THE ROLE OF INTERCROPPING IN SUPPORTING PARTICIPATORY RUBBER REPLANTING PROGRAM

Anang Gunawan [1], Gede Wibawa[2], Muhammad Supriadi[1], Cecilia Nancy[1], M. Jahidin Rosyid[1], and Sugiharto[1]

[1] Indonesian Rubber Research Institute

[2]Indonesian Research Institute for Estate Crops

ABSTRACT

Natural rubber is one of the important estate commodity because rubber is a source of foreign earnings and main income for millions of people. Rubber in Indonesia is dominated by smallholders (85% of the total area of rubber 3.34 million hectares) and source of income for 12.5 million farmers with their families, not including absorbed labors in the supporting industries. In general, the problem of smallholder rubber is low productivity. Four hundred thousand hectares of rubber is old or damaged and need to be replanted. Therefore, the effort to do participatory replanting should be encouraged and accelerated. One component in participatory replanting concept is "providing program of supporting facility for the acceleration of technological adoption", such as management of intercrops. Management of intercrops is implemented as an effort to fill lost of earnings during the immature period and improves maintenance intensity of rubber plantation. Based on the condition of the rubber canopy, intercrop is divided into: (a) intercrop at rubber age under 3 years (canopy still open) and (b) intercrop at rubber age over 3 years (canopy closed). Intercrop pattern for rubber under 3 years are grouped into food and market oriented product. Food oriented crop are paddy, maize, soybean and cowpea, while market oriented are chili, watermelon, long bean, banana, and pineapples. Intercrop for the rubber over 3 years are shade tolerant crop such as ginger, cardamom, *Curcuma xanthorrhiza*, and turmeric/*Curcuma domestica* val. Those intercropping patterns technically provide positive effect to rubber crop production and growth. Fertilizer application and maintenance of intercrop resulted in better growth of rubber and rubber trees are more taken care of. Other intercrop which have good market prospect and suitable to the agroclimate under rubber is medicinal crops, such as *Morinda citrifolia* and *Aloe vera*. Market aspect and supporting institution are important factor in developing intercrop. Development and reinforcement of this supporting institute aspect is one of the programs which is included in this participatory rubber replanting model.

Keywords : rubber, intercrop, replanting, participatory, productivity

INTRODUCTION

Natural rubber is one of the important estate commodity because rubber is one of the main source of foreign income from estate sub-sector and main income for millions of people. In 2000, the total rubber area in Indonesia was approximately 3.37 million hectares with rubber production of 1.3 million ton rubber and the contribution of foreign income was 888.62 million US dollars. Moreover, 85% of area is smallholder rubber whereas rubber is a source of income for 12.5 million farmers with their families excluding absorbed labors in the supporting industry. In general, the problem of smallholder rubber is low of productivity. This is due to the great number of old or damaged rubber trees (400 thousand ha) which needed to be replanted.

The old and damaged rubber trees need to be replanted immediately, considering the fact that the rubber development project in the future is difficult to be implemented since overseas loan and government fund is limited, hence it needs to be pushed by an effort to accelerate self-supporting rubber replanting through increasing the empowering and participatory of farmer and also society. Indonesian Rubber Research Institute, Sembawa Research Station had conducted various studies in pilot-project areas, which finally generated the Concept of Participatory Smallholder Rubber Replanting Model. This model is used as a framework for the implementation of acceleration rubber smallholder replanting program at the centre of traditional rubber regions (existing) in various rubber producing provinces in Indonesia (Supriadi *et al.*, 2002). This model relies on efforts to increase participation and empowering the plantation society to be more optimal. The strategy to be implemented is through the regional approach combined with the individual approach by considering the condition of socio-economic and adoption level by the farmer.

One of the components in participatory smallholder replanting concept is providing program of supporting facility for the acceleration of technological adoption, one of this is management of intercrops. Management of intercrops implemented as effort to fill loss of earnings at the immature of rubber and improves maintenance intensity of rubber plantation. This paper gives an overview of intercrops management and its support in participatory rubber replanting program.

RUBBER AND INTERCROPS OPTION

Before planting intercrop between rubber, the knowledge of the characteristics of crop components (rubber and intercrops) has to be comprehended, so that the farmer could be expected to design the intercrop pattern by themselves.

Rubber Crop

Beside the consideration of genetic factor such as choosing the appropriate clone for appropriate field, the growth characteristic of rubber tree is very important to be understood in choosing intercrop type, and time of intercrop to be planted.

Part of rubber tree which requires attention is the function of root in water and various nutrients absorption from soil. Rubber root will interact with the root of intercrop in exploiting water and nutrients which are available in soil. Rubber root consists of tap root, lateral root which grow from tap root, and feeder root. The number of lateral root at 3 years old varies between 10 - 20 per tree. The length of the lateral root reaches more than 150 cm at the age of 1.5 years. This root concentrates most at soil surface to about 30 cm depth.

Highest number of feeder root, about 50%, are found at depth of 7.5 cm under soil surface. It will decrease progressively with depth and remains 10% at 30 cm depth.

Bark, trunk, and leaf of rubber form the canopy of rubber tree, determine the sunlight intensity reaching rubber interrow. At the immature period of rubber tree, there is a significant relation between girth and width of canopy. For example, the width of canopy increases by 20 cm for every 1 cm increase of girth of BPM 24 clone.

At planting distance, 6 x 3 m or 7 x 3 m and the growth of rubber tree is normal, light intensity, ranged from 40 to 90%, is not the limiting factor at the first two years. Afterwards light intensity will decrease, at three years immature rubber, light intensity which enter interrow of rubber is between 25 and 80% (Wibawa *et al.*, 1997).

Availability of sunlight will depend on the direction of rubber interrow. For the purpose of intercropping, the direction of rubber interrow would be better in East–West direction, so that shading would be less in the interrow.

The Intercrops

While choosing the intercrop, we should consider biophysics, technical or institutional constraints. The sustainability of technology and market of intercrop must be assessed. In practice, farmers grow food and horticulture intercrop, only at the first two until three years of rubber plantation establishment. These crop require full sunshine for their growth. After three years, availability of sunshine and soil interaction would be main constraints in the intercrop development. In this condition, shade tolerant crops should be selected, or rubber distance modified into double row planting pattern (6 x 2 x 14 m), so that sunshine remain available to the intercrop.

Common intercrop types planted at the first two to three years are food or horticulture crops such as paddy, maize, soybean, banana, pineapples, chili, eggplant or watermelon. Shade tolerant crops are species of medicinal crops such as ginger, cardamom, *Curcuma xanthorrhiza*, and turmeric/*Curcuma domestica* val. The perennial intercrops such as salak, *Morinda citrifolia*, coffee, and peppercorn are potential to be developed (Table 1).

Other perennial crop like fruit and wood, have been started to be implemented by some farmers. Research on rubber based agroforestry has started to be conducted in Indonesia, Malaysia, Thailand, Srilanka and India. Some crop patterns which are studied have potency to be developed in the future (wood and also fruits) (Ghani, 1997; Buranathan *et al.*, 1992).

Table 1. The potential crops in supporting rubber replanting program

Condition of rubber canopy	Annual	Perennial
Open	*Aloe vera* Banana Chili Cowpea Eggplant Grass for the livestock feed Maize Paddy Gogo Soybean Watermelon	Gambir Lemon Tea *Morinda citrifolia* Peppercorn
Closed or light intensity 50%	Cardamom *Curcuma xanthorrhiza* Ginger *Koempheria galanga* Laos Turmeric	Coffee Salak Vanili

TECHNICAL ASPECT IN INTERCROP MANAGEMENT

Soil and Climate (Pedo-Climate) Aspects

Soil and climate (Pedo-Climate) represent the natural factor which determines the achievement of farming. The physical and chemical properties, and topography of soil, rainfall and the number of rainy days should be well understood.

Soil

Location of rubber plantation in Indonesia especially spread alongside the Sumatra Island, West Kalimantan, Central Kalimantan and South Kalimantan Provinces (93% of total rubber area in Indonesia). The dominant soil type in the rubber area is Red Yellow Podsolic (Ultisol). Special characteristic of this type of soil is very thin topsoil, between 5-15cm, low in organic materials, low in N, P, K, Mg, Ca, high acidity (low pH), existence of iron concretion in soil which varies in depth and thickness and cause slowdown root growth. Table 2 presents the quantitative data of soil analysis.

Land where the concretion layer emerges at depth less than 50 cm, shall not be cultivated for food crop, because many problems will come up, such as aluminum poisoning which causes dwarfishness at paddy and maize and soybean.

Soil topography is generally flat until hilly. At this condition, opened soil will be easy to be eroded, especially at the rainy season. Choosing soil preparation and proper technical of crop culture to conserve and sustain farming (the conservation soil preparation) is very important in this soil which is sensitive to degradation.

Table 2. Analysis result of the Red Yellow Podsolic at various depth in South Sumatra

Depth (cm)	pH		Organic Matter (%)		p (Bray II)	Cation (me/100 g soil)			CEC me/ 100 g soil
	H_2O	KCl	C-Org	N Total		K	Ca	Mg	
0-20	4.9	3.6	2.94	0.19	4	0.31	0.63	0.12	10.8
20-40	4.9	3.5	0.88	0.09	3	0.03	0.50	0.06	13.3
40-60	4.9	3.5	0.67	0.08	1	0.06	0.39	0.05	12.1
60-80	4.9	3.4	0.40	0.05	1	0.05	0.32	0.01	10.3
80-100	4.9	3.4	0.39	0.03	1	0.02	0.34	0.03	10.0

Rain

Climatic variable which have to be paid attention to is rainfall and rainy days. The system developed by Schmidth-Ferguson is more adaptable for forestry, while Oldeman is suitable for the agricultural sector, specially food crop.

Cultivation of intercrop could be started in June by growing short-aged vegetable crop such as long bean, then in September - October continued by growing upland rice, to get the even and sufficient rainfall distribution. At the harvesting time, about 4-5 months later, rainfall have started to decrease which is good to dry paddy. At next period, farm let the field lay fallow until the next cultivation season.

Planting time and crop type related to the availability of water is very crucial in determining the success of crop pattern (Figure 1). As an illustration the amount of water required by various monthly food crop is presented in Table 3. In general, the most crucial stage in crop cycle, in the case of availability of water is the period of planting and flowering. At first stage, if water deficit occurred in the planting time, it will decrease the population of intercrop, while water deficit at flowering will reduce yield.

Technical Aspect of Cultivation

The quality of rubber plant material and intercrops, play an important role in achievement of intercrop at rubber plantation. At present, seed from various type of intercrops is easy to be bought in agricultural shops.

Besides the quality of seed, availability of prime seed variety at farmer level also have to be paid attention to, if it was not available on schedule the productivity of upland rice will decline. Good adaptation of various local variety to condition of its environment, makes farmer prefer the local variety for particular crops.

Cultivation of intercrops at Red Yellow Podzolic soil, especially maize and soy bean which are sensitive to Al toxicity, require the improvement of the condition of soil before planting. Research result on soil conservation preparation for maize between rubber at Sembawa (Wibawa *et al.*, 2000) indicated that minimum soil preparation (MSP) (once plow

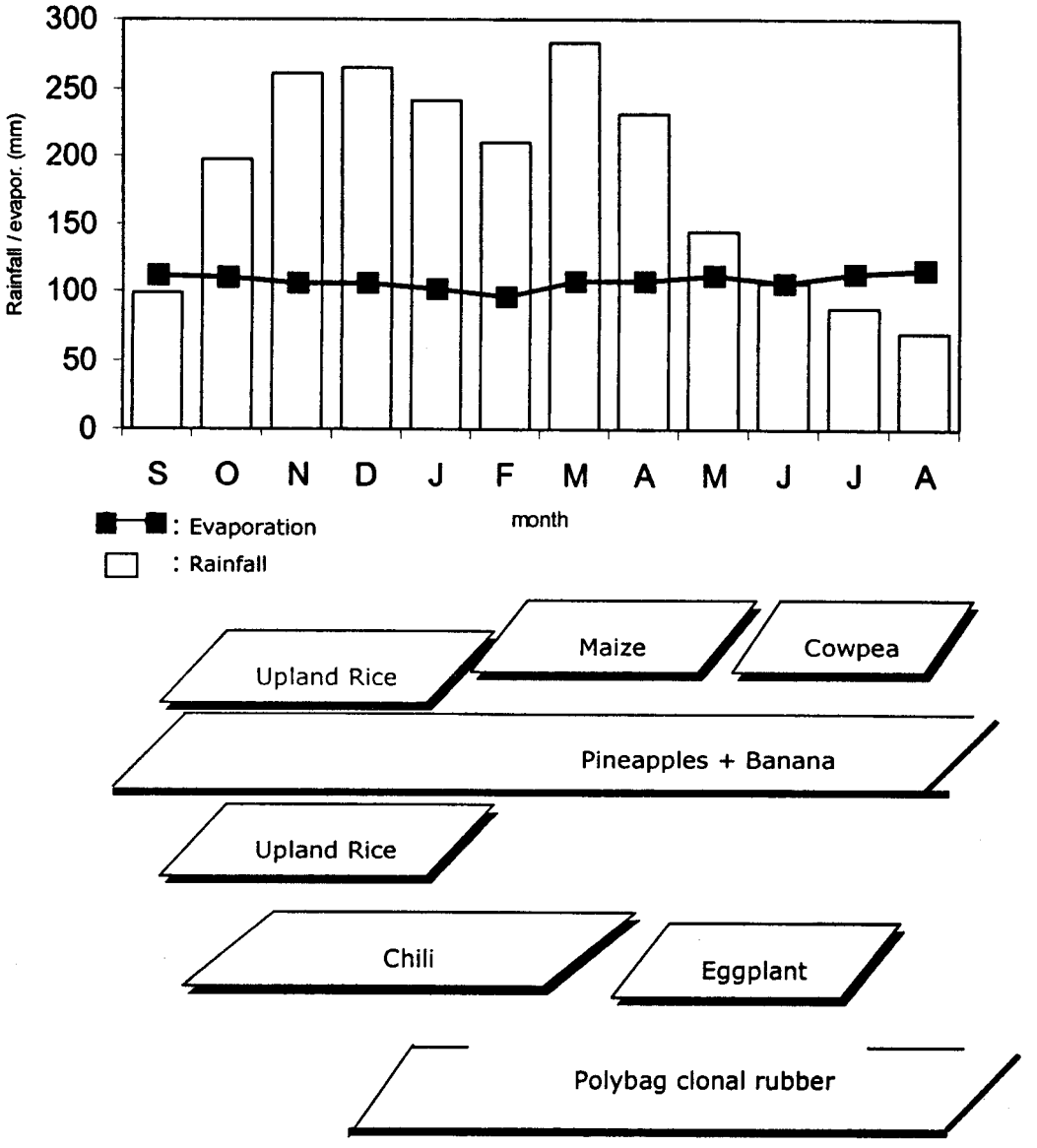

Figure 1. Example of crop pattern arrangement with various intercrop type between rubber according to rainfall pattern in South Sumatra

Table 3. Monthly amount of water required by various food crops

Crop type	Water consumption per month (mm)	Growing period (month)	Total water consumption (mm)
Up land rice*	100-150	4-5	400-750
Maize	85-100	3	255-300
Peanut	80-100	3	240-300
Soybean	75-100	3	225-300

Source : Kung (1971)* modified

and harrow) could be done only just at the first year. This system is better in reducing Al saturation on the surface of soil (20 cm) compared to optimum soil preparation (OSP) (twice plow and harrow). Application of lime in order to reduce the Al saturation could be done near maize crop row (20 cm of maize line) in every planting season at dose of about 1,000 kg/ha. Aluminum saturation as much as 50% will produce minimum 4 ton/ha maize and about 5 ton/ha if Al saturation Al is about 25%. In the early year of planting the minimum soil preparation (MSP) boost up the saturation of Al at soil depth of 20 cm, while with the optimum soil preparation (OSP) the Al saturation is almost no change from previous condition. Organic matter of soil decreases with optimum soil preparation.

At the next observation, at depth 0-20 cm, soil pH of both treatments (MSP and OSP) and the Al saturation decreased compared to previous year, come up with the level assumed not toxic to maize, which is below/under 70%. The difference of aluminum saturation which is high enough between MSP and OSP in the early research, decreased at the second year. The deeper the soil, the pH and nutrient content become lower, on the contrary the contents of Al increases so that Al saturation increases too. This condition is confirmed with what had been found in Red Yellow Podzolic soil at Sitiung, West Sumatra (Aryan *et al.*, 1992).

Rubber tree, especially in the early period of its growth, is sensitive to water stress. Therefore, crop pattern arrangements to reduce the water stress to rubber need to be done. One of this, is to arrange intercrop distance, especially when planted at dry season, or for the type of annual or biennale crop. Food crops which are planted in the rainy season, do not need the special distance to the young rubber since water is available. Figure 2 shows the of influence of soil water content to the growth of rubber girth.

Practically, clean weeding of young one year old rubber should be done in radius of 1 m, then at the following year weeding could be done 0.75-1 m at the left and right of rubber row, especially at dry season to reduce water competition. The rubber row not cultivated by intercrop or spaced out to intercrop with the rubber, is generally occupied by weed. Weeding is more focused at intercrop than rubber. Thereby, although farmer plant

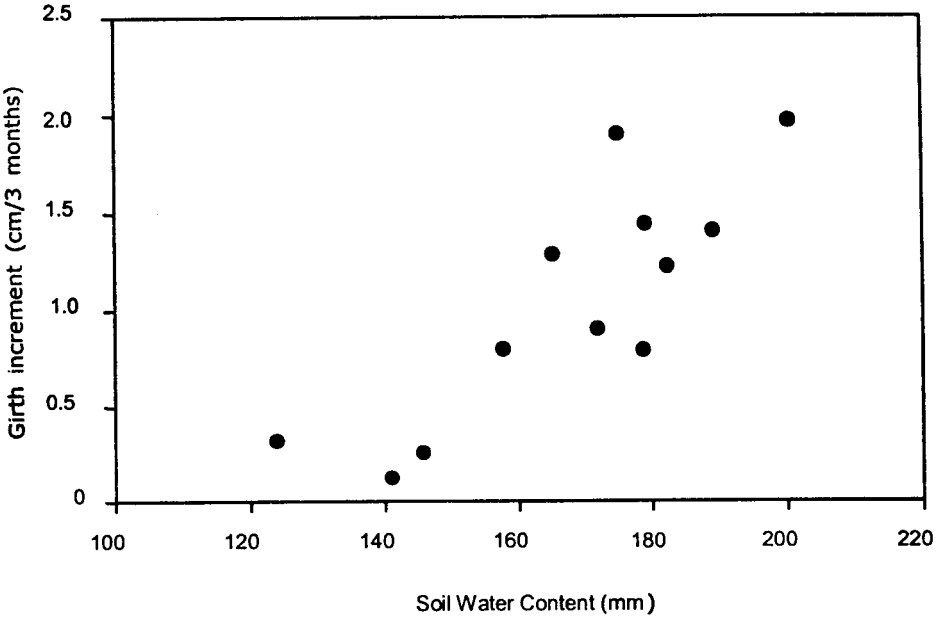

Figure 2. Influence of soil water content on the growth of rubber girth

the intercrops very closed to rubber, as far as that crop was cultivated at the rainy season, it will not retard a lot on rubber growth, at condition in which high input for intercrop input is given, rubber will grow better.

The effect of intercrop on rubber growth varies, depends on intensity of intercrop maintenance, crop pattern and type of intercrops. In general, for annual intercrops pattern such as food and horticultural crops, the rubber growth will not be affected so much as far as water competition can be minimized by planting arrangement, compared with rubber growth with leguminous cover crop (LCC).

Research results conducted by Wibawa *et al.* (1997) indicated that immature rubber growth depend on intercrop or rubber interrow management. Based on this result, farmer typology based on intensity of intercrop management has been made (Table 4). The more intensive and longer period of intercrop management will be better for rubber growth. The maximum difference in rubber girth, which is caused by the effect of different intercrop pattern management until end of research, is 15:41 cm between slowest and fastest growth.

Result of this research also indicated that the technology needed by farmers, at the same area, was different from one farmer to the other. This condition depend on the internal condition of farmer. For farmer, quick rubber growth is the only target of farming. Achievement of his farming goal will be based on the ability at level of farmer family (land,

Table 4. Basic criteria of class/ typology of intercrop cultivation in farmer land

Class	Characteristic of crop management intercrop and rubber interrow				
	Soil preparation	Fertilizer	Intercrop	Maturity of rubber	Weeding of rubber row
1	optimum	livestock manure, N, P, K	Intercrop management very intensive, more than 2 years : chili, watermelon	before 5 years old	
2	plow, harrow	according to recommend-ation dose	ground cover of LCC during two year afterwards change with the natural grass	about 5 years old	2-3 m
3		Minimum, less than ¼ recommend-ation dose	paddy for two years	about 6 years old	2-3 m row is cleaned at least every 4 months
4		without	paddy during first 1-2 years, annual crop planted at the same time with the first paddy cultivation	between 6-7 years old	not regular, grass and broad leaf are dominant weeds
5		without	Paddy only cultivated one year	more than 8 years	without mainte-nance, weed is *Imperata cylindrica* or mixture

labor, capital). At condition, when farmer is unable to buy the input production (fertilizer, herbicide) which usually require cash, farmer will accommodate family labor for compensation.

This result of typology, also give indication that since early growth, intercrop have taken effect to growth of rubber tree. The influence could be positive or negative. To lessen the negative effect, some aspects required to be paid attention to, for example soil preparation, rubber and intercrop fertilization with the organic manure and also inorganic fertilizer, weeding and intercrop pattern.

THE ROLE OF INTERCROPPING IN SUPPORTING PARTICIPATORY RUBBER REPLANTING PROGRAM

Rubber replanting causes the decrease or loss of the source of farmer earning during immature rubber. Important solution to overcome this earning loss problem is by cultivation of intercrop between rubber. Intercrop cultivation between rubber has been admitted very adaptive to the farmer tradition. Farmer could improve the efficiency in utilization of

land and labor. Beside that, result of research indicated that the growth of rubber tree was not decreasing, even in many cases the growth of rubber was better compared to rubber growth with standard legume cover crop (LCC) (Wibawa *et al.*, 1997; Wibawa *et al.*, 1999).

New rubber trees start to yield at age between 5 to 6 years, depend on intensity of the maintenance and type of planting material. In this long waiting period, farmer will lose part of source of earning from its rubber production. Farmer also have to pour family labor or hire labor if shortage of family labor, or invest its capital for buying planting materials, fertilizer, herbicide, fence etc.

Based on calculation of replanting expenses using polybag clonal planting material with medium cost maintenance, the farmers have to provide at least about 1.8 million Rupiahs/ha at one year for early rubber replanting, expense of equipment and material. If labor should be hired, it needs at least about 1.4 million Rupiahs/ha or the total is about 3.2 million Rupiahs/ha. As a whole until tapping at age of 6 years, expenses are about Rp 9.3 million, where almost half of them is labor cost. That amount is big enough to all farmers. At that condition, cultivation of commercially valuable or good market intercrops, such as chili, watermelon and pineapples during the immature period of rubber will be very helpful to get the source of income for them. Food crops could fulfill the farmer family needs, for example paddy which can give the supply food to farmer, for at least first two years of rubber planting.

Intercrop cultivation make farmer efficient in utilization of its limited family labor. In general, from morning until daytime, farmers concentrate on tapping their rubber. If farmer replants his rubber, labor looked after rubber field and also for the maintenance of intercrop. The intensity of intercrop maintenance is also very important to its rubber plantation security from pest attack (pig, ox, monkey) which often happened in region of rubber smallholder centre.

Result of study and primary data collected from various sources indicate that yield from intercrop cultivation vary among farmers for the same intercrop type. This is due to the variation of seed quality, intensity of availability and utilization of means and also technology used by them. Research result from Indonesian Rubber Research Institute concerning technical and financial aspects of annual intercrop (food, horticulture) and shade tolerant from various species of *empon-empon*, and also medicinal crop which are able to be used as reference in intercrop cultivation, is described at Table 5 up to Table 8 (Wibawa *et al.*, 2000).

Calculation of those various intercrop cultivation shows that it is profitable. Therefore, cultivation of intercrop between rubber would overcome the problem of earning loss during immature period of rubber tree when farmers do replanting. But that also depends on various conditions, especially supporting institute. Supporting institute need to achieve the success of intercrop cultivation, availability of input market where farmers would be able to buy input production as well as market output to absorb their intercrop production. These factors are generally not available at farmer level. Availability of market also need the adequate transportation system, so that price received by a farmer would be better.

Table 5. Crop distance and fertilizer dose to various intercrop between 0-3 years old rubber

Crop Pattern / Crop	CD (cm)	D (cm)	PT	Fertilizer (kg/ha)				
				Urea	SP 36	KCl	Lime	Green manure
Maize + Paddy Gogo - Soybean - Cowpea Pattern								
Maize	200 x 25	100	Early	75	90	50		
Paddy Gogo	40 x 10	140	Early	75	150	75		
Soybean	40 x 10	100	Mid	50	90	50	200	
Cowpea	40 x 20	100	End	50	50	50	200	
Maize + Groundnut - Maize + Soybean - Cowpea Pattern								
Maize	200 x 25	100	Early	75	90	50		
Groundnut	40 x 20	140	Early	50	100	75	200	
Maize	200 x 25	100	Mid	75	90	50		
Soybean	40 x 10	140	Mid	50	90	50	200	
Cowpea	40 x 20	100	End	50	50	50	200	
Banana + Pineapples Pattern								
Banana	600 x 300	300*	Early	150	100	100		10,000
Pineapples	100 x 50	150	Early	100	75	50	250	
Chilli	80 x 60	85	Mid	150	175	100		10,000
Watermelon	200 x 150	200	Mid	75	150	75		5,000

CD = crop distance

D = distance from rubber row

PT = planting time (... rainy season)

* = diagonal

Table 6. Yield and benefit of various intercrops between 0-3 years old rubber

Crop Pattern	Year I	Year II	Year III	Price	Year I	Year II	Year III
	(kg/ha)			(Rp/kg)	Value (000 Rp)		
Maize + Paddy Gogo - Soybean – Cowpea Pattern							
Maize	1,500	1,200	900	1,500	2,250	1,800	1,350
Paddy gogo	1,900	1,750	1,200	1,250	2,375	2,187.5	1,500
Soybean	1,100	950	750	3,500	3,850	3,325	2,625
Cowpea	1,250	1,200	615	2,500	3,125	3,000	1,537.5
Total Revenue					11,600	10,312.5	7,012.5
Cost					7,250	6,800	5,500
Benefit					4,350	3,512.5	1,512.5
B/C					1.6	1.52	1.28
Maize + Groundnut - Maize + Soybean – Cowpea Pattern							
Maize	1,750	1,500	1,200	1,500	2,625	2,250	1,800
Groundnut	2,750	2,500	2,200	2,000	5,500	5,000	4,400
Maize	1,500	1,100	950	1,500	2,250	1,650	1,425
Soybean	1,000	950	700	3,500	3,500	3,325	2,450
Cowpea	1,250	1,100	700	2,500	3,125	2,750	1,750
Total Revenue					17,000	14,975	11,825
Cost					7,500	6,250	5,250
Benefit					9,500	8,725	6,575
B/C					2.27	2.4	2.25
Banana + Pineapples Pattern							
Banana		300	400	10,000		3,000	4,000
Pineapples		12,000	14,000	500		6,000	7,000
Total Revenue						9,000	11,000
Cost						3,500	3,500
Benefit						5,500	7,500
B/C						2.57	3.14
Chili							
Revenue	9,000	7,500	6,000	5,000	45,000	37,500	30,000
Cost					12,500	12,500	12,500
Benefit					32,500	25,000	17,500
B/C					3.6	3	2.4
Watermelon							
Revenue	34,000	25,000	20,000	500	17,000	12,500	10,000
Cost					6,000	4,000	4,000
Benefit					11,000	8,500	6,000
B/C					2.80	3.12	2.50

Table 7. Crop distance and fertilizer dose to various intercrops between rubber > 3 years old (time planted – early rainy season)

Crop Pattern / Crop	Crop distance (cm)	Distance from rubber row (cm)	Fertilizer (kg/ha)			
			Urea	SP 36	KCl	Green manure
Cardamom	100 x 100	100	125	125	50	5,000
Ginger	80 x 80	100	150	250	100	5,000
Turmeric	100 x 100	100	150	200	100	2,000
Curcuma xanthorrhiza	100 x 100	100	150	200	100	2,000

Table 8. Yield and benefit of various intercrops between 4-6 years old rubber

Intercrop	Year IV	Year V	Year VI	Price	Year IV	Year V	Year VI
	(kg/ha)			(Rp/kg)	Value (Rp)		
Cardamom							
Revenue	450	600	750	3,500	1,575	2,100	2,625
Cost					1,500	750	750
Benefit					75	1350	1,875
B/C					1.05	2.8	3.5
Ginger							
Revenue	4,000	4,000	4,000	2,000	6,000	6,000	6,000
Cost					4,300	4,300	4,300
Benefit					1,700	1,700	1,700
B/C					1.4	1.4	1.4
Turmeric							
Revenue	4,500	4,500	4,500	1,200	5,400	5,400	5,400
Cost					2,250	2,250	2,250
Benefit					3,150	3,150	3,150
B/C					2.4	2.4	2.4
Curcuma xanthorrhiza							
Revenue	4,500	4,500	4,300	1,000	4,500	4,500	4,300
Cost					1,750	1,750	1,750
Benefit					2,750	2,750	2,550
B/C					2.6	2.6	2.6

CONCLUSION

Acceleration of self-supporting rubber replanting could be done through the increase of the participatory and empowering of farmers and plantation society which is supported by the availability of acceleration of technological adoption facilities, one of them is intercrop technology. Intercrop management in replanting program is important to fill the earning loss during rubber immature period and improve intensity of rubber maintenance. By growing intercrops, the establishment of rubber tree is expected to be successful, particularly during immature period or at best the first three years.

Although in calculation intercrop cultivation is profitable or in other words intercrop is feasible to be implemented in order to overcome the earning loss during immature period, it depends on various conditions, especially supporting institute aspect. This institute is expected to support the success of intercrop cultivation, provide availability of market input where farmer could buy various production support as well as output market where they can sell their intercrop production. Availability of market also need the adequate transportation system, so they can receive better price for intercrop production. This supporting institute which guarantees the continuity of intercrop cultivation has to be prepared at the same time with the start of rubber replanting. Participatory rubber replanting program have been prepared to anticipate various technical, economical and also institutional problem.

The common problem faced by farmer in this intercrop cultivation is obstacle in product marketing, if market was not available, product price was not stable and tend to be low. This condition often makes farmer reluctant to continue its intercrop cultivation. Partnership pattern is often suggested as a way to overcome this constraint. But partnership pattern formed temporarily cannot guarantee to solve the constraint above. For example partnership between farmer as producer and harmonious factory/exporter is not yet found. One of the activity in participatory rubber replanting is assistance which is directed to train and strengthen farmer institute in order to support rubber agribusiness activities at local and also regional level.

REFERENCES

Arya, L. M. 1992. Effects of deep replacement of lime on soil properties root growth, water availability, and crop production in acid upland soils of Sitiung, West Sumatra Indonesia. Pemberitaan Penelitian Tanah Pupuk. Pusat Penelitian Tanah, Bogor. 10:21-23.

Buranatham, W., S. Kongsripun, and S. Shugamnert. 1992. Recent Advances in Multiple Cropping with Hevea in Southern Thailand. Paper presented at 7th ANRPC Seminar. Hat Yai. Thailand. 11p.

Direktorat Jenderal Perkebunan. 2002. Statistik Perkebunan Indonesia 2000-2002. Karet. Departemen Pertanian, Direktorat Jenderal Bina Produksi Perkebunan. Jakarta.

Kung, P. 1971. Irrigation Agronomy in Monsoon Asia. AGPC., Misc. FAO Rome. p.106.

Ghani, I. A. 1997. Smallholders Rubber Farming Systems - Issues and Challenges. ANRPC Seminar on Modernizing Sector at Padang, West Sumatra Indonesia 8-10 July 1997. IRRI, Indonesia.

Supriadi, M. 2001. Strategi Pengembangan Karet Rakyat Melalui Peningkatan Partisipasi dan Pemberdayaan Masyarakat Perkebunan. Pusat Penelitian Karet, Balai Penelitian Sembawa. Dok. 012001.

Wibawa, G., Thomas, M. J. Rosyid, D. Tambunan, dan A. Gunawan. 1996. Study of the component interactions in Hevea-based intercropping system. Prosiding Symposium on Farming System Aspects of Natural Rubber (*Hevea brasiliensis*). pp.15-40.

Wibawa, G., M. J. Rosyid, and A. Gunawan. 1997. Study of Hevea-based Intercropping Functioning. Final Report. Indonesian Rubber Research Institute. Sembawa Research Station. 84p.

Wibawa, G., D. Boutin, AFS Budiman. 1999. Development of Smallholder Rubber Alternatives through Rubber-based Agroforestry. Pros. Lokakarya dan Ekspose Teknologi Perkebunan. Buku I. Model Peremajaan Karet Rakyat secara Swadaya. p.89-98. APPI.

Wibawa, G., M. J. Rosyid, and A. Gunawan. 2000. Intercropping in Rubber plantation (technical manual book). Pusat Penelitian Karet, Balai Penelitian Sembawa. 42p.