

The Economic Impact of Higher-Blend Biodiesel on the Philippine Coconut Industry and end-Users amid Rising Oil Prices & Falling Prices of Coconut Oil

Dr. Hosein Piranfar¹, Cyma Edel Alba² & Faiz Subhani³

Abstract

Amid the weakening global prices of coconut oil and rising prices of crude oil, government agencies and coconut farmers in the Philippines have lobbied for an increase in biodiesel blend from 2% to 5% in order to boost the utilization of coconut oil in domestic diesel and support the local industry. However, Philippine economic managers oppose the move because of the inflationary effect in diesel prices. In order to provide a holistic evaluation that could help devise the country's biodiesel roadmap, the study determined the net economic impact of higher-blended biodiesel on the biofuel supply chain. The economic impacts on producers and consumers were assessed at three biodiesel blend rates – 3%, 5%, 10%. Results showed that benefits outweighed the losses and that the rising oil prices may encourage higher bio-content and better prices for the farmers.

Keywords: Philippines, oil prices, coconut oil blend, coconut industry, economic policy, energy consumers

1. Introduction

The coconut industry plays a vital role in the economic development of the Philippines, particularly with its now extensive export market that started only as a small trade way back in the 1800s. In 2017, the country's agricultural exports accounted for almost 10% of the total exports' revenue, with coconut oil seizing the highest share of 25% in the total agricultural exports value (Philippine Statistics Authority, 2018). However, in 2018, the coconut oil export market was critically hit by the declining global prices amid ample supplies of other vegetable oils and plummeting demand (Philippine Coconut Authority, 2018). In this regard, dedicated government agencies, coconut farmers, coconut oil producers, and other stakeholders put forward several avenues to increase revenue and support the local industry. Among the various propositions, the additional use of coconut oil in domestic diesel is seen to be one of the immediate moves that can be implemented to boost the domestic market and lessen the exposure to the weakening international market. Philippines currently mandates a B2, that is, 2% coconut methyl ester(CME) blend for all diesel distributed in the country and has indefinitely delayed the deployment of B5 (5% CME) biodiesel, which was initially planned for 2015, owing to feedstock and pricing concerns. With the decline in the international prices of coconut oil and subsequent supply glut in the country, CME prices dropped considerably. With the rise in oil prices since 2018 and the new incentives for raising the bio-content for domestic fuel and the fact that regionally all countries are using higher blends, the paper aims to argue for a new roadmap. The paper considers both cost and benefits of the change basing the argument on the net economic impact, which is presented in Table 4 and discussed in Section 4.2 of this study. The sustainability of the higher blend rate in terms of raw material supply is also a key factor, as presented and analyzed in Section 4.

2. Background of the Study

2.1 Coconut production in the Philippines

¹Amity University London/ UWS London, 24 Bedford Square, Bloomsbury, London WC1B 3HN, Email: piranfar@btinternet.com, Tel. 044 2088544775

² Senior Technical Research Analyst, Singapore

³ Doctorate Researcher, UWS London

According to the Philippines Statistics Authority (PSA), about 27% or 3.6 million hectares of cultivated land in the Philippines was allocated for coconut production in 2017. This accounted for 343 million coconut trees that produced 14 million tons of coconut with husk during the same period. The coconut production, however, fluctuates despite the increasing number of coconut trees, particularly from 2014 to 2017 as shown in Figure 1. Productivity is normally hampered by infestation, aging of crops, and frequent occurrence of typhoon in the region. In addition, political issues surrounding the coconut levy fund and the veto of the coconut levy bills limit the growth of the coconut industry (Castillo & Ani, 2019). Nonetheless, the Philippine Coconut Authority (PCA) continues with its coconut tree fertilization and replanting program to improve productivity.

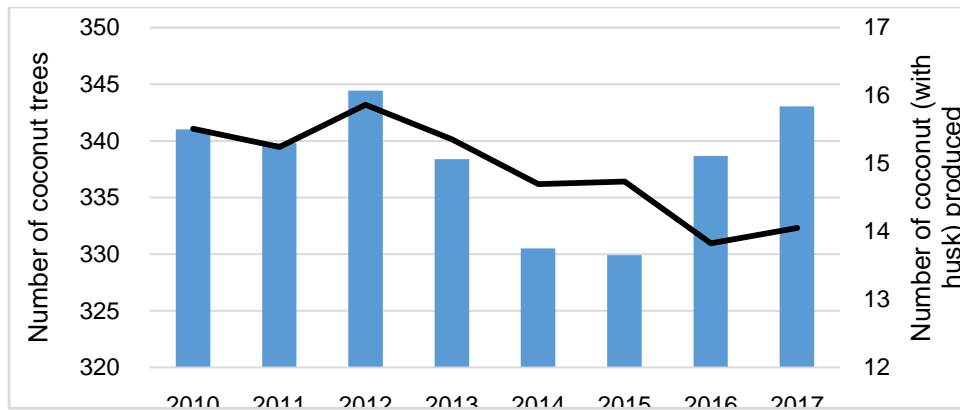


Figure 1: Number of coconut trees and coconut with husk produced in the Philippines, 2010 – 2017 (Philippine Statistics Authority, 2019)

A wide variety of products can be made from the different parts of coconut. Key products include coconut oil, desiccated coconut, copra meal, and oleo chemicals. Other products include coconut water, coconut sugar, virgin coconut oil, coconut flour, coco coir, etc. Among all these, coconut oil, which is extracted from the dried coconut meat copra, is the leading product that has a huge export market mainly in the Netherlands and the United States (Philippine Statistics Authority, 2018).

2.2 Export market performance of Philippine coconut oil

The Philippine Oilseeds and Products Annual reports show that in the last five years, more than 50% of the coconut oil production have been diverted into the international market. As such, coconut oil remains as the top contributor to the country’s agricultural export market as shown in Figure 2, with coconut oil seizing 25% of the total agricultural exports value in 2017.

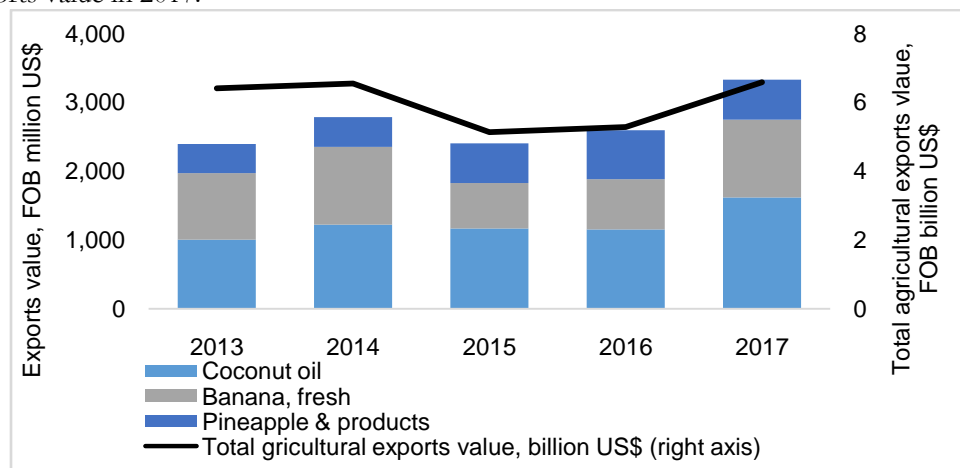


Figure 2: Top three agricultural exports in the Philippines, 2013-2017 (Philippine Statistics Authority, 2018)

The performance of coconut oil in the export market had been generally strengthening through 2017, with exports value increasing by more than 60% from 2013 to 2017.

The main importing countries include Netherlands, the United States, China, Japan, and Italy. However, the export market weakened in 2018 due to competition from other vegetable oils and negative concerns about the health benefits of coconut oil. Figure 3 shows the downward trajectory in coconut exports value and prices. The weakening export performance of coconut oil has largely weighed on the income of local farmers as suggested by the dwindling farmgate prices of raw material copra in Figure 4. From 2017 average of about Php 40 per kilogram, copra farmgate prices dropped by more than 40% in 2018 and by another 30% in the first quarter of 2019.

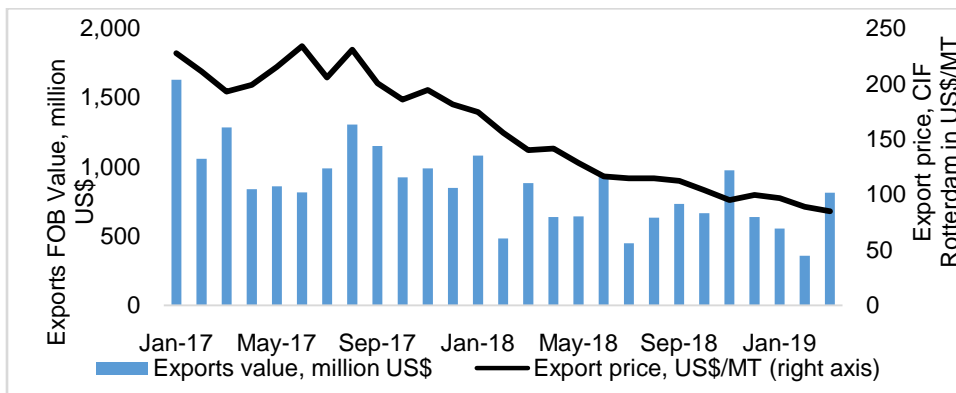


Figure 3: Philippines' monthly coconut exports value and export price, Jan 2017 – Mar 2019 (Philippine Statistics Authority, 2017-2019) (Index Mundi, 2019)

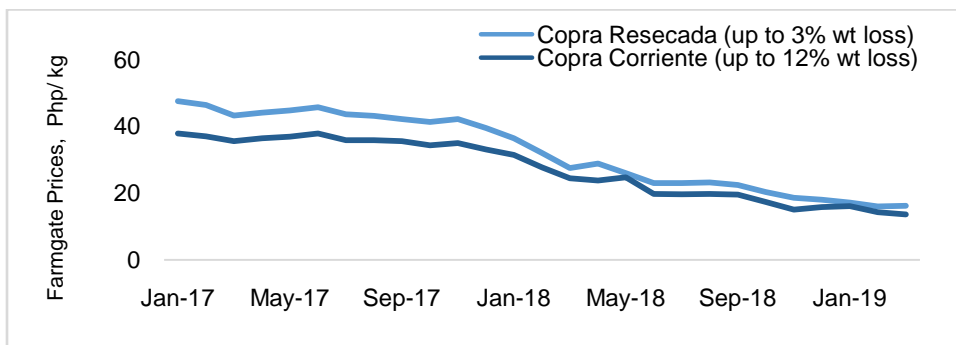


Figure 4: Average farm gate prices of copra in the Philippines, Jan 2017 – Mar 2019 (Philippine Statistics Authority, 2017-2019)

2.3 Coconut oil as biodiesel feedstock in the Philippines

A portion of the country's coconut oil is used for the local production of CME or coco-biodiesel. Coconut oil is initially extracted from copra or dried coconut meat, and then processed by biodiesel producers via transesterification to produce CME at an estimated yield of 95% (Bello, et al., 2015). In the Philippines, 11 registered biodiesel refineries produce CME from coconut oil sourced from local farmers. The total annual capacity is 575 million liters (USDA Foreign Agricultural Service, 2018). The CME product is sold to companies for blending with fossil diesel to produce biodiesel at a blend mandated by the government. The PCA supports the utilization of CME as a petroleum diesel fuel for the reduction of air pollution, better engine performance, and better prices for the farmers. The Department of Energy (DOE) also promotes the use of CME as biodiesel for more efficient combustion that translates to increased engine power, longer mileage, and less emissions. Apart from coconut being one of the key agricultural products of the country, CME is also preferred over other forms of biodiesel such as palm oil and cooking oil because of its chemical properties that give high lubricity for engine protection, solvency for dissolution of carbon deposits in the combustion chamber, and detergency for a cleaner fuel system (Department of Energy, n.d.). In Asia, only Philippines utilizes coconut oil as biodiesel feedstock given the vast coconut plantation in the region. Other countries such as Indonesia, Malaysia, and Thailand rely on their palm oil resources.

2.4 Uncertainties around the Philippine biodiesel roadmap

Following the enactment of Biofuels Act in 2007, Philippines mandated the use of biodiesel to lessen the country’s reliance on fuel imports, lessen greenhouse gas emissions and help agriculture. The act prohibits biodiesel imports in order to support the local industry. The initial biodiesel blend in 2007 was B1 (1% CME) which was then increased to B2 (2% CME) in 2009, and the mandate has not been changed since then despite the planned deployment of B5 (5% CME) biodiesel in 2015. Concerns over the higher prices of coconut oil and CME, as well as the local supply of coconut oil, have led to the indefinite postponement of the implementation of B5 blend. Despite some positive gestures from PCA various taxation reforms and measures have increased the burden on producers and consumers of the blend. In January 2018 and January 2019, refined products had their first and second rounds of tariff hikes. Diesel excise tax rose from zero to PhP 2.5/L in 2018 and to PhP 4.5/L in 2019. Another round of increase is set to take effect in 2020 where diesel excise tax would reach PhP 6/ L (National Tax Research 2019). Notwithstanding this, despite the higher prices of CME relative to neat or fossil diesel, Figure 5 shows that the price gap between diesel and CME has narrowed particularly in 2018 amid declining prices of coconut oil and increasing fuel prices.

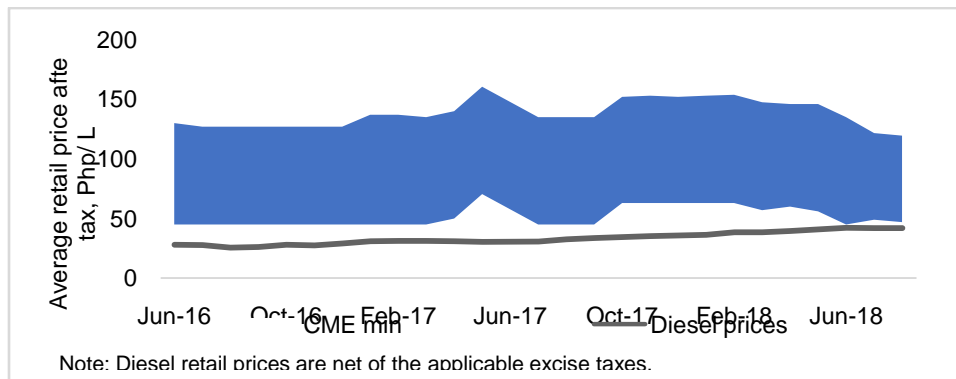


Figure 5: Average retail prices of diesel and CME in the Philippines, Jun 2016 – Aug 2018 (USDA Foreign Agricultural Service, 2017-2018)

Among the Southeast Asian countries, Philippines currently has the lowest biodiesel blend of 2%, with Malaysia, Indonesia and Thailand mandating 10%, 20%, and 7% blend rates, respectively. In Malaysia, the recent increase in blend rate from 7% to 10% was mandated in February 2019. Meanwhile, Indonesia and Thailand seek to further boost the blend rate from 20% to 30% and from 7% to 10%, respectively, to avert declining prices of palm oil. In the Philippines, the current biodiesel blend mandate is expected to remain indefinitely according to the Biofuels Roadmap in the latest Philippine Energy Plan 2017 – 2040, as shown in Figure 6. This roadmap supersedes the previous plan to deploy 5% biodiesel blend by 2015.

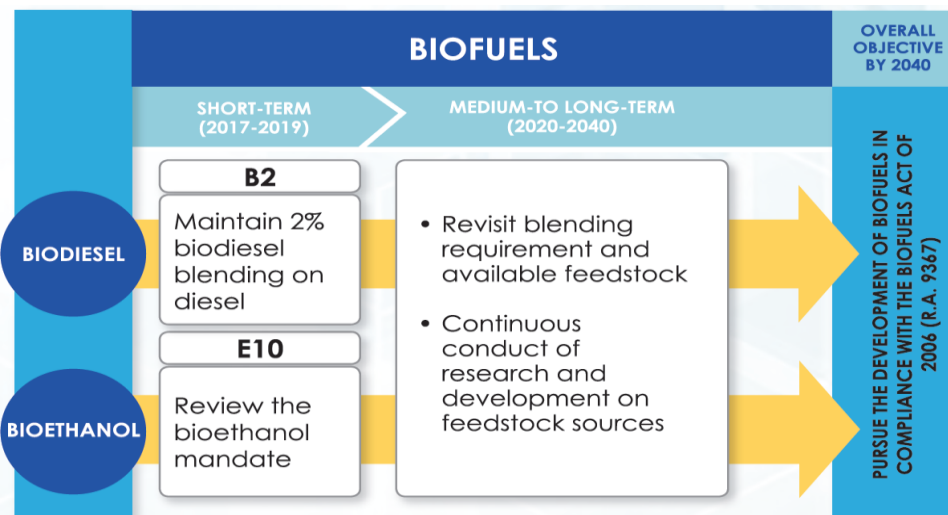


Figure 6: Philippines’ Biofuel Roadmap (Department of Energy, 2017)

3. Review of Related Literature

As the background section covered some of the essential information the literature will focus on specific issues such as viability of CME, the economic impact of higher biodiesel blend, global fuel prices affecting the biodiesel economics, and the implications of higher biodiesel blend in the region

3.1. Viability of CME as biodiesel feedstock

Prior to the enactment of Philippine Biofuels Act, several experiments were concluded to establish the viability of CME either as a fuel enhancer or as an alternative fuel. CME has been known to lessen environmental emissions, improve car engine performance and increase mileage. According to Ables (2004) in 2001, the PCA experiment with DA involving 15 vehicles running on 1% CME showed a reduction of 50% in smoke emissions. He also enumerated later studies including the joint experiment by TUP and a Japanese group which showed an average 20% reduction in the emission of nitrogen oxides and 70% reduction in the particulate matter at 20% CME blend rates of up to 20%. Accordingly, other experiments with 1% and 5% CME improved the mileage and engine performance (Ables, 2004). In 2016, Malik et. al investigated the combustion performance at various CME blends. Results confirmed that biodiesel with higher CME blend rate combusts at a lower temperature and has lower emission concentration, demonstrating the advantages of CME in the transportation sector (Malik, et al., 2017). A preliminary study of the fuel economy of public utility jeepneys, the most popular mode of transportation in the Philippines, using 2% and 5% CME was performed by Quiros and Vergel in 2015. Travel distance, fuel consumption, and load factor were monitored in jeepneys traversing five different routes in Metro Manila. Compared with 2% CME, the 5% CME recorded 3.0% increase in mileage, 12% reduction in idling smoke opacity, and 4.6% improvement in specific fuel consumption (Quiros & Vergel, 2015). However, in 2017, another study regarding the performance and emissions revealed that CME blend rates up to 20% only have a marginal effect on the heating values, specific fuel consumption, mileage, and maximum power. Nonetheless, hydrocarbon and nitrogen oxide emissions decreased with increasing blend rates. Results also showed that blend rates higher than 20% would be counterproductive (Quiros & Laguitao, 2017). Yet another study about the emission and performance of a light duty common rail direct engine fueled by CME-diesel blends revealed that there is no significant difference between biodiesel blends and neat diesel in terms of torque, power, and carbon dioxide and nitrogen oxide emissions at typical speed range of 1200-2400 revolutions per minute (RPM) (Mercado & Quiros, 2017). Notwithstanding this, a 2018 study by Quiros and Aguila, showed better results for higher blend rates such as lower specific fuel consumption of 1% - 5% and improved mileage of 1% - 5%. Carbon monoxide and total hydrocarbon emissions also reduced with increasing blend rates. Study results also showed that 5% CME is the optimum blend rate in terms of fuel economy and emissions improvement (Quiros, et al., 2018). However, more studies will be needed using different vehicle types to strengthen the claim that CME is a viable fuel enhancer and/ or substitute. Meanwhile, Alonzo (2016), in his economic and environmental analysis of the impact of higher-blended biodiesel on the Philippine economy, determined the environmental and health benefits of increasing the blend rate from 2% to 5% CME, which amounted to PHP 7 – 26 million and PHP 472 million, respectively. The environmental impact is taken from the lower greenhouse gas emission and carbon footprint, while the health benefits are attributed to savings in treatment cost, higher productivity, and improved life quality due to lower mortality and morbidity rates from reduced cases of respiratory illnesses (Alonzo, 2016).

3.2. Economic impact of higher biodiesel blend

In 2016, the DOE tapped the University of the Philippines (UP) in conducting two separate studies to help determine the roadmap for biodiesel and assess the impact of higher biodiesel blend on coconut farmers and consumers. The first study conducted by Rodriguez (2016), is not publicly available. Rodriguez, (2013), however, had almost covered the requirements which are represented in the roadmap above, (Fig.6). The second study was carried out by Ruperto Alonzo. Through numerical evaluation, the economic and environmental analysis of the impact of higher-blended biodiesel on the Philippine economy was carried out, recommending the deferment of raising the biodiesel blend in the near term owing to a significant loss of around PHP 3.8 billion to consumers from higher biodiesel price. Accordingly, this negative impact due to higher cost far outweighed the environmental and health benefits. While the study presented results based on the economic impact on end-consumers, it did not look at the possible effect of higher-blended biodiesel in the local coconut industry. With the recent decline in coconut oil export prices, PCA, Department of Agriculture (DA) and other groups have been lobbying for the implementation of B5 blend to boost the agricultural sector and help the local farmers.

However, Philippines economic managers oppose the move because of the consequent increase in diesel pump prices (Ocampo, 2018). A national news reported by the Philippine Daily Inquirer on 26 October 2018 mentioned that the Asian Institute of Petroleum Studies Inc. calculated the potential increase in diesel prices to be around Php 0.45 per liter upon implementation of 5% blend rate.(Ocampo, 2018)On the other hand, another national news from Rappler dated 11 July 2019 mentioned a possible increase of PhP 0.20 per liter in diesel price according to the DOE (Mogato, 2019).Despite the inflationary effect in diesel prices, the PCA remained firm on its stance to increase the biodiesel blend in support of the livelihood of around 3.5 million coconut farmers in the Philippines. However, the relevant quantitative evaluation of the positive effects in the coconut oil industry and the calculation of diesel price increase are not presented. To date, no recent official study or evaluation to show the impact of higher-blended biodiesel on both producers and end-consumers amid the declining global prices of coconut oil has been made available.

3.3. Global fuel prices affecting the biodiesel economics

Apart from coconut oil price trends, recent developments in global fuel prices also support the proposition to increase the biodiesel blend mandate. Pushed by OPEC and partners, pulled by rising demand, and propelled by the worries in the Middle East the crude oil prices have started a new upward trend during 2018 and 2019. This has lifted the retail prices of petroleum products in the Philippines. Given the deregulated nature of the oil market in the country, petroleum prices are directly affected by the volatilities in the global market. Presently, continuing crude supply cut agreement among OPEC and its partners, as well as the US-Iran political conflicts following the withdrawal of the United States from the 2015 nuclear deal, plus the more recent spill-over of the Turkish internal conflict to Syria, are supporting higher oil prices (It is worth noting that Piranfar, 2010, emphasizes the role of certain countries on oil prices rather than the OPEC as a whole). Piranfar, H. (2010), 'Herd Mentality and oil Prices: Implications for Sustainability', *International Journal of Global Environmental Issues*, 10 (1-2): 194 - 209 Supply security risks in the Middle East, abetted by the US-Iran tensions, and potential rise in demand amid the implementation of new International Maritime Organization (IMO) specification change will also back the oil market. The stricter IMO regulation effective 2020, which caps marine fuel sulfur to 0.5% against current limit of 3.5%, will provide an upside particularly to diesel prices, as diesel demand for blending with fuel oil increases. The higher oil prices narrow the gap between fossil diesel and biodiesel and support the appeal to increase the CME blend rate. Murti (2017) studied the influence of crude oil price in biodiesel and its implication on the production of palm oil in Indonesia. Murti emphasized that the higher prices of crude oil increase the competitiveness of biodiesel as an alternative to fossil diesel and subsequently lift demand for palm oil (Murti, 2017).

Prochazka and Honig (2018), in their economic analysis of replacing diesel fuel by crude palm oil in Indonesian power plants on the back of international diesel price evolution, showed that the move may be profitable given the increasing prices of diesel and the weakening Indonesian currency against the US dollar (Prochazka & Honig, 2018). Since high global oil prices increase the attractiveness of biofuel, they also drive the biofuel prices because of improved demand. However, the volatility in oil markets, coupled with the fluctuation in commodity markets particularly for bio-feed stocks, proves the difficulty in determining biodiesel prices. The United Kingdom's Department for Transport developed an internal tool Fuel Quality Directive for assessing the costs and benefits of utilizing biofuels at certain volumes in the country's road transport fuel mix. However, inherent uncertainties in the model are largely attributed to the recent high volatilities in commodity and oil markets (Charles, 2013).

3.4. Implications of higher biodiesel blend in the region

In Murti's 2017 study of the influence of crude oil price in biodiesel and its implication on the production of palm oil in Indonesia, the demand for palm oil increases on the back of more attractive biodiesel utilization. However, as many countries utilize palm oil in their biodiesel, export demand from Indonesia would increase capping the availability of palm oil for domestic consumption. The higher palm oil demand then increases the prices of biodiesel (Murti, 2017).Despite this likely downside the Indonesian government is planning to raise the blend from 20% to 30%(The Jakarta Post, 2018). Similarly, the Malaysian government mandated an increase in biodiesel blend rate from 7% to 10% on the back of falling prices of palm oil and record-high inventories in the region (Kana, 2019).The decision was apparently based on a previous study (Applanaidu, et al., 2014) that saw little increase in the palm oil domestic price (0.07%) due to higher blend of 10%. Thailand, based on prior experience of material shortage and fluctuating blend rates of palm oil is moving from B7 to B10 (Tan, 2019).

In Philippines, regarding food versus fuel issue, Cabanilla and Rodriguez (2008), argued that promoting coconut as biofuel feedstock boosts agricultural value but dampens food sector output. Alonzo (2016), in line with NEDA and PCA, also highlighted that feedstock availability is one of the constraints in meeting the required higher biodiesel demand. However, it is unclear whether the studies considered the large allocation for the export market and the regional supply-demand disruptions that may require additional local production. The need for additional domestic requirements to balance the regional equilibrium, has been faced with political controversies. The coconut production as shown in Figure 1 has been in downward trend. Castillo and Ani (2019) have attributed the stagnant growth of the coconut industry to the lack of government funding, hinting at likely corruption. Nevertheless, they do mention other causes like the declining yield of coconut oil and tight competition from palm oil. Javier (2015) fertilization provided more details: More fertilization, replanting, substitution of coconut cooking oil with palm oil, and strong government support. Javier's substitution idea, however, is questionable. While coconut oil is produced domestically, palm oil is mainly imported, and the local development of palm would be at the expense of the coconut industry (Castillo & Ani, 2019). The threat of imported palm oil to the local coconut oil is also emphasized by Business Mirror (2018) and others (Zahan & Kano, 2018). Hence, coconut oil supply growth in the Philippines hinges on the availability of government funding to improve coconut productivity and minimal disruptions from competitors, mainly palm oil.

4. Research Methodology

4.1. Problem Statement and Objectives

Aim: To work out the net value of an increase in CME blend rate from 2% to 5%-10% amid declining global prices of coconut oil and rising fossil oil prices to the stakeholders: producers of coconut (oil) and consumers of coconut-blended fuel.

Objectives:

- Using the relevant literature to understand the current market.
- How to expand the domestic market for coconut oil to benefit the local coconut oil producers/ farmers
- Determine the cost increase of blended fuel relative to neat diesel
- Determine sustainability of the higher-blended biodiesel in terms of coconut supply
- Find out the factors that hinder the implementation of higher biodiesel blend mandate in the Philippines

4.4. Research Method

A quantitative approach was carried out to evaluate the economic impact of higher-blended biodiesel on the local coconut industry and end-consumers, as well as the determination of raw materials sustainability. The economic impact on the local coconut industry was calculated from the volume of coconut oil diverted from export to domestic market due to additional requirement from higher biodiesel blend and the price differentials between domestic and export coconut oil. On the other hand, the economic impact on biodiesel end-consumers was calculated from the additional volume of CME in the diesel pool to meet the higher biodiesel blend rate and the price differentials between 100% CME and B2 diesel in the local market. This assumes that the increase in product cost due to higher feedstock volume requirement will be transferred to end-consumers. Three blend rates were considered in the study – 3%, 5%, and 10%. For each blend rate, Base, Low, and High cases of price differentials between domestic and export coconut oil (for the local producers) and between 100% CME and B2 diesel (for the end-consumers) were looked at. The net economic impact on the biofuel supply chain was then determined in each case by combining the revenues/ losses from both stakeholders – producers and consumers. Through quantitative analysis, the economic impact on local coconut oil producers and biodiesel end-consumers was determined. Forecast and historical data on supply, demand, and prices were taken from public domain. In cases of unavailability of information due to lack of transparency in the market, estimates were made based on the assumptions presented by the researcher.

5. Results and Discussion

5.1 Results

Three biodiesel blend rates were considered in the study – 3%, 5%, 10%. Given the 2019 diesel demand forecast from the Philippines Energy Supply and Demand Outlook 2017-2040, the CME volumes required at different blend rates were calculated, with results shown in Table 1.

Table 1: CME requirement at different blend rates

Blend Rate	Total CME volume in diesel pool in million Liter/yr. ⁽¹⁾	Additional CME volume requirement at higher blend rate in million Liter/yr. ⁽²⁾
2% (current rate)	161	-
3%	241	80
5%	402	241
10%	803	642

⁽¹⁾2019 diesel demand forecast ⁽³⁾ x blend rate

⁽²⁾2019 diesel demand forecast⁽³⁾ x (new blend rate – 2%)

⁽³⁾8,030 million L/yr (Basis: Philippines Energy Supply and Demand Outlook 2017-2040)

To determine the economic impact on the local coconut industry of using more coconut oil domestically to produce the additional CME volume required at higher blend rates, price differentials between domestic and export coconut oil at three cases – Base, Low, High, were used as reference. At different biodiesel blend rates, the coconut industry is estimated to gain incremental revenues as shown in Table 2.

Table 2: Additional revenue to the local coconut industry as a result of higher biodiesel blend

Case	Domestic – Export coconut oil price differential in PhP/kg ⁽¹⁾	Additional revenue in million PhP/yr ⁽²⁾
At 3% blend rate		
Base Case ⁽³⁾	23.6	1,835
Low Case ⁽⁴⁾	11.6	903
High Case ⁽⁵⁾	35.6	2,767
At 5% blend rate		
Base Case ⁽³⁾	23.6	5,505
Low Case ⁽⁴⁾	11.6	2,709
High Case ⁽⁵⁾	35.6	8,302
At 10% blend rate		
Base Case ⁽³⁾	23.6	14,681
Low Case ⁽⁴⁾	11.6	7,223
High Case ⁽⁵⁾	35.6	22,138

⁽¹⁾ Price differentials taken from May 2019 price set as published by the PCA

⁽²⁾ Price differential x (Additional CME volume requirement as in Table 1 ÷ 95% biodiesel yield x 0.92 kg/ L density)

⁽³⁾Base Case: Midpoint of minimum and maximum domestic price – Export price

⁽⁴⁾ Low Case: Minimum domestic price – Export price

⁽⁵⁾ High Case: Maximum domestic price – Export price

On the other hand, to determine the economic impact on the end-consumers of having more CME in the diesel pool, price differentials between pure CME and currently available B2 diesel in the market at three cases – Base, Low, High, were used as reference. At higher biodiesel blend rates, the end-consumers are estimated to incur losses as shown in Table 3. The corresponding increases in retail diesel prices are also listed in Table 3

Table 3: End-consumer losses as a result of higher biodiesel blend

Case	Pure CME – B2 biodiesel blend price differential in PhP/L ⁽¹⁾	End-consumer losses in million PhP/yr ⁽²⁾	Increase in retail diesel price in PhP/L ⁽³⁾
At 3% blend rate			
Base Case ⁽⁴⁾	17.9	1,441	0.18
Low Case ⁽⁵⁾	2.8	224	0.03
High Case ⁽⁶⁾	61.3	4,921	0.61
At 5% blend rate			
Base Case ⁽⁴⁾	17.9	4,322	0.54
Low Case ⁽⁵⁾	2.8	672	0.08
High Case ⁽⁶⁾	61.3	14,763	1.84
At 10% blend rate			
Base Case ⁽⁴⁾	17.9	11,525	1.44
Low Case ⁽⁵⁾	2.8	1,792	0.22
High Case ⁽⁶⁾	61.3	39,368	4.90

⁽¹⁾ Price differentials taken from 2017 and 2018 Philippine Biofuels Situation and Outlook

⁽²⁾ Price differential x Additional CME volume requirement as in Table 1

⁽³⁾ End-consumer losses / 2019 diesel demand forecast as in Table 1

⁽⁴⁾ Base Case (Aug 2018): Midpoint of minimum and maximum domestic price – export price

⁽⁵⁾ Low Case (Jun 2018): Minimum domestic price – Export price

⁽⁶⁾ High Case (Jan 2017): Maximum domestic price – Export price

The resulting net economic impact on the biofuel supply chain, is presented in Table 4.

Table 4: Gain/ (Loss) in the biofuel supply chain as a result of higher biodiesel blend

Case	Gain/ (Loss) in million PhP/yr ⁽¹⁾
At 3% blend rate	
Base Case	394
Low Case	679
High Case	(2,154)
At 5% blend rate	
Base Case	1,183
Low Case	2,036
High Case	(6,461)
At 10% blend rate	
Base Case	3,156
Low Case	5,430
High Case	(17,229)

⁽¹⁾ Additional revenue to local producers (Table 2) – End-consumer losses (Table 3)

Meanwhile, Table 5 shows the 2019 coconut oil production, domestic consumption and export based on the 2019 Philippine Oilseeds and Products Situation and Outlook. The remaining volumes of coconut oil for export after deducting the corresponding volumes diverted into the domestic market to serve the higher regional demand from increased biodiesel blend rate are shown in Table 6.

Table 5: 2019 Copra and coconut oil production/ consumption/ export (2019 Philippine Oilseeds and Products Situation and Outlook)

Copra/ Coconut oil	Quantity
Copra production	2.72 million MT/ yr
Coconut oil production	1.71 million MT/ yr
Coconut oil for domestic consumption	0.71 million MT/ yr
Coconut oil for export	1.00 million MT/ yr 2.98 million L/ day

Table 6: Remaining volume of coconut oil for export after increasing the biodiesel blend rate

Blend Rate	Coconut oil diverted into the domestic market after increasing the biodiesel blend rate in million L/day ⁽¹⁾	Remaining coconut oil for export after increasing the biodiesel blend rate in million L/day ⁽²⁾
3%	0.23	2.75
5%	0.69	2.28
10%	1.85	1.13

⁽¹⁾ Additional CME volume requirement as in Table 1/ 95% Biodiesel yield/ 365 days

⁽²⁾ Coconut oil for export as in Table 5 – (1)

5.2 Analysis and Discussion

Numerical evaluation showed that a higher biodiesel blend rate will boost the revenues of the local coconut farmers but generate losses to the end-consumers. Looking at the economic impact on the local coconut industry as per Table 2, a direct proportionality is observed between the biodiesel blend rate and additional revenues since the volume of coconut oil diverted into the domestic market as listed in Table 1 increases with the blend rate. At a price differential of PhP 23.6/kg between domestic and export coconut oil (Base Case), the proposed 5% biodiesel blend rate is estimated to add PhP 5.5 billion/yr revenue to the local coconut industry. The price differential considered in the Base Case is generally conservative. However, plotting the domestic and export prices in Figure 8, the trends illustrate a downward trajectory, with the domestic price declining more steeply than the export price. If international demand does not improve and, in turn, commands much lower domestic prices, the base price differential will directionally narrow and approach the Low Case (that is, the difference between the export price and minimum domestic price). For the Low Case considered in the evaluation where price differential is PhP 11.6/kg, the additional revenues from 5% biodiesel blend rate is estimated at PhP 2.7 billion/yr, about 50% lower than the Base Case. Nonetheless, both cases are still profitable to the local coconut industry and can significantly improve the copra farm gate prices.

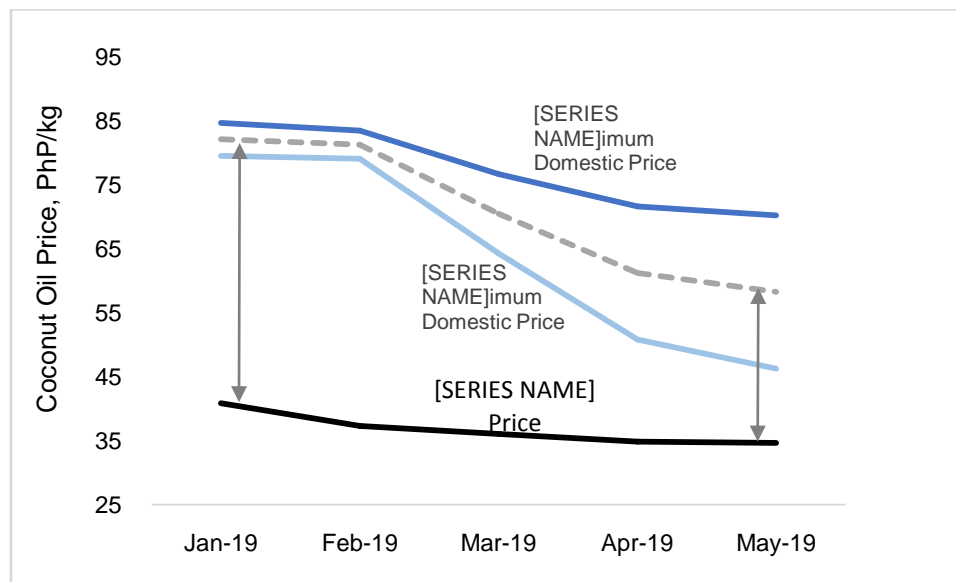


Figure 8: Domestic and export prices of coconut oil from January to May 2019 (Philippine Coconut Authority, 2019)

Meanwhile, the economic impact of higher biodiesel blend on end-consumers is negative particularly because of the higher prices of CME relative to fossil diesel. As presented in Table 3, at a price differential of PhP 17.9/L (Base Case) between 100%CME and B2 diesel, the proposed 5% blend rate is estimated to incur losses of around PhP 4.3 billion/yr, which is equivalent to a retail diesel price increase of PhP 0.54/L. The losses are directly proportional to the biodiesel blend, potentially reaching PhP 11.5 billion/yr at 10% blend rate and equivalent to a retail diesel price hike of PhP 1.44/L. Owing to the increasing global fuel prices, the diesel prices in 2018 and 2019 have risen to approach the domestic price of CME. During the same period, CME prices have declined because of the decreasing price of coconut oil. As such, the price differentials between CME and B2 diesel have narrowed as shown in Figure 5. Referring to Table 3, at Low Case (that is, at price differential of PhP 2.8/L), the losses at 5% blend rate could be as low as PhP 0.67 billion/yr, equivalent to a marginal retail diesel price increase of PhP 0.08/L. With the prevailing low prices of CME and continuously rising prices of international fuel, there is a high possibility that the price gap between CME and B2 diesel will narrow down. Since Philippines has a deregulated oil market and the government does not intervene in setting fuel prices nor provide fuel subsidy, retail diesel prices in the country will follow international trends. Through 2020, the global fuel prices are expected to be supported by the current production cut agreement among OPEC members and its partners and by the new regulation of the International Maritime Organization (IMO), which mandates a much lower sulfur specification for bunker fuels as discussed in Section 1.3. The tighter IMO specification is expected to lift diesel prices with the possible increase in diesel demand for blending with high sulfur fuel to produce IMO-compliant fuels. Hence, increasing diesel prices and subdued coconut oil prices will result in narrow price gap that will subsequently underpin the appeal to raise the biodiesel blend mandate in the country.

At all blend rates – 3%, 5%, and 10% – the net economic impact on the biofuel supply chain, which includes local producers and end-consumers, is positive for the Base Case and is increasing with respect to the biodiesel blend. As shown in Table 4, there is a net gain of PhP 0.4 billion/yr at 3% blend rate, PhP 1.2 billion/yr at 5% blend rate, and PhP 3.2 billion/yr at 10% blend rate. With all the assumptions and constraints kept, additional data points were plotted in Figure 9, resulting in a trend where net economic impact roughly grows by about PhP 0.4 billion/yr for every 1% increase in blend rate.

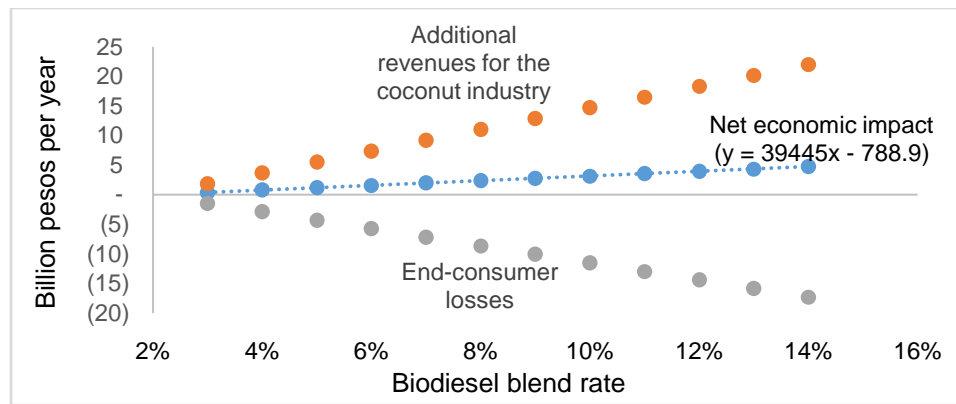


Figure 9: Economic impact at different biodiesel blend rates

Meanwhile, looking at the price differentials, the Low Cases of which the likelihood of occurrence is high as discussed above result in higher revenues than the Base Case. As listed in Table 4, the net gain could reach PhP 0.7 billion/yr at 3% blend rate, PhP 2.0 billion/yr at 5% blend rate, and PhP 5.4 billion/yr at 10% blend rate. On the other hand, the High Cases, of which the likelihood of occurrence is unlikely amid declining prices of coconut oil and prevailing strong global prices of fuels, result in net losses for all blend rates as given in Table 4. In terms of raw material sustainability, Table 6 shows that 0.69 million L/day of coconut oil will be diverted into the domestic market if biodiesel blend rate is increased from 2% to 5%, leaving 2.28 million L/day for export. The net export volume is 23% lower than the initial forecast for 2019 as presented in Table 5. Meanwhile, if the biodiesel blend is increased to 3% and 10%, the export volumes will be reduced by 8% and 62%, respectively. As such, the additional coconut oil volume requirement for higher biodiesel blend rates considered in the study falls within the available volume for export and does not distort the regional supply-demand balance. The coconut oil for domestic consumption will be disrupted when the biodiesel blend is raised to 15%, at which level the export volume would have been depleted. The move to divert export volumes to domestic market to serve the higher biodiesel demand is also aligned with the Philippines Biofuels Act which prohibits imports of biodiesel as mentioned in Section 1.2.

Moreover, since other countries do not use coconut oil as biofuel feedstock, the international demand for Philippine coconut oil will likely not increase because of incremental biodiesel requirement, hence allows the diversion of some volume from export to domestic market. Higher biodiesel blend mandate in the Philippines and increased domestic demand will alleviate losses in the local coconut industry and support its growth, especially after the government vetoed the coconut levy fund that was supposed to be utilized for developmental programs, improving farm productivity and raising farmer's income, as mentioned in Section 1.3.

6. Conclusions

The work aimed at providing a holistic evaluation that could help devise the country's biodiesel roadmap by assessing the economic impact of higher-blended biodiesel on both sides of the supply chain – producers and consumers considering the recent developments in the price trends of coconut oil, CME, and diesel. For this purpose, several sources were investigated in Section 1.3 to determine the factors that hinder the implementation of higher blend rate in the Philippines, including raw material sustainability and inflationary effect in diesel prices which generate losses to end-consumers. The impact of rising oil prices on propelling supply and demand for higher blend in the absence of government support, and the regional policy towards increasing the bio-content of the fuel blend at much higher level than the Philippines were considered in the literature review. In the absence of adequate quantitative evaluation in the literature showing the economic impact of increasing the biodiesel blend rate on both producers and consumers, the paper made some estimates in section 4 to materialize the outcome of using three levels of higher blend. The findings and analysis led the authors to arrive at the following conclusions:

- Raising 2% blend to 5% provides an additional revenue of PhP 5.5 billion/yr to the local coconut industry and a loss of PhP 4.3 billion/yr, to the end consumer resulting in net gain of about PhP 1.2 billion/yr. If global prices of coconut oil remain bearish and diesel prices remain strong the net gain could reach PhP 2.0 billion/yr. The net economic impact is directly proportional to biodiesel blend rates, with a projected increase of PhP 0.4 billion/yr for every 1% increase in blend rate as demonstrated in Figure 8. It is estimated that volatility in oil prices can influence the biodiesel economics, particularly with the fluctuations in global oil prices that are generally directed by the

dominant oligopoly in the oil industry. Recommendation: Given the oil market fluctuations, global and regional economic issues, we suggest the blend rate can be increased piecemeal say from 2% to 3% before going for 5%. This will also help manage the inflationary effect in retail diesel prices, particularly after the 2018 and 2019 price hikes due to excise taxes. Increased reliance on local biodiesel will also curb dependence on imports which are likely to become more expensive as Philippine currency depreciates against the US dollar. Lack of political will has been causing a regional variation in terms of biodiesel blend mandate, with the Philippines way behind the other Southeast Asian countries such as Malaysia, Indonesia, and Thailand. As discussed in Section 1.3, other regions have implemented and are supporting much higher blend rates thanks to their government support. The same objective could be the basis of the increase in the Philippine biodiesel blend mandate, particularly at a time of weakening coconut oil prices and strengthening fuel prices.

7. References

- Ables, R., 2004. Coconut Methyl Ester (CME) as petrodiesel quality enhancer, Quezon City: s.n.
- Alonzo, R., 2016. An Economic and Environmental Analysis of the Impact of Higher-Blended Biodiesel on the Philippine Economy. [Online] Available at: <https://mpr.ub.uni-muenchen.de/87717/> [Accessed 25 April 2019].
- Applanaidu, S. D., Ali, A. & Alias, M. H., 2014. Impact of Biodiesel Blend Mandate (810) on the Malaysian Palm Oil Industry. *Jurnal Ekonomi Malaysia*, 48(2), pp. 29-40.
- Bello, E. I., Adekanbi, I. T. & Akinbode, F. O., 2015. Production and Characterization of Coconut (*Cocos nucifera*) oil and its methyl ester. *European Journal of Engineering and Technology*, 3(3), pp. 25-35.
- Business Mirror, 2018. Palm oil's threat. [Online] Available at: <https://businessmirror.com.ph/2018/12/05/palm-oils-threat/> [Accessed 6 August 2019].
- Cabanilla, L. & Rodriguez, U.-P., 2008. The Food versus Fuel Issue: Case of the Philippines. *ATDF Journal*, 5(1), pp. 68-74.
- Castillo, M. & Ani, P. A., 2019. The Philippine Coconut Industry: Status, Policies and Strategic Directions for Development. [Online] Available at: http://ap.fftc.agnet.org/ap_db.php?id=969&print=1 [Accessed 30 July 2019].
- Charles, C., 2013. A Review of Projected Biofuel Prices for the United Kingdom: Evaluating the role of the FQD model for road transport fuels, s.l.: Global Subsidies Initiative and International Institute for Sustainable Development.
- Corpuz, P., 2019. Philippine Oilseeds and Products Situation and Outlook, s.l.: USDA Foreign Agricultural Service.
- Department of Energy, 2016. Energy Demand and Supply Outlook 2017-2040, Taguig City: Department of Energy.
- Department of Energy, 2017. Sectoral Plans and Roadmaps 2017 - 2040, Taguig City: Department of Energy.
- Department of Energy, 2018. Oil Supply/Demand Report FY 2018 vs FY 2017, Taguig City: Department of Energy.
- Department of Energy, n.d. Coco-biodiesel. Metro Manila: DOE Energy Utilization Management Bureau.
- Index Mundi, 2019. Coconut Oil Monthly Price. [Online] Available at: <https://www.indexmundi.com/commodities/?commodity=coconut-oil&months=360> [Accessed 29 May 2019].
- Javier, E., 2015. Modernization of the Coconut Industry. [Online] Available at: <http://www.nast.ph/images/pdf%20files/Publications/Bulletins/NAST%20Bulletin%20no.%208%20-%20Modernization%20of%20the%20Coconut%20Industry.pdf> [Accessed 6 August 2019].
- Kana, G., 2019. B10 mandate lifts CPO price. [Online] Available at: <https://www.thestar.com.my/business/business-news/2019/02/07/b10-mandate-lifts-cpo-price> [Accessed 7 August 2019].
- Malik, M. et al., 2017. Combustion and Emission Characteristics of Coconut-Based Biodiesel in a Liquid Fuel Burner. *Energies*, 10(458), pp. 1-12.
- Mercado, J. G. & Quiros, E., 2017. Emission and Performance Analysis of a Light Duty Common Rail Direct Inject Engine Fuelled by CME-Diesel Blends, Quezon City: The American Society of Mechanical Engineers.
- Mogato, A., 2019. Higher biodiesel blend pushed as copra prices remain low. [Online] Available at:

- <https://www.rappler.com/business/235183-biofuels-industry-stakeholders-continue-push-higher-biodiesel-blend>
[Accessed 6 August 2019].
- Murti, W., 2017. The Influence of Crude Oil Price in Biodiesel and its Implication on the Production of Palm Oil: The Case of Indonesia. *European Research Studies Journal* , XX(2A), pp. 568-580.
- National Economic and Development Authority, 2015. Preliminary Assessment of the Impact of Biofuel Production on Food Security and the Economy, s.l.: NEDA - Agriculture, Natural Resources, and Environment Staff .
- National Tax Research Center, 2019. Tax Changes You Need to Know: Republic Act No. 10963 Tax Reform for Acceleration and Inclusion. [Online] Available at:
<http://www.ntrc.gov.ph/images/Publications/train/tax-changes-you-need-to-know.pdf>
[Accessed 28 May 2019].
- Ocampo, K., 2018. Higher coco methyl ester in diesel mix. [Online] Available at:
<https://business.inquirer.net/259539/higher-coco-methyl-ester-in-diesel-mix-nixed>
[Accessed 25 April 2019].
- Philippine Coconut Authority, 2017. 2017 Summary of Coconut CME/ Biodiesel Manufacturers/ Exporters, Quezon City: PCA.
- Philippine Coconut Authority, 2018. PCA's Statement on Copra Price Fluctuation. [Online] Available at: www.pca.da.gov.ph/index.php/10-news/173-pca-s-statement-on-copra-price-fluctuation
[Accessed 28 June 2019].
- Philippine Coconut Authority, 2019. Price Watch as of 2019. [Online] Available at: <http://pca.gov.ph/industry/price-watch/2-uncategorised/135-price-watch-2019>
[Accessed 31 May 2019].
- Philippine Statistics Authority, 2017-2019. Highlights of the Philippine Export and Import Statistics, Quezon City: Philippine Statistics Authority.
- Philippine Statistics Authority, 2017-2019. PSA OpenSTAT - Prices. [Online] Available at:http://openstat.psa.gov.ph/PXWeb/pxweb/en/DB/DB__2M__FG/0032M4AFP08.px/table/tableViewLayout1/?rxid=83339153-da5d-47c8-97b8-eeeb2f1da996
[Accessed 25 May 2019].
- Philippine Statistics Authority, 2018. Selected Statistics on Agriculture 2018, Quezon City: Philippine Statistics Authority.
- Philippine Statistics Authority, 2019. PSA OpenSTAT - Economic Accounts. [Online] Available at:
http://openstat.psa.gov.ph/PXWeb/pxweb/en/DB/DB__2B__NA__AN__EG/0212B5CEGA1.px/table/tableViewLayout1/?rxid=83339153-da5d-47c8-97b8-eeeb2f1da996
[Accessed 25 May 2019].
- Philippine Statistics Authority, 2019. PSA OpenSTAT - Trade: International Merchandise and Domestic. [Online] Available at
http://openstat.psa.gov.ph/PXWeb/pxweb/en/DB/DB__2L__PCG/0012L4DGXA1.px/table/tableViewLayout1/?rxid=83339153-da5d-47c8-97b8-eeeb2f1da996
[Accessed 25 May 2019].
- Prochazka, P. & Honig, V., 2018. Economic Analysis of Diesel-Fuel Replacement by Crude Palm Oil in Indonesian Power Plants. *Energies*, 11(504), pp. 1-12.
- Quiros, E. et al., 2018. Performance and Emissions of a CRDI Passenger Van Using CME-Diesel Blends, Quezon City: The American Society of Chemical Engineers.
- Quiros, E. & Laguitao, J. J., 2017. Performance and Emissions Characteristics of Philippine CME-Diesel Blends , Quezon City: The American Society of Mechanical Engineers.
- Quiros, E. & Vergel, K., 2015. Fuel Economy of Public Utility Jeepneys Using 2% and 5% Coco-Methyl Ester (CME)-Diesel Blends — A Limited Preliminary Study. *Journal of the Eastern Asia Society for Transportation Studies*, Volume 11, pp. 44-59.
- Rodriguez, U.-P., 2013. Biofuels and the Philippine Economy: Simulations from a Computable General Equilibrium Model, Laguna: University of the Philippines Los Banos.
- Tan, D., 2019. B10 biodiesel to go mainstream in Thailand – B7 out. [Online] Available at:
<https://paultan.org/2019/07/01/b10-biodiesel-to-go-mainstream-in-thailand-b7-out/>
[Accessed 7 August 2019].

- The Jakarta Post, 2018. Indonesia plans to make 30 percent biodiesel blend mandatory, studies B100. [Online] Available at: <https://www.thejakartapost.com/news/2018/12/10/indonesia-plans-to-make-30-percent-biodiesel-blend-mandatory-studies-b100.html> [Accessed 7 August 2019].
- USDA Foreign Agricultural Service, 2017-2018. Philippine Biofuels Situation and Outlook, Manila: USDA Foreign Agricultural Service - Global Agricultural Information Network.
- USDA Foreign Agricultural Service, 2018. Philippine Biofuels Situation and Outlook, Manila: USDA Foreign Agricultural Service - Global Agricultural Information Network.
- USDA Foreign Agricultural Service, 2019. Philippine Oilseeds and Products Situation and Outlook, Manila: USDA Foreign Agricultural Service - Global Agricultural Information Network.
- Zahan, K. A. & Kano, M., 2018. Biodiesel Production from Palm Oil, Its By-Products, and Mill Effluent: A Review. *Energies*, 11(2132), pp. 1-25.