessary that *M. cajuputi* be transplanted onto raised beds or soil mounds as it has been found that under both raised and non-raised transplanting sites, survival rates are similar. Raising the soil level therefore increases both time of preparation and the overall costs involved. Furthermore, digging mounds or beds may produce a more unstable soil structure to hold the tree and lower the chances of survival.

Growth and Yield

Since 1988, under the initiative of the Pikunthong Royal Development Project, field trials have been conducted in order to select the most suitable species for restoration of secondary peat swamp forest and 13 species of peat swamp plants grown in organic

soil of Narathiwat province. From the results of these studies, it was concluded that *M. cajuputi* was the species which grew best under these conditions (Figure 1).

In the first 13 years of growth, heights of *M. cajuputi* were measured at 1.4, 2.3, 3.5, 5.0, 5.7, 6.7, 6.8, 7.3, 8.4, 8.6, 9.22, 9.53 and 9.7 meters respectively while stem diameters, measured 10cm above the soil surface, were recorded at 2.1, 3.6, 6.0, 7.9, 10.2, 12.6, 14.0, 14.9, 15.9, 16.4, 19.0, 19.21 and 20.31 centimeters (Table 1 and figure 2). In terms of survival rates of *M. cajuputi*, when planted in a matrix of 2x2 meters spacing, species aged 5, 9 and 13 years, displayed survival rates of 88, 83 and 62 percent respectively. This represents high tree densities of 2,200, 2,075 and 1,550 trees per hectare respectively.

In terms of biomass it was found that plants aged 5 years and 6 months would represent a biomass of stem, branch and leaf equivalent to 12.9, 4.9 and 2.6 ton per hectare respectively and an average volume of timber equivalent to 37.9 cubic meters per hectare. At the age of 10 years and 6 months, biomass of stem, branch, leaf and bark were estimated equivalent to 25.9, 6.5, 4.6 and 3.3 ton per hectare (Table 1). The timber, when dried in an oven or by other means, would reduce in weight by 50%, while leaves and bark, when dried, reduced to only 38.0 and 28.3% of their natural weight

Results of further trials on growth of *M. cajuputi* in acid sulphate soils, in Toh Daeng swamp, Narathiwat Province, where 20 different native forest species were planted in 2000 showed that after just 12 months *M. cajuputi* had grown well and displayed an average height of 2.34 meters and trunk diameter of 4.39 cm.

In addition to field trials, further documentary evidence is drawn from Thailand's Nakhon Si Thammarat Province and the Royal Thai Government's project to financially support growth of economic forest species. In *Cha-uad* district of Nakhon Si Thammarat Province, where soil pH has been recorded in the order of 3.8 to 4.0, many people chose to plant *M. cajuputi* on areas which previously were abandoned grasslands. Observations and measurements made on heights species planted by farmers in the area testify to the plants resistance and suitability. Mr Ahthid Krundeth of village No 7, Cha-Uad District – nationally recognized for his forest plantation efforts - had, in 1995, planted 1.8 hectares comprising rows consisting of sets of 3 trees spaced at one meter intervals, each set separated by gaps of 2 meters before the next set (picture C), representing a density of 4,640 trees per hectare. Observations taken when the trees were 7 years old showed height of 8.37 (SD±0.68) meters and diameters measured at chest height of 7.05 (SD+-6.3).

Similarly, another farmer, Mr Sawan Sengtan's 1.6 hectares of *M. cajuputi* - planted in 1994 on a 1.6 x 1.0 m matrix (picture D) - displayed heights of 9.72 (SD±0.98) meters and chest height diameters of 8.42 (SD± 2.31) centimeters, while Mr. Kamrop Bradip's 4.8 hectares, spaced at 1.6 x 0.5 m (picture E), displayed heights of 9.73 (SD±0.67) meters and chest height diameters of 7.96 (SD±1.74) cm, both after just 8 years (picture E).

This *M. cajuputi* that was planted in *Cha-ud* District also displayed higher growth rates than *M. cajuputi* planted in trials under the Pikunthong Royal Development Project in Narathiwat Province, while individual trees also displayed better health and development characteristics. This ability to grow well together with the high survival rates observed shows *M. cajuputi* to be an effective choice of species for restoring economic forest to abandoned grassland areas.

In other countries such as Malaysia, *M. cajuputi* has been recorded with chest height diameters of 23 and 30 centimeters when aged 6-7 and 12 years respectively. Subsequently, trees aged 7 years are judged to be most suitable for harvesting as at this age the tree has already passed its optimum growth rate (Sandrasegaran, 1966) and further development is slow. This reflects the findings of studies from Vietnam, which conclude that 8 to 10 years represents an ideal growth period prior to harvesting for timber (Thien, 1997). The rate of growth of *M. cajuputi* in Vietnam is equivalent to 0.6-0.7 centimeters, 0.7-1.0 meters and 8 - 10 cubic meters per hectare per year (Thinh, 1997).

At Indonesian Government plantations established in order to provide cajuput oil 9,000 hectares of *M. cajuputi* were planted at densities of 5,000 trees per hectare (Oyen and Dung 1999). Harvesting of trees and other products started within 4 years. In Western Pakistan, India, Singapore, Borneo, North America *M. cajuputi* has also been planted for commercial purposes.

Natural *M. cajuputi* grown in Narathiwat province has shown a rate of growth of stem, branch and leaf equivalent to 3,119, 719 and 231 kg per hectare per year. In total this increases by approximately 4,070 kg per hectare per year and represents and an increase in timber volume of 10.3 cubic meters per hectare (Charin. 1985).

Maintenance and Management of M. cajuputi forest

Under natural circumstances, *M. cajuputi* is a pioneer species which grows rapidly after incidents of forest fire and has a high ability to rapidly colonies the vacant land. In some areas, within 2 years of forest fire, up to 400 trees per square meter have been counted. While some trees propagate from the natural dispersal of seed, others originate from damaged roots and broken trunks but thrive equally, increasing in height by up to 2 m per year.

In terms of pests and illness, *M. cajuputi* is vulnerable to very few, with the exception of some insects which utilize the outer bark of the tree trunk. As a consequence of its natural durability, care and maintenance of *M. cajuputi* plantations is quite easy and requires minimal care and attention. During the first 3 years of growth, weeding once or twice per year and ensuring that land is protected from forest fires may prove sufficient. In addition to this, trees displaying slow or stunted growth can be removed to allow better growth for remaining species. Nevertheless in the event of growing for cajuput oil, the tree height is not important and can be controlled in order to allow easier access to the leaves.

When harvesting for timber, it is recommended that trees are felled by cutting some 30cm above the soil surface which is considered to be the ideal height to allow propagation of new stems from the remaining stump. If cutting is made too low, this exposes the new growth to risk of damage from flooding, while cutting too high has shown new stems to be weak and susceptible to breakage (Arenon and Manat, 2001). Through controlled harvesting such as this, *M. cajuputi* plants growing in Narathiwat Province's peat swamps can be sustainably grown and harvested every 6 years on a rotational basis (Soravisuitra 1997).

Recommendations and Limitations

Growth and management of *M. cajuputi* in the form of economic forest plantations to provide timber and cajuput oil is an approach to forestry and farming with a bright future. Nevertheless, current results of study show that trees will differ in size and characteristics depending on their geographic location, and consequently this will affect the quality and yield of cajuput oil and timber. It is therefore necessary to increase the current amount of study given to the method for silvicultural system, especially in the selection and development of species necessary to increase the growth rate and product yield to meet the needs of market conditions. Attention needs to be given to a range of factors, *inter alias* the development and choice of quick growing species and the effect of species type on yields of cineol from leaves.

It is also necessary to study, in greater detail, the potential for producing medicinal and other products. In combination with timber and cajuput oil harvesting, this can increase the economic value of *M. cajuputi*.

The most significant limitation to the wider growth and plantation of *M. cajuputi* is the risk and potential damage through forest fire. At all plantation sites, it is necessary to take preventative measures in order to mitigate the risk and protect the investment of the plantation.

Conclusions

M. cajuputi has a wide range and variety of uses, both to local people and on the open market, and is capable of growing well and adapting to a range of geographic areas and conditions. The Royal Thai Government has also determined that *M. cajuputi* is suitable as an "economic crop" and therefore commercial plantation and harvesting is permitted and not in conflict with current forestry legislation. *M. cajuputi* also has a high potential to support the lives of the farmers, especially those in secondary and degraded swamps. While, which under normal circumstances, harsh soil conditions are an obstacle to use of the land, growing and management of *M. cajuputi* under these conditions is a new approach.

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