Economic Feasibility of Organic Palm Oil Production in Malaysia

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ABSTRACT

The importance of organic farming has increased due to its environmentally friendly methods and growing consumer awareness of food safety. Based on estimates, world retail sales of organic foods will reach USD 29-USD 31 billion in 2005. Producing palm oil by organic cultivation is highly possible in Malaysia since many oil palm agronomic practices in the country already have minimum environmental impacts and are moving towards even more eco-friendly methods. The command of a premium price is the main attraction for investment in organic food production.

INTRODUCTION

Organic agriculture refers to holistic management systems which promote and improve agro ecosystem health, including biodiversity, biological cycles and soil biological activity. It emphasizes the use of locally adapted systems such as cultural, biological and mechanical methods in preference to off-farm inputs or any synthetic materials to fulfil specific functions within the system (Malaysian Standard, 2001). Organic procedures involve integrated management of land, crops and animals that aims to achieve optimal agro ecosystems which are socially, ecologically and economically sustainable.

The importance of organic farming has developed significantly in the last decade due to its environmentally friendly methods and growing consumer awareness in food safety. Consequently, agricultural producers the world over have shown interest in such farming systems which are likely to be supported by governments and institutional bodies.

MARKET DEVELOPMENTS

World organic food consumption has grown at a rate of 25% per annum in the last decade and is expected to reach 15% of total food consumption in 2005 (Minou and Willer, 2003). The aggregate worldwide market for organic foods based on the size of the retail market was estimated at USD 19 billion in 2001, an increase of 19% from the previous year, and is expected to reach USD 29-USD 31 billion in 2005. It is a niche

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market, of about 1% to 3% of total food sales but is expected to keep on growing in the future.

The United States is the world's biggest organic food market at USD 9.5 billion in 2001 with annual growth rates of 15%-20% and estimated to reach USD 11-USD 13 billion in 2003. The European market was estimated to be about USD 9 billion in 2001 with different situations for each market. Some markets for organic foods, such as Denmark and Germany, have stagnated, while others, like United Kingdom, Netherlands and Switzerland, are still growing. Based on market development with estimated annual growth rates from nil to 20%, retail sales are expected to total USD 10-USD 11 billion in 2003. Top selling categories of organic products comprised approximately 40% of fresh vegetables and fruits, followed by non-dairy beverages, breads and grains, packaged foods and dairy products.

Currently, crude organic palm oil comes from Africa and Latin America with processing done in the importing countries. Organic palm oil can become an important value-added attribute in various food preparations, particularly snacks, confectioneries, bakery products and baby foods. The potential demand for organic palm oil will be driven by the market development of organic foods in the future, which is likely to be influenced by the demand for safer and healthier foods, and also better environment conservation.

OBJECTIVES

This paper attempts to provide information on the economic viability of producing crude palm oil through cultivation techniques and processing methods that conform to organic procedures. The scope of this study encompasses the production of organic fresh fruit bunch (FFB) at the field level, followed by processing of the FFB at the mill.

METHODOLOGY

Methodology

The methodology used is based on cash flow analysis of the extra income generated by the investment. A 25-year cash flow over the oil palm productive life is used to determine the costs and production figures for organic and conventional farming. The appropriate cost structure for organic farming was derived from the conventional cost structure, followed by comparison of financial costs and returns with different yields and prices.

Technical information is gathered from visits to experts, supplemented by reviews of their studies, while related cost information is compiled from investigations in local outlets and by telephone or e-mail enquiries to the relevant suppliers. Additional information was gathered from a visit to a local estate itself a studying organic agriculture for oil palm.

The model assumes 5000 ha of oil palm producing both palm oil (CPO) and palm kernel (PK). The area is divided into 2500 ha of conventional farming and the other 2500 ha under organic production with a dedicated processing mill of 10 t FFB/hr capacity for each system. The oil palms are planted at 148 palms/ha and start bearing in year three, based on the yield profile of advanced DxP seedlings.

The financial costs and returns evaluation uses the cost-benefit analysis (CBA) approach that includes several measurements from the project, such as net present value (NPV), internal rate of return (IRR) and benefit-cost ratio (B-C ratio).

Assumptions

A number of assumptions are required to facilitate the evaluation of financial performance by both the organic and the conventional methods. These assumptions may not apply to every situation since establishment and production practices may vary significantly from estate to estate and mill to mill. The assumptions are:

Assumptions on use of fertilizers. Fertilizer is a very important input and one of the highest cost items in oil palm cultivation. No chemical fertilizers must be used.

Various organic fertilizers such as POME sludge cake, decanter solids, sheep or chicken dung, tapioca and sago waste are available in the market. The prices range between RM 300 to RM 4000/t depending on their materials form whether powder, granules or pellets and nutrient content. Organic fertilizers are invariably low in nutrients (N: 2%-3%, P: 0.3%-0.6%, K: 2%-3%, Mg: 0.4%-0.5%), thus larger quantities are needed to provide enough nutrients. This escalates the cost of production. About 6 t/ha/yr of organic fertilizers are recommended by one of the local suppliers for oil palm. This will cost approximately three to four times higher than that for conventional oil palm cultivation.

Studies on the utilization of oil palm by-products such as mulching with pruned fronds, empty fruit bunches (EFB) and palm oil mill effluent (POME) as replacement for chemical fertilizers have been done extensively with encouraging outcomes. *Table 1* shows the various nutrient contents that can be obtained from a hectare of oil palm.

Composition analysis of EFB reveals that 1 t of EFB (fresh weight) has the fertilizer equivalent of 7 kg urea, 2.8 kg rock phosphate,

TABLE 1. NUTRIENTS CONTENTS IN BY-PRODUCTS OBTAINED FROM A HECTARE OF OIL PALM (kg/ha/yr)

Part of palm	N	P	K	Mg	Ca
Annual pruning	107.9	10.0	139.4	17.2	25.6
Empty bunches	5.4	0.4	35.3	2.7	2.3
Fibre	5.2	1.3	7.6	2.0	1.8
Shell	3.0	0.1	0.8	0.2	0.2
Effluent (raw)	12.9	2.1	26.6	4.7	5.4

Source: Tarmizi (2000).

19.3 kg muriate of potash and 4.4 kg kieserite (Singh *et al*., 1999). The interaction between EFB application and chemical fertilizer on inland soil improves oil palm growth and increases yield by up to 75% (Singh *et al*., 1999), while on coastal soil, the response depends on the type of alluvium. After taking into account the transport costs for the EFB, the savings in fertilizer can reach RM 142 ha or 28% less than the prior cost (Nasir, 2001).

Practically, EFB is applied in a circular band at about 15-30 t/ha/yr for newly planted and immature palms, and about 25-40 t/ha/yr spread in the avenues or placed in heaps between mature palms on coastal soils and 35-70 t/ha/yr on inland soils. EFB is highly recommended by agronomists to be spread in a single layer because it can cover a larger root area, prevent weed growth, keep the soil moist and also minimize breeding of the rhinoceros beetle. The cost of EFB application can range from RM 3.50 to RM 10/t depending on the transport used, distance from the mill and method of in-field distribution (Singh *et al*., 1999).

Another source of nutrients is pruned palm fronds which are stacked in between palm rows. This practice can help reduce soil erosion when placed across harvesting paths and along contours and also increase the root concentration under the decaying leaves that supply lots of nutrients. Previous studies have shown that application of POME *per se* as an alternative to inorganic fertilizers provides many benefits to the cultivation of oil palm such as a cost-effective approach in waste utilization and substantial savings in fertilizer costs, improve palm growth and yield with negligible effects on the environment (Singh *et al*., 1999), and also increase the soil nutrients and moisture level needed by oil palm. POME is a mixture of sterilizer condensate, separator sludge and hydrocyclone wastewater which, in both raw and treated forms, contains high level of nutrients. Its application on land is allowed with the prior approval of the Department of Environment, Ministry of Natural Resources and Environment. The frequency of POME application for mature oil palm should be spread out to no less than three rounds a year and each application should not exceed 2.5 cm rain equivalent per year, while for immature palms the amount should be lower (Zin *et al*., 2000). *Table 2* shows the estimated capital and operating costs for the various land application systems. In this exercise, the tractor, tanker and pump system is used to apply treated POME in the field.

TABLE 2. LAND APPLICATION SYSTEM AND RELATED COSTS

Land application system	Capital cost (RM/ha)	Operating cost (RM/ha/yr)
Longbed	1 200 – 1 700	180 – 220
Flatbed	1 300 – 1 800	180 – 240
Furrow on sloping land	1 500 – 1 800	200 – 240
Furrow on flat land	750 – 1 250	175 – 250
Sprinkler	1 800 – 3 120	240 – 310
Tractor/tanker/pump	320 – 380	90– 110

Source: Singh *et al*. (1999).

Planting of legume covers during the immature phase, which is a standard oil palm cultivation practice, to check soil erosion and reduce weed competition can also be another source of fertilizer, particularly N fertilizer. Legumes like *Centrosema pubescens, Muchuna cochinchinesis, Peuraria javanica*, *Calopoganium mucunoides, Calopogonium caerulum* and *Phaseolus calcaretu* are recognized for their nitrogen fixing capacity. Two major benefits from legumes include savings in nitrogen fertilizers and improvements in the soil physical properties (Chan, 1992).

Another approach to replenish soil organic matter and enhance its fertility is the zero burn or no-burn technique for land clearing. Besides contributing to a cleaner environment and abiding by the law, its benefits include earlier fruiting, lower fertilizer requirements due to the large quantities of nutrients being recycled to the soil where the organic matter is biodegraded, and a higher return compared to clean burn (Singh *et al.,* 1999; Mohd Noor, 2003).

In this exercise, the application of 6 t/ha/yr of organic fertilizers is estimated to cost three times more than the conventional cost during immature years, and it is assumed that they can provide the nutrients required by the oil palms. The cost will be reduced approximately by

30% when EFB and POME are introduced to the field. Overall, the right combination of organic fertilizers, EFB and POME application, if implemented correctly under the guidance of agronomists, can be as effective as chemical fertilizers.

Assumptions on weeds control. For organic cultivation, cultural practices such as the planting of cover crops or beneficial plants and also EFB mulching can be used to suppress the growth of weeds, as well as reduce soil moisture evaporation. Manual weeding or mechanical weeding using the appropriate machines can be used for weed control. For instance, tractor-drawn service cutters can trim the weeds along the harvesters' path on flat terrain, while regular desilting using a rotary (dondi) ditcher can control weeds in the field-drains in coastal planting (Singh *et al*., 1999).

Biological control by integrated farming with ruminants, especially cattle, can substitute for manual weeding whereby 150 cows can replace four men to save weeding cost of RM 30 to RM 50/ha/yr (Rosli, 2000) or reduce the plantation-weeding cost by 17% to 38% (Jusoh and Mohd Noor, 2002). Furthermore, it provides another source of organic fertilizer, plus additional revenue through the sale of livestock.

Application of mechanical or manual controls during the immature years is inevitable since biological control cannot be implemented. Since both controls are costly as experienced by the local estate studying organic practices, the weeding cost in organic farming is estimated to be about 4.5 times higher than that for the conventional one. Although integration with animals is highly recommended in organic systems, it is excluded in this exercise in order to evaluate the investment return from producing organic palm oil only.

Assumptions on pests and diseases control. Organic farming systems balance the beneficial organisms against the pests, not seek to eliminate pests *in toto*. The application of chemicals for control is strictly prohibited.

Conservation of plants that are hosts to beneficial insects and parasitoids or are pest-resistant is also applauded in organic cultivation. The planting of cover crops or natural vegetation to cover breeding sites can also suppress the beetle population. Beneficial plants, such as *Cassia cabanensis, Crotalaria usaramoensis, Asystasia intrusa* and *Euphorbia heterophylla,* prolong the lives of beneficial insects (Singh *et al*., 1999), thus balancing the pests with their predators. *Cassia cabanensis*, a leguminous crop, is host to more than 300 bagworm parasitoids, and thus suppresses *Metisa plana* (Mohd Basri and Norman, 2002). Establishment of other nectariferous plants, such as *Euphorbia heterophylla* or *Antigonon leptopu*s, in open areas can also control pest outbreaks effectively (Singh *et al*., 1999). Other forms of biological control or predation practiced include the barn owl for rat control, while the use of *B. thuringiensis* for lepidopterma control has increased. The release of predators periodically has been practiced commercially to control leaf-eating caterpillars in some plantations (Singh *et al*., 1999).

Strict monitoring on the estate site is also important for noting any pest or disease outbreaks. Early detection of some pests can be an effective measure, so that the appropriate action can be taken quickly before the population reaches a level that causes economic injury to the investment. *Table 3* shows the threshold numbers of pests (from previous studies) beyond which their control is difficult.

Pesticides from natural sources or biopesticides, have been developed locally and abroad. A strain of *Metarhizium anisopliae* found by MPOB is effective in controlling *O. rhinoceros* larvae (Ramle *et al*., 2001). Since it is still not widely available in the market, the price of *M. anisopliae* is higher than those of the chemical controls - approximately RM 150/kg as compared to *Carbuforan* and *Cypermethrin* at RM 4.50/kg and RM 9.50/litre, respectively. However, its application is easier and has a long lasting residue of about three months in the field. In addition, its application cost inclusive of labour and equipment is estimated to be less than that for chemical control.

Pheromone trapping, allowable under organic farming, can be used to minimize the population of adult rhinoceros beetles (Norman and Mohd Basri, 2000). Trapped beetles may be infected with baculovirus of *Oryctes* or *M. anisopliae* before release back to the field to spread the virus and fungus. If the population of *O. rhinoceros* beetle is still high, then mechanical control by pulverization of the area may be necessary.

Cultural practices such as deep ploughing can be useful in areas where *Ganoderma boninensis* that causes basal stem rot is prevalent. All biomass leftovers should be pulverized and spread thinly in alternate avenues. Based on the average cost of production, pest and disease control constitutes about 3% of the upkeep and cultivation cost and only less than 1% of the total cost of production. Since the proportion is so low, the cost for pest and disease control in the organic production system is expected to remain the same as for the conventional one.

TABLE 3. ECONOMIC THRESHOLDS OF IMPORTANT PESTS OF OIL PALM

Common name	Scientific name	Economic threshold	Reference
Bagworm	*Metisa plana*	10 larvae/frond	Wood (1971)
	Pteroma psendula	30-60 larvae/frond	IRHO (1991)
	Metisa plana	8-47 larvae/frond	Basri (1993)
	Mahasena corbetti	5 larvae/frond	Wood (1971)
Nettle caterpillar	*Darna trima*	10 larvae/frond	Wood (1971)
		30-60 larvae/frond	IRHO (1991)
	Setora nitens	5-10 larvae/frond	IRHO (1991)
	Darna diducta	10-20 larvae/frond	IRHO (1991)
	Setothosea asigna	5 larvae/frond	Hoong and Hoh (1992)
Rhinoceros beetle	*Oryctes rhinoceros*	10% palms with damage	Wood (1968b)
		3-5 adults/ha	IRHO (1991)
Bunch moth	*Tirathaba rufivena*	30% of the palms with at least one bunch >50% attacked in young plantings and 60% in older plantings	IRHO (1991)
Cockchafer	*Adoretus*	5-10 adults/palm	IRHO (1991)
	Apogonia	10-20 adults/palms	IRHO (1991)
Rat	*Rattus* spp.	< 20% bait acceptance	Wood (1968a)
		20% bunches with damage	Cheong, S P (per. Comm.)

Source: Yusof *et al*. (2001).

Assumptions on labour. Organic farming requires more labour or mechanization for upkeep and maintenance. However, the number of workers in these activities constitutes only a small portion of the labour force in the plantation. On the whole, the labour cost in organic farming is estimated to be higher by 10% to 20% than conventional farming by hiring more workers or by paying higher wages due to more work to be done in the field. Therefore, from the social perspective, organic farming can provide more employment in the estate and also elevate the standard of living of plantation workers through better income.

Assumptions on yield. Basically, if adequate nutrients are applied to the crop either through organic or conventional farming, the yield for both methods will be the same.

Previous trials on POME application (*Table 4*), although in small scale, have proved that it can increase yield by 2% to 27%, while studies on EFB application (*Table 5*) demonstrated that yield can be increased 1% to 75% depending on the type of soil. The application of POME and EFB is not just to reduce the amount of organic fertilizers and the cost of production but also to increase the FFB yield.

In the analysis, the yield of organic oil palm is expected to match the conventional one as shown in *Figure 1* with the same yield profile as enough nutrients are provided even though the cost is rather high. The yield profile is plotted based on data from the Biology Division of MPOB (Azman and Mohd Noor, 2002).

TABLE 4. STUDIES ON POME APPLICATION

System	Soil type	Duration (yr)	% Increase	Reference
Sprinkler	Inland	3	19	Lim *et al.* (1983)
Sprinkler	Coastal	4	18	Lim (1987)
Tractor/tanker	Inland	3	12	Tam *et al.* (1982)
Tractor/tanker	Coastal	5	10	Trial by Golden Hope Plantations
Furrow	Coastal	5.5	27	Trial by United Plantations
Flatbed	Inland	6	20	Lim (1987)
Longbed	Coastal	2	15	Trial by Sime Darby Plantations
Tractor/tanker and flatbed	Inland	4	2.3	Khalid Haron and Zin (1994)

Source: Singh *et al.* (1999).

TABLE 5. STUDIES OF EMPTY FRUIT BUNCH APPLICATION

Soil series		% Increase	Reference
Inland	Rengam	20	Chan *et al.* (1993)
	Malacca	75	Lim and Chan (1990)
	Durian	12	Chan *et al.* (1993)
	Tavy	16	Chan *et al.* (1993)
Coastal	Lunas	19	Gurmit *et al.* (1990)
	Briah	1.09	Loong *et al.* (1988)

Source: Singh *et al.* (1999).

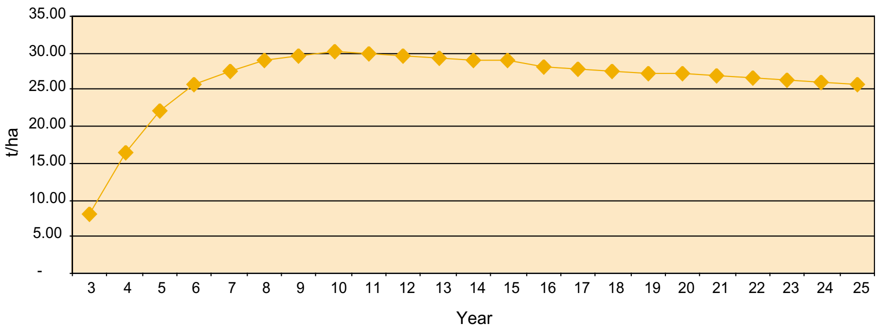

Figure 1. Yield profile of fresh fruit bunch.

Assumptions on processing and transportation. Processing the FFB can be done through various methods, namely, mechanical screw-press, basket and bowl centrifugation, wet process, solvent extraction, *etc*. For organic palm oil production, screw-pressing followed by clarification in settling tanks and centrifugation can be employed for oil extraction. It is a simple method, able to handle high throughputs without any chemicals and accepted worldwide. So, the cost of processing organic FFB is assumed to equal the conventional one.

The organic palm oil integrity must be maintained during storage, transportation and handling. It must be protected either from mixing with non-organic products or contact with intolerable materials and substances. Even storage areas and transport containers previously used for non-organic palm oil must be cleaned using methods and materials permitted in the handling of organic products.

The transport cost is expected to be higher because more transport is involved in organic farming such as moving EFB and POME to the field and transport of labour around the estate.

Assumptions on price. The price of organic palm oil will depend on developments in the organic edible oil market. Basically, a premium is expected for products traded in niche markets since they have special characteristics or attributes that can fetch a higher price as compared to normal products. *Table 6* shows the prices of organic oils, which are approximately twice those of conventional oils except for olive oil.

However, any investment in an organic system that depends on the premium alone should be cautioned against because the usual demand and supply mechanism would tend to force prices down over time and reduce the premium as experienced by the European market. In this analysis, the price of conventional palm oil is assumed to be RM 1000/t and the price of palm kernel RM 500/t. Considering the premium, the price of organic palm oil is estimated to be 50% higher than the conventional one, at RM 1500/t.

Inspection and certification system. A food can only be labelled organic if it had been produced in accordance with organic production and processing standards and verified by designated authorities. The *organic* claim is allowed for products that contain only organic ingredients, with a tolerance of 5%. These standards are to protect the rights of organic producers and to ensure consumer confidence in buying a certified organic product.

The certification procedures include inspection and verification of the agricultural practices at the farm, processing operations and conditions at the mill. An agriculture product, especially from a perennial crop may take as long as three years before it can be certified organic. During the probation period, it can only be labelled as *transition to organic*.

Organic certification is governed by a set of international

TABLE 6. PRICES OF ORGANIC AND CONVENTIONAL OILS (USD)

Oil	Conventional	Organic
Soyabean (5 gal pail @ 38.5 lb pail)	27.00	40.00
Canola (5 gal pail)	35.20	70.00
Extra virgin olive oil (5 gal pail)	75.50	99.30
Sunflower (5 gal pail: 35 lb pail)	34.00	72.65

Source: http://edibleoils.net

standards covering organic production and its subsequent handling and processing. Certification of the product can be obtained whether through local certification bodies, international entities or a partnership between these bodies.

The certification cost is estimated to be RM 20 000 to RM 35 000 annually based on the scale of operation, inclusive of inspection, certification, a one year license and access to support services. Additional charges may apply depending on the expenses, location and time required for these activities.

ESTIMATION OF THE ESTABLISHMENT AND UPKEEP COSTS

The establishment and upkeep cost component comprises non-recurrent costs, maintenance costs and upkeep costs. *Table 7* compares the establishment cost for the first year between conventional and organic farming. In total, the first year establishment cost for organic farming is RM 4490/ha, or 44.6% higher than the RM 3110/ha for conventional farming. The extra is mainly due to higher fertilizer and upkeep costs, especially for weeding.

The cost of cover crops is expected to be much higher, *i.e.* twice that of conventional farming, because it also includes other beneficial plants that will play major and multiple roles in the organic system. The higher cost also acts as proxies for its importance in the system by creating and maintaining biodiversity and biological cycle of the oil palm plantation.

The average cost for producing FFB organically throughout the investment period is estimated at RM 193/t as compared to RM 116/t by the conventional system, while the average cost of producing 1 t of organic CPO is about RM 935/t, which is higher than that for producing non-organic palm oil at RM 626.35/t.

TABLE 7. ESTABLISHMENT AND UPKEEP COSTS, FIRST YEAR (RM/ha)

Item	Conventional	Organic
Non-recurrent		
Felling and clearing	724	724
Terracing and soil conversation	215	215
Roads, bridges, paths	175	175
Drains	134	134
Survey, lining, holing and planting	189	189
Planting material	666	666
Sub total	**2 103**	**2 103**
Maintenance		
Road, bridges, paths, *etc.*	70	70
Drains	50	50
Terraces	50	50
Soil/water conservation	40	40
Boundaries and survey	30	30
Sub total	**240**	**240**
Upkeep		
Weeding and lallang control	219	984
Cover crops and beneficial plants	169	338
Pests and diseases	54	54
Pruning	20	20
Census and supply	24	24
Other costs of upkeep	54	54
Sub total	**540**	**1 474**
Fertilizers	227	681
Total	**3 110**	**4 498**
Total (exclude non-recurrent costs)	1 007	2 395

RESULTS AND DISCUSSION

The feasibility for investment is analysed at a discount rate of 10% over 25 years. For conventional farming, CPO and palm kernel prices are fixed at RM 1000 and RM 500/t, respectively. The price of organic palm oil is estimated at RM 1500/t, while the price of palm kernel remains constant, so that the outcome of the investment will show solely the impact of organic palm oil.

The result shows that producing palm oil through organic farming can be a viable proposition because of its capability to generate a NPV of RM 32.6 million, about RM 8.6 million higher than that by the conventional system, and produce a B: C ratio of 1.17, which is higher than unity. However, the IRR is only 16.8%, less than that from conventional farming of 17.4% and the payback period is longer by a year, *i.e.* eight to nine years as compared to the conventional seven to eight years *(Table 8)*.

Scenario and Sensitivity Analysis

The premium is an influential factor in determining the

TABLE 8. COST-BENEFIT ANALYSIS

Parameter	Conventional	Organic
Net present value (NPV)	RM 24 073 437.36	RM 32 567 978.33
Internal rate of return (IRR)	17.4%	16.8%
Benefit cost ratio (B:C)	1.16	1.17
Payback period	7 – 8 years	8 – 9 years

profitability of organic production in view of the higher production costs. However, the advantage will slowly disappear as more and more organic edible oils enter the market.

Table 9 shows that when the price of organic palm oil is RM 1000/t, the return to investment is inferior to conventional production. The NPV shows a deficit with an IRR of only 4.9%, B:C ratio less than unity and a payback period of 14 to 15 years. Therefore, a significant premium is required to ensure the viability of producing palm oil through the organic system.

Further analysis shows that the performance of organic farming is at par with conventional farming with an IRR of about 17.4% if the price of organic palm oil is approximately RM 1535/t, or 53.5% higher than that for the conventional oil. If the price of organic palm oil follows the price pattern of organic soybean oil, *i.e.* twice higher than the conventional one, or RM 2000/t, then the return is far greater (*Table 9*).

Table 10 shows the economic performance of organic farming if the organic FFB yield declined by 10% and 20% at a price of RM 1500/t. The result demonstrates that if the FFB yield decreases by 10%, the IRR is lower at 13.9% but the B:C ratio is still higher than unity.

The investment is still economically sound with positive net return and payback period of 9 to 10 years. But, if the yield decreases by 20% or more, then the economic viability of organic production cannot match the conventional one.

CONCLUSION

Organic products are gaining acceptance by consumers in developed countries and are making progress in producing countries worldwide. Production of organic palm oil is another opportunity for the Malaysian palm oil industry to diversify palm oil products. Extensive studies on agronomic practices related to environmental friendly practices have been done and can facilitate conversion to organic oil palm production. Technical assistance can be sourced from authoritative or relevant bodies.

Evaluation of viability according to the cost structure used revealed that producing organic palm oil can be profitable if it commands a substantial premium and its yield equals the conventional yield. Organic production with a 50% premium can generate an IRR of 16.7% with NPV and B:C ratio slightly higher than those of the conventional one. Even a reduction in yield by 10% still provides a good return to investment although somewhat inferior to that for conventional production.

The returns from organic palm oil can be further improved by reducing the production cost of, which is mainly increased by the higher costs of organic nutrients and upkeep. A higher FFB yield can be obtained by EFB mulching

TABLE 9. COST-BENEFIT ANALYSIS WITH PRICE VARIATIONS

Price (RM/t)	1000	1535	2000
Net present value (NPV)	(RM 18 598 854.68)	RM 36 149 656.65	RM 83 734 811.35
Internal rate of return (IRR)	4.9%	17.4%	25.0%
Benefit cost ratio (B:C)	0.78	1.20	1.56
Payback period	14 - 15 years	7 – 8 years	6 – 7 years

TABLE 10. COST-BENEFITS ANALYSIS WITH YIELD VARIATIONS

Parameter	Yield reduce by 10%	Yield reduce by 20%
Net present value (NPV)	RM 17 676 383.25	RM 2 784 788.17
Internal rate of return (IRR)	13.9%	10.7%
Benefit cost ratio (B:C)	1.07	0.96
Payback period	9 – 10 years	10 – 11 years

and POME application as has been proven. Besides that, these by-products can reduce the fertilizer cost and improve the soil condition. The co-product of organic palm oil, *i.e.* organic palm kernel with its potential organic products, will boost the prospects for the investment. Furthermore, integration with livestock and intercropping can provide additional benefits.

Finally, the intangible benefit of producing palm oil through organic farming is really enormous in terms of building up the image for environmental-friendly palm oil products from the Malaysian palm oil industry.

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