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Performance of the High Value Native Species of *Shorea parvifolia* Planted under Invasive Species of *Acacia mangium*

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Abstract

Shorea parvifolia is the high value native species at South East Asia (especially in Malaya-Indonesia) forest and has a high commercial value. This research was aimed to analysis the growth and yield of *Shorea parvifolia* and its performance that planted under invasive species of *Acacia mangium* stands. The research was conducted at Kapuas District, Central Kalimantan Province, Indonesia. Type of soil at the site is ultisol with 2, 606 mm/year of precipitation average. Initially, *Acacia mangium* planted with space namely 3 m x 3 m at 1993. After two years, seedlings of *Shorea parvifolia* were planted among akasia plants with 1, 111 tress/ha of density. Thinning of akasia plants were conducted stage by stage, especially at the stunted plants or dead. The data were latest analyzed at 2014 or at the moment of 19 years old. Research result showed that at the 1, 5, 10, 15, and 19 years old, life percentage of *Shorea parvifolia* are 94. 8%, 78%, 66. 4%, 57. 5%, and 53% respectively. Average diameter of *Shorea parvifolia* at the same times are 1. 27 cm, 6. 13 cm, 12. 8 cm, 19. 86, and 27. 46 cm respectively, and their average total height are 1. 51 m, 5. 27 m, 10. 89 m, 17. 18 m, and 24. 41 m respectively. Volume growth of *Shorea parvifolia* at the same times namely 0. 05 m^3/ha, 3. 97 m^3/ha, 36. 93 m^3/ha, 145. 44 m^3/ha, and 303. 62 m^3/ha respectively. In order to rehabilitate the degraded area, included to against the invasive species as *Acacia mangium*, planting the native species of *Shorea parvifolia* is very suitable.

Keywords: growth and yield, native species, invasive species, *Shorea parvifolia.*

Introduction

Deforestation and degraded forest in Indonesia tended to increase that caused by increasing of resident and wood requirement (Singh*et al*. 1995), illegal logging, shifting cultivation, illegal minning, illegal occupation of land, forest fire (Indrawan 2008), conversion of forest (Saharjo 2008), and poor forest management (Wahjono and Anwar 2008). In line with that, logs production from natural production forest tended decreasing, start from 26 million m^3 coming from 59, 6 million ha of production forest in 90s become become just 9. 1 million m^3 from 27. 8 million ha of production forest only in 2000 (APHI 2014). Deforestation and degraded forest won't be stoped happened if there isn't repair of production forest management system in Indonesia.

Silvicultural systems that have been applied in Indonesia since 1972 to present are Indonesia Selective Cutting, Indonesia Selective Cutting and Planting, Indonesia Selective Cutting and Strip Planting, Clear Cutting with Natural Regeneration, Clear Cutting with Artifial Regeneration, and Gap Cutting are very expected could give shave to sustainable forest management and increasing forest productivity. Selective Cutting and Strips Planting (SCSP) silvicultural system with intensively silvicultural technique has done limited to 29 of forest concessions since year 2009, using species of Dipterocarp species especially *Shorea parvifolia*. This species is recommended to plant in strips areas of SCSP system and believed could to increase the forest productivity in Malaya-Indonesia.

This research was aimed to analyze growth and yield and its performance of high value native species of*Shorea parvifolia* that planted under invasive species of *Acacia mangium* at the dryland tropical forest in Central Kalimantan Province, Indonesia. *Acacia mangium* is invasive species and fast growing species and light demanding (intolerant) species that suitable planted at the degraded land (Mindawati, 2011). Wood of *Acacia mangium* can be used to work working, pulp and paper, etc. (Dephut, 1989; Tuomela, 1996). Meanwhile, *Shore*a spp are slow growing species and tolerant species that dominante the tropical rain forest as the climax species. These species can not grow well planted at the open areas, conversely very suitable planted under canopy of stand. Thereby, mix plantation between *Acacia mangium* and *Shorea* spp is very ideal to maximise land use at the degraded area on the forest region.

Method

The research was executed at the research plot of *Shorea parvifolia* that planted at 1995under *Acacaia mangium* plantation that planted at 1993, located at the dryland tropical forest, Kapuas District, Central Kalimantan Province, Indonesia (Figure 1) Type of soil is ultisol with 2. 606 mm/year of precipitation average. Initially, *Acacia mangium* planted with space namely 3 m x 3 m. After two years, seedlings of Shorea parvifolia were planted among akasia plants with 1, 111 tress/ha of density. Thinning of *Acacia mangium* plants were conducted stage by stage, especially at the stunted plants or dead. The data of *Shorea parvifolia* were latest analyzed at 2014 or at the moment of 20 years old.

Measured variables were diameter breast high (dbh) and height of *Shorea parvifolia* that planted under *Acacia mangium* stands. Collection of data were conducted at 1, 5, 10, 15, and 20 years old, then analyzed using life percentage, mean annual increment, and current annual increment.

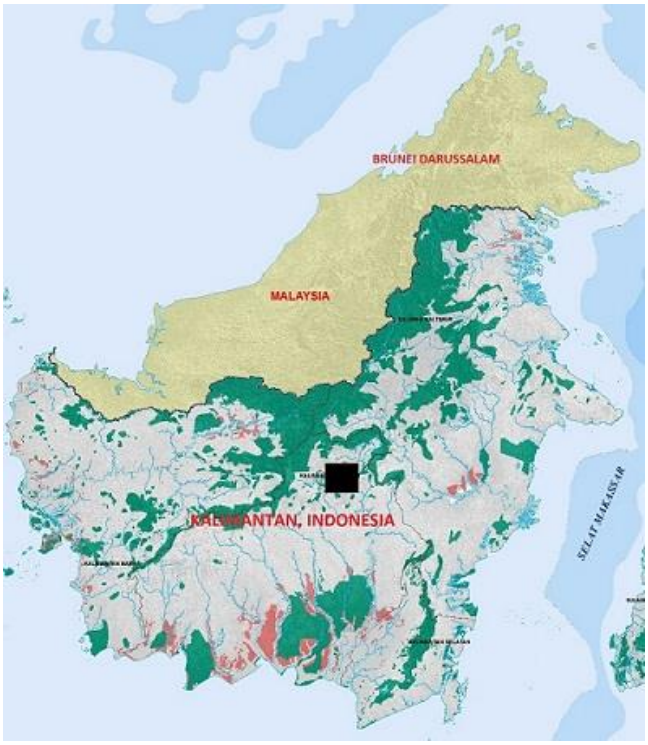

Figure 1: Research plots location at the Kalimantan (Borneo) island of Indonesia

Result and Discussion

Growth of *Shorea leprosula*

The data recapitulation of *Shorea parvifolia* at theresearch plot which collected at 1995, 1999, 2004, 2009, and 2014or at the moment of 1, 5, 10, 15, and 19 years old were showed in Table 1. Research result showed that life percentage of *Shorea parvifolia*at the 1, 5, 10, 15, and 19 years old are 94. 8%, 78%, 66. 4%, 57. 5%, and 53% respectively. *Shorea parvifolia* is native species of Kalimantan that very suitable grow at the site. At the 19 years old, there are 589 plants of *Shorea parvifolia*, a good number for density of plants. Initially, plantation of *Shorea parvifolia* was used the space namely 3 m x 3 m or 1. 111 plants/ha in density. At the 20 years old, life percentage of this plants are 53%. The high forest canopy cause some plants are repressed by superior plants so that many stunted plants and death. At the Table 1 also showed that diameter of *Shorea parvifolia* at the 1, 5, 10, 15, and 19 years old are 1. 27 cm, 6. 13 cm, 12. 8 cm, 19. 86, and 27. 46 cm respectively, meanwhile total height of *Shorea parvifolia* are 1. 51 m, 5. 27 m, 10. 89 m, 17. 18 m, and 24. 41 m respectively.

Table 1: Growth of *Shorea parvifolia* at the research plots

Year	Age	Diameter	Height of branch	Total height	Life Perc.
	(year)	(cm)	(m)	(m)	(%)
1996	1	1. 27	0. 55	1. 52	94. 8
2000	5	6. 13	2. 22	5. 27	78. 0
2005	10	12. 8	5. 56	10. 89	66. 4
2010	15	19. 86	10. 5	17. 18	57. 5
2014	20	27. 46	12. 44	24. 41	53. 0

Source: worked data

Several plants came down with pest of insect (*Alcides* sp. , *Locusta migration*) that cause some holes at the leaves of *Shorea parvifolia* although there are no death. *Alcides* sp can played possum if be captured (Pracaya. 1991). Many plants are death that be caused by lost ability in the competition to get soil nutrition, grow space, and sunlight because with each passing day the diameter of *Shorea parvifolia* become more bigger and its height become more higher. Under the circumstances, some trees defeat the other trees. Initially (at the 1995) the density of *Shorea parvifolia* plantation is 1. 111 tree per ha, however after 20 years later the density get down to 589 trees per ha. Competition is limited factor for plant to grow well at the forest (Soekotjo. 1995; Deptan. 1980). In order to reduce the competition, it be done with thinning periodically.

Figure 2 show *Shorea parvifolia* plantation at the research plot at the moment of 5 years old and 15 years old. At the figure, plantation was looked high in density that caused by there are mix plants between *Shorea parvifolia* and initial plants of *Acacia mangium*. The high density like that is expected become a good site for growt of *Shorea leprosula* and then stage by stage, Acacia mangium was harvested.

Plantation project using Dipterocarp species, especially *Shorea* app, is still very limited because these species were characteriscally semi-tolerant so they are very difficult to be cultivated. They can not grow well at the close areas (as at the natural forest floor) or at the open areas (as at the clear cutting areas) (Mc Kinnon *et al*, 2000). Seedling of *Shorea* spp is grow well on the gap of forest with light intensity start from 42. 71% to 45. 73% or 52. 1 to 55 densiomener scale (Stuckle *et al*. 2001; Wahyudi, 2011). Gap area as like that could be created at the time moment of conducted selective cutting or in the form of the strip line of SCSP system. The other method is planted under canopy of plants. In order to rehabilitate degraded areas and to develop the plantation of Shorea spp, so this method is very suitable applied in the large scale.

Competition to get nutrients from soil. light from above. and space to grow are happen on the forest (MacKinnon *et al*. 2000). Furthermore. the growth of plantation at the site is more caused by light factor from above (Mori 2001, Romell 2007). despitefully the other factor like soil fertility. temperature and humidity. Kikuchi (1996) wrote that increased temperature cause the decreasing the organic matter at the forest floor.

Figure 2. *Shorea parvifolia* plantation in the research plot at 5 years old (left) and 15 years old (righ)

However. there are three factors that influence the growth and yield of plantation. i. e. environmental factor. silvicultural technique. and genetics. Environmental factors (sites) are comprised two sub factors. i. e. soil factor and climate factor (Fisher & Binkley 2000, Kozlowski & Pallardy 1997, Soekotjo 1995). Soil factors are comprised some sub factors like physical. chemical. and biologycal properties. soil water. slope. altitute. and aspect of site. Climate factors are comprised some sub factors like precipitation. temperature. light. humidity. winds. and geographical position. Silvicultural factor is the effort and activity that conducted by human in order to increase the growth and yield of plantation. like intensively plantation. tending. pruning. harvesting technique. reduce impact logging and so on. Then. genetic factor is depended by species and innately internal factor (Finkeldey 1989, Hani'in1999, Kumar & Matthias 2004, Na'iem& Pamuji 2006). Tree improvement is the human effort to improve the innately internal factor in order to increasing growth and yield of plantation.

Growth model for diameter and total height of *Shorea parvifolia* is explained using polynomial equation. These models could be used to predict the diameter and total height of *Shorea parvifolia* plants based on their age. The polynomial growth models of *Shorea parvifolia* are Y = 0, 183 + 1, 1559X + 0, 0104X^2 for diameter and Y = 0, 7082 + 0, 8354X + 0, 0175X^2 (R^2=91, 99%) for total height (Figure 3). These models have a good coeficient determination (R^2), namely 92, 99% and 91, 98% for diameter and total height respectively. Growth of *Shorea* spp is formed the sigmoid, where it slow in early and stage by stage more fast until it attains 35 cm in diameter of tree (Wahyudi, 2011). In the same case, growth of *Hovea cernua* is also formed the sigmoid, slow in early and then more fast until it attains 40 cm in diameter of tree

(Gunawan & Wartomo 2002). Based on the both research mentioned, *Shorea parvifolia* plants at 20 years old (at the moment of latest measured at 2014) are still in the range of high growth, with the result that the graphics tend to raise in the growth.

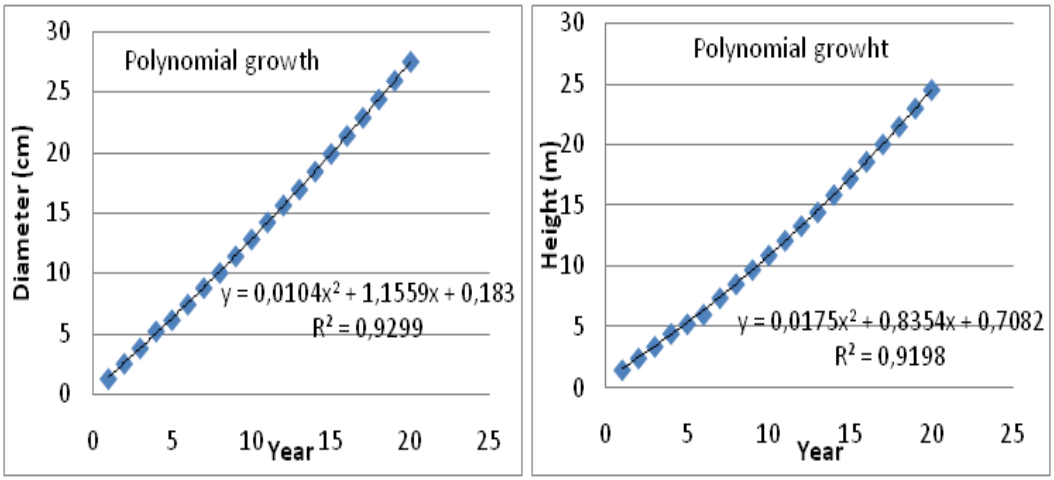

Figure 3: The polynomial growth models of *Shorea parvifolia* plantation planted under *Acacia mangium* stands in diameter and total height

Shorea spp is slow growing and intolerant species that suitable grow in the site with wide range of soil fertility, in fact, even these species can grow well at the marginal soil of ultisol (Mc Kinnon *et al*, 2000). Much of the species grow well at the dryland forest, except *Shorea balangeran* and small part of *Shorea* spp which can grow at the wetland forest. In order to survive and to increase their growth, *Shorea* spp conduct the symbiosis with mycorhizae to get more nutrients and protect the roots from pest and disease (Supriyanto, 2001).

Yield of *Shorea parvifolia*

Volume growth of *Shorea parvifolia* at 1, 5, 10, 15, and 19 years old namely 0. 05 m^3/ha, 3. 97 m^3/ha, 36. 93 m^3/ha, 145. 44 m^3/ha, and 303. 62 m^3/ha respectively. Mean Annual volume Increment (MAvI) of *Shorea parvifolia* at the same times namely 0. 05 m^3/ha/year, 0. 79 m^3/ha/year, 3. 69 m^3/ha/year, 9. 70 m^3/ha/year, and 15. 18 m^3/ha/year respectively, whereas Curren Annual volume Increment (CAvI) of *Shorea parvifolia* at same times namely 0. 05 m^3/ha/year, 1. 45 m^3/ha/year, 11. 12 m^3/ha/year, 15. 30 m^3/ha/year, and 42. 88 m^3/ha/year respectively (Table 2). These data can show the productivity of *Shorea parvifolia* that planted under *Acacia mangium* stands.

Table 2: Annual growth of volume of *Shorea parvifolia*

Year	Age (year)	Diameter (cm)	Height of b (m)	Standing stock (m^3/ha)	MAI Vol (m^3/ha/year)	CAI Vol (m^3/ha/year)
1995	1	1. 27	0. 55	0. 05	0. 05	0. 05
1999	5	6. 13	2. 22	3. 97	0. 79	1. 45
2004	10	12. 80	5. 56	36. 93	3. 69	11. 12
2009	15	19. 86	10. 50	145. 44	9. 70	15. 30
2014	20	27. 46	12. 44	303. 62	15. 18	42. 88

Source: worked data

MAvI can show the mean productivity of plants at the site at the certain year, meanwhile CAvI volume can show the current productivity of plants at the certain year (Radonsa *et al.* 2003). At the 19 years old *Shorea parvifolia*has mean productivity namely 15. 18 m^3/ha/year whereas at the same time, current productivity of *Shorea parvifolia* is highest than mean productivity, namely 42. 88 m^3/ha/year, it show that plants still in the range of high growth. At the moment, standing stock of *Shorea parvifolia* stand attain 303. 62 m^3/ha.

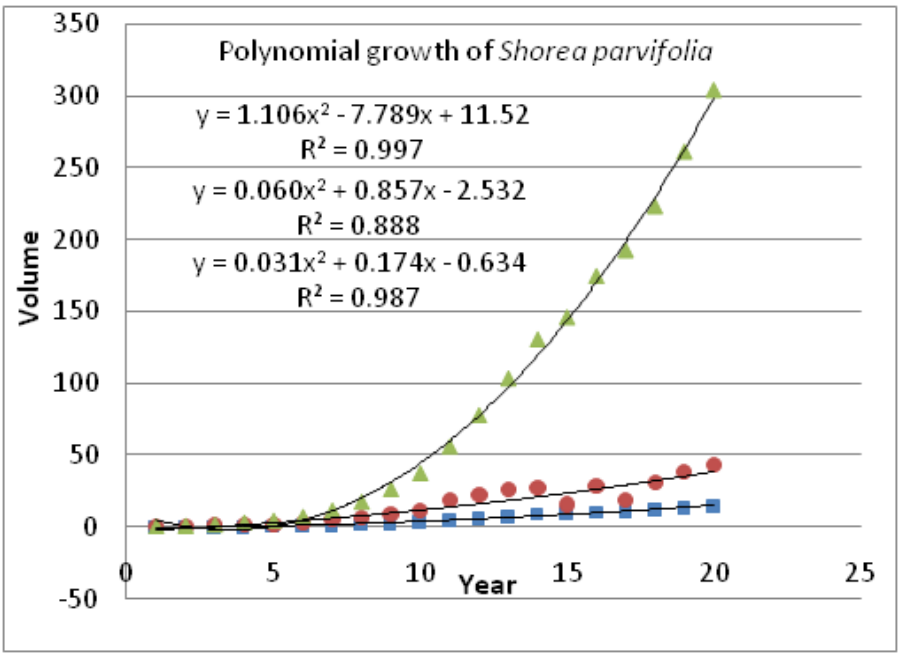

Figure 4. The polynomial growth models of *Shorea parvifolia* plantation planted under *Acacia mangium* stands in volume

Growth model for volume of *Shorea parvifolia* is explained using polynomial equation. These models could be used to predict the volume of *Shorea parvifolia*

plants based on their age. The polynomial growth model of *Shorea parvifolia* is Y = 11, 524 – 7, 7892X + 1, 1064 X^2 (R2=99. 74%), meanwhile the polynomial CavI and MavI models are Y =-2, 5324 + 0, 8576 X + 0, 0607 X^2 and Y =-0, 6342 + 0, 1747 X + 0, 0318 X^2respectively (Figure 4). These models have a good coeficient determination (R^2), namely 99. 749%, 88. 83%, and 98. 79% for volume growth, CAvI, and MAvI respectively, so these equation models can be used for predict the growth of volume of *Shorea parvifolia* plantation based on their age.

Conclusion

Shorea parvifolia is the native species of Kalimantan and it suitable grow at the marginal site under invasive species of *Acacia mangium*. Life percentage of *Shorea parvifolia* at the 1, 5, 10, 15, and 19 years old namely 94. 8%, 78%, 66. 4%, 57. 5%, and 53% respectively. Average diameter of *Shorea parvifolia* at the same times namely 1. 27 cm, 6. 13 cm, 12. 8 cm, 19. 86, and 27. 46 cm respectively, and their average total height are 1. 51 m, 5. 27 m, 10. 89 m, 17. 18 m, and 24. 41 m respectively. Volume growth of *Shorea parvifolia* at the same times namely 0. 05 m^3/ha, 3. 97 m^3/ha, 36. 93 m^3/ha, 145. 44 m^3/ha, and 303. 62 m^3/ha respectively. Planting the high value native species of *Shorea parvifolia* is very suitable conducted at the degraded area, included to against the invasive species as *Acacia mangium*,

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