

FEASIBILITY STUDY ON MICROBIAL PRODUCTION AND POTENTIAL FOR COMMERCIALIZATION

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ABSTRACT - *The aim of this study is to find out the potential of the microbial formulation is viable to be produced and commercialized as a bio control agent to overcome the black pod disease and cocoa pod borer (CPB) problems in Malaysia. Black pod disease and CPB are major disease and pest of cocoa in Malaysia. Damages caused by the black pod disease and CPB can result in significant loss of cocoa yield for up to 90%. Currently fungicides and insecticide usage in controlling black pod disease and CPB is widely practised by the cocoa farmers in Malaysia. However, the usage of chemical pesticides is not cost effective to the cocoa farmers and also not environmentally and user friendly approach. Hence, biological control may offer an alternative approach to the management of effective integrated disease management systems. This study will discuss on the production and potential for commercialization of microbial which focus on competitors' analysis on the use of chemical pesticides and microbial formulation in the cocoa plantation. The financial analysis for the production of microbial and the net effect to the cocoa farmers were also discussed. The finding from the study has shown the proposed microbial is cost effective compared to the usage of chemical pesticides, the microbial formulation cost only RM143 per year as compared to chemical pesticides that cost RM900 per year. This means that microbial formulation has potential to reduce the production cost for cocoa farmers in Malaysia.*

Key words: Microbial formulation, Black pod and Cocoa pod borer

INTRODUCTION

MCB's Bio-control Agent is a patented microbial formulation, which is a novel technology for the integrated management of black pod disease and cocoa pod borer (CPB) and also mosses on cocoa. These products of liquid and powder formulation which containing of 6 isolates of epiphytic bacteria (1×10^8 CFU/ml) have a synergistic formulation where the microbes produced Bio-surfactant which create unfavorable condition to CPB to lay the eggs on the cocoa pod surface (mechanical barrier) beside destruction and retardation of mycelium growth, user-friendly technology, synergistic, cost-effective formulation and non-toxic to non-target organisms. This product can also kill the mosses growth on the cocoa stems. This product was successfully mass-produced through fermentation process using a user-friendly technology. (Patent Number: MY-135549-A).

The application of chemical control in the management of cocoa diseases is mainly practiced in the control of black pod and cocoa pod borer, which often shows explosive epidemics. In view of rising consumer concern with the environment and health, and the fact that premium prices are paid for organically grown products, the potential for

environmental friendly and sustainable biological control methods using beneficial microbes to combat pathogens has been investigated. Fungal and bacterial antagonists were collected from the rhizosphere and phylloplane of cocoa. Recent research conducted revealed that certain bacteria and fungi isolated from the surfaces of healthy and infected cocoa pods are antagonistic to *Phytophthora palmivora* (Ahmad Kamil & Mohd Yusoff, 2017; Ishak *et al.*, 2017). Research findings also demonstrated that the bio-control agents could be produced in liquid culture. The use of bio-fermentation for mass production of bio-control agents needs to be cost-effective, and they should cost less than chemicals. The method of application depends on the mode of action of bacteria and should be compatible with established crop-management practices.

Benefits of the product

Microbial formulation is a novel technology for integrated management of black pod and cocoa pod borer on cocoa. Microbial formulation is proven a user-friendly technology, synergistic, cost-effective formulation and non-toxic to non-target organisms. This product is part of the integrated strategies on the

management of major pest and disease and also mosses on cocoa.

Production cost of the product

Table 1 show the cost of producing 400 liter of microbial formulation. The formulation required 320 liter of water, 80 liter of molasses and 4 gram of powder composition. The total cost for producing 400 liter of microbial formulation is RM220.32 which equal to RM0.55 per liter.

Table 1: Production cost of microbial formulation for 400 liter

	Requirement	Cost per unit	Cost
Water Composition	320 liter	0.0006	RM0.20
Molasses Composition	80 liter	2.75	RM220
Powder Composition	4 gram	0.03	RM0.12
TOTAL COST			RM220.32
COST PER LITER			RM0.55

COMPETITOR ANALYSIS

The microbial formulation is proven to be cost-effective compared to chemical pesticides. Microbial formulation is a 2 in 1 strategy which acts as a bio-control agent for fungicides and insecticides. Table 2 compared the cost of using microbial formulation and

chemical pesticides. One hectare of cocoa farm required 3 liters of chemical insecticide and 7.5 kilogram of chemical fungicides, which required investment cost of RM900 per year. Meanwhile, using the microbial formulation, farmers only need to spend around RM143 per year.

Table 2: Comparison of cost between chemical pesticides and microbial

	CHEMICAL PESTICIDES		Microbial
	Insecticide	Fungicide	
Price per unit	RM75 (1 liter)	RM45 (500g)	RM0.55 (1 liter)
Usage per spray	15ml	75g	-
Cost per ml/gram	RM0.08	RM0.09	-
Cost per pump of knapsack sprayer (16 liter/ pump)	RM1.13	RM6.75	-
Cost per ha	RM11.25	RM33.75	RM7.15
Yearly Cost	RM225	RM675	RM143
Yearly Usage	3 liter	7.5kg	260liter
TOTAL YEARLY COST	RM900		RM143

Note: Each year require 20 times of spraying the insecticide/fungicide/ microbial
 Insecticide – 1 hectare requires 10 pumps of knapsack sprayer for each spraying
 Fungicide – 1 hectare requires 5 pumps of knapsack sprayer for each spraying
 Microbial – 1 hectare requires 13 Liter microbial for each spraying

Table 3 shows the production cost of producing cocoa using microbial formulation. One hectare of cocoa required RM3,143 of material cost which consist of GML for RM420, fertilizer for RM2,400, herbicides for RM180 and microbial for RM143 per year.

Meanwhile, Table 4 indicates the cocoa production cost with chemical pesticides. The cost for GML, fertilizer and herbicides are the same. However, the estimated cost for insecticides is RM225 per year and cost for fungicides is RM675 per year.

Table 3: Production cost (with microbial)

	PRODUCTION (Ton)				
	0.5	1	1.5	2	2.5
A. INCOME (RM7,000/ton)	3,500	7,000	10,500	14,000	17,500
B. MATERIAL COST	3,143	3,143	3,143	3,143	3,143
GML (1.5 ton/ha/year) x RM14/bag [50kg]	420	420	420	420	420
Fertilizer (24 bag [50kg] x RM100/bag)	2,400	2,400	2,400	2,400	2,400
Herbicides (16 liter/ha/year) x RM11.25/liter	180	180	180	180	180
Microbial (260 liter/ha/year) x RM0.55/liter	143	143	143	143	143
NETT PROFIT	357	3,587	7,357	10,857	14,357

Table 4: Production cost (with chemical pesticides)

	PRODUCTION (Ton)				
	0.5	1	1.5	2	2.5
A. INCOME (RM7,000/ton)	3,500	7,000	10,500	14,000	17,500
B. MATERIAL COST	3,900	3,900	3,900	3,900	3,900
GML (1.5 ton/ha/year) x RM14/bab [50kg]	420	420	420	420	420
Fertilizer (24 bag [50kg] x RM100/bag)	2,400	2,400	2,400	2,400	2,400
Herbicides (16 liter/ha/year) x RM11.25/liter	180	180	180	180	180
Insecticide (3 liter/ha/year) x RM75/liter	225	225	225	225	225
Fungicide (7.5kg/ha/year) x RM90/kg	675	675	675	675	675
NETT PROFIT	-400	3,100	6,600	10,100	13,600

Cocoa farmers in Malaysia is a price taker, hence the price of cocoa reflect the gross income to farmers. In order to ensure that the cocoa farmers in Malaysia receive higher return from the cocoa production, the material cost must be as minimize as possible. However, good agricultural practice must not be neglected for a better cocoa yield. With microbial formulation, cocoa farmers can decrease the production cost for insecticide and fungicide control from RM900 with chemical pesticides to only RM143 with microbial formulation.

RM7,000 per tonne, the cocoa farmers will be in loss position, the return would be negative RM400 using the chemical pesticides. If a cocoa farmers using the microbial formulation, the estimated return to cocoa farmers is RM357.

Figure 1 depicted the comparison of farmer's income with microbial formulation and income with chemical pesticides. If a cocoa farmers can produce 500 kilogram of cocoa with estimated cocoa price of

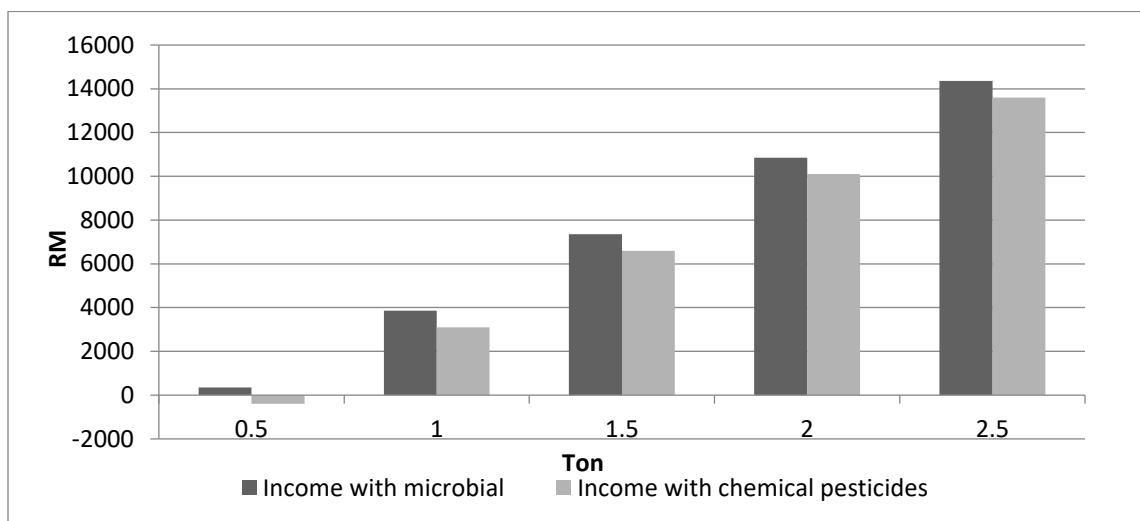


Figure 1: Comparison of farmer's income with microbial and chemical pesticides

If a farmer can produce one tonne of cocoa, the net income to farmer would be RM3,857 with microbial formulation and RM3,100 with chemical pesticides. The cost differences would be RM757. If a farmer can produce 1.5 tonnes of cocoa, 2.0 tonnes of cocoa and 2.5 tonnes of cocoa, return to the farmer for using microbial formulation would be RM7,357, RM10,857, and RM14,357, respectively. However, if a farmer

using chemical pesticides, return to the farmer would decrease to RM6,600, RM10,100 and RM13,600, respectively. Hence, microbial formulation is proven to be cost effective compared to chemical pesticides. Lower cost of production is desirable in producing cocoa because it affected the farmer's income which is a current core issue in Malaysian cocoa industry.

Table 5: Production cost with labour cost (with microbial)

	PRODUCTION (Ton)				
	0.5	1	1.5	2	2.5
A. INCOME (RM7,000/ton)	3,500	7,000	10,500	14,000	17,500
B. MATERIAL COST	3,143	3,143	3,143	3,143	3,143
GML (1.5 ton/ha/year) x RM14/bag [50kg]	420	420	420	420	420
Fertilizer (24 bag [50kg] x RM100/bag)	2,400	2,400	2,400	2,400	2,400
Herbicides (16 liter/ha/year) x RM11.25/liter	180	180	180	180	180
Microbial (260 liter/ha/year) x RM0.55/liter	143	143	143	143	143
C. LABOUR COST	2,063	2,063	2,063	2,063	2,063
NETT PROFIT	-1,706	1,794	5,294	8,794	12,294

Table 6: Production cost with labour cost (with chemical pesticides)

	PRODUCTION (Ton)				
	0.5	1	1.5	2	2.5
A. INCOME (RM7,000/ton)	3,500	7,000	10,500	14,000	17,500
B. MATERIAL COST	3,143	3,143	3,143	3,143	3,143
GML (1.5 ton/ha/year) x RM14/bag [50kg]	420	420	420	420	420
Fertilizer (24 bag [50kg] x RM100/bag)	2,400	2,400	2,400	2,400	2,400
Herbicides (16 liter/ha/year) x RM11.25/liter	180	180	180	180	180
Insecticide (3 liter/ha/year) x RM75/liter	225	225	225	225	225
Fungicide (7.5kg/ha/year) x RM90/kg	675	675	675	675	675
C. LABOUR COST	2,063	2,063	2,063	2,063	2,063
NETT PROFIT	-2,463	1,037	4,537	8,037	11,537

Table 5 and Table 6 show the production cost of cocoa beans with labour cost. The current minimum wages announced by the federal government on 2nd November 2018 is RM1,100 in Malaysia (NST, 2018). With that amount, the labour cost in cocoa cultivation would be RM2,063. If a farmers can cultivate 0.5 ton of cocoa beans the net profit to the cocoa farmers is -

RM1,706 with microbial and –RM2,463 with chemical pesticides. A positive net profit can only be achieve with production of cocoa beans is equal and more than 1 ton. If farmers apply the microbial, the remuneration to the farmers is higher compared to the net profit received by the farmers using chemical pesticides.

MARKET FEASIBILITY

Cocoa Industry in Malaysia

Cocoa has a long history in Malaysia, the golden age of cocoa was in 1989 which recorded the largest cocoa cultivated area of 414,236 hectares (MCB, 2020). However, started from the year 1991 cocoa area began to decreased. The declined in area was due to continuous poor prices trend (Wahab, 1998). Land under the cocoa cultivation had reduced from 398,950 hectares in 1991 to 100,803 hectares in year 1999 which show a reduction of 74% of cocoa cultivated area. Starting from year 2000, cocoa area recorded less than 100,000 hectares. Since then, the cocoa area had declined progressively, in year 2000, it is 75,765 hectares and in year 2005 the cocoa cultivated area was only 33,994 hectares which shows a decrease of 42,368 hectares of cocoa area. It is estimated that in year 2019 there are 15,647 hectares of land planted with cocoa tree. Figure 2 show the cultivated area and cocoa production trend in Malaysia.

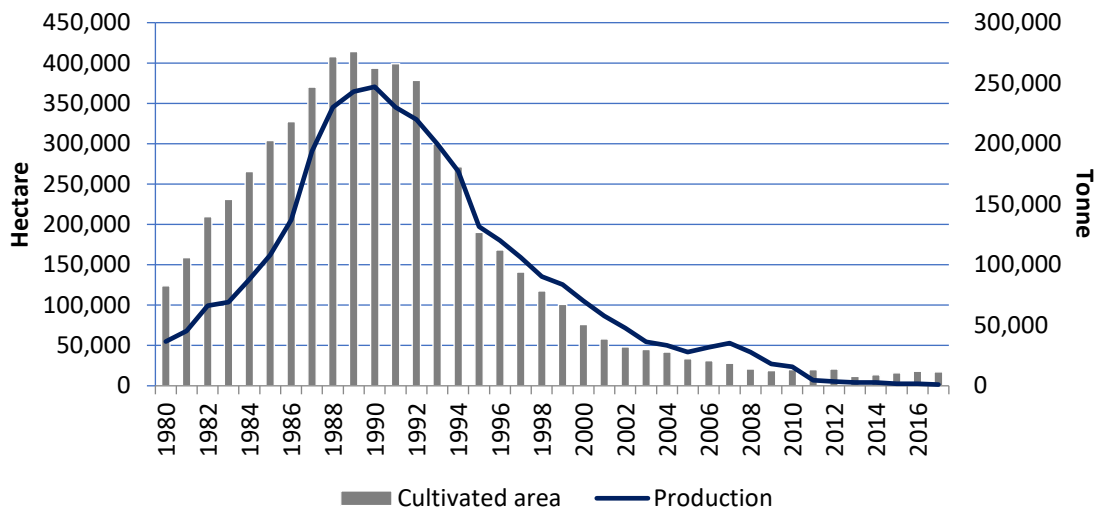


Figure 2: Cocoa cultivated area and production of cocoa beans in Malaysia

The production of cocoa beans is also in decreasing trend. The decreasing trend was contributed by cocoa prices being lower than current cost of production for a large segment of farmers and plantation owners. There is also an evident in the form of decreasing yield (Wahab, 1998). Based on the report on Cocoa Smallholders Census conducted in 2012 (MCB, 2012), factors contributing to the lower cocoa yield were pest and disease problem, aging farmers, good agriculture practice (GAP) was not in practice and lower returns to farmers.

The KRI's report states that in Malaysia, the biggest threat to farmers' profit are pests and diseases, while price volatility, labour shortage and logistics are secondary issues. The World Cocoa Foundation (WCF) estimates that 30 to 40 percent of cocoa production losses in major cocoa-growing countries is caused by pest and disease infestation (Che Omar, Yap, & Sazali, 2018). Based on the result from the report on Cocoa Smallholder Census 2012 (MCB, 2012) showed that 82% of the farmers are facing the pest problem while 74% cocoa farmers in Malaysia are having issue with the cocoa disease. Farmers in Malaysia is not practicing GAP, this is due to 51% of farmer's age are more than 50 years old, higher input cost which resulted in lower return to the farmers worsen the issue. Cocoa farmers in Malaysia are

dependent on the input subsidized by the MCB. They are not willing to invest in chemical pesticides due to higher price which affecting their return on investment. Hence, microbial control agent is the main solution in replacing the higher cost in using chemical pesticides.

Microbial Market Potential in Malaysia

Microbial has huge potential in the Malaysia's cocoa industry. Although, the cultivated area in Malaysia is in decreasing trend since 1989 but starting 2013 a recovery period in cocoa industry is noticeable. In 2012, cocoa planted area was 11,748 hectares increased by 33% to 15,647 hectares in 2019. The cocoa cultivated area is an opportunity to microbial as bio-control agent is not harmful to human and more cost effective compared to using chemical pesticides. Table 7 indicates a market share on microbial formulation in the Malaysia cocoa industry and its potential sale. If a total of 5% from the total cocoa cultivated area is using microbial formulation replacing the chemical pesticide, the potential sale of microbial formulation would be RM111,826. If we are able to commercialise and capture 25% from the total cocoa cultivated area in Malaysia, the potential sale of microbial formulation would be RM559,416.

Table 7: Microbial formulation market potential in Malaysia

Market Share	5%	10%	15%	20%	25%
Cultivated Area	782 ha	1,565 ha	2,347 ha	3,129 ha	3,912 ha
Potential Sale	RM111,826	RM223,795	RM336,621	RM447,447	RM559,416

Anticipated Future Market

Southeast Asia accounts for approximately 14% of the world's cocoa supply. The region includes well-established cocoa producers such as Indonesia, the world's third largest producer, and emerging producers such as Vietnam and the Philippines. Approximately, 1.77 million hectares of area planted

with cocoa in South East Asia. In Indonesia alone, there is around 1.7 million hectares of cocoa. This would be a huge market potential for microbial formulation in replacing chemical pesticides. In the Philippines and Vietnam, there are around 13,910 hectares and 12,056 hectares of land planted with cocoa respectively. These can be depicted in Figure 3.

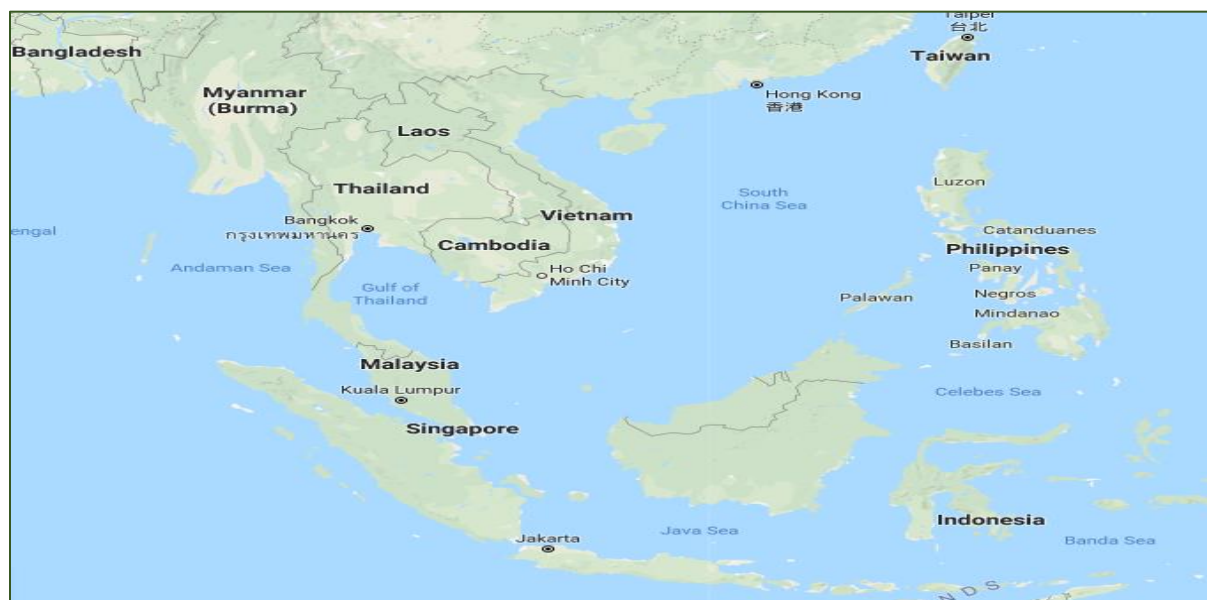


Figure 3: Cocoa in South East Asia

If we can supply 2% of microbial formulation in South East Asia market, the gross return with selling price of RM0.55 per liter would be RM5 million. If we can capture 5% of the market, the gross return would be

RM12 million. However, if the market share of microbial in South East Asia is 15%, the gross return would be more than double to RM37 million. This can be shown in Table 8.

Table 8: Market share and gross return of microbial

Market Share	2%	5%	10%	15%
Indonesia	RM4,940,470	RM12,351,175	RM24,702,349	RM37,053,524
Philippines	RM39,783	RM99,457	RM198,913	RM298,370
Vietnam	RM34,480	RM86,200	RM172,401	RM258,601
TOTAL	RM5,014,733	RM12,536,832	RM25,073,663	RM37,610,495

According to the ICCO's forecasts for the 2019/20 cocoa year, the global cocoa production accounted for 4.75 million metric tonnes (ICCO, 2020). Three largest producing countries account for, in aggregate, approximately 66.3% of global cacao production, and consist of the Ivory Coast (45.3%), Ghana (16.8%) and Indonesia (4.2%). A further 22% is produced by the

next four largest producers, Brazil, Nigeria, Cameroon and Ecuador with production market shares estimated at 4, 5.5, 6.1 and 6.8 per cent, respectively. The other relatively small contributors, at this current point in time, to the global market are Peru, Colombia, Mexico, Dominican Republic and Papua New Guinea.

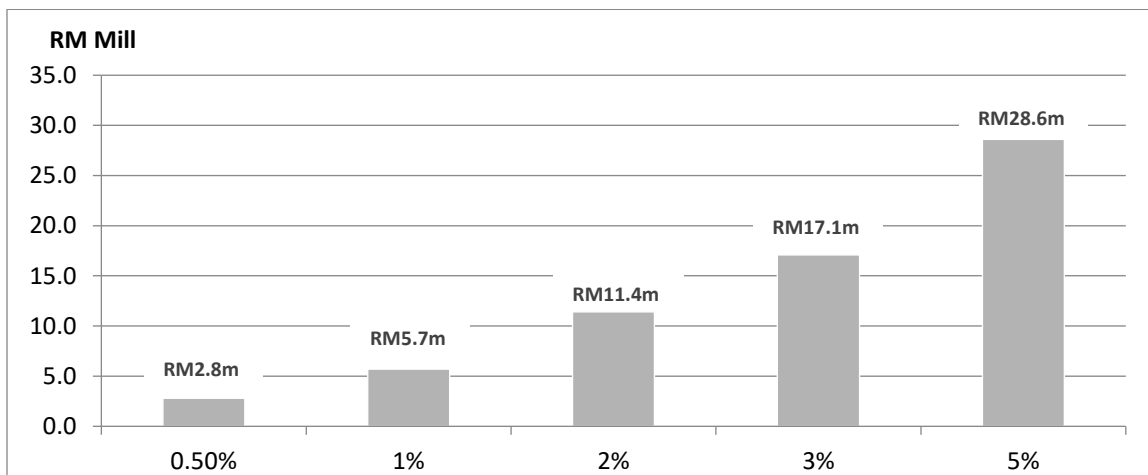


Figure 4: World potential market share of microbial

Hence, we can roughly estimate that there are around 4 million hectares of area planted with cocoa. Figure 4 depicted the potential market share of microbial formulation in the global cocoa market. In the most pessimistic view, if we can capture at least 0.5% of the global market, the potential gross sale of microbial formulation would be RM2.8 million. The gross sale would increase to RM5.7 million, RM11.4 million, RM17.1 Million with 2% market and 3% market share, respectively. In the optimistic view, if we can capture 5% from the world total cocoa hectareage, the gross return would be RM28.6 million.

Sale Projection

Table 9 shows the suggested sale price for each liter of microbial. The cost of producing a liter of microbial is RM0.55, if the sale price is RM1.00 per liter the gross profit is RM10.4 million and the net profit is RM4.7 million after minus the cost of production which is RM0.55 per liter. If the sale price is RM1.50, RM2.00, RM2.50 and RM3.00 per liter, the net profit would be RM9.8 million, RM15.1 million, RM20.3 million and RM25.5 million, respectively.

Table 9: gross profit and net profit of microbial formulation

Sale price	World Market Share at 1%				
	RM1.00	RM1.50	RM2.00	RM2.50	RM3.00
Gross Profit	10,400,000	15,600,000	20,800,000	26,000,000	31,200,000
Net Profit	4,680,000	9,880,000	15,080,000	20,280,000	25,480,000

CONCLUSION

The finding from the study has shown the proposed microbial is cost effective compared to the usage of

chemical pesticides, the microbial formulation cost only RM143 per year as compared to chemical pesticides that cost RM900 per year. This concludes that microbial formulation has a potential in reducing

the production cost for cocoa farmers in Malaysia. This product also has a market potential, not only in Malaysia but also others cocoa growing countries.

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