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# Significance of Experience, Farm Size, Quantity of Propagules and Location for Seaweed Farmers in the Divided Island of Sebatik

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**Abstract:** Seaweed-*Kappaphycus-Euchema Cottonii and Denticulum* species was first cultivated at Sabah side of Sebatik in 2009. By November 2014, sixty one Sabahan seaweed farmers cultivated 122 ha or 3,050 long lines. Thirty Sabahan seaweed farmers in Kampung Pendekar (3.2 m.t dried) and 31 in Burst Point (12.5 m.t dried) produced 16 metric tonnes of dried seaweed contributed 31% to Tawau's total production (51 m.t). The remaining 69% were from farmers in Cowie Bay that separates Sebatik from municipality of Tawau. Indonesian in Desa Setabu, Sebatik started in 2008. However, the number of Indonesian seaweed farmers, their cultivated areas and production (as well as quality) in Sebatik increased many times higher and faster than the Sabah side of Sebatik. In 2009 more than 1,401 households in Kabupaten Nunukan (including Sebatik) cultivated over 700 ha and have produced 55,098.95 and 116, 73 m.t dried seaweed in 2010 and 2011 respectively. There is a divergence in productions from farming the sea off the same island under similar weather conditions. Which of the eight explanatory factors were affecting production of seaweeds in Sebatik? Using Cobb Douglas production function, Multiple Regression analysis was conducted on 100 samples (50 Sabahan and 50 Indonesian). Results; Variable significant at $\alpha = 0.05\%$ are Experience in farming whereas Farm size; Quantity of propagules and Location — *Dummy* are the variables significant at $\alpha$ 0.01%. Not significant are variables Fuel; Age; Number of family members involved in farming and Education level.

**Key words:** Seaweed-Kappaphycus-Euchema Cottonii; Sabah side of Sebatik; Indonesian side of Sebatik; cultivated areas; Cobb Douglas production function; multiple regression

**JEL codes:** Q22

## 1. Introduction

Sebatik is a divided island (refer to map 1-below), Republic Indonesia owned more than half of its land area, precisely 246.1 $km^2$ which is administratively divided into five Kecamatan under Kabupaten (Regency) of Nunukan, North Kalimantan Province (or KALTARA). Remaining 187.23 $km^2$ of the island is under N.60 — Sabah State Assembly of Sebatik and Parliamentary 191 — Kalabakan. It takes 20 minutes by boat from a jetty in

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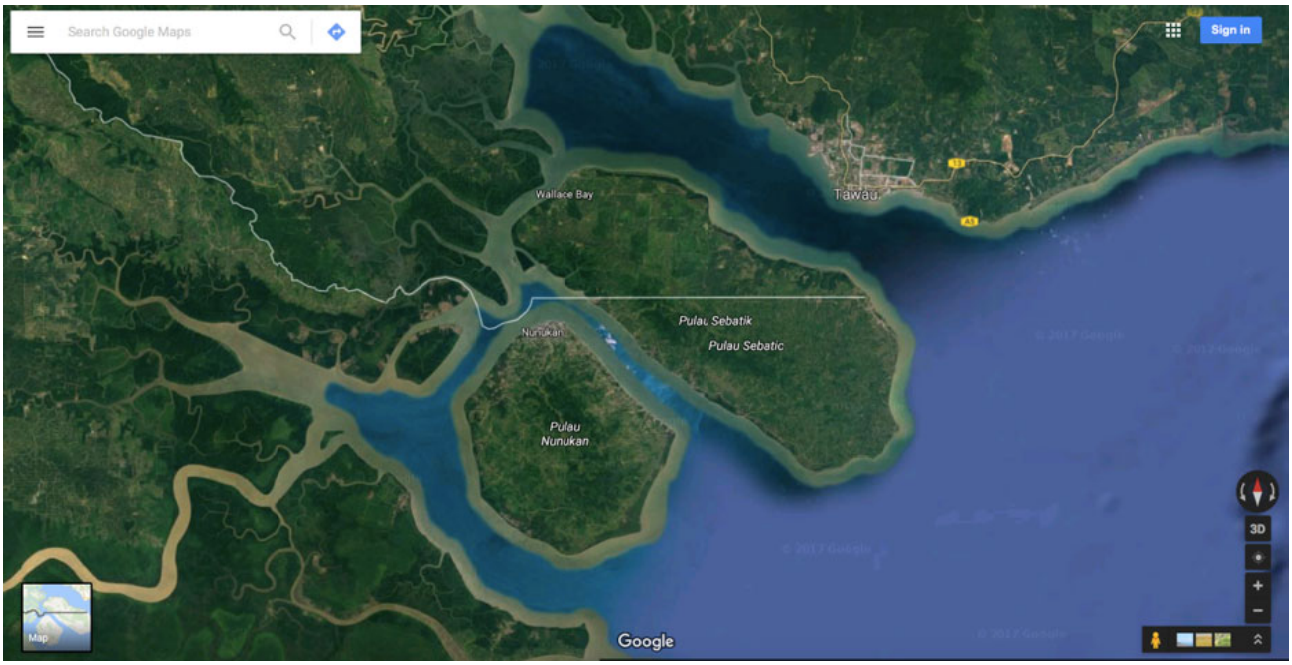
Municipal of Tawau across the eight kilometres-Cowie (Wallace) Bay to a jetty at Kampung Sungai Tongkang, Sebatik.




**Map 1 Areas Cultivated with Seaweed in the Divided Island of Sebatik**

The island is a home to 80, 000 Indonesian and 25,000 Malaysian (Wikipedia). However, Nefianto et al. (2014, p. 219) estimated there was 26,431 Indonesian of various ethnicities such as Bugis, Tidung, Timur, Toraja, Jawa, Dayak, Batak and others. Malaysian residing in Sebatik most likely no less than 10,215 registered voters (Statistic Yearbook Sabah, 2014, p. 231). The people in Sebatik used to be artisanal fishermen and subsistence farmers. There used to be a logging by North Borneo Timber Company until 1980s after all its rainforest was gone. Followed by the land settlement (oil palm smallholding) schemes for hard-core poor. It was then abandoned but in 2010 it was rehabilitated by Sabah Land Development Board. Today many of its villagers mostly Bugis, Tidung and Bajau are participants in Mini Estate Sejahtera projects or working for oil palm companies. Palm oil are boon to them. Except in the thriving Desa Sungai Nyamuk, life of the Indonesian living across river of the same name used to be slow moving.

In 2008, there was unusual high demand for *Kappaphycus and Euchema Cottonii* a (kappa) carrageenan bearing seaweed all over Semporna, Lahad Datu, Kunak and Tawau. Swoop by the euphoria and taxpayers funded projects implemented by Department of Fisheries- Sabah and other agencies, many artisanal fishermen in Sungai-Kuala Merotai, Sungai Udin, Brantian-Umas as well as in Sungai Pendekar and in Burst Point in Sebatik started to cultivate seaweed. The farms in Burst Point was visible from Malaysian PGA Security and Quarantine for Animals& plants Post (at Jambatan Tanjung Arang opened in 2015) or from the Republic Indonesia Military Post Kaca, 500 meters across the border.

As shown in Table 1 above, in six months seaweed farmers in Tawau including Sebatik have produced 0.063% of Sabah's seaweed. Two years after that it increased 40 times and Tawau contributed 1.6% to Sabah's production surpassing Banggi, not that far behind Kunak. In 2014, Banggi were no longer producing but Tawau contributed 2.3% to Sabah's total production.

**Table 1 Production of Seaweed in Tawau Compared to Other Districts in 2010, 2012 and 2014 (Weight Wet in m.t)**

| | 2010 | 2012 (ex-farm gate price in MYR) | 2014 (ex-farm gate price in MYR) |
|---|---|---|---|
| Jan | - | 450 (2.50) | 303.80 (3.80) |
| Feb | - | 480 (2.50) | 377 (3.79) |
| March | - | 420 (2.40) | 450 (3.79) |
| Apr | - | 430 (2.30) | 463 (3.79) |
| May | - | 400 (2.20) | 523 (3.80) |
| June | 15 | 450 (2.20) | 598 (3.49) |
| July | 12 | 450 (2.20) | 477 (3.00) |
| Aug | 14 | 460 (2.20) | 475 (3.00) |
| Sept | 23 | 440 (2.20) | 465 (2.31) |
| Oct | 24 | 450 (1.90) | 582 (2.80) |
| Nov | 22 | 460 (1.70) | 552 (3.10) |
| Dec | 22 | 470 (1.70) | 560 (3.09) |
| Tawau total (wet weight m.t) | 132 | 5,360 | 5,826.90 |
| Semporna | 171,859.00 | 252,270 | 223,380.90 |
| Lahad Datu | 28,390.00 | 64,470 | 7,711 |
| Kunak | 7,127.40 | 9,100 | 8,414 |
| Banggi | 342,00 | 270 | Ceased to exist |
| Sabah total | 207,850.40 or 20,785.04 dried X MYR3 per/kg = wholesale valued at 62,355.12 (MYR'000) | 331,470.00 or 33,147 dried | 245,332.80 or 24,533.28 dried X MYR3.32 per/kg = wholesale valued at 81,460.88 |

Source- Annual Fisheries Statistics 2010, 2012 and 2014

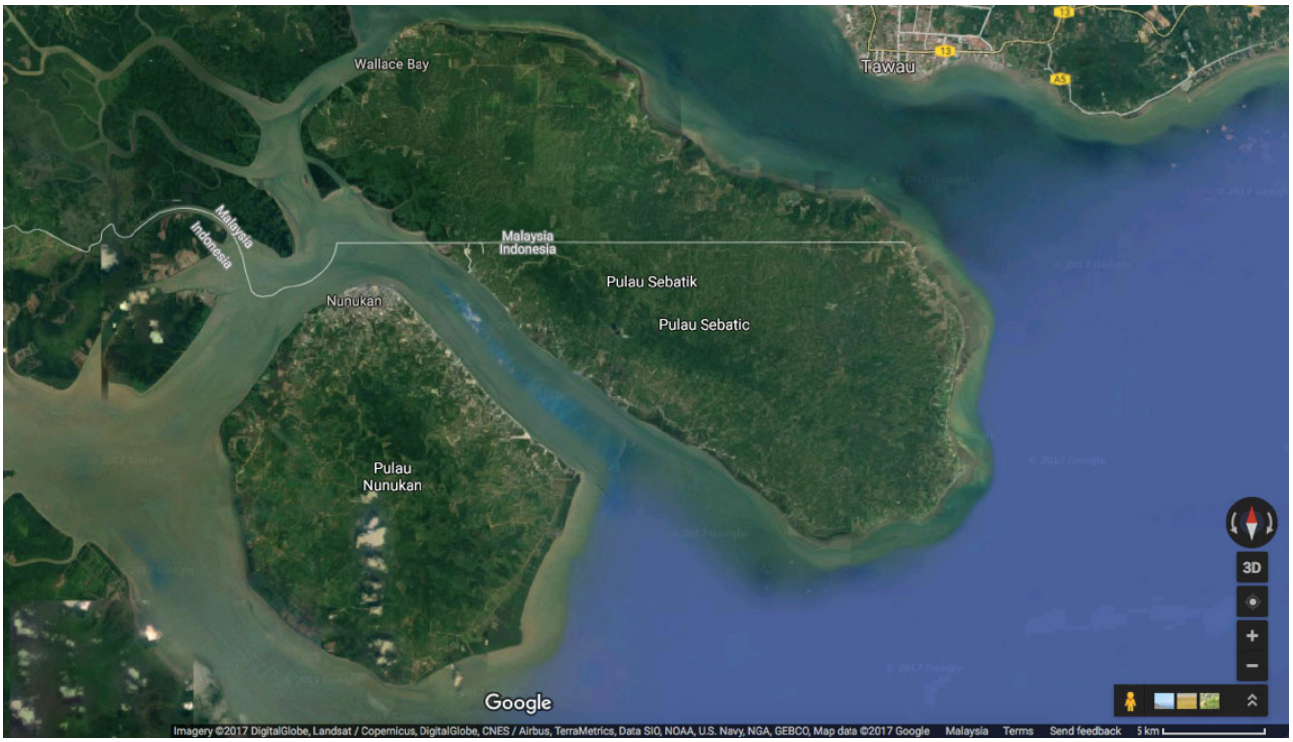
**Table 2 Seaweed Producing Areas in Sebatik Island and Other Areas in Tawau in November 2014**

| Location | Number of farmers | Cultivated area acres | Number of long lines | Production (dried sw/m.t) |
|---|---|---|---|---|
| Zone Sebatik Sungai Pendekar | 30 | 150 | 1500 | 3.2 |
| Zone Burst Point, Sebatik | 31 | 155 | 1550 | 12.5 |
| **Sub-total Sebatik** | **61** | **305** | **3,050** | **15.7** |
| Zone Merotai | | | | |
| Sungai Merotai | 45 | 225 | 2550 | 5.3 |
| Kuala Merotai * | 30 (4 clusters) | 150 | 1550 | 6.3 |
| Sungai Udin | 35 | 175 | 1750 | 3.5 |
| Sungai Brantian/Umas | 18 | 90 | 900 | 4.1 |
| **Sub-total family farms and clusters** | **128** | **945** | **9,480** | **34.9** |
| Sungai Merotai | Famous Alpine private limited company | 50 | 360 | 15.8 |

Source: Mohd Ariffin Amit (2014). Pengeluaran Rumpai Laut Tawau November 2014, Department Fisheries Sabah District Office in Tawau. * September 2014.

The news of high price at MYR4 per/kilo in 2008 encouraged the Indonesian fishermen in Desa Setabu to cultivate seaweed. Ever since then, their life no longer slow but in frantic pace. The euphoria spread like a wild fire 30 kilometres south reaching the communities of Nunukan Island and coast to coast in Tarakan 100 kilometres

away from Sebatik. The details and stories about seaweed farming in Kabupaten Nunukan have been discussed by Reski (2013); Setiawan (2013) and are summarized in Table 3.




**Map 2 Nunukan Island of Indonesia**

**Table 3 Seaweed Production in the Kabupaten Nunukan including Sebatik Island from 2008-2014**

| Year | Households farming SW | Cultivated areas (in ha) | Production (wet SW in m.t) | Value (at IDR 1,000) |
|---|---|---|---|---|
| 2008 | 174 | 31 | ? | ? |
| 2009 | 481* | 436.90* | 39,321 | 31,456.800 |
| 2010 | 1,443 | 712.06 | 56,542.77 | 45,234.216 |
| 2011 | 1,851 | 1,297 | 116,215.22 | 48,139.530 |
| 2012 | 1,684 | 1,555.63 (443ha in Kecamatan Nunukan Selatan) | 146,674.41 | 76,698.316 |
| 2014 | 3,000 in Kelurahan Tanjung Harapan, Sebatik island | 1,713ha in Kecamatan Nunukan Selatan<br>40ha in Kecamatan Sebatik | Each farming 1,000 to 5,000 long lines producing 18 kg dried per line.<br>Kabupaten Nunukan Produced 3,000 m.t dried SW monthly | Ex-farm gate price IDR5,500 per/kg dried |

Source: Compiled using data cited in Reski (2013, pp. 3, 54-55) and Radiarta et al. (2016, pp. 31-34).

Setiawan (2013, p. 1) reported that in 2009 (refer to * in Table 3 above) more than 1,401 households in Kabupaten Nunukan including Sebatik have cultivated 700ha. Productive areas other than Kecamatan Sebatik, are Kecamatan Sebatik Barat (Desa Setabu, Desa Binalawan, Desa Liang Bunyu and Desa Bambangan) and Kecamatan Sebatik Timur (Desa Tanjung Harapan, Desa Sungai Nyamuk, Desa Bukit Aru Indah and Desa Tanjung Aru). In 2014 (refer to table 3) the cultivated areas in Kecamatan Sebatik was 19% of the entire area in Kabupaten Nunukan. Together with the other Kecamatan, Sebatik contributed 30% of monthly dried seaweed

produced in Kabupaten Nunukan. Compare that to sixty one Malaysian farmers in Sebatik contributed 31% of Tawau's total seaweed production in November 2014. As shown in table 2, the number of farmers, cultivated areas and long lines in Burst Point, Sungai Pendekar and Clusters in Kuala Merotai are about the same. Yet Burst Point produced four times more than Sungai Pendekar and doubled the production from clusters in Kuala Merotai.

Many seaweed farmers in Setabu and Kelurahan Tanjung Harapan was hoping to bring dried seaweed over to Tacara — a semi-refiner in Tawau or sells to Lucky Frontier — a factory in Kunak. Unfortunately they were unable to bring it to much closer market in Tawau. Instead they had to sell it to Tengkulak (middlemen) at the discounted price. Otherwise they have to pay for shipping, logistics and transhipments at Tunon Taka port in Nunukan to send it to refiners in Makassar, Banten or Surabaya.

Radiarta et al. (2016, p. 35) asked why some family farming are more successful than others. Zooming into Kelurahan Tanjung Harapan they observed that the successful ones tends to be those with three to eight dependents, mostly Bugis and Tidung ethnic, aged 20 to 40 and not necessarily owning a boat. Azwir et al. (2011) answered this question using by putting 70 samples to tests. Half of the samples was from Kecamatan Abeli where farms are more exposed to strong waves while the rest from Kecamatan Kendari, sheltered areas. Four factors was found significant- farm size, quantity of propagules, education level and a Dummy-location. Not significant were farming experience, number of dependents and labour. Banyuriatiga et al. (2017) tested 100 samples collected from Amal Beach in Tarakan. Almost similar conclusion was drawn. Farm size, quantity of propagules, farming experience and dummy — location was found to be significant. But labour, fuel, age, number of dependents and education level were not significant.

## 2. Objectives

This paper aimed to find out which factors makes some farms more successful than others. Secondary is to provide an overview of the emergence of Sebatik and Tawau as one the main seaweed producers for Sabah.

## 3. Data and Methodology

### 3.1 Primary Data Collection

Selection of respondents or other samples aspects followed Slovin Methods and procedures recommended in Ryan (2013). Interviews with 50 Malaysian seaweed farmers were conducted during AGM meeting of Koperasi Bumi Asli Merotai (Besar) Tawau Berhad in May 2016 and also during field visits to Sungai Pendekar and Burst Point in Sebatik Island in July 2016, visits to Sungai Merotai, Sungai Udin and Sungai Brantian-Umas, Merotai Tawau in October-November 2016. The other half of respondents consist of 50 Indonesian seaweed farmers interviewed during meeting of Koperasi Berkah Bahari Kabupaten Nunukan in February 2016 and sites visit in March 2016 to Kecamatan Sebatik Barat (Desa Setabu, Desa Bambangan), Kecamatan Sebatik Timur (Desa /Kelurahan-Tanjung Harapan, Desa Sungai Nyamuk) and Kecamatan Sebatik Tengah (Desa Aji Kuning).

Interviews were guided by structured questionnaire on eight aspects; farm size ; quantity of propagules; fuel (used per round); age (of farm's owner); farming experience; number of family members involved in farming; education level of farmer and farm location (1 = located within designated zone or 0 = otherwise). All 50 respondents are farm owner, full time and assisted by his or her own family members (labour). Seaweed farming is anything but an alternative livelihood. Farming seaweed part time or alternating it with other type of jobs (most likely artisanal fishing) is almost impossible.

Independent variables are similar to Azwir et al. (2011) and Banyuriatiga et al. (2017) except for three variables. Labour was not included in the model specified in section 3.2 because the sampled farms were run by the family. They were not hired workers per se. Most were paid in — kind not in cash. The variable-number of dependents in the household was modified into number of family members involved in farming. And dummy — location was modified into 1 = within designated zones or 0 = otherwise.

**3.2 Theoretical Framework**

Seaweed farms at both sides of the Sebatik Island used long line a technique similar to farms studied by Azwir et al. (2011) and Banyuriatiga et al. (2017). Therefore their production functions must be significantly or not significantly influenced by more or less the same variables.

Cobb Douglas production function Y = F (K, L) expressed in the following Multiple Linear Regression equation:

Ln Y =Ln a+ β1 Ln X1+ $\beta 2\ Ln\ X2 + \beta 3\ Ln\ X3 + \beta 4\ Ln\ X4 + \beta 5\ Ln\ X5 + \beta 6\ Ln\ X6 + \beta 7\ Ln\ X7 + d\ D + e$

Whereby:

X1 = Farm size (number of long lines — the only farming technique at the study sites);

X2 = Quantity of propagules (bibit or fresh seaweed cultivated during previous or current round);

X3 = Fuel (diesel or solar IDR 6,000-8,000 per litre) for the boat used in each round of farming)

X4 = Age (of the farm's owner);

X5 = Farming experience (which includes trainings received);

X6 = Number of family members involved in farming;

X7 = Education level of farmer;

dD = Dummy -Farm location (1 = located within designated zone or 0 = otherwise).

## 4. Results and Discussion

**Table 4 Results of Multiple Linear Regression on explanatory variables for production of seaweed in the divided island of Sebatik.**

| Variables | Coefficient | "t" count | sig |
|---|---|---|---|
| Ln Constant δ | 2.407*** | 20.806 | 0.00 |
| Ln Farm size | 0.012*** | 0.200 | 0.002 |
| Ln Quantity of propagules | 0.913*** | 8.196 | 0.001 |
| Ln Fuel | -0.019 ns | -0.844 | 0.507 |
| Ln Age of farm owner | 0.078 ns | 0.930 | 0.359 |
| Ln Farming experience | 0.066** | 2.500 | 0.026 |
| Ln Number of family members | 0.020 ns | 0.630 | 0.540 |
| Ln Owner's education level | 0.020 ns | 0.350 | 0.730 |
| Dummy Location | 0.027*** | 0.360 | 0.002 |
| R square | | | 0.904 |
| Adjusted R square | | | 0.894 |
| F count | | | 92.173 |
| F sig | | | 0.000*** |

Note: *Significant 90% (α =0.1; F table =1.70; t table =1.66195); ** Significant 95% (α = 0.05; F table =1.98; t table =1.98669); ***Significant 99% (α =0.01; F table=2.63; t table =2.63159); ns = Not Significant

Salient features of the results in table—above are as follows;

**4.1 The T-test, Adjusted R square and F-test**

The t-test shows t-significance (at the error rate of each explanatory factors) value smaller than α hence the independent or explanatory variables has significant effect on dependent (Y) variable (seaweed production).

Adjusted $R^2$ value shows that 89.4% of dependent variable can be explained by the independent variables and 10.6% explained by variables not included in the model.

The F-Test shows the value of F count 92.173 is more than F table 2.63 (with a probability of 0.000) at significant level α = 1% meaning all explanatory variables have influence on seaweed production in Sebatik island.

**4.2 Farming Experience Significance α = 0.05**

The coefficient or farming experience = 0.066. It is possible for an aspiring new seaweed of any age or an apprentice to learn know — how of farming in just one round (≥ 45 days). After all, steps from preparing propagules until post-harvesting are repetitive and monotonous. Trying it out is a precondition, necessary but not sufficient. A farmer need a lot of time to try and errors or to experience and to acquire skills in making decision under uncertainties such as unpredictable weather. Holding prices constant, experience is significance in determining the probability of any farm to survive and succeed.

**4.3 The Quantity of Propagules, Farm Size and Location — *Dummy*, All Are Significant at α = 0.01**

The (elasticity) coefficient for quantity of propagules = 0.913 which is greater than farm size = 0.012, that is to say by adding one percent more propagules to the mean (or average harvested) production are expected to results in an increase of 0.903% of production. An increase of one percent to the average farm size are expected to increase the production by 0.012%. The farms located within designated sea areas is expected to be able to produce 0.027% more seaweed than those farming outside.

Why is it only 4% of Indonesian in Sebatik Island with a very limited job opportunities are into farming seaweed? The main reason is that a good quality propagules — strains that are fast growing and not susceptible to diseases such as Ice-Ice and Epiphytes or Sireng are quite expensive. Hence beyond the means of hard-core poor fishermen. When it is purchased with their precious life time saving or with a high interest loans (low creditworthiness) it will be accounted for as a large fixed cost of initial investment in the first round. A 100 kg propagules usually grow after 45 days ten times more or less given usual rate of loss of 5-10%. So the harvested wet seaweed can be divided, half as propagules for subsequent round 2 and the other half 500kg to be sold as 50kg dried seaweed. And so propagules generated in the subsequent rounds can pay for the other incurred variable or operating costs. However, once the farm reached a break even or through the pay-back period, farmer will be in the position to have more profit for saving and consumption or future expansion. The later will incur additional cost and ultimately hinges upon the space availability (certain sea areas are more fertile than others therefore are more crowded), its ownership and the rules governing it.

Equally significance α = 0.01 are location of the farms. Those located within the zone, i.e., allowable waters are of 50-400 meters from the lowest tide limit is expected to have 0.027% (coefficient value) more production compared to farms outside the zone. In 2010, Ministry of Fisheries and Marine Affairs have set a zoning order. Tarakan government have implemented it but many farmers did not or does not want to comply and were reported farming as far as 10km away from coast created conflicts over water ways (Banyuriatiga et al., 2017, p. 88). This zoning was not yet enforced on farmers in Nunukan or Sebatik. Never the less, farms have self-organized and congregated very near to the villages, fertile and protected by the islands from monsoon and far away from estuary and mangroves. Sungai Pendekar and Burst Point have been farmed long before Sabah-DOF came up with

zoning and all the incentives (jetties, provided training and subsidized inputs). They are inside the zones not due to their obedience to authority.

**4.4 Not Significant Are Fuel; Age; Number of Family Members Involved in Farming and Education Level**

Coefficient for fuel = negative 0.019 or an increase of one percent to an average fuel usage reduces about the same percentage in production. As a farmer grow older he gained more farming experience but at the same time less able to do physically demanding tasks. Moreover, the roles of child labour, men or women, young or old complements each other in processes of long line farming. Majority of sampled Indonesian farmers has low and/or no formal education at all. Most with large family (high fertility and fecund), extra mouths to feed and also extra hands to work up to certain extent. For the poor Indonesian seaweed farmers', diesel are very hard to get (chronic shortage in Nunukan Regency) and are the most expensive operating costs. So they have learned to minimize and often not to use diesel as their survival strategy. Obviously physical strength are far more important than the four not significant variables.

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