

## THE POTENTIAL OF COCOA INTEGRATION PLANTING SYSTEMS WITH OTHER ECONOMIC CROPS: CROP DIVERSITY

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**ABSTRACT** - *Integration is a combination of two or more crops or livestock in a piece of land to increase income. It has been practiced in many crops for years in many countries especially in the developed countries. Instead of increasing income to the farmers, integration can also reduce the effect of crop price fluctuation and failure of crops due to pests and diseases outbreak. In Malaysian Cocoa Board, we have tested several integration systems of cocoa with other economic crops to identify the suitable combination especially in order to increase income. The integration systems that have been investigated were cocoa-coconut, cocoa-oil palm, cocoa-fruit trees, cocoa-timber species and cocoa-herb. These integrations were studied in the aspects of the planting system, planting density, yield and income earning. Some of these studies have been carried out for years and some of them are still at the beginning stage. This paper will discuss further on suitability of combination in each planting system. The best combination of planting system gives the highest income to the farmers from both crops.*

**Key words:** cocoa, economic crops, integration, planting system, planting density

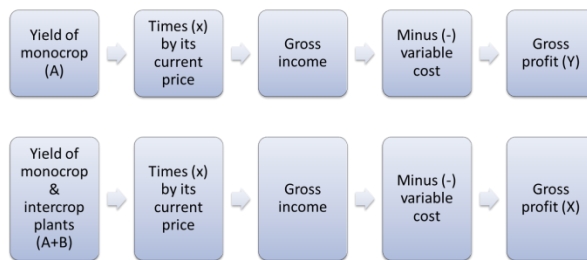
### INTRODUCTION

Integration is a combination of two or more crops or livestock in a piece of land to increase income. It has been practiced in many crops for a long time in many countries especially in developed countries. Instead of increasing income to the farmers, integration can also reduce the effect of crop price fluctuation, where when the price of one crop dropped; other crops can safeguard the income of the farmers. Failure factor of one crop due to outbreak of specific pests and diseases to that crop or due to nature (drought or flood), also can be reduced or can be buffered by the other crops. Apart from that, there are several other benefits that integration can offer. With crop integration, soil erosion due to rainfall can be minimized, the spread of pests and diseases can be reduced since some crops can be a barrier plant, available nutrients in soil and light can be used

efficiently by both crops especially if selected crops are different in root depth and plant height, respectively and lastly, integration can reduce competition between crops and weeds where, with full stands of both integration crops, the penetration of light to the ground is less and depress weed growth.

In the nature of cocoa cultivation, it needs shade trees to have better growth and higher yield. Therefore, the combination of cocoa with other suitable crops as shade trees is recommended. In many cocoa producing countries such as Ghana (Osei-Bonsu *et al.*, 1996) intercropping cocoa with staple foods such as maize, plantain, yam and cassava has been practiced for a long time.

In order to gain maximum crops yield in the intercropping systems, the selected plants must have enough space to grow, timely efficient and the most important is minimal competition factors between the crops. Beets (1982) stated that the plants used under intercropping system should be the ones which have different growth potential: they even can give mutual benefit. The evaluation on the economic aspect that has been developed by Beets (1982) is as in Figure 1.



**Figure 1: Economic evaluation of the intercropping systems (Beets, 1982)**

Other than economic evaluation, land equivalent ratio (LER) was also important in the intercropping system. Land equivalent ratio is the ratio of the area sole cropping to the area under intercropping needed to give equal amounts of yield at the same management level. It can be calculated as follows:

$$LER = \frac{Y_{ci}}{Y_{cm}} - \frac{Y_{di}}{Y_{dm}}$$

Where :

- Y<sub>ci</sub> - Yield of cocoa under intercropping
- Y<sub>cm</sub> - Yield of cocoa under monocrop
- Y<sub>di</sub> - Yield of other plant under intercropping
- Y<sub>dm</sub> - Yield of other plant under monocrop

In Malaysia, integration of cocoa with other economic crops is not new. There are publications on intercropping cocoa with rubber (Denamany *et*

*al.*, 1992 and Denamany, 2000) and oil palm (Denamany and Amiruddin, 1991, Nawi, 1992, Nawi *et al.*, 1994.). Rubber trees are planted in double hedge-row distances of 22m x 3m x 2m (400 plants/ha) and the densities of cocoa planting range from 960 to 2133 trees/ha were tested. Denamany (2000) reported that cocoa planting densities of 1600 plants/ha and higher had yields of more than 2 tonnes/ha/yr in the second years of production. However, lower cocoa densities (960 and 1200 plants/ha) had significantly higher yields (> 2tonnes/ha/yr) compared to higher densities at the sixth and seventh years of production. However, at the fourth year of rubber production, rubber yields of more than 2.2 tonnes/ha/yr were obtained for plots with low cocoa densities (960 and 1200 plants/ha). The hedge system of planting rubber to integrate cocoa is a promising system.

Planting a row of oil palm and 3 rows of intercropped cocoa with a density of 110 and 760 plants/ha respectively gave the maximum returns based on market price of cocoa and oil palm at that time (Nawi, 1991). Oil palm planting was planted at 13m x 7m and cocoa planting distance of 3m x 3m; an average annual yield of 479 kg/ha for cocoa and 17.84 tonnes fresh fruit bunch (ffb)/ha oil palm respectively were obtained. The highest cocoa yields were obtained from plots where the oil palm was planted in a double row hedge at 7m x 7m and cocoa was planted in five rows (Nawi *et al.*, 1984). A systematic thinning of 2 rows of oil palm out of every 6 consecutive rows to accommodate cocoa trees showed promising cocoa yields (Denamany & Amiruddin, 1991). With a cocoa density of 625 plants/ha, yields of more than 400 kg/ha could be achieved in the third year of production. Yields from the 10-year old oil palm ranged from 14-15 tonnes ffb/ha.

Although there were publications on this subject, there is still a space to study other crop combinations to evaluate in order to get the best combinations of crops. Therefore, this study was undertaken to observe the suitable combination for integration of cocoa with other economic crops.

## MATERIALS AND METHODS

This study has been carried out in several Malaysian Cocoa Board Research and Development Centre, i.e. Jengka, Bagan Datuk, Madai and Lundu. It involved few planting patterns of cocoa integrated with other economic crops.

Among the integrations are cocoa with coconut, fruit crops (durian, dokong), oil palm, rubber, timber species (mahogany, sentang, kelampayan). Table 1 below shows the intercropping system of cocoa with other economic crops, planting distance and planting density.

**Table 1 :** Intercropping system of cocoa with other economic crops

No	Planting system	Planting distance	Planting density (stands/ha)
<b>1</b>	<b>COCOA-COCONUT</b>		
i	Cocoa	3m x 3m	736
	Coconut	5m x 21 m	147
ii	Cocoa	3m x 3m	677
	Coconut	5m x 18 m	162
iii	Cocoa	3m x 3m	605
	Coconut	5m x 15 m	181
iv	Cocoa	3m x 3m	635
	Coconut	8.5m x 6.5m	104
<b>2</b>	<b>COCOA-DURIAN</b>		
i	Cocoa	3m x 3m	870
	Durian (single hedgerow)	9m x 23 m	48
ii	Cocoa (6 rows)	3m x 3m	670
	Durian (double hedgerow)	9m x 9m x 23 m	72
iii	Cocoa (normal planting)	3m x 3m	1111
	Durian (mix)	12m x 12 m	69
<b>3</b>	<b>COCOA-TONGKAT ALI</b>		
i	Cocoa	3m x 3m	1111
	Tongkat Ali	3m x 3m	1111
ii	Cocoa	3m x 3m	1111
	Tongkat Ali	1m x 3m	3333
iii	Cocoa	3m x 3m	1111
	Tongkat Ali	1.5m x 3m	2222
iv	Cocoa	3m x 3m	1111
	Tongkat Ali	2.25m x 3m	1481
<b>4</b>	<b>COCOA-DOKONG</b>		
i	Cocoa (3 rows)	3m x 3m	758
	Dokong (1 row)	7m x 13.2m	108
ii	Cocoa (4 rows)	3m x 3m	844
	Dokong (1 row)	7m x 15.8m	90
iii	Cocoa (5 rows)	3m x 3m	906
	Dokong (1 row)	7m x 18.4m	78
iv	Cocoa (6 rows)	3m x 3m	952
	Dokong ( 1 row)	7m x 21m	68

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<b>COCOA-OIL PALM</b>			
i	Cocoa (normal planting)	3m x 3m	664
	Oil palm (2 rows, perimeter planting)	10m x 10m	38
ii	Cocoa (normal planting)	3m x 3m	1,008
	Oil palm (1 row, perimeter planting)	10m x 10m	21
iii	Cocoa (6 rows)	3m x 3m	595
	Oil palm (double hedgerow)	10m x 10m	69
iv	Cocoa (6 rows)	3m x 3m	524
	Oil palm (single hedgerow)	10m x 10m	33
v	Cocoa (3 rows)	6m x 3m	281
	Oil palm (double hedgerow)	10m x 10m	72
vi	Cocoa (3 rows)	3m x 3m	440
	Oil palm (single hedgerow)	8.5 m x 6 m	146
vii	Cocoa (4 rows)	3m x 3m	527
	Oil palm (single hedgerow)	8.5 m x 6 m	131
viii	Cocoa (5 rows)	3m x 3m	597
	Oil palm (single hedgerow)	8.5 m x 6 m	119
ix	Cocoa (6 rows)	3m x 3m	655
	Oil palm (single hedgerow)	8.5 m x 6 m	109
<b>6</b>			
<b>COCOA-TIMBER SPECIES</b>			
i	Cocoa (5 rows)	3m x 3m	818
	<i>Neolamarckia cadamba</i> (kelampayan) - (double hedgerow)	3m x 24.46m	204
ii	Cocoa (5 rows)	2m x 2m	1,302
	<i>Khaya senegalensis</i> (mahogany) - triple hedgerow	2m x 3m	651
iii	Cocoa (5 rows)	2m x 2m	1,378
	<i>Khaya ivorensis</i> (mahogany) - double hedgerow	2m x 3m	689
iv	Cocoa (5 rows)	2m x 2m	1,378
	<i>Azadirachta excelsa</i> (sentang) - double hedgerow	2m x 3m	689
<b>7</b>			
<b>COCOA-SOURSOP</b>			
i	Cocoa (6 rows)	3m x 3m	689
	Durian belanda (double hedgerow)	4m x 4m	172

## RESULTS AND DISCUSSIONS

Till to date, there are more than 7 economic crops that have been intercropped with cocoa with more than 30 planting systems which have been tested in MCB. Among these planting systems, some of them have already established on the ground for more than 10 years and the data was previously published. But there are still many planting systems that are under research and just planted for approximately less than 5 years. Therefore, this section will discuss the revenue and its pro and con either based on actual production or estimation by its plantings system.

### *Intercropping of cocoa-coconut planting systems*

Table 2 below shows an actual or estimation of each planting system in cocoa-coconut intercropping. An actual production and revenue on the cocoa-coconut planting systems (systems no. i - iv) in Cocoa Research and Development Centre (CRDC), Jengka, Pahang were extracted from Nurfadzilah and Rozita (2018a). It was an average of five years production data, which is 6 to 11 years after planting. Based on this four planting systems, it is clearly shown that intercropping of cocoa and coconut gave higher revenue (RM15,000 - RM17,000) compared to cocoa alone (RM6,800). Meanwhile, an estimation of revenue when planting coconut alone shows the highest (system no. vi) (RM25,000) compared to any cocoa-coconut planting systems. Despite that, intercropping still can be a good option in order to minimize the risk of commodity price fluctuation for both crops and to safeguard if any outbreak of pests and diseases occurred to both crops.

Under system no. v, which is a planting system that has been applied in CRDC Bagan Datuk and yield was estimated based on previous papers (Ahmad Kamil *et. al.*, 2013, Hakim and Redzuan, 2011) shows that this combination of cocoa-coconut gave the highest yield.

From field observation, intercropping cocoa-coconut is easier to maintain especially in terms of

crops agricultural best practices. Coconut trees itself are low maintenance crops with lower root systems compared to cocoa which needs more intensive care with deep root systems. These root systems give both crops an opportunity to absorb nutrients more efficiently. Furthermore, both crops did not share the same pathogens, making this combination of crops is viable.

### *Intercropping of cocoa-fruit trees planting systems*

Table 3 shows a few of cocoa-fruit trees planting systems. There are cocoa-durian (Nurfadzilah and Rozita, 2016), cocoa-dokong (Nurfadzilah and Rozita, 2018b) and cocoa-soursop planting systems.

Among these three fruit trees, intercropping between cocoa-durians shows the highest income where farmers can get approximately RM40,000 to RM60,000 per year depending on the planting system. Although the income of this intercropping looks more lucrative than other combinations of intercropping, there are challenges to face when intercropping cocoa with durian. Based on our experiences, most durian trees were attacked by canker disease which caused by *Phytophthora palmivora*. Eventually, infected trees were killed although all prevention measures have been taken such as wiping the infected area at the stem with fungicide especially metalaxyl. Most of them died at the average age of 10 years after planting. Cocoa and durian share the same pathogen, *Phytophthora palmivora*, which causes disease infection. Without proper management, it can kill both crops at the same time.

For cocoa-dokong intercropping systems, 3 rows of cocoa with 1 row dokong gives the highest yield compared to other intercropping systems. More income comes from dokong compared to cocoa when the estimation price of dokong is at RM1.50/kg (farm gate price). However, when referring to the ground situation, most of the time, the price of dokong is only at RM0.50 - RM1.00/kg, and sometimes it is just left ripe

underneath trees because the price is too low compared to the harvesting cost. In addition, dokong is seasonal crop and it can rotten faster without proper storage. Therefore, cocoa can protect farmers during this situation.

Other potential intercropping of cocoa is with soursop. As we knew, soursop became popular after it was claimed to have many medicinal values such as having high vitamin C and antioxidant content, increased body immunization and etc. In CRDC Jengka, this project is just at the beginning stage. Production of cocoa was just started a few years ago and production of soursop fruits is still inconsistent. Therefore, it is only an estimation of yield of both crops based on a report published by a related agency. From an estimation, this combination of intercropping is worth where it can generate income up to RM22,000/year which is RM1,833.00/month. However, during our observation, the main problem of soursop is the fruit frequently has fruit disorder like rotten. We have used various control measures such as wrap the fruits, spray with insecticide and fungicide. But all these measures still did not work on the fruit disorder.

#### ***Intercropping of cocoa-tongkat ali planting systems***

Intercropping of cocoa with herb, tongkat ali also has been evaluated in CRDC Jengka, Pahang. In this system, planting density of cocoa is still the same as cocoa monocrop since tongkat ali is a plant that has a single stem without branches (Table 4). Tongkat ali are planted in between cocoa trees with four planting distances. The planting distances for tongkat ali were 1m x 3m, 1.5m x 3m, 2.25m x 3m and 3m x 3m. Based on actual yield data (both for cocoa and tongkat ali) by Nurfadzilah and Rozita (2015), system no. i, which is tongkat ali was planted at higher density (3,333 stands/ha) gave the highest revenue. However, yield of tongkat ali is only once in its life span, but it can be planted again if needed. With this intercropping system, instead of income from cocoa only, farmers can have an extra income from tongkat ali. From our

experience, tongkat ali does not need any extra care during its growth.

#### ***Intercropping of cocoa-oil palm planting systems***

Oil palm is one of the crops that have been widely planted in Malaysia. One of the reasons why oil palm is being selected as a popular crop among farmers or estates is because it is believed to offer profitable income with minimum maintenance. Thus, intercropping cocoa with oil palm (Table 5) is also tested in CRDC Jengka (system no i - vi) and in CRDC Madai (system no. vii - x) to evaluate its suitability.

Yield of both crops in CRDC Jengka is only estimation since this research has just started and production is just at the beginning. All cocoa-oil palm planting systems (Table 5) show that revenue gained from both crops are very low which is between RM5,700 - RM9,000/year. So do the cocoa-oil palm planting systems in Madai, Sabah which have been well-established for more than years. Yield in the plots were very low due to attacks by monkeys from nearby forest. Therefore, both yield (cocoa and oil palm) was only an estimation. Based on estimation, any planting system also has low revenue which is only around RM10,000/year.

When compared to cocoa monocrop (estimated 1.00tonne/ha with price of RM8,000/tonne), revenue from cocoa alone is higher than some of the intercropping systems. Meanwhile, revenue from oil palm in the monocrop system is approximately RM7,000/year based on yield 20tonne/ha/year with price of RM350.00/tonne. Thus, in terms of revenue, there is not much difference between cocoa monocrop or intercrop with oil palm. However, for security purposes, this combination of intercropping is still viable.

***Intercropping of cocoa-timber species planting systems***

In addition to the intercropping cocoa with common economic crops such as coconuts, fruit trees and oil palm, intercropping cocoa with timber species was also studied. A research was carried out in CRDC Bagan Datuk in 2002 to evaluate the suitable planting systems and timber species (Table 6). There are three species of timber; *Khaya senegalensis* (Mahogany), *Khaya ivorensis* (Mahogany) and *Azadirachta excelsa* (Sentang). In this trial, cocoa was planted at 2m x 2m planting distance in 5 rows which is high density planting. Whilst, *Khaya senegalensis* was planted at 2m x 3m planting distance in triple hedgerow and the other two species of timbers were planted at 2m x 3m planting distance in double hedgerows.

Cocoa yield was estimated since the actual data on that plot was not recorded properly due to the changes in officer in charge during the time. Estimated yield shows that all cocoa-timber planting systems in CRDC Bagan Datuk have similar yield. For timber, till to date, after 18 years planting, it is still not harvested. Estimation on the revenue from timbers is not available since there is no information on those timbers in Malaysian Timber Industry Board (MTIB) and Department of Forestry (DoF) website.

Meanwhile, another intercropping cocoa-timber was developed in CRDC Jengka. *Neolamarckia cadamba* or cadamba was selected to be intercropped with cocoa in 2014. There is also no information on revenue of this timber species in the related website. Although estimation on revenue from these planting systems cannot be made at the moment, from observation, planting distance of cocoa with timber needs to be revised (especially in CRDC Bagan Datuk). After years of planting, timber trees become denser and give more shade to cocoa trees, eventually will lower yield of cocoa since cocoa needs 70% sunlight during its mature phase. Furthermore, closed distance between cocoa and timber lead the branches of timber to drop on cocoa trees and interferes with the development of the trees.

**Table 2 : Actual/estimated production and income of each planting density/system per hectare in cocoa-coconut planting systems**

No	Planting system	Planting distance	Planting density (stands/ha)	Average yield/year*	Average gross income/year (RM)	Average gross income combination/year (RM)	References*
i	Cocoa (4 rows)	3m x 3m	736	911.56	7,292.48	15,595.48	Nurfadzilah and Rozita, 2018a
	Coconut (double hedgerow)	5m x 21 m	147	8,303	8,303.00		
ii	Cocoa (5 rows)	3m x 3m	677	811.22	6,489.76	15,226.76	<i>Estimation price:</i> a. cocoa - RM8,000/tonne b. coconut - RM1.00/nut
	Coconut (double hedgerow)	5m x 18 m	162	8,737	8,737.00		
iii	Cocoa (6 rows)	3m x 3m	605	659.67	5,277.36	15,429.36	
	Coconut (double hedgerow)	5m x 15 m	181	10,152	10,152.00		
iv	Cocoa only	3m x 3m	1,111	861.49	6,891.92	6,891.92	
v	Cocoa (6 rows)	3m x 3m	635	635	5,080.00	17,560.00	<i>Estimation cocoa</i> a. 1kg/tree/year
	Coconut (single hedgerow)	8.5m x 6.5m	104	12,480	12,480.00		<i>Estimation coconut</i> (Hakim & Redzuan, 2011)
vi	Coconut only	8.1m x 8.1m	178	25,000	25,000.00	25,000.00	a. Yield - 25,000 nuts/ha



**Table 3: Actual/estimated production and income of each planting density/system per hectare in cocoa-fruit trees planting systems**

No	Planting system	Planting distance	Planting density (stands/ha)	Average yield/year*	Average gross income/year (RM)	Average gross income combination/year (RM)	References*
<b>A</b>							
<b>COCOA-DURIAN</b>							
i	Cocoa	3m x 3m	870	526.84	4,214.72	40,214.72	Cocoa - Nurfadzilah and Rozita, 2016
	Durian (single hedgerow)	9m x 23 m	48	2,400	36,000.00		
ii	Cocoa (6 rows)	3m x 3m	670	507.06	4,056.48	60,056.48	<i>Estimation - durian</i> a. Yield - 50 fruits/tree/year b. Weight - 1.5kg/fruit c. Price - RM10.00/kg
	Durian (double hedgerow)	9m x 9m x 23 m	72	3,600	54,000.00		
iii	Cocoa (normal planting)	3m x 3m	1111	561.22	4,489.76	56,239.76	
	Durian (mix)	12m x 12 m	69	3,450	51,750.00		
<b>B</b>							
<b>COCOA-DOKONG</b>							
i	Cocoa (3 rows)	3m x 3m	758	758	6,064.00	17,404.00	Nurfadzilah and Rozita, 2018b
	Dokong (1 row)	7m x 13.2m	108	7,560	11,340.00		
ii	Cocoa (4 rows)	3m x 3m	844	844	6,752.00	16,202.00	<i>Estimation - cocoa</i> a. Yield - 1tonne/ha/year b. Price - RM8,000/tonne
	Dokong (1 row)	7m x 15.8m	90	6,300	9,450.00		
iii	Cocoa (5 rows)	3m x 3m	906	906	7,248.00	15,438.00	<i>Estimation - dokong</i> a. Yield - 70kg/tree/year b. Price - RM1.50/kg
	Dokong (1 row)	7m x 18.4m	78	5,460	8,190.00		
iv	Cocoa (6 rows)	3m x 3m	952	952	7,616.00	14,756.00	
	Dokong ( 1 row)	7m x 21m	68	4,780	7,140.00		
<b>C</b>							
<b>COCOA-SOURSOP</b>							
i	Cocoa (6 rows)	3m x 3m	689	689	5,512.00	22,712.00	<i>Estimation - cocoa</i> a. Yield - 1 tonne/ha/year b. Price - RM8,000/tonne <i>Estimation - soursop :</i> a. Yield 20pcs/tree/year b. Weight - 1kg/pcs c. Price - RM5.00/kg
	Durian belanda (double hedgerow)	4m x 4m	172	3,440	17,200.00		

**Table 4: Actual/estimated production and income of each planting density/system per hectare in cocoa-tongkat ali planting systems**

No	Planting system	Planting distance	Planting density (stands/ha)	Average yield/year*	Average gross income/year (RM)	Average gross income combination/year (RM)	References*
i	Cocoa (kg/ha)	3m x 3m	1111	1,149.67	9,197.36	25,862.36	Nurfadzilah and Rozita, 2015
	Tongkat Ali (kg/tree)	1m x 3m	3333	3,333	16,665.00		
ii	Cocoa (kg/ha)	3m x 3m	1111	1,596.59	12,772.72	21,660.72	Tongkat ali weight i. 1.0kg/tree ii. 0.8kg/tree iii. 1.1kg/tree iv. 1.25kg/tree
	Tongkat Ali (kg/tree)	1.5m x 3m	2222	1,777.6	8,888.00		
iii	Cocoa (kg/ha)	3m x 3m	1111	1,469.09	11,752.72	19,897.72	Estimation - tongkat ali Price - RM5.00/kg
	Tongkat Ali (kg/tree)	2.25m x 3m	1481	1,629.	8,145.00		
iv	Cocoa (kg/ha)	3m x 3m	1111	1,615.66	12,925.28	19,869.03	
	Tongkat Ali (kg/tree)	3m x 3m	1111	1,388.75	6,943.75		

**Table 5: Actual/estimated production and income of each planting density/system per hectare in cocoa-oil palm planting systems**

No	Planting system	Planting distance	Planting density (stands/ha)	Average yield/year*	Average gross income/year (RM)	Average gross income combination/year (RM)	References*
i	Cocoa (normal planting)	3m x 3m	664	664	5,312.00	7,174.00	<i>Estimation</i> <i>Cocoa :</i> a. Yield - 1tonne/ha b. Price - RM8,000/tonne  <i>Oil palm:</i> a. Yield - 20tonne/ha b. Stands - 143 trees/ha c. 0.14 tonne/tree d. Price - RM350.00/tonne  ** System no. vii-x : cocoa actual yield is very low due to attacked by monkeys from nearby forest in CRDC Madai, Sabah
	Oil palm (2 rows, perimeter planting)	10m x 10m	38	5.32	1,862.00		
ii	Cocoa (normal planting)	3m x 3m	1,008	1,008	8,064.00	9,093.00	
	Oil palm (1 row, perimeter planting)	10m x 10m	21	2.94	1,029.00		
iii	Cocoa (6 rows)	3m x 3m	595	595	4,760.00	8,141.00	
	Oil palm (double hedgerow)	10m x 10m	69	9.66	3,381.00		
iv	Cocoa (6 rows)	3m x 3m	524	524	4,192.00	5,809.00	
	Oil palm (single hedgerow)	10m x 10m	33	4.62	1,617.00		
v	Cocoa (3 rows)	6m x 3m	281	281	2,248.00	5,776.00	
	Oil palm (double hedgerow)	10m x 10m	72	10.08	3,528.00		
vi	Cocoa (6 rows)	3m x 3m	635	635	5,080.00	10,176.00	
	Oil palm (double hedgerow)	6.1m x 9.1m	104	14.56	5,096.00		
vii	Cocoa (3 rows)	3m x 3m	440	440	3,520.00	10,520.00	
	Oil palm (single hedgerow)	8.5 m x 6 m	146	20.0	7,000.00		
viii	Cocoa (4 rows)	3m x 3m	527	527	4,216.00	10,271.00	
	Oil palm (single hedgerow)	8.5 m x 6 m	131	17.3	6,055.00		
ix	Cocoa (5 rows)	3m x 3m	597	597	4,776.00	10,166.00	
	Oil palm (single hedgerow)	8.5 m x 6 m	119	15.4	5,390.00		
x	Cocoa (6 rows)	3m x 3m	655	655	5,240.00	10,315.00	
	Oil palm (single hedgerow)	8.5 m x 6 m	109	14.5	5,075.00		

**Table 6: Actual/estimated production and income of each planting density/system per hectare in cocoa-timber planting systems**

No	Planting system	Planting distance	Planting density (stands/ha)	Average yield/year*	Average gross income/year (RM)	Average gross income combination/year (RM)	References*
i	Cocoa (6 rows)	2m x 2m	1,302	1,302	10,416.00		Estimation - cocoa a. Yield - 1 tonne/ha/year b. Price - RM8,000/tonne  Timber - information on yield and price of the specific timber was not available on the Malaysian Timber Industry Board (MTIB) and Department of Forestry website
	<i>Khaya senegalensis</i> (mahogany) - triple hedgerow	2m x 2m	651				
ii	Cocoa (4 rows)	2m x 2m	1,378	1,378	11,024.00		
	<i>Khaya ivorensis</i> (mahogany) - double hedgerow	2m x 3m	689				
iii	Cocoa (4 rows)	2m x 2m	1,378	1,378	11,024.00		
	<i>Azadirachta excelsa</i> (sentang) - double hedgerow	2m x 3m	689				
iv	Cocoa (5 rows)	3m x 3m	818	818	6,544.00		
	<i>Neolamarckia cadamba</i> (kelampayan) - double hedgerow	3m x 24.46m	204				

## CONCLUSION

In general, there are many advantages in planting cocoa through integration with other economics crops, especially when cocoa is a crop that needs shade to grow healthy and obtain high yield. Therefore, selection of suitable crops to be integrated with cocoa is a continuous process where each selected crop may need different maintenance which might be different from cocoa maintenance. Normally, the selection of crops to be intercropped with cocoa must be from less maintenance crops, do not have strong competition with cocoa and can give optimum income when combining both crops. Above all intercropping planting systems that have been observed on the ground, intercropping cocoa with coconut seemed the most stable combination in terms of revenue and the easiness to maintain the crops.

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