An Assessment of Comparative Advantage of Pineapple Production (*Ananas comosus*) among Smallholders in Johor, Malaysia

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Abstract. Pineapple is a tropical fruit that contains great nutritional values and fine flavor with high export potential and provide income generation for many smallholders in Malaysia. Despite its popular appeal, there is little empirical data on the costs and competitiveness of its production in Malaysia. The objective of study was to assess a comparative advantage of pineapple production in Johor using Policy Analysis Matrix Model. A sample of 191 farmers was selected through a random sampling technique in Johor. The study demonstrated that Malaysian smallholders particularly in Johor had strong comparative advantages in the production of pineapple. The findings showed that the Domestic Cost Ratio (DRC) value for pineapple was 0.94, suggesting pineapple smallholders generated private profits because their ratio implied that the value added per unit of product was larger than the value of domestic resources used to produce a unit of pineapple. Along with it, the SCB value was positive, which means at social price, smallholders were socially profitable and internationally competitive. To conclude, the article presents recommendations for potential enhancement of the viability of pineapple smallholders.

Keywords: Potential Enhancement; DRC; Viability of Pineapple; Competitiveness

1. Introduction

1.1. Overview of the Pineapple Sector

In Malaysia, pineapple is one of the most promising demand of fruit in the local and export markets [1]. Out of 100 per cent pineapple produced, seventy per cent of it consumed as a fresh fruit in the country of origin [2]. It originated from warm climates in the Americas, being the main producers: Thailand, Brazil, Philippines, India and China [3]. Pineapple belongs to the bromeliad family, which consist of 50 genera and about 2,500 known species [4]. *Ananas comosus* is the most familiar species that exploited for commercial purposes [5]. The expansion of pineapple plantations was commenced from canned pineapples industry that showed in London from Singapore in year 1886 by J.F. Nicholson. From the moments, the canneries establishment expended in Penang, Johor and Selangor [6].

Malaysia’s pineapple industry started with the intercropping system in 1888. Pineapple become an intercrop plant that is crucial to coconuts, areca nuts, rubber and other fruits trees. The expansion of...
rubber plantations stimulating pineapple industry as an intercrop plant thus increasing the importance, such that fluctuating world prices for canned pineapple lauded the enactment of the Pineapple Industry Ordinance in 1934. To control the progress of the industry, the rules and regulations were set up which encouraged greater interest towards the industry as expressed with the beginning of pineapple monocropping in Johor [7].

Pineapple is the first crop grown as a commodity crop in Malaysia with high export potential [8]. Pineapple from family Bromeliaceae is considered as an important tropical fruit. After bananas, pineapple was recognized by the United Nations Conference on Trade and Development (UNCTAD) in the ranking of commercial tropical fruits for production on a worldwide basis. Pineapple has been an important industrial or commodity crop with greater benefits. Pineapple contained numerous nutritional, medical and industrial value which promoting and enhancing well-being of mankind.

The popular pineapple varieties in Malaysia are MD2, Moris, N36 and Sarawak and typically planted in Johor, Sarawak, Sabah, Kedah, Selangor, Negeri Sembilan, Pahang and Terengganu. Johor ranks first in term of production accounting for more than 16% of total production [9]. The MD2 has been identified as a key crop under the National Key Economic Area (NKEA) of the Economic Transformation Program (ETP). This variety also has been identified as EPP7’s catalyst for the premium fruit market. Compared to other varieties, MD2 is better in several qualities. Among them are: uniform bright colour, sweeter taste, four times vitamin C content, lower fiber, lower acidity, thinner skin, smaller fruits at an average of 1.5kg each, and no longer shelf life [6].

2. Literature Review

2.1. Production of Pineapple in Malaysia

In Malaysia, pineapple is one of the former industrial crop and has an existence for nearly a century. Pineapple cultivation offers lucrative income for growers especially with the establishment of high planting density in farm and the use of cultivar that provide a stable yield and high resistance towards disease. In 2018, Department of Agriculture (DoA) [10] reported that 272,570 Mt of pineapple have been produced throughout the year of 2015. The details of planted area, production and value of production from pineapple are presented in Table 1.

| Year | Planted Area (Ha) | Harvested Area (Ha) | Percentage of Harvested Area (%) | Production (Mt) | Value of Production (RM) | Average yield (Mt/Ha) | Potential Production (Mt/Ha) |
|------|-------------------|---------------------|---------------------------------|----------------|-------------------------|----------------------|-----------------------------|
| 2015 | 10,847.0          | 8,975.3             | 82.7                            | 272,570.0      | 386,140,884             | 30.4                 | 62.0                        |
| 2016 | 13,148.9          | 10,354.1            | 78.7                            | 391,714.4      | 515,248.7               | 37.8                 | 62.0                        |
| 2017 | 12,898.44         | 10,130.76           | 78.54                           | 340,721.95     | 668,666.83              | 33.63                | 62.0                        |

Source: DoA (2018)

Meanwhile, Table 2 represents specific numbers of production of pineapple according to the states in Malaysia 2015. Production of pineapple in Peninsular Malaysia shows the decrement number from year 2014 to 2015 which is 294, 161.01 MT was recorded [11].

| State  | Hectarage (Ha) | Harvested Area (Ha) | Production (Mt) | Value of Production (RM) |
|--------|----------------|---------------------|-----------------|--------------------------|
| Johor  | 6,357.3        | 5,384.5             | 199,773.4       | 278,762,333              |
| Kedah  | 469.8          | 388.5               | 6,611.6         | 9,366,395                |
Kelantan  259.5 195.0  4,365.3 6,184,229  
Melaka  8.8  7.3  57.9 81,992  
Negeri Sembilan  177.5 172.4  6,195.2 8,776,464  
Pahang  112.0 88.2  2,168.0 3,071,329  
Perak  65.3  62.2  2,142.5 3,035,202  
Perlis - - - -  
Pulau Pinang  303.5 213.5  6,937.1 9,827,558  
Selangor  385.5 316.1  5,150.9 7,297,056  
Terengganu  41.4  41.0  709.6 1,005,309  

Peninsular Malaysia  8,180.6 6,868.6 231,111.4 327,407,867  
Sabah  941.8 760.7  14,952.0 21,182,000  
Sarawak  1,724.6 1,346.0  26,506.6 37,551,017  
W.P. Labuan - - - -  
MALAYSIA  10,847.0 8,975.3 272,570.0 386,140,884  

2.2. Export of Fresh Pineapple  
Export for fresh pineapple shows a positive increment from year 2011 until 2016 with aggregate growth by 3% annually (Figure 1). This favorable trend proves that fresh pineapple has a potential in international market. In year 2016, fresh pineapple from Malaysia has been entered new markets such as Korea, China and Taiwan while retained the main market for Malaysia which is Singapore and United Arab Emirates. The increasing number of hectarage for MD2 variety too become one of the factor for Malaysia to elevate the number of fresh pineapple export to Gulf States such as Turkey, Iran, Egypt and Arab Saudi that showed an increasing demand trend [11].

2.3. The Pineapple Market in Malaysia  
In order to improve the livelihoods of small farmers through income generating, the pineapple industry contributes greatly to the socioeconomic development of the country [12]. It helps to promote economic development in the nation and the growth of other economic support activities, like packaging, transport and other value-added activities in Johor in particular [8]. Johor is known to be the biggest producer of pineapple in 2017 with an estimated volume of production of 274,284 metric tons (Table 3) [10].
Table 3. Top producing state in Malaysia for pineapple production, 2017.

| State  | Hectarage (Ha) | Production (Mt) |
|--------|---------------|-----------------|
| Johor  | 8,112         | 274,284         |
| Sarawak| 1,767         | 25,664          |
| Sabah  | 972           | 11,155          |

Source: Booklet Statistik Tanaman (Sub-Sektor Tanaman Makanan), (DoA, 2018)

Raziah [13] claims that the fall of the Malaysian pineapple industry has been due to many factors. The impairment of the quality of peat soil resulting from prolonged use for production of pineapples has been believed to impair crop productivity. Diminished peat soil yield was most likely caused by the *Paratylenchus* species nematode. Detailed studies of the populations of nematodes in the soil and root of pineapple plants showed a high population of *Paratylenchus* species during various stages of growth in several affected commercial farms.

Peat soils bring huge economic advantages to their regions. For use as horticultural compost, peat is extracted. The high water retaining capacity and airflow are very popular in commercial horticulture. Peat is also used to produce electricity for fuel. It is available in cold climates as briquettes for heating homes. Peat soil are drained and used for farming applications (pasture and crop production) and forestry [14].

Shah [15] reported that in order to meet the demand of domestic and overseas markets, Malaysia will need at least 3,000 ha of land to grow MD2 pineapples. Minister of Agriculture and Agrobased Industry, Datuk Salahuddin Ayub, said to The Star Online, that currently there are only 2000 hectares of land used in Johor for the growing of pineapples. The export of MD2 pineapples is to more than 13 countries including Oman, Iran, the UAE, Turkey, Singapore and South Korea. Kuwait and China are the latest on the list of exporting countries in the near future and in discussions with various European countries in order to export the fruit for them.

Although the Malaysian agricultural policies are intended to boost productivity and to increase producers’ incomes in particular for smallholder farmers, it is considered important to be competitive in the pineapple sector. It is important to examine the factors affecting the competitiveness of pineapple industry by considering the economic importance of pineapple in local and global market. Previous studies that dealt with pineapple sector in Malaysia examined mostly on marketing, socioeconomics and supply chain issues which mainly on case studies basis [8]. This study aims to comprehensively examine the competitiveness of the pineapple sector in Malaysia and make appropriate recommendations.

At present, very few studies have examined the degree of competitiveness on agricultural production in Malaysia at the farm level. Thus, this study aimed to develop and apply a more comprehensive framework of analysis to analyze the competitiveness performance of the Malaysia pineapple production as well as to measure the competitiveness of the Malaysia pineapple production particularly in Johor state, using the Policy Analysis Matrix.

### 3. Materials and Methods

#### 3.1. The Policy Analysis Matrix (PAM)

PAM was coined by Monke and Pearson in 1989 is a double-entry bookkeeping analytical framework, which widely applied to compute private and social profits for a variety of farming systems under different technological and institutional situations. PAM assists policymakers and analyst to comprehend with the effects of policy on competitiveness as well as farm-level profits. PAM also
helps to impact of public investments on the efficiency of the agricultural system and the effects of agricultural research and development on economic efficiency and comparative advantage [16].

The policy analysis matrix is a product of two accounting identities. One defining profitability as the difference between revenues and costs. The other measuring the effects of divergences (distorting policies and market failures) as the difference between observed parameters and parameters that would exist if the divergences were removed [17]. The methodology for policy analysis provides information for policymakers who address three key issues in the analysis of agricultural policy.

PAM also consisted by three rows that defines profitability as the difference between income and costs; (1) private profitability; (2) social profits and; (3) divergences. Private profitability (D) assesses the value of all outputs and inputs in private or actual prices. It can be calculated using revenues (A) minus total cost (B+C), where B and C are tradable and non tradeable inputs \( D = A-B-C \). The private profitability calculation indicates whether the production is profitable or not from the individual farmer’s views. Second row, social profits (H) is difference between revenues and costs which reflects social opportunity cost and measure efficiency as well as comparative advantage \( H = E-F-G \). The third row, the divergences which measures difference between observed private price and estimated social price. It is explained by the effects of policy or by the existence of market failure (Monke & Pearson, 1989).

| Table 4. A structure of the Policy Analysis Matrix (PAM) |
|----------------------------------------------------------|
| **Income** | **Tradable inputs** | **Non-tradable input Domestic factors** | **Profit** |
| Private Prices | A | B | C | D=A-B-C |
| Social Prices | E | F | G | H=E-F-G |
| Effect of domestic divergences and efficiency—distorting policies | I=A-E | J=B-F | K=C-G | L=G-H=I-J-K |

Source: Monke and Pearson (1989)

An explanation of PAM Table 4 is described as follows (Table 5):

| Table 5. A Policy Analysis Matrix Framework |
|--------------------------------------------|
| A Revenue based on private prices |
| B Tradable input cost based on private price |
| C Domestic input cost based on market price |
| D Private profits |
| E Revenue based on social price |
| F Tradable input cost based on social price |
| G Domestic input cost based on social price |
| H Social profits |
| I Output transfer |
| J Input transfer |
| K Factor transfer |
| L Net transfer |

| Table 6. Measurement for Government Protection |
|-----------------------------------------------|
| Profitability coefficient (PC) | \( PC = \frac{D}{H} \) |
| Domestic cost ratio (DRC) | \( DRC = \frac{G}{(E-F)} \) |
| Private cost ratio (PCR) | \( PCR = \frac{C}{(A-B)} \) |
| Social cost benefit ratio (SCBR) | \( SCBR = \frac{(F+G)}{E} \) |
Nominal protection coefficient (NPC)  
\[ \text{NPR} = \frac{A}{E} \]

Effective protection coefficient (EPC)  
\[ \text{EPC} = \frac{(A-B)}{(E-F)} \]

Source: Monke & Pearson (1989)

The various quantities in the PAM can be used to generate a number of ratios that cast light on competitiveness and how it is affected by government policies. These include the following: (1) domestic cost ratio (DRC), social cost benefit ratio (SCB), profitability coefficient (PC), subsidy ratio to producer (SRP) and private (social) net return to land (PNRL/SNRL).

The DRC is widely used as an indicator of competitiveness. The DRC measures the efficiency of utilization of domestic factors in the analyses of production system. The index calculated is a ratio of social costs for domestic factors to their value added. If the DRC<1, the production in a country is competitive. If the DRC>1 it indicates that the country is not competitive in production of the analyzed goods.

The SCB is an alternative for DRC in measuring comparative advantage. The SCB is defined by the ratio of total resources cost to the revenue. The SCB provides more accurate rankings of the comparative advantage of alternative activities. If the SCB<1 it signifies that a production in question is competitive while if the SCB>1 indicates that production is not competitive.

The nominal protection coefficient (NPC) is one of the most commonly methods to measure price distortions [18]. If NPCO < 1 indicates the presence of tax (tariff) on output, NPCO > 1 show the presence of subsidy and NPCO =1 (in the absence of market failures) reveals the absence of intervention but NPCI < 1 implies subsidy, NPCI > 1 implies tax. The Effective Protection Coefficient (EPC) defined as the ratio of value added in private price to value added in social prices \( \frac{(A-B-C)}{(E-F-G)} \) or \( D/H \).

The PC measures the incentives effects of all policies or net policy transfer. A final incentive indicator is the subsidy ratio to producer (SRP) which the value equal to the ratio of net divergences to social prices or SRP = \( \frac{L}{E} = \frac{(D-H)}{E} \). Both the NPC and EPC ignores the transfer effect of factor market policies and thus do not provide a complete indicator of incentives (Monke and Pearson, 1989).

Besides that, the net private return to land (PNRL) and social net return to land also calculated in this study. The PNRL is defined as \( A-B-C \) without the cost of land use and SNRL as \( E-F-G \) without the land use. This implied that, the higher the PNRL (SNRL), the higher the private (social) profit per hectare of land employed in the production of commodity (Abdul Fatah and Von Cramon Taubadel, 2017).

4. Results and Discussion

This section provide progressively discusses the findings of the policy analysis matrix with appropriate interpretations. Table 5 displays the main outcomes of the protection and comparative advantage coefficients for the Johor pineapple farm. To measure the competitiveness of the Johor pineapple industry, Domestic Cost Ratio (DRC) and Social Cost Benefit (SCB) had been estimated. The DRC compares domestic resource costs measured at the various social price to the economic benefit measured at social market prices. In DRC scale, the use of social prices helps us to check whether using limited domestic inputs in pineapple production generates good returns for Malaysia.

Further estimation in the PAM were based on data from world price as a reference prices for computing social prices for output and input respectively. In PAM framework, inputs are aggregated into tradable and non-tradable. In this study, the tradable inputs include site cleaning, weeding, fertilizer (foliar and spread), hormone, and planting material while non-tradable inputs was labour.

4.1. Policy Analysis Matrix (PAM)

Pineapple production at agriculture industry level has been studied to study the effects of policy on the pineapple sector in Johor. We use world prices to calculate the social prices of inputs and outputs. The addition of site cleaning, weeding, fertilizer, hormone and planting material cost are used to calculate
the social price of tradable inputs. Social prices are calculated with the addition of labour cost for non-tradable inputs. Table 7 presents the main results of the analysis.

Table 7. A structure of the Policy Analysis Matrix (PAM).

|                      | Revenue                  | Cost                     | Profits          |
|----------------------|--------------------------|--------------------------|------------------|
|                      |                          | Tradable inputs          | Non-tradable     |                  |
|                      |                          |                          | input Domestic   |                  |
|                      |                          |                          | factors          |                  |
| Private Prices       | 22,950.00                | 7,350.30                 | 2,450.00         | 13,149.70        |
| Social Prices        | 9,450.00                 | 7,386.58                 | 1,954.00         | 109.42           |
| Effect of domestic   | 13,500.00                | (36.28)                  | 496.00           | 13,040.28        |
| divergences and      |                          |                          |                  |                  |
| efficiency–distorting|                          |                          |                  |                  |
| policies             |                          |                          |                  |                  |

Source: Own field survey (2018)

Once production input costs and revenues are calculated at private and social prices, components estimated of the policy analysis matrix can be produced by filling in the sample rows and columns. The matrix is built on a one-acre basis and average farm level production and the average pineapple sample are in RM/acre. Table 7 presents the results of the pineapple production using the policy analysis matrix for farm level in Johor in 2018. The matrix results indicate that Johor's pineapple crop is profitable from private prices for farmers, with D values were positive. In this study, the social profitability (H) pineapple commodity was positive in Johor, showing the use of efficient resource of non-tradable inputs (local resources). The pineapple production system in Johor is seen to be surviving without government support, which means that non-tradable inputs (local resources) are efficiently used. It is therefore necessary to maintain efficient use of resources by introducing modern technology and the efficient redistributing of resources, either by increasing productivity or reducing production costs.

The private price policy on the other hand does encourage the local resources to be efficiently used, while the results show that the difference between revenue from private prices (A) and the revenue from social prices (E) was positive. That means private revenue is higher than social revenue, indicating high government intervention for pineapple production in 2018, as a result of government action by increasing local pineapple prices above world prices and market failures. The divergence in the results of the Johor Matrix was negative, meaning that traded social price inputs were higher than tradable inputs in private prices, indicating that subsidies or taxes on the tradable inputs were imposed. Besides the market failures, the divergence in non-tradable inputs (K) in Johor showed positive, showing that the subsidy or tax on non-tradable inputs is also available.

Table 7 of this study shows that pineapples production at Johor in 2018 was more profitable for producers with market distortions than profitability without distortions on the market. The positive value of the net effect (L) resulted in policy matrix analyses. In the pineapple commodity system, government policy interventions reflect the output prices for short term benefit domestic producers [19]. The PAM structure shows that, on average, the pineapple sector gained private profits of RM 13, 149.70 / acre in the pineapple production sector. Calculating the differential from income to expenditure at private price. Because of the difference between private and social prices, smallholders are receiving an extra profit on RM 13 040.28 / acre, working under current market and state policy conditions. In other words, RM109.42 / acre is a social income which means an indicator of efficiency and competitiveness, and the difference between private and social income reflects a net income transfer resulting from the change in state policies.

The PAM analysis results generally show both good and bad impacts on the market situation of the existing policy. On the one hand, pineapple producers in Johor disadvantage from slightly expensive
internal resources. Currently, expenses on the internal production factors or non-tradable inputs are RM2,450.00/acre, which is higher than the level of social non-tradable prices (RM1,954.00/acre). Tradable production factors also reveal the same situation, but it is important to note that the current imperfect economic system increases the cost of tradable resources. Currently, pineapple producers pay tradable input costs of RM7,350.30 per acre at private price and RM7,386.58 per acre in social prices. The pricing policy in pineapple industry also caused an increase from RM9,450.00 to RM22,950.00 per acre in farm income. In general, the current production system allows for profitable production of pineapple at both private and social prices.

Table 8 displayed the results calculated from Policy Analysis Matrix. In Johor, the DRC value for pineapple is estimated to be 0.94, suggesting that the value of domestic resources used in production is lower than the value added. This implies an efficient use of domestic resource in production of pineapple and that producing in Johor was socially profitable. The index value also indicates that Johor use local resources lower value that global resources. As well as the SCB, which is the other indicator of the system’s comparative advantage. It takes into account the full cost of production of the social prices, confirmed the DRC findings, where SCB values for Johor was positive, which means the system has a comparative advantage and efficient use of resources.

The summary results on protection coefficients for pineapple in Johor are reported in Table 8. The NPCO coefficients show that domestic price has remained above the corresponding international reference price. Dissimilarly, NPCI values of less than one suggests that the government policies are reducing input costs for pineapple in Johor. It noted that the Nominal Protection Coefficient (NPC) of production was more significant than 1 for in Johor and the average of the total sample, as shown in Table 8. This means that pineapple prices protected are higher than those of the world market, indicating that government support for pineapple produced, and that means that, with this policy, producers get prices higher than the global prices. Where the local pineapple price for the average total sample was 2.42 of the global market price. It called positive protection for producers. In return, consumers face negative protection, and the government's existing policy must pay higher prices to obtain the pineapple.

The SRP values was positive in total sample, indicates that there is a real support and positive incentives for domestic producers of the pineapple commodities in Johor so that the ratio for the total sample was 94%. The PCR index values in total sample shows that the private profits (D) was greater than social profits (H), this means that the pineapple production system in Johor does not benefit from the government subsidy policy to achieve high social profits compare to private profits.

An EPC value of greater than one suggests that government policies provide positive incentives to pineapple farmers in Johor. The Effective Protection Coefficient (EPC) was positive for the entire study sample and was above 1, as demonstrated in Table 8. This means that, in private prices, the added value of pineapple production is higher than the social price value added, whereby the value added is 7.56 for social value added at private prices. Positive protection in Johor 2018 for pineapple production resulting from the government's determination of the pineapple price at a price above due to the effect of the duties on imports of pineapples. Private profits are higher than social profits through positive protection of pineapple production, which demonstrates the competitiveness of pineapple market.

| Table 8. Summary of Ratios of Competitiveness, Comparative Advantage and Protection in Pineapple Production. |
|-----------------------------------------------|
| **Ratio indicators** | **Values** |
| NPCO | 2.42 |
| NPCI | 0.99 |
| EPC | 7.56 |
| SRP | 1.37 |
| PCR | 0.15 |
5. Conclusion
Malaysia has tremendous potential to be the world's largest producer of fresh pineapple, particularly in Southeast Asia and Gulf countries. The aims for this study were to measure the competitiveness of the Malaysia pineapple production at farm level and to analyze the competitiveness performance of Johor pineapple production in the industry. The empirical findings showed that the Domestic Cost Ratio value for pineapple is estimated to be 0.94, suggesting that the value of domestic resources used in production is lower than the value added. This implies an efficient use of domestic resource in production of pineapple and that producing in Johor was socially profitable. Along with it, the SCB values for Johor was positive, which means the system has a comparative advantage and efficient use of resources. They will therefore assist in rising their profits and strengthening their livelihoods.

Lastly, there are several thought and considerations for the future study obtain from this study. First, factors on extensive services should be improved in order for farmers to be educated and motivated for productive and profitable agriculture. Second, research and development on which agricultural productivity is highlighted should be upgraded. Finally, future studies should take into account sample data from the five largest pineapple-producing states in Malaysia. In order to achieve better outcomes in the competition analytic area, this will make future research more compact and detailed.

Acknowledgment
The authors would like to acknowledge the financial assistance received from Lestari Grant, UiTM (Grant No: 600-IRMI/DANA 5/3/GOT (001/2018) that was used in carrying out this study.

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