Should We Rely on Natural Forests to Produce Timber? A Preliminary Study of Kelantan

Noraida Abd. Wahob¹ and Abdul-Rahim Abdul Samad¹*

¹Department of Economics, Faculty of Economics and Management, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia

E-mail: abrahamabsamad@gmail.com

Abstract. Kelantan is one of the states in Malaysia with the third largest forest area in Malaysia. Most of the forest in Kelantan has not explored. However, some of the forest areas cleared for logging and development activities. In response to the Malaysian government's commitment to sustainable forest management, the state of Kelantan took the initiative by developing forest plantation to support the production of raw materials for timber-based industrial activities. The major sources of the raw materials for timber coming from the natural forest instead of forest plantation. This paper examines the economic impact on the supply of timber in Kelantan complies with the scenarios under Sustainable Forest Management (SFM) practices. The Ordinary Least Square method was used time-series data from 2010 to 2017. The scenario comprised of three scenarios; (i) reduced by 24% in harvested area in natural forest, (ii) increased by 24% in harvested area in forest plantation and (iii) incorporated with scenarios (i) and (ii). The result reveals that the supply of timber affected by SFM practices. However, the shortage of timber enhanced by the production of timber from forest plantation by 4.8% when both scenarios imposed together. This indicated that the changes from dependence on the natural forest-to-forest plantation to produce timber in the further are needed. The state government of Kelantan need to encourage forest authority to increase the intensity of forest plantation in Kelantan order to fulfill the production of timber as raw material for forest products. This action would generate economic growth in the timber-based sector in line with its sustainability in Kelantan. It will also help to enhance its forest conservation goal in Peninsular Malaysia.

1. Introduction

Forest plantation currently supplies only one-third of the global industrial roundwood demand [1]. A structured management of forest plantation needed for achieving higher growth rates and typically produce high quality timber [2]. Forest plantations recognized as one of the substitute [3] in order to reduce the pressure of natural forest [4] and to meet the need of the global demand for industrial timber [5].

Forest plantation is not a concept and a new practice for Kelantan. Kelantan was started the planting the forest since a long time ago with a variety of type of tree and always keep increasing the area along the year (Table 1). Kelantan more focused on three types of species, which are Teak, Hevea, A.excelsa and another type of species with small numbers [6]. From the table show that the number of forest plantation increasing every year.

Although the number of forest plantation area in Peninsular Malaysia slightly reduced from 2016 to 2018, Kelantan showed an increasing trend over the year. Based on Figure 1, the percentage share of
forest plantation area of Kelantan to Peninsular Malaysia shown an increasing trend from 14% in 2012, 17.7% in 2013, 18.4% in 2014, 22.4% in 2015, 29.7% in 2016, 31% in 2017 and 31.9% in 2018. also shown increasing trend and become second largest revenue after Pahang with amount RM29,648,850 in 2018 [6]. As shown in Figure 2, the percentage share of production of timber Kelantan to Peninsular Malaysia was about an average 23.4% along the year from 2010 to 2018.

However, when look at the sources of raw material, Kelantan still harvests their natural forest, although in a small portion [6]. Based on Table 2, Kelantan still harvests the natural forest based on annual coupe approved for forest area licensed for harvesting from 2012 to 2018. At the same time, Kelantan also has forest area licensed for harvesting from forest plantation.

### Table 1. Forest Plantation Established in Permanent Reserved Forest (ha) in Kelantan, Source: Forestry Department Peninsular Malaysia, 2018

| Year | Acacia | Teak | Pine | Hevea A.excelsa | Other | Total |
|------|--------|------|------|-----------------|-------|-------|
| 2010 | -      | -    | 11,218 | -                | 2,672 | 13,890 |
| 2011 | -      | 111  | 3,654  | 15               | 660   | 4,440 |
| 2012 | -      | 111  | 11,478 | 15               | 666   | 12,270 |
| 2013 | -      | 111  | 16,535 | 15               | 666   | 17,327 |
| 2014 | -      | 111  | 22,706 | 15               | 666   | 23,498 |
| 2015 | -      | 111  | 30,644 | 15               | 666   | 31,436 |
| 2016 | -      | 111  | 32,977 | 15               | 717   | 33,820 |
| 2017 | -      | 111  | 34,249 | 20               | 717   | 35,097 |
| 2018 | -      | 111  | 34,977 | 15               | 1,743 | 36,846 |

### Figure 1. Forest Plantation area and Percentage of Share Kelantan to Peninsular Malaysia, Source: Forestry Department Peninsular Malaysia, 2018
Figure 2. Production of Timbers and Percentage Share Kelantan to Peninsular Malaysia 2010-2018, Source: Forestry Department Peninsular Malaysia, (2018)

The scenario reflected the demand for timber from the forest product industry. As known, the timber industry is the most significant source of income in Kelantan economic. According to Kelantan Menteri Besar Datuk Ahmad Yakob, forest revenue is the biggest contributor with a total of RM172.96mil, or 29.12% of the entire revenue in Kelantan in 2016 [7]. Furthermore, forest revenue

Table 2. Forest Area Licensed for Harvesting 2012-2018 (ha), Source: Forestry Department Peninsular Malaysia, 2018

| Year | Annual Coupe | Forest Plantation | Others | Total | State Land | Alienated Land | Total Area Licensed For Harvesting |
|------|--------------|-------------------|--------|-------|------------|----------------|-----------------------------------|
| 2012 | 5,910        | 5,903             | 5,824  | -     | 11,727     | 2,083          | 20,212                           |
| 2013 | 5,910        | 5,908             | 7,255  | -     | 13,163     | 1,891          | 17,535                           |
| 2014 | 5,910        | 3,404             | 3,872  | 4,979 | 12,255     | 665            | 17,641                           |
| 2015 | 5,910        | 2,120             | 10,002 | -     | 12,122     | 372            | 15,064                           |
| 2016 | 5,417        | 2,625             | 8,002  | 1,831 | 12,458     | 341            | 16,611                           |
| 2017 | 5,417        | 3,230             | 5,430  | 4,145 | 12,805     | 74             | 12,879                           |
| 2018 | 5,417        | 3,148             | 13,274 | -     | 16,422     | 391            | 21,720                           |

Therefore, this article attempt examines the economic impact on the supply of timber from natural forest and forest plantation in Kelantan complies with the scenarios under Sustainable Forest Management (SFM) practices.

2. Methodology

The model of this study is based on an expanded model develop by [8]. However, based on [9] model, they accumulated the raw material by total timber harvesting from natural forest and forest plantation without addressing the sources of the timber. In this study, a slightly modification model from [8] and [9] were done by addressing the sources of the raw material from forest plantation. The schematic presentation of Integrated Modelling of Primary Timber Processing incorporated with forest plantation illustrated in Figure 3.

This study started with the estimation of supply model using econometric analysis Stata 9.5 on data available from the year of 2010 to 2018. The study employs the Ordinary Least Square method and the model as below:

\[ TSB_t = a_0 DB_t^{a_1} AH_t^{a_2} WB^{a_3} \varepsilon_t \]  

\[ \ln TSB_t = a_0 + a_1 \ln DB_t + a_2 \ln AH_t + a_3 \ln WB_t + \varepsilon_t \]
Where:

\( TSB_t \) = Total supply of sawn timber
\( RYT_t \) = Domestic price of sawn timber
\( HANF_t \) = Harvested area in natural forest
\( HAFP_t \) = Harvested area in forest plantation
\( IC_t \) = Input cost
\( t \) = Years
\( \varepsilon_t \) = Error term
\( \ln \) = Natural logarithm

Figure 3. Integrated Modelling of Wood-based product Market incorporated with Forest Plantation [9]

From the original model of sawn timber supply in Equation (1), it can be transformed by using a log-linear form. Equation (2) estimates the total supply of timber. The relationship should be positively related to harvested area and royalty. \( TSB_t \) is the supply of timber as the endogenous or dependent variable. In this study price of timber replaced by royalty because the unavailable of timber price. \( RYT_t \) is the royalty received of timber, which is an important variable in determining the quantity of sawn timber supply. \( HANF_t \) and \( HAFP_t \) are the natural forested area and forest plantation was opened for harvesting in order to produce timber for the annual coupe. \( WB_t \) is the total wages paid by sawmills, simultaneously represents the input cost to the production cost since unavailable data for wages in logging activity.

Then, a simple extrapolation models used to project most of these values. The entire model set to make forecasts from the year 2017 until 2030. The scenarios imposed in 2018. The coefficient of the variables, which illustrated in the form of elasticity, then inputted into the forecasting analysis platform. The platform used is Excel Spreadsheet. The scenarios impose on the forecasted values define as below:
S1 Reduction by 24% in harvested area in natural forest

The percentage of reduction in the harvested area was adapted from a study conducted by [10]. This scenario reflected the foregone revenue from buffer areas. According to Malaysian criteria and indicators (MC&I) for SFM practices took 24.33% with RM2,065.60/ha. This forgone revenue included timber revenue incurred by the licensee and loss of royalty charges, which not collected by the Government.

S2 Increase by 24% in forest plantation

The scenario reflected in the first scenario. The same value which a 24% increase in harvested area in forest plantation reflected by S1

S3 Incorporate S1 and S2

This scenario represented incorporation of all 3 scenarios as above in order to see the integration relationship between them. Each scenario showed some changes and how each scenario tried to offset the other scenario to make integrating changes.

Then, the discussion was discussed in terms of graft, together with comparative values reflected from each scenario. The tracing through the impacts were the most critical parts in evaluating the scenario.

3. Result and Discussion

The summary statistics and correlation matrix depicted in Table 3 and 4.

### Table 3. Summary Statistics

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|----------|-----|------|-----------|-----|-----|
| lnTSB    | 8   | 13.67| 0.31      | 13.18| 14.05|
| lnHANF   | 8   | 8.34 | 0.45      | 7.66 | 8.79 |
| lnHAFP   | 8   | 9.17 | 0.27      | 8.67 | 9.47 |
| lnIC     | 8   | 7.00 | 0.11      | 6.88 | 7.15 |
| lnRYT    | 8   | 16.02| 2.46      | 9.94 | 17.00|

### Table 4. Correlation Matrix

|         | lnTSB | lnHANF | lnHAFP | lnIC | lnRYT |
|---------|-------|--------|--------|------|-------|
| lnTSB   | 1     | 0.7081 | 0.1102 | 0.7624| 0.3455|
| lnHANF  |       | 1      | 0.3409 | 0.855 | 0.4039|
| lnHAFP  |       |        | 1      | 0.4034| 0.2449|
| lnIC    |       |        |        | 1    | 0.4165|
| lnRYT   |       |        |        |      | 1     |

Econometric diagnostics for the supply model is provided in Table 5. The coefficients were the elasticities of the respective production models. The coefficients for all variables showed correct signs for each market commodity model, and this was consistent with the theory.

### Table 5: OLS regression and Diagnostic Test

5
|                | Coefficient | Std. error | T-stat | P-value |
|----------------|-------------|------------|--------|---------|
| lnRYT          | 0.016       | 0.055      | 0.290  | 0.788   |
| lnHANF         | 0.154       | 0.450      | 0.340  | 0.754   |
| lnHAFP         | 0.335       | 0.485      | 0.690  | 0.539   |
| lnIC           | -2.151      | 2.054      | -1.050 | 0.372   |
| Contant        | 24.109      | 16.718     | 1.440  | 0.245   |

**Diagnostic Test**
- Breusch-Pagan test for heteroskedasticity: No problem
- Breusch-Godfrey test for serial correlation: No problem
- Stability Test: Stable

Notes: ***Significant at 1%, **significant at 5%, *significant at 10%.

Based on Figure 4, the supply of timber of all forecasted line showed a decreasing trend. Among of the forecasted line, forecasted line TSB (S2) with the green line shown the highest one, followed by TSB (S1S2) with a purple line, baseline TSB with a blue line and the last one TSB (S1) with the red line.

![Figure 4](image)

**Figure 4.** Forecasting Result on Production of Timber in Kelantan. (Notes: The yellow line referred to historical data. The vertical line referred to the threshold between historical data and forecasted data)

In this impact analysis (Table 6), under scenario S1, where the harvested area was reduced by 24%, the total production of timber was decreased by 4.1% from 608,772 m$^3$ to 583,975 m$^3$. The percentage of changes of decreasing of total production was the same at 2020 by 183,202 m$^3$ to 175,740 m$^3$ because along the time, the quality of production was being focused by the same size of harvested area. By implementing SFM practices, the enhancement of timber’s quality to be produced was potentially higher rather than a large quantity of timber but with low quality of timber. Differ from scenario S2, when the domestic price of timber (refer to royalty) rose by 24%, total production of timber was increased by 8.9% from 608,772 m$^3$ to 662,659 m$^3$. The percentage change was still the same in 2030 by 4.1% from 608,772 m3 to 662,659 m3. This scenario showed that the role of forest plantation as a substitute for the natural forest as the supply of raw material is a good indicator in order to reduce the dependency on natural forest. However, when both scenario 1 and 2 (S1S2) imposed, the value shows slightly lower than S2 by rose 4.8% from 608,772 m$^3$ to 637,862 m$^3$. The percentage change was still the same in 2030 by 4.8% from 608,772 m$^3$ to 191,956 m$^3$. Incorporating all scenarios S1S2, scenario successful in overriding the baseline to produce the best forecast line. It reveals that the role of forest plantation as a substitute to the natural forest to produce timber as raw material was an exceptional impression.

**Table 6.** Average Forecasted Values on Production of Timber in Kelantan
### Year Variables

|                | 2018  |
|----------------|-------|
|                | $T SB$ (m$^3$) | $\Delta$ | $\%$ | $T SB$ (m$^3$) | $\Delta$ | $\%$ |
| Baseline Scenario | 608,772 | n.a | n.a | 183,202 | n.a | n.a |
| S1-Reduction by 24% in harvested area Natural Forest | 583,975 | (24,797) | (4.1) | 175,740 | (7,462) | (4.1) |
| S2-Rise by 24% in harvested area in Forest Plantation | 662,659 | 53,887 | 8.9 | 199,418 | 16,216 | 8.9 |
| S1S2-Incorporate SI and S2 | 637,862 | 29,089 | 4.8 | 191,956 | 8,754 | 4.8 |

Note: S1, S2 and S1S2 referred to the abbreviation for Scenario 1, Scenario 2 and Scenario 3

The main finding was forest plantation is one of the option to reduce the dependency on the natural forest as the supply of raw material of timber. In order to answer the title “Should We Rely on Natural Forests to Produce Timber?” based on the finding, the answer it is a big “NO”. The government of Kelantan need to reduce the annual coupe of natural forest and increase the annual coupe from forest plantation since Kelantan was the highest plantation area among other states in Peninsular Malaysia.

### 4. Conclusion

In conclusion, Kelantan should not rely on the natural forest to produce timber and move to forest plantation as raw material to produce timber. The findings suggest that the Kelantan need to reduce annual coupe from natural forest and replace by increase annual coupe from forest plantation. This action would generate economic growth in the timber-based sector in line with its sustainability in Kelantan. It will also help to enhance its forest conservation goal in Peninsular Malaysia. From the economics points of view, the continuity of the primary sources of timber is vital to ensure the production of timbers for the future is adequate to continue the domestic and international demand.

### Acknowledgements

This research supported by Geran Universiti Putra Malaysia 2018, (GP-IPM/2013/9402300) provided by Universiti Putra Malaysia (UPM).

### References

[1] Forest Stewardship Council (FSC) 2012 Strategic Review on the Future of Forest Plantations.

[2] Siry JP, Newman DH 2001 A stochastic production frontier analysis of Polish State Forests *Forest Science*, 47, pp. 526-533

[3] Poudyal AS, Sapkota S 2017 Pine plantations management in Community Forest: Application of silviculture to enhance productivity, replacement of timber import and conversion into mixed forest. *Proceedings of the First National Silviculture Workshop*. 19-21 February, 2017 Kathmandu, Nepal

[4] Ainembabazi and Angelsen, 2014. Do commercial forest plantations reduce pressure on natural forests? Evidence from forest policy reforms in Uganda For. *Policy Econ.*, 40, pp. 48-56

[5] Pirard, R., Dal Secco, L. & Warman, R 2016 Do timber plantations contribute to forest conservation? *Environmental Science and Policy*, 57, 122–130. [https://doi.org/10.1016/j.envsci.2015.12.010](https://doi.org/10.1016/j.envsci.2015.12.010)

[6] Forestry Department Peninsular Malaysia 2018 Forest Plantation Peninsular Malaysia. ISSN1394-0074

[7] The Star, 2016 Kelantan highly dependent on forest-derived revenue. Retrieved from [https://www.thestar.com.my/news/nation/2016/10/28/kelantan-highly-dependent-on-forestderived-revenue/](https://www.thestar.com.my/news/nation/2016/10/28/kelantan-highly-dependent-on-forestderived-revenue/)

[8] Mohd Shahwahid, HO 1995 Forest conservation and its effects on Peninsular Malaysia log supply. *ASEAN Economic Bulletin*, 11(3), pp. 320-334
[9] Noraida AW, Abdul-Rahim AS, HO Mohd-Shahwahid. 2018 Assessing the Economic Impact of Sustainable Forest Management Practices on the Timber Market in Peninsular Malaysia. *Journal of Tropical Forest Science, 30*(1), pp. 9–24

[10] Ahmad Fauzi, P., Salleh, M., Mohd Shahwahid, H.o., Abdul Rahim, N. Awang Noor, A.G. & Muhamad Farid, A.R. 2002. Cost of harvesting operations in compliance with ITTO guidelines for SFM. In Pp. 63-84. A Model Project for Cost Analysis to Achieve Sustainable Forest Management. Volume II: Main Report. N. Abdul Rahim (ed.) Frim/ITTO, Kuala Lumpur