Development of Wide Row Spacing to Increase Land Productivity of Rubber Plantation

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Abstract

Rubber is an important commodity in Indonesia since it is source of income for more than 12 million people and source of foreign exchange. Since 2011, there have been significant changes to he condition of rubber price, which also affected the income of smallholder. Some smallholders converted rubber plantations to other crops such as oil palm, coffee or annual crops such as maize and upland rice. In order to prevent more conversion of rubber to other crops, a technology is needed to increase the land productivity of rubber plantation. A technology that might be developed is the cultivation of rubber with wide row spacing (18 m x 2 m) x 2.5 m.Plant population of using this planting distance is 400 trees/ha. Using this wide spacing, smallholder could cultivate intercrops such as maize, paddy, cassava, etc. in area between rubber rows. The planting distance of maize as intercrop is 40 cm x 10 cm, while for paddy the planting distance is 75 cm x 20 cm, and the planting distance for cassava 100 cm x 100 cm. This technology has been developed in South Kalimantan and South Sumatra Province in the area of 700 ha and 400 ha, respectively. The oldest rubber plant was 100 months, however most of them are 12-36 months. Rubber clone used was PB 260. Survey conducted in 50 smallholdings and observation in the field, showed that the growth of rubber plant using this wide row spacing was good. The trees could be tapped at the age of 55 months. The average yield of rubber was 1500 kg/ha/year. The yield of hybrid maize in the third year has reached 5000 – 5500 kg/ha, upland rice of Dayang Rindu varieties could produce 2000 – 2250 kg/ha, peanuts 2000 – 2200 kg/ha, and cassava 16000 – 19000 kg/ha. Wide row spacing in rubber plantation has good prospect, because until third year, smallholders obtained yield from the intercrops, whereas the growth of rubber was normal.

Keywords: rubber, land productivity, wide row spacing, intercropping

1. Introduction

Rubber is an important commodity in Indonesia since it is as a source of income for more than 12 million people as well as a source of foreign exchange. Since 2011, there have been significant changes in rubber price, The price of natural rubber was about US$ 4.5 per kg of SIR 20 in 2011 but continued to decline thereafter and reached US$ 1.31 per kg of SIR 20 in July 2016.

The fall in rubber price has socio economic impact on smallholders in South Sumatra. Almost 800000 households or 46% of the population of South Sumatra earn their livelihood from rubber (Directorate General of Estate Crops, 2013; Statistical Agency of South Sumatra, 2012). According to Syarifa et al. (2015), low rubber price had an impact to the decline of income, the decline in investment ability of smallholders to establish rubber plantations, the decline in purchasing power of smallholders and to generate income by investment outside

rubber farming. Moreover, there has been conversion of rubber plantation to the other more prospective crops.

Efforts are needed to maintain Indonesian rubber production by increasing the productivity of land. One possiblemethod is development of rubber intercropping. The study of Rosyid et al. (2000;2002;2006;2007); Wibawa et al. (1994); Zainol et al. (1993); Lin Weifu et al. (1999); Rodrigo et al. (1995;2001;2004); Raintree (2005); Pathiratna dan Perera (2004;2006); Zeng Xianhai et al. (2012), Snoecka et al. (2005), showed that intercropping between rubber rows could increase the income of smallholders. It also helped in maintaining the rubber plantation, increase soil organic matter and improve soil physical and chemical fertility.

In order to prevent further conversion of rubber to other crops, a technology is needed to increase the land productivity of rubber plantations. A technology that can be developed is the cultivation of rubber with a wide row spacing (18 m x 2 m) x 2.5 m. Population of rubber using this planting distance is 400 trees/ha. Using this wide spacing, smallholders could cultivate intercrops such as maize, paddy, cassava, etc. between rubber rows The main constraint in developing rubber intercropping is the low intensity of light because of the shade canopy of rubber plant. When rubber plant are four years old, with planting distance of 6 m x 3 m, the light reduction could be 75%. The intercrops planted in the shade gave 50% lower yield compared to the same rcropplanted without shade (Sopandie et al., 2002; Wirnas, 2005; Sahuri dan Rosyid, 2015). Therefore, ther is a need for change in the spacing of rubber.

Rosyid (2006); Rosyid (2007) and Rosyid *et al*. (2012) tried different planting distances of 6 m x 3.3 m, 6 m x 4 m, 8 m x 2.5 m, 10 m x 2 m, 12 m x 1.66 m and (12 m + 4 m) x 2.5 m The best growth of plants was at the spacing of 6 m x 4 m. However, with the planting distance of 6 m x 4 m, at the age of 27 months, the light intensity was 20%, whereas at the distance of (12 m + 4 m) x 2.5 m, the light intensity was 60%. The intercropping could be established until 5 years for planting distance of 12 m x 1.66 m, while for hedge row planting distance (12 m + 4 m) x 2.5 m the intercropping could be established until 6 years.

This paper was to determine the effect of double row spacing (18 m x 2 m) x 2.5 m (400 trees/ha) on the growth of rubber and rubber production compared to single-row spacing 6 m x 3 m (550 trees/ha).

2. Materials and Methods

Period and location

This study was conducted in the demonstration plot of double row spacing that has been developed in Tanah laut District, South Kalimantan Province and Musi Rawas District, South Sumatra. The area of demonstration plot was 700 ha and 400 ha, respectively. The study was conducted during 2009 – 2016.

Data collection

The data was collected by observing the plantations and interviewing the participant farmers, individually and by Focus Group Discussion. Primary and secondary data were collected and tabulated for further analysis. Details of cropping patterns, location of study, and the number of respondents are presented in Table 1.

Tabel 1. Cropping patterns, location of study, and number of respondents.

Planting Pattern	Varieties	Location/ District	Number of Respondents
A : Maize (Hybrids)	Pioner	Tanah Laut	35
B : Upland rice	Dayang Rindu	Musi Rawas	5
Maize	Pioner		
C : Maize	Pioner	Musi Rawas	5
Peanut	Kidang		
D : Cassava	Adira 1	Musi Rawas	5

Rubber clone used was PB 260 using single row spacing 6 m x 3 m (550 trees/ha) and double row spacing (18 x 2 m) x 2.5 m (400 trees/ha). Planting distance of maize is 40 cm x 10 cm, paddy 75 cm x 20 cm, and cassava 100 cm x 100 cm. Primary data included rubber girth at the age of 8 – 100 months after planting, rubber production at the age of 7, 8, 9 years after planting, and production of intercrops (maize, paddy, peanut, and cassava).

Experimental layout

Treatments comprised two spatial arrangements of planting rubber (Figure 1): (1) single row avenue planting pattern (SR) with a row spacing of 6 m and plant spacing of 3 m; (2) double row avenue planting pattern (DR) with a plant spacing of 2.5 m and a double row spacing of 2 m and 20 m gap between double rows. The planting density was 550 trees/ha in SR and 400 in DR. In row planting arrangements, crops could be planted in between the rows or in the gap.

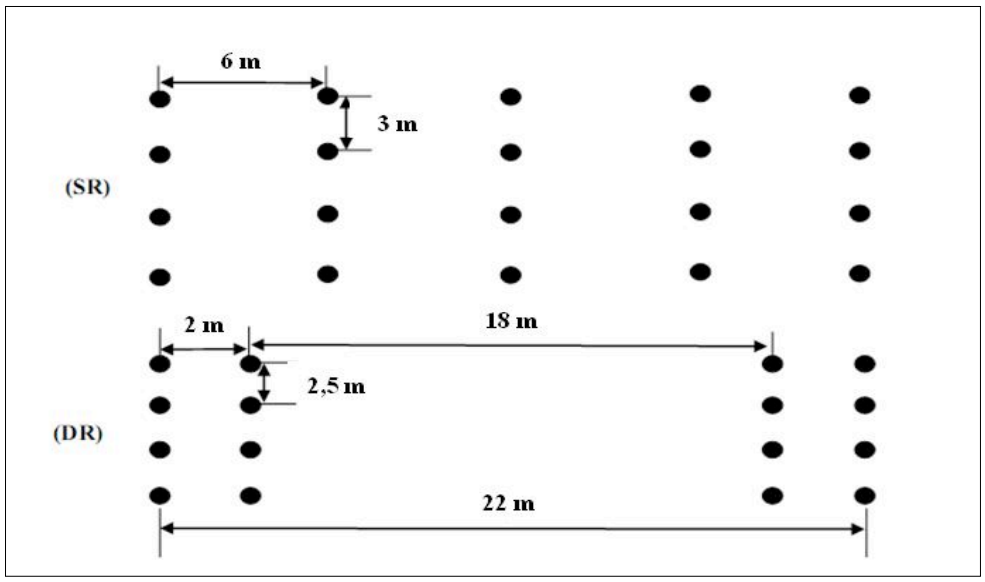

Figure 1. Schematic diagram showing the layout of different spatial arrangements of planting rubber. SR: Single row avenue planting pattern; DR: double row avenue planting pattern.

Data analysis

The data were analyzed using Table Curve 2.0 Software and Minitab14 Software fo tabulating.

3. Results

Plant girth

In general, the girth increament of rubber with double row spacing was good and it could be opened at the age of 55 months (4.5 years). The girth of rubber at the age of 100 months (8 years) with single row spacing was 56.10 cm and double row spacing was 55.20 cm (Figure 2). This indicated that single row spacing slightly better 0.9 cm compared to double row spacing, but not significantly different statistically (P = 0.484).

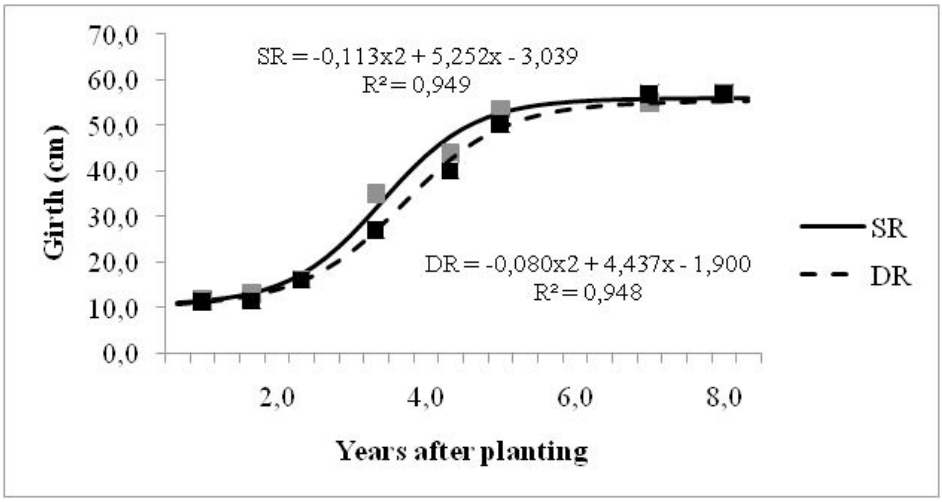

Figure 2. Effect of planting patterns on the girth of rubber tree. SR: Single row spacing; DR: Double row spacing

Latex yield

Production of latex per tree both in single row spacing and double row spacing were the same. However, the yield per hectare for single row spacing was higher than that of double row spacing (Table 2), since the population of trees in single row spacing was more than that in the double row spacing.

Tabel 2. Effect of planting systems on rubber yield

Age (year)	SR		DR	
	Yield (g/p/s)	Yield (kg/ha)	Yield (g/p/s)	Yield (kg/ha)
7	20	1500	20	1200
8	25	1800	25	1500
9	30	2250	30	1800

SR: Single row spacing; DR: Double row spacing

Intercrops yield

The yield of intercrop from period at 1-2 years of rubber age on the SR system is presented in Table 3 On the SR system, intercrops can only be planted up to two years After two years, rubber canopy closed and hence light penetration was reduced upto 60% Table 3 shows that upland rice cropping pattern yield was 2000-2200 kg/ha and hybrid maize yield was 5000-5500 kg/ha.

Tabel 3. Intercrops yield on the SR system

Planting Pattern	Location	Rubber Age			
		1 Year		2 Year	
		1st Period	2nd Period	1st Period	2nd Period
Upland rice (DMR kg/ha)	Musi Rawas	2100 – 2300	1900 - 2300	1900 - 2200	1800 - 2180
Hybrid maize (DGM kg/ha)		4700 – 5200	5200 - 5600	4800 - 5500	4500 - 5400

Remarks:
- ✓ The population of hybrid maize, upland rice, and cassava as rubber intercrops on JT system was 60% of the population in monoculture.
- ✓ The production of dry milled rice (DMR) in monoculture was 2000 - 2500 kg/ha (Pringadi et al., 2012).
- ✓ The production of dry grain maize (DGM) in monoculture was 7500 - 8500 kg/ha (Sudiana and Martiningsih, 2012).

The yield of intercrops from at 1-3 years of rubber age in the DR system is presented in Table 4. In the DR system, intercrops could be planted at the age of rubber trees for three years The yield of hybrid maize in pattern A was 5000 – 5500 kg/ha,in pattern B it was 4800 – 5100 kg/ha, and in pattern C 5000 – 5100 kg/ha. The yield of upland rice Dayang Rindu variety in pattern B was 2000 – 2250 kg/ha. The yield of peanut in pattern C was 2000 – 2200 kg/ha. The yield of cassava in pattern D was 16000 – 19000 kg/ha. After maximum development of rubber canopy in DR system 60 - 75% of land area could still be used for intercrops.

Tabel 4. Intercrops yield in the DR system

Planting Pattern	Location	Rubber Age					
		1Year		2 Year		3 Year	
		1st Period	2nd Period	1st Period	2nd Period	1st Period	2nd Period
Pattern A:							
Hybrid maize (DGM kg/ha)	Tanah Laut	4900 – 5100	5400 – 5600	5100 - 5300	4900 - 5100	4800 - 5100	5000 - 5200
Pattern B:							
Upland rice (DMR kg/ha)	Musi Rawas	2000 – 2150	-	1900 - 2100	-	2200 - 2300	-
Hybrid maize (DGM kg/ha)			4900 – 5100		5000 - 5200		4700 - 4900
Pattern C:							
Hybrid maize (DGM kg/ha)	Musi Rawas	5000 – 5150	-	4900 - 5100	-	-	-
Peanut (DGP kg/ha)			1900 – 2100		2100 - 2200		
Pattern D:							
Cassava (FSC kg/ha)	Musi Rawas	15000 – 16800	-	18900 - 19800	-	-	-

Remarks:
- ✓ The population of hybrid maize, upland rice, and cassava as rubber intercrops on JG system was 80% of the population in monoculture.
- ✓ The production of dry milled rice (DMR) in monoculture was 2000 - 2500 kg/ha (Pringadi et al., 2012).
- ✓ The production of dry grain maize (DGM) in monoculture was 7500 - 8500 kg/ha (Sudiana and Martiningsih, 2012).
- ✓ The production of dry grain peanut (DGP), in was 2000 - 2300 kg/ha (Sudjadi dan Supriati, 2001).
- ✓ The production of fresh sweet cassava (FSC) in monoculture was 19000 - 25000 kg/ha (Wargiono et al., 2006).

4. Discussion

In general, the growth of rubber and latex yield from single row spacing and double row spacing were not significantly different. This was in line with the results of the study by Rodrigo et al. (2004). Generally, the production of latex individually by single row spacing was equal to double row spacing, however, the yield per hectare of single row spacing was higher than double row spacing. This was caused by the difference in population. Single row spacing has more population (550 trees/ ha) compared to double row spacing (400 trees/ ha). The yield of latex per hectare dependon the production per tapping and number of tapped trees. In this study, by using double row spacing, smallholders could plant intercrops for longer period. during the economic life of rubber. This is in line with the result of study by Rodrigo et al. (2004); Raintree (2005); and Zeng Xianhai et al. (2012).

The yield of intercrops with double row spacing was more than that in the single row spacing. This is because the penetration of light is optimal.. This agrees with the result studies on paddy, maize, peanut, and soybean intercrops with rubber under double row spacing in India (Rajasekharan and Veeraputran, 2002), Srilanka (Rodrigo et al., 2004), Vietnam and Laos (Raintree, 2005), and Cina (Zeng Xianhai *et al*., 2012).

Rodrigo et al. (2001 and 2004) used the planting distance of rubber with double row or triple row 14,1 m x (2,4 m x 2,4 m) and equilateral triangle with sides 2,4 m x 20,1 m. Using these systems, intercrops could be cultivated for four to five years or even more. Raintree (2005) showed that planting distance of 18 m x (2,5 m x 2 m), with tea as intercrops in Laos, provide resistance to wind compared to single row spacing of 12 m x 2 m dan 15 m x 2 m. At a spacing of 15 m x 2 m many plants collapsed due to wind. Zeng Xianhai *et al*. (2012), showed that double row spacing of rubber 20 m x (2 m x 4 m) and single row spacing 7 m x 3 m could be tapped at same age and there was no difference in production. However, double row spacing in rubber plantation is suitable for cash crops intercropping for longer period. This is because with the double row spacing, the light penetration is higher.

According to Rosyid (2002; 2006;2007), at planting distance of 14 m x (6 m x 2 m) and 12 m x (4 m x 2,5 m) the rubber growth was slightly inhibited, while at planting distance of 6,6 m x 3 m it was good, and at 13 m x (3 m x 3 m) the rubber growth was good with more light penetration. Factors that supressed the growth was the distance between rows, the narrower the distance the greater the competition between plants in the row. However,the intensity of the sunlight from both hedge row spacing were the same, (about 60%), so that inter-rows could still be used for paddy and soybean intercropping with shade tolerantvarieties.

Double row spacing in this study could be used for intercropping for long periods during the economic life of rubber. This spacing effectively solved problems in competition for light, nutrients and space. This system could attract planters to invest in rubber plantation to increase the land productivity of rubber plantation areas.

5. Conclusion

The results of the study showed that the growth with single row spacing in the first year of tapping was slightly better than that of double row spacing. The production of latex from individual trees both in the single row and double row were the same. However, the yield of rubber per hectare with single row spacing was higher than that in double row spacing. as the plant population was higher in the single row system The yield of hybrid maize was 5000-5500 kg/ha, paddy (Dayang Rindu variety) 2000-2250 kg/ha, peanuts 2000-2200 kg/ha and cassava 16-19 tons/ha. Double row spacing system had higher light penetration. In conclusion, double row spacing has been proven as suitable system for intercropping in rubber plantations for longer period.

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