The College of Wooster

The Palm Oil Industry – Destructive or Sustainable? Defining Sustainable Palm Oil

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Abstract

Palm oil comes from the fruits of the African oil palm tree and is an ingredient in half of all packaged snack foods and many other products such as toothpaste and shampoo. As an industrial crop, it has continued increasing in demand and expanded to take over nearly 40% of all vegetable oil production worldwide. The overview takes a look at palm oil production from seedling to plantation to palm oil mills and further down the market to your supermarket shelves. This chapter ends by taking a brief look into the sustainability of the palm oil industry. So what does sustainable palm oil production even mean? I take a look into the history of the sustainability concept and follow up by building a theoretical framework on the three pillars of sustainability and sustainable development: environmental, economic, and social. I performed meta analyses on five case studies in order to assess the current and potential future directions of sustainability for each of these three pillars. What I found was that the palm oil industry does show signs of potential to become much more sustainable. My data shows that it is not the oil palm tree itself that is unsustainable, but rather the organizational cultures, plantation operations, and widespread lack of compliance that has resulted in little to no sustainability efforts. A few attempts are being made to come up with a sustainable alternative ingredient to palm oil. However, the oil palm actually produces yields higher than any other vegetable oil in the market. Due to the continually growing and massive expansion of the palm oil industry over the last few decades, there are a number of different ways that the palm oil industry can be made much more sustainable if the proper steps are taken.

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Introduction

Ever since I was a young elementary schooler, I've always had a passion for learning about monkeys and apes. At the age of seven, I attended a day camp at the St. Louis Zoo in Missouri where I had grown up for most of my life. Throughout the week, I had the opportunity to learn about many species that live in tropical rainforests, including a number of species of primates in Southeast Asia. Overtime, I became more and more fascinated with the species I was learning about and seeing up close and firsthand. One of my favorite animals has always been the orangutan species. At the end of the week, the zookeepers taught me about a product, known commonly as palm oil, that destroys orangutan's natural habitats and has led to them becoming extremely endangered. Ever since that day I first learned about this, I've never been a consumer of the product throughout the rest of my life. The rest of the campers and I were determined to never consume the product that was endangering the species we'd learned to love and learned so much about throughout the week.

Odds are you're unfamiliar with this product, but did you know it's likely in many of the products you use and consume nearly every single day? It's in everything from makeup, toothpaste, and shampoo to chocolate, doughnuts, ice cream, cereal, cookies, chips, and many other popular common snack foods. Although it goes by many names, palm oil is the most common name for the ingredient. I had no idea that an ingredient in the foods I was consuming basically everyday was putting the species I loved most in danger. There are many sources that find global consumption of palm oil has been on the rise since the 1970's and has exponentially increased since the late 1990's to early 2000's. Eighty five percent of this production occurs in Indonesia and Malaysia, while expansion of palm oil production has also been significant in Latin America.

Over the last fifteen years, I've dedicated countless hours into researching palm oil and learned more and more about the ingredient through every year. Beginning at the age of seven, I made my parents stop buying products such as Cheez-It's, Oreo's, Nutella, and more. I would go to the grocery store with my mom and look through every ingredient in the processed foods she bought to find alternatives. Sometimes, there have been things she and my younger sisters couldn't resist for their own diet such as Girl Scout cookies. However, I've continued staying away from these products even if I used to like them before.

When given the opportunity to choose my topic in science-related papers throughout my elementary and middle school education, palm oil was typically my first choice for research. In eighth grade, I was part of an extracurricular competition called Science Olympiad where one of the events I competed in was on food sciences research. I immediately jumped at the opportunity, so that I could work with a chemistry teacher on the chemical properties of palm oil in an attempt to understand why there weren't alternative ingredients. Throughout high school, I gave presentations and informed classmates about palm oil to try and convince them into joining my protest by not consuming it. As a first year at the College of Wooster, my First Year Seminar (FYS) semester-long project developed a business was called "Smart Cart" that's meant to help consumers stay away from certain ingredients, in particular palm oil, when shopping. This way consumers wouldn't need to go through the painstaking process of looking through every ingredient in each of their products. My sophomore year, the Environmental Studies program at the college only offered a minor, but I was determined to self-design my major by creating a proposal to the deans in order to continue my passion for researching palm oil as part of my college studies.

With the help of Matt Mariola as my advisor, we began thinking of a topic that could form my Independent Study. I started explaining all the things I knew about palm oil and introduced him to a "lightning presentation" I had given in a climate change course the previous semester on the topic. Over time, we began asking one question more and more as we were going through all the information on palm oil; what does "sustainable palm oil" even mean?

I approached this research with the perception that there was little to no chance palm oil could possibly be sustainable. When I first started the research process, I immediately jumped into writing about all of the negative things I'd discovered over the previous 14.5 years about palm oil. However, I really needed to explore the nature of palm oil and what "sustainability" really means in order to better understand my topic. I quickly realized that the term sustainability is so fluid that it can be used to mean many things depending on the person using it and the context of what they're talking about. The definition has evolved and adapted in many ways in an attempt to analyze a number of environmental topics as environmentalists are continuously learning more about our surroundings.

So instead, I began by taking an introspective look into palm oil from the eyes of someone that knows nothing about the oil palm or it's sustainability. In this way, my research beings with the aim of providing a narrative about palm oil that doesn't express any sort of bias and walks the reader through the operations of the palm oil industry and the oil palm crop from beginning to end. It's not until the conclusion of that chapter that it begins to hint at the sustainability from my previously mentioned knowledge and research. The proceeding chapter aimed to define sustainability using theories of sustainability and sustainable development. I based my theoretical framework in a way that helps the reader understand it's broad definition and vast understanding that still has one general significant meaning to it that can be widely

understood. Using this framework, I began to draw on how I can expand on current research about palm oil without simply writing and repeating the same old general research out there about how it's terrible for the environment and more. Therefore, I came upon the decision with my advisor to meta analyze several studies and to assess for myself the current and potential future sustainability and sustainable development of the oil palm crop and palm oil industry that's explored in my results. In this way, my research actually expands on current research on palm oil by providing my own unique way of contributing to scientific and social readings about palm oil and its sustainability. Hopefully, this will lead to many future studies and can be expanded on and used in other studies to contribute even further to academic knowledge.

Previous research of the palm oil industry has drawn on one dominant conclusion that palm oil is terrible for the environment and therefore cannot be sustainable. Using my research, I wanted to help gain a broader understanding of the palm oil industry as a whole rather than focusing on one particular piece of the industry to study. My research doesn't find one necessary conclusion but rather draws on many. What I find are several answers that respond to my research question in many different ways. This variation is a result of different companies falling under different enforcement regimes and holding varying ideologies resulting in many different practices performed with a wide array of operational and organizational techniques.

Palm Oil Overview

I. **History, Biology, and Growing Conditions of Palm Oil**

Palm oil is an edible vegetable oil that comes from the red-orange pulp of the fruit grown on the oil palm tree. Most commonly, palm oil comes from the fruit grown by the African oil palm *Elaeis guineensis*, but it has also been made from the American oil palm *Elaeis oleifera* and the maripa palm *Attalea maripa*. The oil palm tree has several very large bunches full of dozens of palm oil fruits in each bunch around the top of the tree trunk. The fruits have a kernel in the middle with a very hard shell surrounded by the fleshy red mesocarp that makes up the fruit. Palm oil can also come in the form of palm kernel oil which is less red and more yellow as it comes from the kernel of the palm oil fruit. This is because palm kernel oil lacks the carotenoids that give palm oil its naturally reddish color. The characteristic dark red color of the palm oil is due to carotenoids such as alpha-carotene, beta-carotene, and lycopene (*Palm Oil*). These same compounds are found in other yellow, orange, and red vegetables. Palm oil, red palm oil and palm kernel oil are all slightly different due to variations in processing, but first let's turn our attention to where it originates.

Palm oil originated in West Africa where it was used as a staple food crop as far back as 5,000 years ago. The use of palm oil increased in demand after the British Industrial Revolution with expanded overseas trade and new purposes such as industrial lubricants, candle-making, and cooking oil (*History and Origin*). The oil palm plant was introduced to South East Asia in 1848 where most of the production now takes place. Additionally, oil palm trees were initially planted mainly as an ornamental crop until commercial planting began in 1917. The first commercial

scale plantation was founded in 1917 in Malaysia where it's established in Tennamaran Estate in Selangor (*History and Origin*). The oil palm became an industrial crop after large-scale cultivation took off in the 1960's with an increase in palm oil plantations.

At the time, the oil palms required many more workers due to the fact they were pollinated by hand. This significantly limited efficiency until 1981 when African palm weevils were introduced to South East Asia and began pollinating the fruits without any human assistance (*Why Palm Oil Is So Cheap*). This also improved yields with larger and more densely packed bunches of oil palm fruits leading to increased production. Furthermore, the negative health implications from trans fats revealed in the 90's led to even bigger spikes in demand with processed foods now using palm oil as a 'healthier' alternative (*Why Palm Oil Is So* Cheap). Today, palm oil is not only used as a cooking oil but it's in half of all packaged snack foods from granola bars and chips to cookies and ice cream, and palm oil is also used in many cosmetics and shampoos as well as a recently increasing demand for its use as a biofuel. As a cash crop with efficient and high yields, palm oil derived from the fruits of the oil palm tree has become a multibillion-dollar ($44 billion in 2013 according to Bloomberg) industry that supplies 39% of the world's vegetable oils due to its ongoing rise in demand (Brown et. al, 2016). The oil palm is a cash crop, meaning that it's grown for commercial purposes in order to make profit.

As an agricultural crop that requires many resources to grow alone, the oil palm demanded significantly larger amounts of resources after commercial scale plantations expanded the industry in the 1960's. These plantations have several key elements for suitable land and climate conditions in order to optimize growth and production. The palm oil plant grows within 10 degrees latitude of the equator, but ideal conditions are within 5 degrees. It also requires five to six hours of bright sunlight per day and 80% humidity. Palm oil cultivation is most suitable in

the deep well-drained medium loam soil, rich in humus with a well-distributed rainfall of 2500 to 4000 mm per year and a temperature range between 19 and 33 degrees Celsius (Mahat, 2012). A single oil palm tree might need 150-200 liters of water per day. Biomass production is the total mass of the oil palm crop within a given area. As a result of the significant irrigation necessary for oil palms, the fast-growing crop has a high productivity in yields and biomass production. Most of the biomass on palm oil plantations collects up during planting seasons.

The planting season begins immediately after the nursery stages for young oil palm trees. Supply of high-quality seed, seedlings and young palms from breeders and nursery operation are critical to every plantation's long-term success (Mahat, 2012). A germinated oil palm seed is typically cultured in a prenursery for 3 months followed by an additional nine to ten months in a nursery before moving the plant to a plantation area for normal growing. The prenursery and nursery stages are conducted with varying practices, producing different results in oil palm size and growth efficiency. Using oil palm waste as organic compost in seedling production has been shown to produce positive growth performance and high nutrient uptake (Rosenani et al., 2016). Oil palm farmers must assess the varying qualities of seedlings from several nurseries in order to receive the best yielding crop for their plantations. The oil palm can be planted any season but June to December is the optimal time frame for further productivity. Plantations are made in a triangular system containing up to 143 trees per hectare with each tree planted 9 meters apart. The first harvestable fruit bunch comes after 2.5 to 3 years and produces only 2 to 3 kilograms.

Fruit bunches will reach peak productivity 8-15 years after the oil palm has been planted and plantations typically cut down trees after 22 to 25 years for replanting. Although the oil palm tree can live up to 200 years, this is economically viable for plantations as peak productivity has passed and the industry height limit of 25 feet coincides with this shorter lifespan. Otherwise, the

tree can reach up to 70 to 100 feet in height. Peak productivity is around four to five tons of palm oil per hectare per year. Processing mill plants are often built within the area of plantation because the fresh fruit bunches must be treated in an oil mill within 24 hours to preserve the quality of the palm oil. Crude palm oil is transported from these mills to refineries where palm kernel oil and red palm oil are processed to neutralize its flavor and odor, or in some cases to neutralize its color to appeal to the Western ideology of an ideal vegetable oil.

II. Refinery Processes and Nutritional Profile of Palm Oil

There are many palm oil refining processes and refinery companies use variations of these in different systems across the industry. An example of one of these systems from Golden Agri-Resources is described in Figure 1a & 1b below and uses several processes that are described which purify crude palm oil from mills before distribution. Red palm oil has been taken from the fruit of the oil palm using mechanical extraction termed “cold-pressing” since the mid-1990s (*Palm Oil*). This is when a machine called an expeller squeezes the oil from fresh palm kernels using a high mechanical pressure at a temperature below 122 degrees Fahrenheit. Red palm oil is known as “virgin”, or unrefined palm oil.

Refinery is a mandatory step for palm oil production for many food manufacturing industries because it removes undesirable materials such as color bodies, oxidative components, gums, metal contaminants and volatiles from crude palm oil. It also provides a duller and lighter color to ‘improve’ its appearance to be more likely accepted by a society accustomed to light colored and tasteless fats and oils. According to Evita Ochel from Evolving Wellness, the flavor strength of palm oil varies based on the products purity and whether its raw or cooked, but red

palm oil has a very pronounced flavor that could be reminiscent of carrots (Ochel, 2013). There are chemical (such as alkaline treatment) and physical (such as steam refining, molecular distillation, and membrane refining) methods followed by bleaching and deodorizing steps. From the example in Figure 1a and 1b below, bleaching absorbs all the color pigments in the oil so that they can get filtered out and form bleached palm oil. Chemical methods remove impurities and volatile compounds from palm oil, but cause losses in triacylglycerol's and pose a high impact on the environment. Physical methods, on the other hand, require accurate treatment to remove phosphorus and result in lower storage stability than chemical methods. In general, the refinery process improves the stability and shelf life while also changing the taste and color of palm oil and altering its nutritional contents.

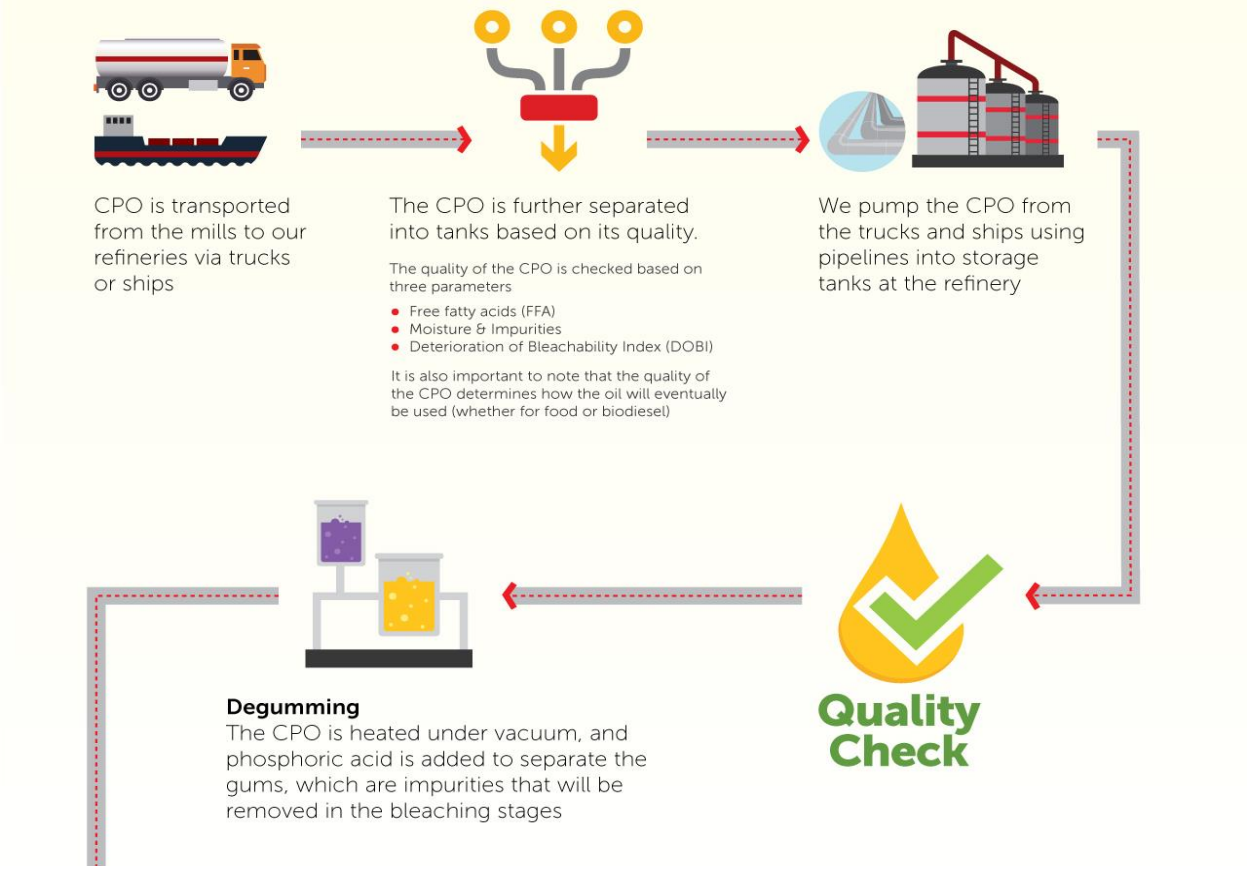


Figure 1a: Palm Oil Refining Process

Available from: https://goldenagri.com.sg/palm-oil-refining-process/

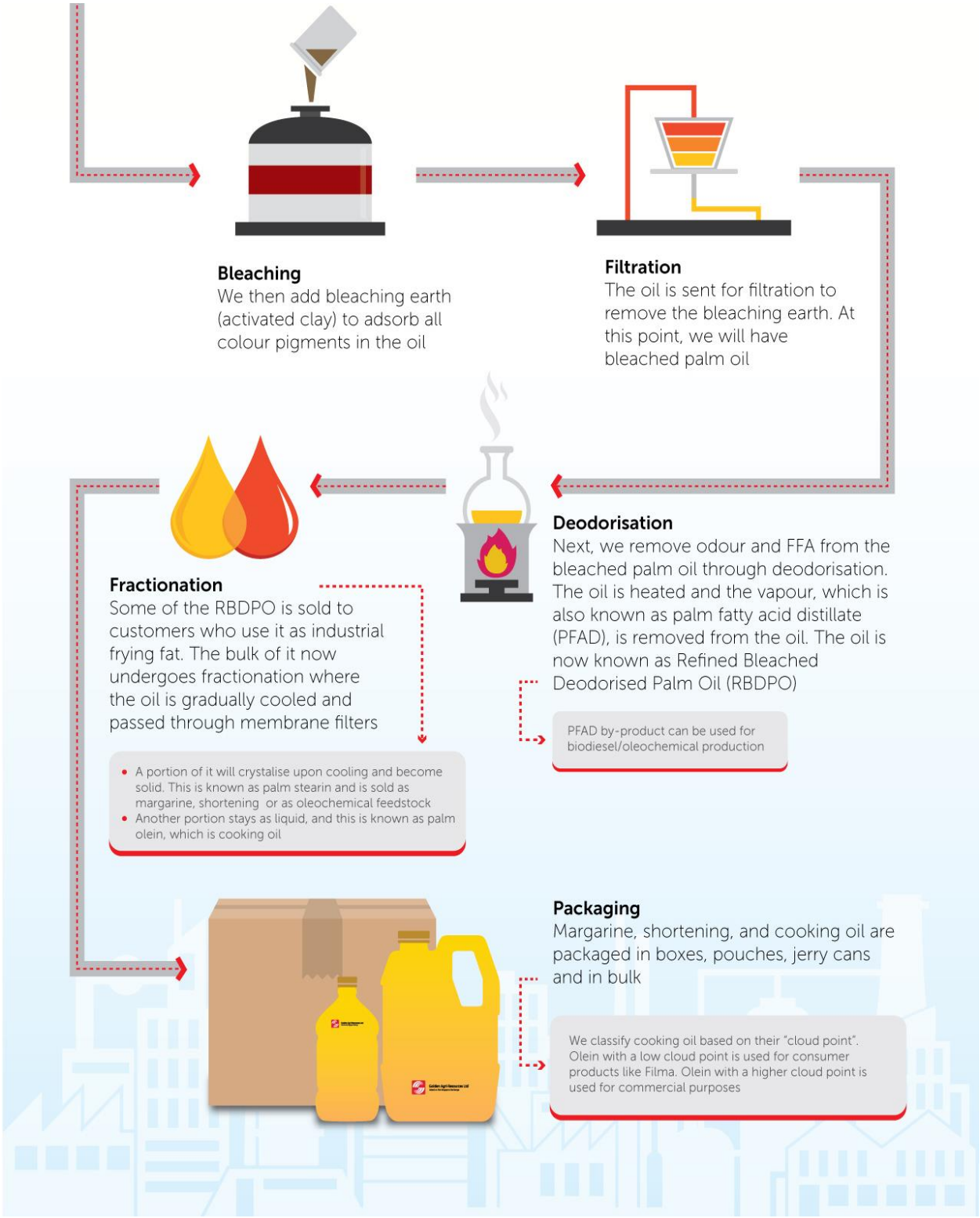


Figure 1b: Palm Oil Refining Process

Available from: https://goldenagri.com.sg/palm-oil-refining-process/

Palm oil that is refined, bleached, and deodorized at large factory palm oil refineries changes to result in a different texture, physical state, and nutritional profile for palm oil. A higher saturated fat content generally leads to a more solid feel of the fatty oil at room temperature. Palm oil is a semi-solid at room temperature but can be processed into a liquid cooking oil. In the example of the fractionation process by Golden Agri-Resources in Figure 1b, palm oil gradually cools and passes through membrane filters that separate palm stearin from palm olein. Palm stearin is solid and mainly sold as margarine or shortening, and palm olein is liquid and used as a cooking oil. Palm oil alone contains 50% saturated fatty acids and a high amount of the antioxidants beta-carotene and vitamin E. Saturated fat has a bad reputation due to its link to heart disease, however, there are some benefits to consuming palm oil. Beta carotene is a red-orange pigment that provides the colorfulness of the fruit and is also commonly known from carrots for providing good vision and overall health. Palm oil has fifteen times more retinal equivalents than carrots. Vitamin E can help provide good vision, reproductive health, and protects the skin and brain cells. Crude palm oil (red palm oil) also contains other beneficial compounds such as triacylglycerols and phytosterols as well as impurities such as phospholipids, free fatty acids, and lipid oxidation products all removed through refining processes.

Palm oil with little free fatty acids and impurities and good bleaching is often considered higher quality and is used in the edible oil industry while lower quality palm oil is used for biofuels, candles, cosmetics, and soap production. Palm oil and palm kernel oil differ in their physical and chemical properties, as shown in Table 1 & 2 below, resulting in different intended applications. Palm kernel oil contains 85% saturated fatty acids, mainly lauric acid, while palm oil contains 50% saturated fatty acids, mostly palmitic acid. Palm oil also contains 40% monounsaturated fatty acids, mostly oleic acid, and 10% polyunsaturated fatty acids, mostly

linoleic acids (Mancini et. al, 2015). Table 1 shows this makeup of fatty acids in palm oil compared to palm kernel oil. Additionally, it's important to note that the composition is altered differently when chemically treated to create biodiesel. While the fatty acid composition of palm oil and palm kernel oil can be difficult for the average reader to interpret, it assists in understanding why palm oil is so widely used for cooking and as an ingredient in processed foods for its unique composition.

Palm oil is less saturated than butter and contains little to no trans-fats which are much worse than saturated fats because they lower good cholesterol even further. According to Harvard nutrition experts, "palm oil is clearly better than high trans-fat shortenings and probably a better choice than butter. But vegetable oils that are naturally liquid at room temperature, such as olive oil and canola oil, should still be your first choice" (Robb-Nicholson, 2007). Saturated fats tend to increase blood cholesterol levels and are mostly only found in vegetable oils that are tropical like coconut and palm oils but can also commonly be found in meat and dairy products. Polyunsaturated fat tends to lower blood cholesterol levels and is mostly found in plant sources like sunflowers, soybeans, and corn. Unlike saturated fats, monounsaturated fats also tend to lower low-density lipoprotein (bad cholesterol). These two fats are found in vegetable oils such as olive oil, canola oil, and peanut oil as well as some plant foods such as avocados. Table 2 shows a list of vegetable oils, shortenings, and animal fats and the percentage of unsaturated and saturated fatty acids within each of these products. Palm oil has a similar fatty acid composition to beef fat with only coconut oil and butter having a higher percentage makeup of saturated fatty acids. It also has a lower percentage of unsaturated fatty acids than everything except butter and coconut oil on Table 2 besides palm kernel oil. The only product with a higher percentage makeup of saturated fatty acids and a lower percentage makeup of unsaturated fatty acids than

palm kernel oil is coconut oil. Everything from the nursery stage to the plantation practices to the refining process has an effect on the quality of the palm oil produced. Different approaches and varying company practices in every step of the oil palm industry before packaging and distribution can result in slight variations for the variables shown in Tables 1 and 2.

Table 1: Fatty Acid Composition of Palm Oil and Palm Kernel Oil

Fatty Acid	**Palm Oil**	**Palm Kernel Oil**
Lauric Acid	0.2	47.8
Palmitic Acid	44.0	8.5
Oleic Acid	39.2	15.4
Linoleic Acid	10.1	2.4
Other Fatty Acids	6.5	25.9
Total SFAs	49.9	82.1
Total MUFAs	39.2	15.4
Total PUFAs	10.5	2.4

SFA = Saturated Fatty Acid, MUFA = Mono-Unsaturated Fatty Acids, PUFA = Poly-Unsaturated Fatty Acids

Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6331788/

Table 2: Percentage Fatty Acid Composition of Various Products

Shortenings, Vegetable Oils, & Animal Fats	Polyunsaturated Fatty Acids*	Monounsaturated Fatty Acids*	Total Unsaturated fatty Acids*	Saturated Fatty Acids*
Sunflower Oil	66	20	86	10
Soybean Oil	58	23	81	14
Canola Oil	33	55	88	7
Olive Oil	8	74	82	13
Soft Tub Margarine***	31	47	78	17
Stick Margarine***	18	59	77	19
Coconut Oil	2	6	8	86
Palm Oil	9	37	46	49
Palm Kernel Oil	2	11	13	81
Chicken Fat	21	45	66	30
Beef Fat	4	42	46	50
Butter Fat	4	29	33	62

*Values are given as a percent of total fat **Total unsaturated fatty acids = polyunsaturated fatty acids + monounsaturated fatty acids. The sum of unsaturated and saturated fatty acids will not equal 100 because there's a small amount of other fatty substances that are neither saturated nor unsaturated ***Made with hydrogenated soybean oil and hydrogenated cottonseed oil.

Source: NutriStrategy; *Available from: https://www.nutristrategy.com/fatsoils.htm*

III. Fertilization of Palm Oil and Herbicides Used

In all operations from nursery to plantation to refinery, the quality and dietary contents change, but so does the plants productivity and yield based on varying practices. As previously mentioned, using oil palm waste as an organic component in the nursery stage can positively alter the nutrient uptake and growth performance. The productivity of the oil palm tree is largely dependent on fertilization, making it very important to palm oil plantations. Due to the increasing prices of fertilizer, labor and transportation costs, up to 60% of the cost of maintenance of palm oil plantations is related to fertilizer application (Daemeter Consulting, 2013). Fertilization

demand also increases with every cycle of replanting the palm oil plantation (typically every 25 years). This means that with every cycle of starting over and replanting oil palms fresh on the same cropland, the soil demands more and more fertilization in order to produce the same yields. Some areas in Indonesia are now in the fourth generation of planting in which there's increasing concern related to the depletion of soil fertility due to potassium and the toxicity of aluminum (Daemeter Consulting, 2013). Recording data and taking proper documentation of the fertilizer and soil quality could lead to effective palm oil plantation management. Because phosphorus is usually released more slowly into the soil, the fertilizer phosphorus is given earlier than nitrogen. Under circumstances the acidity becomes relatively alkaline (relatively high pH), nutrients such as nitrogen are critical to oil palms and can then be provided by fertilizers such as urea (Daemeter Consulting, 2013).

According to a study by Daemeter Consulting in Indonesia, their findings are high for fertilizer requirements in the mature stage ranging from 6 to 9 kilograms per tree per year, and with an average of 143 trees per hectare the need for fertilizer ranges 858 to 1,287 kilograms in a year (Daemeter Consulting, 2013). For some rapid soluble fertilizers such as urea and Muriate of Potash(MoP), particularly vulnerable to leaching, effective fertilization needs the fertilizer to be applied twice a year. Small farmers often create plantations over peatlands and hilly topography where the need to fertilize is more profound. Inorganic synthetic fertilizer is the most widely used type of fertilizer on palm oil plantations, and compound fertilizers are sometimes used in the nursery stage (Daemeter Consulting, 2013).

Table 3: Standard Fertilizer for Mature Stage

Age Groups (Year)*	Fertilizer Dosage (kg/palm/year)		
	Urea	TSP-36	MOP
3-8	2.00	1.50	1.50
9-13	2.75	2.25	2.25
14-20	2.50	2.00	2.00
21-25	1.75	1.25	1.25

*dosages of fertilizer for all palms need to be adapted to the soil conditions.

Source: Indonesian Oil Palm Research Institute, Medan; Available from: http://daemeter.org/new/uploads/20130905132708.Final_Fertiliser_and_independent_smallholders_in_Indonesia____Background_and_Challenges.pdf

We will now turn our attention from the use of fertilizers to the use of herbicides on palm oil plantations. Paraquat dichloride, more simply ‘paraquat’, has become one of the most widely used herbicides for more than 40 years in both small and large plantations. This weed killer is highly toxic as it can be fatal if inhaled, ingested, or absorbed through the skin. Paraquat poisoning symptoms include “nosebleeds, eye irritation, contact dermatitis, skin irritation and sores, nail discoloration, nail loss and abdominal ulceration” and there is currently no known cure (*Pesticide Use in Oil Palm Plantations*). Paraquat has been banned or restricted in many countries. Malaysia is considering lifting a 2-year ban to phase out its use while Indonesia has strict regulations only for using paraquat to those limited number of people that are trained and certified. Glyphosphate is an herbicide produced by Monsanto being used to replace paraquat, and although much less toxic than paraquat, still has some harmful environmental and negative health implications including harm to human placental cells leading to late abortions and other pregnancy problems. Because both herbicides don’t bind to the plantations sandy soils and many

parts of Indonesia experience very high amounts of rainfall, the herbicides are washed into rivers and streams supplying the only drinking water and basic household needs to nearby villages surrounding plantations (*Pesticide Use in Oil Palm Plantations*). The use of these herbicides leads us to begin questioning the negative environmental implications from palm oil production. Palm oil companies must assess whether the benefits of these chemical fertilizers, herbicides, and pesticides outweigh the consequences. Again, there are so many various approaches to palm oil production and different practices are used all across the nursery, plantation, and refinery stages based on a company's standards environmentally, economically, and socially.

IV. The Debate Over Palm Oil Sustainability

The production of palm oil produces a variety of manufacturing, processing, and environmental challenges. Plantations produce huge amounts of biomass which must be dealt with. The oil can be used as biodiesel, but this competes with other industrial uses. And all of this occurs on fragile rainforest ecosystem soils with high levels of native biodiversity that is all but wiped out when plantations are created. So, the question this raises is, can this massive worldwide agricultural and food processing sector be managed sustainably? We begin answering this question by analyzing how and why the palm oil industry has become so increasingly large.

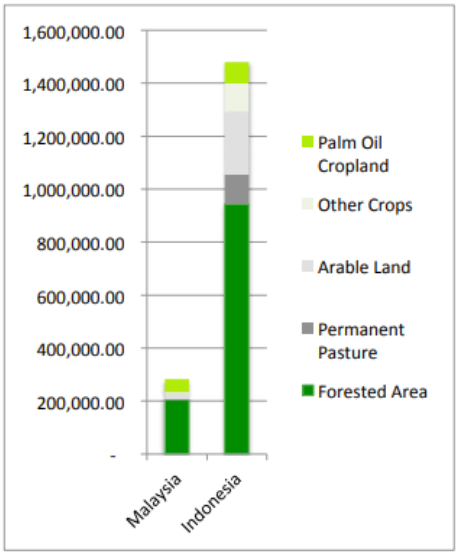
In addition to palm oil supplying 39% of global vegetable oils (Brown et. al, 2016), global production of palm oil was nearly 50 million metric tons per year in 2012, having more than doubled since 2000 (FAO 2013). One of the major contributing factors to the expansion of the palm oil industry has been due to the inexpensive price tag that's come with it. Palm oil is the most inexpensive vegetable oil because it produces yields more than five to eight times higher

than any other oil crop per hectare and it has relatively low labor costs sometimes due to forced labor and/or child labor (*Palm Oil and Global Warming*). Each oil palm tree can produce 10 tons of fruit per hectare; 3.9 tons of palm oil and 0.5 tons of palm kernel oil can be extracted from this fruit per hectare per year (*What is Palm Oil?*). Considering a plantation can produce 3.9 tons of palm oil per hectare, palm oil produces much more than rapeseed oil, sunflower oil, and soy which produce 0.8, 0.7, and 0.5 tons, respectively, per hectare (*What is Palm Oil?*). Furthermore, when research revealed links between heart disease and trans fats in partially hydrogenated oils, palm oil became a replacement oil in processed foods because its low in trans fats which increased its use tremendously. Biodiesel fuel made from vegetables has become an increasing market with palm oil recently beginning to expand in that market as well. All of these factors play a reason into why palm oil has expanded so significantly and is now an industrial crop.

The massive increase in palm oil plantations coincided with an increase in the discovery of such a large variety of uses that palm oil provides. Palm kernel oil is mostly used for soap and industrial purposes as well as some processed foods while the palm oil from the actual fruit is mainly used for food production. Almost 75% of global production of palm oil goes into food products such as cooking oil and processed oils and fats, but it is also being used for biofuel production (*The Impacts of Palm Oil on Biodiversity*). Palm oil plantations now produce over 66 million tons of palm oil annually on over 27 million hectares of land covering Earth's surface. The warm, humid climate in the tropics offers optimal growing conditions for oil palms. Manufacturers around the world have taken very different approaches in producing palm oil and meeting the environmental needs during palm oil production. Different practices exist in different countries because various approaches are taken due to legislation, geographic location, resources and environmental awareness.

An expansion in palm oil plantations between 1990 and 2010 resulted in an increase from 6 to 16 million hectares of land area which now accounts for around 10% of global permanent cropland. Indonesia and Malaysia's planted area has increased by 40% and 150%, respectively, as they've been the center of this development and currently make up 80% of global palm oil production (FAO 2016). These two countries are located in Southeast Asia. Malaysia is split into two land areas: one is on a peninsula south of Thailand and the other is on the island of Borneo, which borders with Indonesia and Brunei. The Malaysian palm oil industry now has over 5 million hectares of palm oil plantations covering almost 14 percent of the country's total land area (REHSRM, 2014). Figure 2 below shows a makeup of just how much land coverage is forested or used for agriculture, including palm oil plantations, in Indonesia and Malaysia. There have been attempts to grow oil palms in countries farther north like Cambodia, but it can only grow along the Southern border as the climate is too dry and not as particularly well suited as Indonesia and Malaysia.

Figure 2: Total Makeup of Land Coverage/Usage in Indonesia and Malaysia



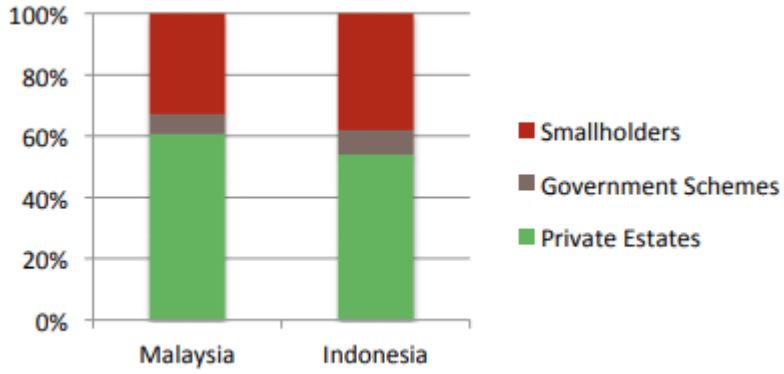
Source: Humanity United; Available from: http://humanityunited.org/pdfs/Modern_Slavery_in_the_Palm_Oil_Industry.pdf

One of the most common practices among palm oil companies looking to assert an environmentally friendly appearance is certification through the Roundtable for Sustainable Palm Oil (RSPO). The RSPO is a non-profit organization that's working to promote the production and consumption of sustainable palm oil by providing companies with a voluntary certification program that began in 2004. The certification was developed by stakeholders all across the palm oil supply chain: growers, processors/traders, social and environmental (non-governmental) organizations, manufacturers, retailers, and banks (Gaworecki, 2018). In 2007, 39 principles of sustainability were defined that growers and processors of palm oil must be in compliance in order to be certified by the RSPO. An executive board directs the RSPO by operating as the highest authority, organizing a general assembly, and supervising groups of members. The executive board has led a few attempts at reducing the carbon footprint and eliminating other negative consequences from the palm oil industry, including the supervision of two groups of scientists in identifying practices which would greatly reduce greenhouse gas emissions (Gaworecki, 2018). Although there might be organizations like the RSPO that aim to benefit the palm oil industry and environment with sustainable practices, the list of negative impacts from the palm oil industry continues to be quite extensive.

Much of the global palm oil production comes at the expense of tropical rainforests, causing harm to local animals and plants as well as local people that rely on these ecosystems for food and resources throughout their life. Areas in Southeast Asia that are at risk due to deforestation for palm oil production are biodiverse with endangered species such as the Sumatran orangutan, tiger, and elephant, as well as the Bornean orangutan and pygmy elephants in these habitats (*Palm Oil and Global Warming*). Many of the species in these forests are found nowhere else on Earth and only 15 percent can survive in oil palm plantations (Fitzbert et. al,

2008). Some “generalist species” like pigs and snakes, because of oil seeds and rodents like rats/squirrels, respectively, have a high presence on plantations. Plantation owners often hunt these species for additional sources of income. (*The Impact of Palm Oil Culture on Biodiversity*). The development of palm oil plantations has significantly contributed to the loss of biodiversity and increasing habitat loss in biodiversity-rich tropical rainforests due to deforestation. 40% of palm oil production comes from “small scale production actors” that tend to harbor higher diversity than industrial plantations (*The Impact of Palm Oil Culture on Biodiversity*). Figure 3 below displays the percentage of smallholders, private estates, and government schemes below. Each poses varying degrees of negative impacts from palm oil production based on individual company decisions in the industry and the regulations they face and the degree that they’re enforced.

Figure 3: Percentage Makeup of Palm Oil Plantations in Indonesia and Malaysia



Source: Rainforest Action Network; Available from: https://www.ran.org/wp-content/uploads/2018/06/Case_Study_Bumitama_Finance.pdf

There are many ways that the palm oil industry tries to cover up these negative statistics by throwing out a few positive traits to overshadow them and following with false claims of how there’s “complete sustainability”. One example from a website, *Palm Oil World*, claims to provide consumers with a “true picture” of the oil palm industry, Malaysian Palm Oil Board

(MPOB), with the help of the Malaysian palm oil industry, after supposedly assessing "the whole spectrum of Malaysian palm oil production" and affirming that it's environmentally friendly and sustainable (*Oil Palm and the Environment*). The website states that palm oil is the highest yielding and uses the least land because it produces 4.5 tons of palm oil (4 tons palm oil, .5 tons palm kernel oil) per hectare compared to just 0.45 tons for soybean oil. The oil palm is ten times more efficient because it uses a tenth of the land for the same production and produces after 3 years with a productive lifespan of 25-30 years. *Palm Oil World* claims that "the Malaysian oil palm industry uses sustainable practices to ensure that the environment and biodiversity are not harmed by cultivation of the crop through the adoption of good agricultural practices" (*Palm Oil World*, 2019). The author claims there is zero burning involved in the replanting process of oil palms between cycles and that the palm oil plantation is as effective as the rainforest in absorbing carbon dioxide from fossil fuel emissions.

Remote sensing studies of plantations across 20 countries showed that 45 percent of oil palm plantations were forested land in 1989 (Vijay et. al, 2016). The estimates are 54% and 40% for Indonesia and Malaysia, respectively. According to some studies, palm oil production has contributed to 50% of deforestation in some parts of the world (*The Impact of Palm Oil Culture on Biodiversity*). 31% of South American palm oil plantations studied were once forested land in 1989, including 39% in Brazil and 0% in Colombia, but only 2% in Central America and 7% in Africa. A study of Latin America finds similar results for that region with 21% coming from previously forested land concentrated in the Amazon regions of Peru, Ecuador and Brazil. The remaining 79% of oil palm expansion is estimated to have occurred on lands that were already some production system prior, predominantly cattle ranching (Barthel et. al, 2016).

Tropical forests store around 46% of the world's living terrestrial carbon with 25% of the world's carbon emissions coming from deforestation (Soepadmo, 1993). Slash-and-burn agriculture is a farming method of cutting and burning plants in a forest or woodland to create a swidden (*Slash-and-Burn*). Vast spreads of rainforest in South East Asia, Latin America, and Africa are being slash-and-burned releasing tons of carbon into the atmosphere; the world's largest producer of palm oil, Indonesia, even surpassed the United States in greenhouse gas emissions in 2016. In fact, palm oil biofuels have "three times the climate impact of traditional fossil fuels" (*Palm Oil - Deforestation for Everyday Products*). Malaysia, Indonesia and Papua New Guinea together support a covering over 27 million hectares of the most extensive tropical peatlands in the world. Only 36% of the original peat swamp forest coverage in these regions remain, with only 9% currently in designated protected areas, and the majority of the remaining areas quickly degrading (Barthel et. al, 2016). Peat can be defined as "an accumulation of partially decayed vegetation or organic matter" (*Peat*). Peatland ecosystems store 30% of the world's terrestrial soil carbon (D.H. Vitt, 2013). As is evident, there are many ways the palm oil industry has a large carbon footprint.

A study by researchers led by Thomas Guillaume, a postdoctoral researcher at École Polytechnique Fédérale de Lausanne (EPFL) in Switzerland, analyzes the heavy carbon costs and benefits of converting rainforests in Sumatra, Indonesia into oil palm plantations. For each hectare of forest cleared for the monocultural growing of oil palms, 174 tons of carbon emissions are released into the atmosphere - equivalent to 530 people flying from Geneva to New York in economy class according to Guillaume. This figure has been calculated using the difference in carbon stocks from the forested land and the oil palms. Guillame claims previously estimated figures used by the IPCC and sustainable palm oil certification bodies like the RSPO are quite

old and based on limited information to quantify the amount of greenhouse gases emitted by oil palm operations causing them to inaccurately be too low. Once oil palms have been harvested, biomass returns to the soil as a resource for living organisms can drop 90% from a healthy rainforest ecosystem.

Palm Oil World states that palm oil is capable of assimilating 36.5 t of dry matter per hectare per year compared to just 25.7 t for natural rainforests. The website claims that from this biomass, pressed fibers and palm kernel shells are used as solid fuel for the boiler to generate steam powering the plantation and the domestic worker's electricity. The author also claims palm oil is the most efficient in terms of energy balance (input-output ratio) and that palm oil requires the lowest inputs of pesticides, fertilizers, and fuel per unit of oil.

A survey of 50 respondents from different backgrounds and various education levels and ages were asked questions to discover the knowledge, attitude, and practices of pesticide use among smallholder oil palm farmers in Sandakan, Sabah. This is a major oil palm plantation area in Sabah. The study concludes these palm oil smallholders in Sandakan are taking good measures in pesticide handling practices, but that the groups could be more engaged in sustainable agricultural practices. In general, pesticides are a short-term solution that controls pests and increases profit, but it is widely known how dangerous these pesticides are to human health and the environment.

The oil palm crop is very demanding in terms of fertilization as was previously described and shown in Table 3, and this only increases with each cycle of replanting. Additionally, when an oil palm plantation goes through replanting, there's a high production of biomass including the oil palm trunk and palm frond. The oil palm frond consists of about 100 leaflets and reaches five to nine meters in length with spikes all over. When processing mill plants turn fresh fruit

bunches into crude palm oil, several kinds of waste are produced: empty fruit bunches, mesocarp fiber, palm kernel shells, palm kernel meal, and palm oil mills effluent. There's a very high prevalence of these wastes in Indonesia as palm oil mills and oil palm plantations spread across 22 provinces. In 2015, 71.2 million tons of oil palm frond biomass alone was produced from 11.3 million hectares of oil palm plantations. "Breakthrough studies need to be conducted in order to improve the added value of oil palm, minimize the waste, and make oil palm industry more sustainable" by using these wastes economically for alternative fuel, fertilizer, chemical compounds, and biomaterials (Hambali & Rivai, 2017). Although there needs to be studies on oil palm waste streams, there is research on how palm oil could be made more sustainable.

A recent study claims that palm oil is one of the largest drivers of greenhouse gas emissions from global land use and land cover changes. The study provides "fine resolution estimates" (100x100 meters of cropland) of greenhouse gas emissions from crude palm oil production in 2015 and potential estimates for emissions in 2030 that would reduce the greenhouse gas footprint of Indonesia by 42% if avoiding development on peat and forested land. This is an estimate that also doesn't compromise the increase in output production demanded in 2030. The estimated greenhouse gas footprint for Indonesian palm oil production is 5.7 tons of CO2 per hectare of crude palm oil on average; ranging from as little as 0.7 tons in some places to as many as 26 tons in other areas (Yee Lam et. al, 2019).

Another case study from the Journal *Global Environmental Change* uses a set of "suitability criteria" to first find all the land in the world that could potentially grow palm oil and it ranks the land on a color coded map from marginal to suitable to perfect. These criteria are based on the oil palm's growing conditions in relation to climate, soil, and topography. Climate criteria include annual precipitation, number of dry months, average annual temperature, and

coldest temperatures for that area of land. The study finds 1.37 billion hectares of total suitable land for oil palm cultivation in 12 tropical countries. Then a set of biophysical suitability and "sustainability criteria" is applied and the study finds 234 million hectares or 17% of overall suitable land is available for palm oil cultivation. Protected areas cover 30% of suitable oil palm area that's excluded from oil palm expansion. The results also exclude "high carbon stock forest" meaning there's greater than 100 tons above ground biomass per hectare. This includes nearly two thirds of all suitable land. While 234 million hectares (17% of all suitable land) might seem like a lot, only 18% of this land is within 2 hours' transportation of the nearest city, and there's also going to be competition for other agricultural commodities on this land.

There's clearly a lot of debate over whether the palm oil industry is truly sustainable, and whether it can be made more sustainable in the future as there are currently many sustainability challenges. The purpose of my study will be to unpack this debate in detail and assess what the scientific literature has to say. However, we must first take a detour into what it means to be sustainable or unsustainable and how to determine what meets sustainability standards and sustainable development. In order to determine whether the industry is sustainable, we must first define what sustainability means. This will be explored in the following theory chapter on sustainability and sustainable development.

Theory

History of Sustainability Concept

The term ‘sustainability’ is now central to environmental discussions and often comes up in the form of ‘sustainable’ or ‘unsustainable’ when discussions are raised in conversations and in the media surrounding environmental issues. However, the term was “hardly heard until the late 1980s, 20 years after the contemporary environmental movement got going” (Dresner, 1). Norwegian prime minister Gro Harlem Brundtland chaired the United Nations World Commission on Environment and Development and published the report *Our Common Future* which first made sustainability and sustainable development prevalent terms. This report is commonly known as the Brundtland Report which recommends that the new approach to the conflict between environmental protection and economic development is through sustainable development. Sustainable development has popularly been defined as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" since the Brundtland Report in 1987. These “needs” are often difficult to define as what society defines as a decent life varies depending on the population and the microcultures involved. This obstacle is what makes it most difficult to apply this definition in the real world as it is seemingly impossible to determine a universally accepted and definitive term for what exactly ‘needs’ are precisely.

The definition of sustainable development provided by the Brundtland Commission is often criticized as hopelessly vague. Environmental scientist Tim O’Riordan expresses his concerns in the 1988 essay “The Politics of Sustainability” that because sustainable development

is such a vague term this allows people to claim almost anything as ‘sustainable development’ making it less meaningful. When sustainable development was first conceptualized as an official term, there was a conflict between those that focused on the “environmental sustainability” sides and the opposing industrialists and developers favoring “industrial development” sides of sustainable development. Sustainable development now serves to improve and make sustainability agreements as a “meeting point for environmentalists and developers” (Dresner, 70). Sustainable development is meant to draw a bridge between the two opposing sides so that they may discuss the most probable and efficient way to move forward with the least amount of conflict. At a symposium shortly after the Brundtland Report was made public, Dutch member of parliament Jan Pronk convinced Hans Opschoor not to reject the concept of sustainable development before giving a public presentation due to political and international implications. The ramifications that could come from turning the other cheek on increasing global environmental problems by discrediting the term would be far worse than accepting it with a few flaws. After criticizing the term for being non-operationalizable, Opschoor later told Pronk he was glad he hadn’t dismissed the term when concluding his speech to the symposium and it ended up bringing 200 countries together to discuss the important issues at hand.

Environmental protection was once seen as a threat to development and growth until the Brundlandt Report revealed a healthy economy requires a healthy environment. Before this was published, the major political problem was reconciling concern for environmentalism with the desire for economic development in the South and economic growth in the North (Dresner, 35). The Brundtland Report created the most politically acceptable idea of sustainable development, and it displays a sophisticated balance between concern for social equity and resource

conservation. The concept of sustainability has so much flexibility, resulting in a historical role sustainability plays in facilitating discussion between actors with varying interests.

Brundlandt identifies three critical elements of sustainable development; she defines the "crucial elements of sustainable development as meeting basic needs, reorganizing environmental limits, and the principles of intergenerational and intragenerational equity." This significantly reduces the vagueness of the term, but the problem of operationalizing sustainable development remains. Economic and social development goals must be defined "in terms of sustainability in all countries - developed or developing, market oriented or centrally planned" (Dresner, 73). In this case, development can be defined simply as transforming economically and socially in a progressive manner. Development policies must "pay attention to such considerations as changes in access to resources and the distribution of costs and benefits" in order to be considered sustainable (Dresner, 73). Several aspects of the institutional environment in a specific country affect the costs and potential benefits of environmental management systems, resulting in differences in sustainable development across various countries. Differences in sustainable practices become commonplace because companies operate in different organizational fields and are therefore subject to different institutional pressures. Sustainable development concepts vary but share certain general features and have a broad strategic framework to achieving sustainability.

The Intergovernmental Panel on Climate Change (IPCC) was formed in 1988, and in 1992 the United Nations Framework Convention on Climate Change from the UN Earth Summit began generating fears of international action to reduce carbon emissions from fossil fuel emissions. Society transitioned out of the perception that environmental resources are unlimited and that there are no limits to societal growth and progress. Sustainable development

incorporates the idea of changing relationships in society between individuals and nature. Modern society now understands the dramatic side effects that have come with recent advancements in technology resulting in the destruction of our environment and therefore our planet. In the last couple decades, there has been an increasing focus on the transition away from carbon dependence and toward sustainable development. Since 1992, evidence for climate change has increased and less of an impulse to avoid human responsibilities to nature now exist. Society has since transitioned from controllable risks that are external such as wildlife to more internal risks; those which are immanent to the system such as floods, storms, habitat loss, and droughts. The term "risks" involves a situation causing danger to the environment. External risks are environmental concerns that do not directly affect humans such as wildlife preservation, protection of national parks and endangered species, etc. Whereas, internal risks such as pollution and climate change effects are internal risks directly affecting us. Recently, society has focused much more on internal risks that are harder to control but that directly impact a wider human population. Rather than preserving wildlife or certain environmental habitats (i.e. National Parks, biodiverse ecological habitats in tropical countries, etc.) for the sake of sustaining these for future generations to see and explore, we now focus less on these external risks and more on major risks (i.e. climate change) that could affect our own futures. The transition from external risks to internal risks has brought a change from wastefulness of resources and excessive consumption to finite resources and carrying capacity. Carrying capacity is known as the maximum population a specified environment can withstand given the food, water, land, and other resources necessary to sustain the given quantity of life. This is a well-known concept when environmentalists talk about environmental sustainability.

If you were to look up an exact definition of sustainability, you'll likely find a vast discrepancy from one source to another on how exactly it can be described. It might simply be stated as the ability to exist constantly. Alternatively, today some might argue that it's the capacity of the environment/biosphere and human civilization to coexist. Although most sources will discuss the environment in great detail, sustainability is also commonly linked to other areas of growth. The natural environment can play a significant role toward a sustainable economy as well as a healthy community. Moreover, the natural environment can directly provide resources and raw materials to produce goods and services needed in a healthy economy, and it can also provide clean air, natural resources and a nontoxic environment for a healthy community. Most environmentalists will describe three main pillars of sustainability: social, environmental, and economic. Otherwise, informally referred to as the people, planet, and profits. Although these three pillars can be closely tied together, the purpose of this chapter will be to break down what exactly sustainability and sustainable development means in terms of the environmental, social, and economic world in which we live.

Economic Sustainability and Sustainable Development

The idea of sustainability comes from the idea of limits to growth, and exhaustible resources being a finite stock that deplete over time. In economic terms, sustainability can be described as non-declining capital, but that capital no longer just includes monetary and human-made capital. Human-made capital is the man-made infrastructure and technology in a given area. Natural capital is very important to sustainability as these are allocated resources available in a natural area for a particular species. Capital gives you the potential to do things. Natural resources and social capital are needed in addition to money to be sustainable. Natural capital is

the stock of natural resources and assets within a given environment including geological assets, soil, water, air, and all living things. Generally, human populations take away from natural capital in order to support our quality of life. The degree to which humans take away from natural capital plays a factor in determining our level of sustainability.

Environmentalists often criticize conventional economics when calculating Gross National Product (GNP) statistics for treating the consumption of the Earth's capital as if it were income. In this case, a state of "sustainability" would be achieved in a situation of non-declining capital. However, there's a lot of controversy in economics over whether human-made capital (human capital) and natural capital should be grouped together or separately. If they are grouped together as the same capital, a question is raised over how increases in human capital and decreases in natural capital somehow even out to equal sustainability. This raises a difficult question for economists as to what extent technology can compensate for a loss of natural resources, and any degree of sustainability assumes some level of suitability between the two. The 'sustainable' part of Brundtland's 'sustainable development is "the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs" (Dresner, 83). In *Blueprint for a Green Economy*, David Pearce expands on the basic definition of sustainability in economics as 'non-declining capital' by adding more than human-made and monetary capital values and inserting 'natural capital' values. The idea of natural capital originated from attempts at defining the value of the Earth itself to human beings and was first used in the Brundtland Report.

Most decisions we make are an economic decision resulting in an internal evaluation of the level of value a specific material has. Those decisions don't have to involve money if there is some form of exchange of value. Utility is an economic term used to describe the value of use,

and something humans want to maximize, thereby maximizing pleasure from use. We extract resources to produce goods which are consumed and create utility. Humans have intrinsic value but they aren't equal in monetary value. Intrinsic value is a value that is independent of human interests and is ecocentric. Ecosystems have intrinsic value, and will therefore be preserved. However, even if we go to intrinsic value there is still a value hierarchy because we have conflict. For example, some species of wildlife have intrinsic value and this value is especially high because the species has been threatened near extinction. In human values, humans are worth more than the environment and consider our species far more important. In order to better understand the way we apply a hierarchy to value, we must first define different categories of value.

The concept of 'use value' deals with the willingness to pay to use. For example, I want to go whale watching, but I can't in Wayne County. Use value is how much I would be willing to pay in order to use that environmental service; in this case, whale watching. I have to pay for transportation to get to an ecosystem with whales plus the cost of a boat or a tourist company with a boat and the combined costs in order to go whale watching are use value; willingness to pay for using the environment. Existence value is value measured by the willingness to pay to ensure that a resource continues to exist in the absence of any interest in future use. Existence value is equivalent to intrinsic value. All our national parks have both use and existence values and are anthropocentric, meaning human centered. Use value most often deals with recreational experiences and includes costs of travel, equipment and time spent. When people travel to a national park in order to sightsee this takes use value for them to use the environmental service. The national park also has existence value because it is being maintained without any degradation and there is a cost that we're willing to pay to ensure it continues to exist. Existence

value is anthropocentric and a willingness to pay for the environment unrelated to use or option values. Option value is like use value as it is the willingness to pay for the option of using the environment in the future. In other words, to have the willingness to pay to have the option to be able to use that land in the future. If I'm a recreational fisher and there are several environmental locations that I aspire to someday use to go fishing, that's an option value. That value that the recreational fisher is willing to pay to use these fishing habitats in the future as well as sustain them until that time is option value.

In *The Principles of Sustainability*, author Simon Dresner assesses varying levels of sustainability on a scale from "weak sustainability" to "strong sustainability". According to Dresner, a world with systems of very strong sustainability levels would be impossible because this maximum level of sustainability assumes no substitutability of technology and natural resources. For example, there would be no extraction of natural resources such as oil. Moderate strong sustainability, on the other hand, allows for the depletion of natural capital if it's compensated for in another way. In Dresner's example, this could mean oil revenue going to the development of solar energy technology. Very weak sustainability levels would mean that there's an infinite substitutability of natural resources for technology and adheres to a total capital rule. Whereas moderate weak sustainability levels would mean there's only conserving of 'critical natural capital'.

The concern raised by *Blueprints for a Green Economy* is that if you don't know the outcome of this substitutability and whether it's going to sustainable measures, you can't assume the outcome will be a good one. Most of society is "risk-averse" and acts in a manner to avoid bad consequences. "What underlines notions of sustainability is not a failure to understand economics, but a more risk-averse approach to life…" (Dresner, 87). Environmental economist

John Pezzey provides insight into sustainability in the face of environmental resource constraints by contrasting mainstream and ecological economics. He aims to apply concepts on the economics of sustainability at global and national levels to national income accounting and sustainability. He also analyses the politics of pollution taxes by comparing carbon emissions taxes and carbon emissions trading schemes impacts on mitigating global warming. Pezzey further provides insight into the economics of sustainability by distinguishing sustainability and survivability. Sustainability is a path to development that wouldn't lead to declines average levels of well-being in the future. Whereas, survivability could lead to declines in well-being as long as they stay above a certain minimum necessary for human life. The degree of substitutability of human and natural capital is evidently crucial to determining sustainability levels.

As previously mentioned, very strong sustainability measures would make life as we know it impossible. However, strong sustainability allows for declines in any natural capital as long as it is equally compensated for in another form of capital. Dresner provides the example of increases in solar technology making up for increases in consumption of oil reserves. Loss of forests in one area could just as simply be replaced by forests elsewhere using this concept. On the other hand, weak sustainability would allow for high levels of depletion in natural capital so long as 'critical' levels are kept (Dresner, 87). Dresner distinguishes the varying levels of sustainability stating:

> For a supporter of strong sustainability, it would be important to conserve the present amount of forest. For moderately weak sustainability, natural capital can be turned into human-made capital as far as it is deemed ecologically possible. For moderately strong sustainability, natural capital should be preserved unless there is a substitute that can be invested in with the proceeds (Dresner, 88-89).

Dresner believes it is useful to distinguish between two types of natural capital he calls ecospheric natural capital and non-ecospheric natural capital. He wants to distinguish between natural capital that has value solely as resources and other kinds with other values attached. Critical natural capital would be specific solely to resources vital to maintaining Earth's life support systems whereas ecocentric natural capital is broader and covers a wide range of every aspect of the exosphere even those with unknown uses. Supporters of strong sustainability, according to Dresner, are happy to deplete non-ecospheric natural capital so long as there's an investment in future substitutes, and they are also generally less relaxed about depletion of ecospheric natural capital believing there's no "substitute for the natural world" (Dresner, 89). Their opponents often criticize them for the maintenance of current levels of natural capital. Supporters of weak sustainability believe natural capital will be replaced by human-made capital making it okay to run down natural capital so long as we stay above a certain minimum level for survival.

In a weak sustainability approach, so long as natural capital stocks stay above that minimum critical value, there's no problem depleting natural resources. Dresner assesses a few problems with this notion: 1) it can't be sensible to run down non-renewable resources without any kind of investment in the development of their future substitute, 2) a question is raised over what an ecologically safe limit of ecospheric natural capital might be, & 3) we don't know what natural capital would later be vital in some currently unknown way, and weak sustainability likely encourages the destruction of that natural resource we may eventually need (adapted from Dresner, 89).

A strong sustainability approach can also have a few weaknesses. Increasing national measurements of natural capital has previously been attempted in some countries that try to

calculate this value. The problem is that a country with a great economy, few natural resources, and high environmental standards could appear highly sustainable if the nations forested lands are expanding, the rivers and watersheds are kept clean and unpolluted, and there's low levels of extracting non-renewable resources. What isn't revealed in the country's sustainability is that it could be "exporting unsustainably" such as destruction of international rainforests, large fossil fuel imports, and corporations holding companies abroad to low environmental standards. Dresner states that "there can be no such thing as 'sustainability in one country'" (Dresner, 90). In other words, a company can only hold values of strong sustainability if they are strongly sustainable on a global level rather than solely within the company workplace.

The concept of sustainability from the perspective of a nature theory of value is that consumers are ultimately responsible for pollution and need to be willing to spend more. The nature theory of value is defined as value being created through human interaction with nature. Many capitalist economic agents make their decisions based solely on internal consequences. Meaning they will want to get the most out of not only workers but also machines, energy, natural capital, and everything input so long as there are no internal consequences against the company. There may, however, be external consequences causing environmental degradation that go against the nature theory of value. In economics, these "consequences" are often referred to as externalities.

An externality is the impact resulting from a product being made or obtained. There can be both positive and negative externalities. Specifically, externalities are an economic term for a side effect or consequence of a commercial activity that affects other parties without this being reflected in the cost of the good or service. What this means is that negative externalities generate cost to economic agents that weren't the result of those agent's decisions. For example,

if demand for renewable energy/fuel is rising, consumers have a green ethic, and restrictions are taken off the coal industry, then that industry's profit likely may not even increase if they profit at all. This outcome is entirely based on the decisions of the consumer rather than the economic agents. This is consistent with the nature theory of value concept of sustainability because every decision the average consumers make are based on sustainability; some will stop consuming after a reasonable goal. Even if the population was only a quarter of what it is today, there would continue to be carbon emissions, but there would also be little to no pollution. Pollution is when waste is greater than the assimilative capacity of the environment and is typically a negative externality. Pollution is generated in the production of the product but likely wasn't an intention behind the economic agents' original decisions.

A resource positivist perspective on sustainability is defined as over time there are no limits to the ability of society to sustain itself. A resource positivist might believe that sustainability is about distributional equity, and about who gets what. This perspective on sustainability is that consumers should leave the future the option to be as well off as the present. The population makes decisions to be as well off as they want, and those decisions are made through the market. This means that we, as consumers, must take the pressure off the environment. The drawback of natural capital is that it generates an economic rent and this rent is invested in physical capacity.

A resource pessimist perspective on sustainability is that the global environment is fixed and the ability to sustain future generations is threatened by the status quo. The role of the government may not guarantee the option for the future to be as well off as the present. While the government may control the market, they may not do it for the betterment of the future. It is the members of society that rank the importance of ecosystems. Those in the present make the

decisions about policy that will affect the option in the future. The nature theory of value states that value is created through human interaction with nature; and that the consumer will make their decisions based on sustainability. Meaning that at a certain point the consumer will end consumption if they've reached a reasonable goal. Under a nature theory of value perspective of sustainability, the environment is something consumers make decisions around in order to be sustainable rather than just as well as they want it to be.

The remainder of the economic sustainability section focuses less on defining sustainability through the lens of various concepts, and more on how to implement practices of economic sustainability. In order to overstep the comfortability of being "just as well off" as society deems necessary to being sustainable for a positive future, some environmentalists have proposed a concept known as ecotaxation. Many environmental economists "support the introduction of economic instruments such as taxes and tradable permits to encourage environmental efficiency" (Dresner, 98). Energy prices don't often incorporate the 'external costs' to society of pollution from energy usage. This is a negative externality from use value. In the 1970's and 1980's most environmentalists were ideologically opposed and favored only regulations because a tax on the environment would allow the rich to pay to pollute. Today, most of the opposition to ecotaxation comes from oil, chemical, and car industries. With tax burdens now shifting from labor to energy and raw materials, the effects can "combine the political and economic imperative of growth with the ecological imperative of decreasing environmental impact" (Dresner, 98).

A more complex form of ecotaxation, known as Ecological Tax Reform(ETR), has a green goal that's far more ambitious than the outcomes of a carbon tax. Ecotaxation is seen as raising extra revenue to provide a "green gloss" over the country to protect the environment. The

problem with this concept, however, is that people and businesses will avoid paying extra taxes if they don't deem it as necessary. The plan of ETR is to reduce labor taxes in order to compensate for new energy taxes introduced at very low levels and raising them up at five percent per year. A shift in societal mindset about ETR would be much more accepting after a subtle onset of the tax is followed by gradual increases in the willingness to pay for the environment. ETR stops taxing labor out of the market and instead taxes energy and raw materials inputs. Most importantly, ETR "plays to the strengths of the Western economy - technological innovation, rather than their weakness - high labor costs" (Dresner, 99).

Another approach to sustainability that has been popular among environmentalists for taking external values into consideration is using the approach of environmental space. Resource regeneration functions and pollution absorption functions are ecological phenomena putting a constraint on economic activity; limits to environmental impact(s) set by them are what's known as the "environmental utilization space". This concept first appeared in a 1982 paper on the economics of global life-support systems by German economist Horst Siebert, and was later taken up by Dutch economist Hans Opschoor. When environmental space was applied in the Netherlands in 1988 the National Institute for Public Health and Environmental Protection concluded they would have to reduce the nation's resource/energy consumption and waste production to a fifth of its level by 2010 (Dresner, 91). This obviously requires major shifts economically and requires a sustainable environment; playing a role in considering the environmental pillar of sustainability and sustainable development addressed in the following section.

Environmental Sustainability and Sustainable Development

In this section of the chapter, I will look at environmental sustainability through the lens of several key concepts that scholars have used to understand our impact on the environment such as environmental space, ecological footprint, and ecosystem services just to name a few. Environmental sustainability has very frequently been debated over the last few decades, and it's been increasingly prevalent in conversations around the world with the threats of climate change quickly approaching a point of no return. Some people may disagree on an exact definition of the term "environmental sustainability" and what quantifies what is or isn't "sustainable" for the environment. There are many reasons for discrepancies, including that it can be hard to identify statistical dimensions and multivariate data on certain characteristics of the environment's survival in the future because of their complexities. However, some agencies have made attempts at developing Environmental Sustainability Indexes(ESIs) and although they too are very intricate, they precisely measure variables of environmental concern in an unambiguous manner that determines a level of sustainability. Some environmentalists have had difficulties generating an ESI that can be widely understood while still having a clear method of calculating the scores and ranks of each variable concerning the environment. Doing so requires an understanding of environmental sustainability and sustainable development.

Returning to the concept of environmental space, in 1993, the report *Action Plan Sustainable Netherlands* explicitly linked sustainable development to environmental space. The report claims to raise question over distribution as soon as the present overuse of environmental space is recognized (Dresner, 91). Hans Opschoor was chairman of the Dutch government's Advisory Council for Research on Nature and the Environment from 1990 to 1995. According to Opschoor, the notion of environmental space is that sustainable development implies that the environmental impacts of human activities stay well within the limits of how much

environmental space the biosphere can withstand. Environmental space is a concept reflecting that "at any given point in time, there are limits to the amount of pressure that the earth's ecosystems can handle without irreversible damage to these systems or to the life support processes that they enable" (Dresner, 91). The concept suggests searching for the threshold levels that could damage environmental systems if they're surpassed and regard these values as operational boundaries of environmental space that must be held accountable to. He started research on what the size of "environmental space" actually is. Opschoor liked how environmental space expresses a notion of scarcity or limitedness of the environment by expressing its potentialities and configuring how the space is distributed. Opschoor considers three different dimensions of environmental space:

1. pollution of natural systems with xenobiotic substance or natural substances in unnatural concentrations;
2. depletion of natural resources: renewable, non-renewable (and semi-renewable);
3. loss of naturalness (integrity, diversity, absence of disturbance)

(Dresner, 91-92).

Environmental sustainability can be very complex when considering the expansive list of major negative environmental impacts going on all around the world. Dresner states that "the rich countries, with one quarter of the world's population, use three quarters of the raw materials and energy traded in the world, and are responsible for most of the pollution in the world" (Dresner, 92). A similar concept to environmental space, known as the ecological footprint, looks at the area of land a lifestyle uses, but its weakness is that its unidimensional (considering only that area of land used). However, ecological footprint still has its benefits that will be explored in the next paragraph. The environmental space concept is simply more multidimensional; better at dealing with a broad range of issues and negative impacts like global warming. To determine if a country's production and consumption patterns align with

sustainable development, one must compare the use of resources and the pollution of that country with the amount of environmental space the country owns. Private property rights are a necessary condition for the efficient allocation of finite resources because over time they ensure exclusive ownership, the ability to transfer the ownership right to others, and the requirement that the legal system recognizes and enforces private ownership. By determining the 'world environmental space' and dividing this value with the world population, you can take this variable and multiply it by a country's population to determine what a sustainable environmental space value/goal might be. This exercise using environmental space shows just how far Western society has gone to consume too many resources and surpass these values.

Although environmental sustainability can be a complex concept encompassing many negative environmental issues that are significant across the world, it's quite possible to analyze these issues on a more micro scale that looks at sustainability and sustainable development of an individual party. For sustainability concepts that are less broad and focus on more narrow issues with negative environmental impacts than global warming, ecological footprint might be a better concept than environmental space. The concept of ecological footprint is defined as the impact of a person or community on the environment, expressed as the amount of land required to sustain their use of natural resources. Ecological footprint is very similar to Daly's first principle of sustainability to limit human activity within the level of the Earth's carrying capacity. This term looks deeply at how much of the environment we are using and how much we have. According to Global Footprint Network:

> The Ecological Footprint of a person is calculated by adding up all of people's demands that compete for biologically productive space, such as cropland to grow potatoes or cotton, or forest to produce timber or to sequester carbon dioxide emissions. All of these materials and wastes are then individually translated into an equivalent number of global hectares
> (*FAQs*).

There are many more real-world methods of determining environmental sustainability than just the ecological footprint concept that apply to everyday issues in our environment.

Many environmentally friendly companies, or companies enforced to comply with environmental regulations, have principles of sustainability and sustainable development within company management and apply practices to everyday work life. There are many ways companies and corporations can live more sustainably such as developing new technologies such as renewable energy and green technology and decreasing their carbon footprint. Additionally, individuals need to make serious adjustments in their lifestyles to conserve natural resources and be aware of their ecological footprint. When assessing the level of sustainability of a company or business, one must analyze air quality & emissions, land use, soil & water pollution, and solid wastes including hazardous wastes that the plant emits. There are also many ways that environmental sustainability is important for more than the conservation and protection of our environments and natural resources, respectively.

Dresner then goes on to define Herman Daly's four principles of sustainability that reflect this. Daly's first principle of sustainability is to limit human activity to a certain level that's within the Earth's carrying capacity. The second principle of sustainability is to ensure that technological advances are done in a matter that increases efficiency rather than productivity. One interpretation of this principle might be to focus on increasing yield (output per unit of input) to get more in return for the effort and resources used rather than simply focusing on how to increase the outcome no matter the input required. This leads into Daly's third principle of sustainability for renewable resources requiring maintaining crop production by restricting the quantity of harvest within regeneration rates to avoid long-term depletion. Additionally, "waste emissions

should not exceed the assimilative capacities of the receiving environment" (Dresner, 89). Assimilative capacity is the maximum capability of an ecosystem to withstand toxic substances without impacts to the ecosystem species' or deleterious effects on the environment. Lastly, the fourth principle of sustainability states that non-renewable resources can't be depleted faster than the rate of renewable substitutes replacing these resources.

An environmental sustainability concept known as ecosystem services looks at how the environment has an effect on humans rather than most concepts that have been covered analyzing human's impact on the environment. This concept also helps in understanding why it is so important to be environmentally sustainable. Ecosystem services are benefits people obtain from the ecosystems around them, including that of provisioning, regulating, supporting, and cultural. These are the direct and indirect contributions of ecosystems to human survival and well-being. Sustainability involves increasing the quality of human life while staying cautious of the Earth's carrying capacity and supporting its ecosystems. This is a sustainability concept developed by the International Union for Conservation of Nature(IUCN) whose mission is to "influence, encourage and assist societies throughout the world to conserve nature and to ensure that any use of natural resources is equitable and ecologically sustainable" (*International Union for Conservation of Nature*). This concept ensures accountability for natural assets and preserves the environment for future generations.

Environmental sustainability has been driven by global production and consumption patterns that have been destroying nature at persistent and dangerously high rates. As populations continue to increase exponentially and we rely on the Earth's natural resources so heavily, the earth's natural ecosystems and their species have declined. Although some environmentalists

believe natural capital may be substituted by human-made capital, the problem with the notion of substitutability in sustainability is that some environmental assets have no substitutes. For example, *Blueprint for a Green Economy* addresses how there's no way to recreate the ozone layer. David Pearce also addresses how there are services provided by natural assets for which there are no ready substitutes: climate-regulating functions of ocean phytoplankton, the watershed protection functions of tropical forests, the nutrient-trap and pollutant-cleaning functions of wetlands, etc. (Dresner, 83). Seeing as human and natural capitals aren't substitutable, we must conserve the natural assets we still have. Especially when considering that we don't have the complete knowledge of all the Earth's natural resources and environmental cycles that are constantly changing the state of these resources, we cannot deplete resources that could be impossible to attain again and we do not know the full extent of potential outcomes that could come from this. Technological advances, however, could advance the degree of substitutability between the two types of capital. This may lead to positive effects such as technological advances that make the planet more sustainable (improvements in conserving energy and natural resources), but on the other hand could lead to negative effects such as depletion of natural resources or irreversible environmental damages.

Because ecological conditions vary so much from country to country, there is no single universal answer as to how environmental management practices must be done. Every country, international corporation and world leaders must work on their own sustainable development policies concerning their negative environmental impacts anywhere and everywhere on Earth. Another environmental sustainability concept developed by environmentalist Paul Hawken involves a balance between the currently disruptive relationship between earth's two most complex systems—human culture and the living world. This comes from the realization (and the

science behind it) that we are destroying the earth's environment and using natural resources faster than they can be replenished and regenerated, respectively. This has obvious effects on environmental sustainability and sustainable development as it relates to concepts such as carrying capacity. Additionally, depleting Earth's resources can often lead to negative consequences socially as a disregard for environmental sustainability can often correlate with a lack of social sustainability. This interpretation of environmental sustainability also addresses some areas of social sustainability covered in the next section.

Social Theory on Sustainability and Sustainable Development

The term sustainability has a multidisciplinary use, and in addition to natural and economic resources, we also need social resources. In order to be socially sustainable, there must not be compromise over meeting the social needs of future generations. This section dives into the meaning behind social sustainability and how to be socially sustainable. Social sustainability has had considerably less attention in public dialogue than economic and environmental sustainability. Furthermore, environmentalism did not exist as a social concept until relatively recent times.

The first wave of US environmentalism began as a response to a rapid expansion of industrial society during the late 19th to early 20th centuries. Following shortly after this in 1962, the second wave of US environmentalism began, and society was no longer just interested in preserving nature just for its own sake and for its aesthetic and recreational values. The second wave of US environmentalism greatly enlarged environmentalism into what we think of the term today and created an institutionalization of environmental concepts beginning with Earth Day in

1970. However, the 1970's also experienced a period of "ecological innocence" where environmental organizations didn't do much because they assumed the lax regulations put in place would make everything "fine" or sustainable for the future.

Many social scientists believe there's a lack of social theory on the concept of sustainability. Few conceptual tools existed that could bring various actors together before sustainable development existed as a social concept. However, technology and social organization can now be transformed and improved to begin a new era of economic growth. Society was once still holding onto the idea of the American dream of upward mobility and social progress being so easily secure. Natural resources were once so plentiful that limits to progress didn't exist and society focused on making the present better than the past and the future better than the present. Modern society now understands the dramatic side effects that have come with recent advancements in technology resulting in the destruction of our environment and therefore our planet. Social sciences may respond to a need for sustainable development due to climate change by focusing on the way's society depends on carbon emissions, and the importance in which it must search for alternatives to these emissions. While humans have always thought about the environment throughout history, how humans think in terms of value and use of the environment has only recently been important in social theory. A theoretical framework on sustainable development can be useful for analyzing and understanding sustainability projects, as well as methods for improving them and the costs behind sustainability efforts. In the last couple decades, social sciences have begun to analyze how economically sufficient societies have become dependent on carbon and the potential path away from this dependence to become sustainable. The various frameworks shed light on topics that are to be considered in policies and planning in order to create a sustainable future.

Sustainable development incorporates the idea of changing relationships in society between individuals and nature. In the last couple decades, studies have increasingly focused on the societal transition away from carbon dependence and toward sustainable development. Society has transitioned out of the perception that environmental resources are unlimited and that there are no limits to societal growth and progress. The Brundlant Commission argues that in a world in which poverty exists, a healthy environment is not possible (Dresner, 36). Society has transitioned away from external risks which are visual and controllable and played a stronger focus on internal risks like the excessive waste and overconsumption of resources which are finite and must take the environment's carrying capacity into consideration. In fact, the United Nations Department of Economic and Social Affairs states in its 2030 Agenda for Sustainable Development that:

> We recognize that eradicating poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and an indispensable requirement for sustainable development. All countries and all stakeholders, acting in collaborative partnership, will implement this plan. We are resolved to free the human race from the tyranny of poverty and want and to heal and secure our planet. We are determined to take the bold and transformative steps which are urgently needed to shift the world onto a sustainable and resilient path (*Social Development for Sustainable Development*).

Sustainability has popularly been defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" since the Brundtland Report in 1987. As previously mentioned in the chapter introduction, needs are often difficult to define as what society defines as a decent life varies depending on the population and the microcultures involved. For sustainability to satisfy long term needs, sociologists Littig & Grießler (2005) develop an analytical concept to theorize the relationship between nature and society. Needs can be defined broadly as the satisfaction of consumption and production relevant to the use and exploitation of natural resources and ecological systems, which are at the same

time also affected by the output of emissions and waste in terms of nature (Littig & Grießler, 2005). There are many ways society can find needs in relation to sustainable development. Some of the well-known social needs are food, drinking water, housing, clothing, and protection from harm. Social sustainability might make it priority to promote these basic needs for as long as possible. However, "protection from harm" as a need has evolved to include health care and protection in case of illness, old age, and social hardship. If the definition is extended further it may include other needs like education, recreation, social relationship, to call for a broader scope of action and opportunities to satisfy these (Littig & Grießler, 2005). The latter is what Littig & Grießler believe to shape a decent life, and to satisfy these needs and the exchange between nature and society involves some form of work (paid labor) therefore central to sustainability.

Capitalist production has unfortunately driven an exponential increase in demand to supply greater quantities in cash crops and vegetable oils at a lower price. This has given rise to the eco-socialist perspective that increased capitalist production leads to decreases in the quality of the environment. This is likely because environmental resources have often been undervalued and overexploited (Dresner, 36). This is evident by the previous statistic from Dresner that rich countries expend the majority of all raw materials and energy used in the world while causing most of the pollution in the world. Capitalism has stemmed from an imperialistic origin that extract natural resources and separates the "haves" from the "have nots" in society. This greatly altered the human-nature relationship to change and affecting economic, technological, and ideological structures in terms of policy changes. The Brundlant Report aimed to improve policy by integrating environmental decisions into central economic decision making (Dresner, 36). Social sustainability and economic sustainability are very closely tied together as there's a focus

on a more equitable exchange between parties and an emphasis on an equal distribution of resources and opportunities for everyone.

Unfortunately, some populations in modern society are able to avoid or simply ignore internal risks with wealth and class. This is what's known as the tragedy of the commons – a term used in social science to describe a situation in a shared-resource system where individual users acting independently according to their own self-interest behave contrary to the common good of all users by depleting or spoiling that resource through their collective action. Most often, this complements anthropocentric values that consider human beings (themselves) as the most important entity and interpreting the world based on human values and experiences. On the other hand, biocentric values provide a perspective that value in the world does not reside within human beings alone. Systems thinking is a social sustainability approach acknowledging systems as organized entities made up of interrelated and interdependent parts, including feedback loops, causal relationships, and nonlinearities. Systems thinking places an emphasis on connections rather than individual self-interests and places the value of the whole system as greater than the sum of its individual parts.

Sociologist Eric Lichtfouse develops a theoretical framework for attitudes toward sustainable agriculture, and particularly farmers attitudes as they are the individuals enforcing or veering from sustainable agriculture. There are several factors that contribute toward sustainable agricultural beliefs based on this framework. First, religious spirituality can be a resource in positively contributing to the environment. The second factor is quality of life as farmers with a more positive attitude on life are more likely to contribute to sustainable development in relation to the agriculture for society. Lichtfouse finds that access to information can result in a more positive quality of life (and therefore positive environmental agricultural practices) as knowledge

and information bring confidence, skills, ability, and experience (E. Lichtfouse, 2009). An increasingly positive quality of life results in daily tasks becoming more and more easy to perform, and this results in farmers becoming more likely to perform sustainable agricultural behaviors. Education also plays an important role on farmers attitudes toward sustainable development. Lastly, the theoretical framework provides a theory that women are closer to nature because of their nurturing and caring role resulting in a more intimate relationship with the environment than men and a higher likelihood to practice sustainable agriculture.

Social sustainability issues can be complex, and almost certainly have cross disciplinary effects in economic and environmental sustainability issues. Social concerns surrounding agricultural development include land use rights, forced or child labor, terms of labor including wages and treatment, as well as health and safety and gender discrimination. For social sustainability to be achieved, there must be patterns of growth and equality among various actors and companies. Negative social impacts can occur when companies are in noncompliance with regulations or principles.

There are many challenges posed by social sustainability. For instance, everyone has their interpretation of material needs (natural resources, raw materials: environmental sustainability) that several parties are involved with to satisfy these needs (production and exchanges within the market: economic sustainability). However, the equitable distribution of these resources can become quite problematic due to competing needs over a finite amount of resources. Typically, when companies are socially sustainable, they put more value into research and development of products and producing these with quality rather than the marketing and sales of their products. In this scenario, there's a higher likelihood of social sustainability because the company is respecting intergenerational equity and not compromising the ability of future generations to

meet their own needs. Corporate culture can shift towards social sustainability when leaders and stakeholders come to an understanding that we all live on the same single planet. Social sustainability demands an economy that's not extractive but instead that's regenerative and focuses on embracing the values of sustainability and sustainable development.

For farming communities to support sustainable development, farmers need to first understand the alternatives to traditional farming methods and why sustainable farming practices are better for their crops, communities, and livelihoods. Overall, there isn't a substantial conflict over whether sustainable development is good for society as individuals agree on this. However, there's conflict between individuals and institutions such as redistribution of wealth and the responsibility of current generations on future generations. Lastly, there are also extrinsic and intrinsic values through which society views agricultural and sustainable development.

Conclusion

All the aforementioned information is critical to understanding approaches to sustainability in order to prevent the continuation of societal dependence on unsustainably produced products so environmentalists can further influence positive sustainable development. The following chapter aims to analyze several sources of literature on the palm oil industry in order to assess the levels of economic, social, and environmental sustainability and sustainable development. When assessing a firm's environmental performance, several actors play an influence: governments, customers, competitors, community and environmental interest groups, and industry associations. When each of these actors exert different levels of environmental concern, the firm deals with institutional pressures and is forced to make decisions on sustainable development beyond the minimum regulatory compliance exerted by enforcement of the

institutional pressures of governmental laws. If a proposed sustainability system benefits the environment and generates profit, then sustainability will likely be achieved in society. If sustainability is to be achieved, we must also ask what is produced and how, and who receives from this proposed system.

Institutional pressures influence a company's environmental management practices in several ways potentially resulting in sustainable development. There are several factors in play that affect a company's decision to adopt sustainable practices, yet organizations subject to the same institutional pressures pursue different strategies. A parent company is a company with controlling interest in another company, potentially having control over operations. Due to the multitude of plant and parent company characteristics, various firms interpret institutional pressures differently resulting in different environmental management practices. Coercive forces in the form of regulation and regulatory enforcement are the main causes of these practices, and firms sharing the same organizational field are affected similarly by the institutional forces they create. For example, the discovery that chlorofluorocarbons (CFCs) depleted stratospheric ozone quickly led to institutional coercive forces (the implementation of the Montreal Protocol) that phased out the manufacturing and use of products containing CFCs (Delmas & Toffel, 2004). Several aspects of the institutional environment in a specific country affect the costs and potential benefits of environmental management systems, resulting in differences in sustainable development across various countries. Differences in sustainable practices become commonplace because companies operate in different organizational fields and are therefore subject to different institutional pressures.

Methods

The purpose of my study thus far has been to unravel the three pillars of sustainability (social, environmental, economic) as well as to gain an understanding of palm oil from an unbiased perspective that explores the industry from seedling to distribution for your consumption. The first part of this process has been to develop an overview of the oil palm tree as an agricultural crop without discussing anything positive or negative sustainability-wise until the chapter's conclusion hints at some such statements without diving too deep quite yet. In this way, a reader without any prior knowledge of my topic can now gain an understanding of all the basics of the palm oil industry and what goes into the ingredient in many of the products they might consume every day. The second part involved creating a theoretical framework of sustainability and sustainable development in order for the reader to understand their significant meanings. This helps to apply the theory to what is and isn't sustainable in the palm oil industry.

For my study's results I chose five different studies that take that deeper dive into the palm oil industry's sustainability and sustainable development. I thought that the best way to gain a complete understanding of whether or not the palm oil industry is 'sustainable' was to perform a meta-analysis of several studies that allows me to summarize and assess for myself the current and potential future sustainability of the palm oil industry. By conducting my research with this methodology, I didn't need any sort of people participants which meant that I didn't need one specific study site since I wasn't relying on anyone else but myself. This proved to be a significant benefit and worked to my advantage as I could do my writing from my apartment on campus when I found alone time, my senior carrel in Andrews Library on the College of Wooster's campus when I needed a more quiet space, or Knowlton Café in the new Ruth Williams Life Sciences building on campus when I had time between classes.

I was initially planning to talk to people from the oil palm nurseries, plantations, and mills to those involved in the financing, selling, marketing, and participating organizations such as the RSPO, government agencies, assisting schemes, and NGO's involved in the palm oil industry. This would include everyone throughout the palm oil industry from supporting proponents to sustainability advocates to those protesting the industry's negative effects socially, environmentally, and economically. By doing this, I would've been talking to people throughout the entire industry to gain a full understanding of everybody's perspectives and fully assess the current and potential future levels of sustainability. However, I quickly realized this was far too ambitious of a goal after reaching out to three individuals and waiting days or weeks to hear back given the considerable time differences across the world.

One of the drawbacks that provided a disadvantage using my selected methodology was that I didn't have the time or funding to travel across the world to Southeast Asia and witness the sustainability of the palm oil industry firsthand. My initial idea turned out to be far too much for my study and proved to be harder than I initially thought to reach out and hear back quickly enough given the timeframe of my study. Although, I still had many benefits to my methodology including that there were still endless sources of information to choose from through case studies and research conducted by scientists all over the world. This was especially true compared to the significantly less quantity of information available fifteen years ago when my interest first began with this topic, and by no longer having to reach out to individuals to conduct interviews I was able to narrow the field of information I would need to look through for my study.

I collected all my data through the five meta-analyses I performed on separate case studies within the palm oil industry. My primary goal was to assess the current and potential future levels of sustainability within the industry. The majority of this process was to examine

case studies within the palm oil industry and identify the factors of sustainability presented in order to grade each pillar of sustainability on a scale from none to weak to moderate to strong sustainability. If one or more of the three pillars of sustainability was not touched upon within the case study, a grade of "not assessed" was given to that portion of the sustainability index. I believe analyzing several case studies from across the palm oil industry, especially from Indonesia and Malaysia, is the best way to understand the full complexity of economic, social, and environmental sustainability within the palm oil industry. I created an excel template before going through each study that had rows representing each of these three pillars of sustainability and columns showing the previously mentioned rankings. Below each of the three rows representing the pillars of sustainability, I arranged an assortment of 12 colors from dark red at the very beginning of the "none" ranking to dark green at the very end of the "strong" ranking. This became what was known as my own personal "sustainability index".

For each individual case study, I would first read through the entire thing once or twice depending on the length of that set of data. This proved to have both benefits and drawbacks as some studies were only ten to fifteen pages in length while others were nearly 400 pages long. In order to make this easier, I would take notes on "highlights" in a notebook to keep track of page numbers with important pieces of information on the sustainability of palm oil. After going through the study, I would begin by writing an in-depth summary in my own words. Some of the longer case studies I used for meta-analysis had statistics and figures that required quoting the author(s) in order to express the facts within the industry. As I would write a summary, I'd be thinking about what was considered sustainable or unsustainable and add this sort of commentary. Going through this summary and meta-analysis process of my methodology probably took me anywhere from twelve to fifteen hours to complete per study.

Following this summary and analysis of a case study, I would use my sustainability index template created in Microsoft Excel to form my grades of each of three pillars of sustainability. For each ranking, I would add an illustration of an arrow to represent the extent of the current level of sustainability for that environmental, economic, or social pillar. Then, I would add what Excel calls a chevron to represent the extent of my assessment for what the study believed the potential future sustainability in the palm oil industry could be. These illustrations were inserted over the 12 shaded colors represented by the red, orange, yellow, and green color scheme for the none, weak, moderate, and strong grading scale under each column, respectively. Again, if the study didn't assess the full spectrum of one of the industry's three pillars of sustainability, a grade of "not assessed" was given under the final column titled N/A. Afterwards, commentary was inserted into the three rows representing the three environmental, economic, and social pillars of sustainability in textboxes above the arrows or chevrons. Overall, using arrows and chevrons to represent the current and potential future levels of sustainability, respectively, within the palm oil industry proved to be quite effective. Lastly, I would go back to my meta-analysis in the Word document where I was writing my research for the study and add commentary where necessary to explain why I had given certain grades.

Due to my interest in this topic for the last fifteen years and my consumer decisions against the palm oil industry, one of the drawbacks to this methodology is that there's always going to be a hidden bias behind the grades I assign in the sustainability indexes. It would be impossible to get rid of this bias entirely because I've put so much time into researching my topic before beginning my independent study. Despite this drawback, I continued to try and give grades that would not reflect my own personal feelings toward palm oil and the industry's negative effects on the environment. I was looking for data from authors that reflected their

feelings in case studies, as well as the actual science that backed up their claims. I was careful not to exclude data that was both positive and negative about palm oil plantations and their operations across the various countries where they operate. I was also basing my framework around a similar idea to Dresner's in that there could none, weak, moderate, and strong sustainability factors at play. One of the drawbacks to this is that it was sometimes difficult to assign grades because there isn't one defining grade across the industry. There's such a wide variety of sustainability with plantations operating under different civil regimes such as environmental and social laws varying depending on customary, state, and national laws within their respective areas of operation. For this reason, I chose to make arrows and chevrons for the current and potential future sustainability gradings, respectively, so that I could draw on the wide range of sustainability within the industry in my indexes. Additionally, some plantations operate under non-legal regimes assigned by organizations such as the RSPO if they choose to go for sustainability certification, and not all plantations within these organizational rulings will follow their guidelines.

My theory chapter supports that the organizational culture these plantations operate under can heavily influence how they define sustainability within the palm oil industry. I had to be careful not to step into these meta analyses with a preset conception of how the palm oil industry currently appears in my eyes. One of the benefits behind grading sustainability indexes based on a reading from a previous case study is that it made it easier to draw conclusions without my own personal bias. At the same time, this can be seen as a drawback as I was unable to see how the authors past experiences shaped their viewpoints. If I had talked to people face-to-face or over the phone, I likely would've determined preset questions based on my own ideas about the palm oil industry. What I ended up finding is that there isn't necessarily zero sustainability across the

palm oil industry. Additionally, the benefit behind this type of methodology is that I didn't need to spend time transcribing the massive amounts of information before analyzing to find sustainability grades for my indexes. However, due to the nature of the meta analyses and the large amounts of time and consideration I put into each assessment; I was unable to analyze as make as many sustainability indexes as I would've liked. If I had started my methodology earlier than January 2020 and had more than two months to perform the meta analyses I would've been able to make two or three more sustainability indexes as I had hoped to originally make seven. If I were to go back, I would've spent less time summarizing and more time on the key conclusions from each study. At the same time, the benefit behind this methodology is that I was able to spend more time getting very in-depth with each meta-analysis and sustainability index.

For my first sustainability index, I chose a case study that was representative of the beginning of my overview chapter by focusing on the biology of the oil palm tree. First, the study assesses the suitability of where the crop can be grown around the world. Then, it uses sustainability criteria to assess where the best places (socially and environmentally) where the crop should be grown. In this way, the reader can make connections to the beginning of my independent study and apply the sustainability of the crop to where the future directions of the palm oil industry should go if this were to be a key consideration. However, the drawback is that economic sustainability and sustainable development is not completely taken into consideration besides a couple of factors. For this reason, my second sustainability index comes from a much longer study that assessed all three pillars of sustainability. The drawback behind this study is that because of my time constraints and the study being nearly 400 pages in length, I could not make a sustainability index behind every claim in the study or it would have been far too long in writing and very time consuming for my methodology. Because of this, I chose to focus on the

chapter's sections that were specifically about the environmental, social, and economic factors behind the palm oil industry's sustainability. This was still my longest meta-analysis and therefore took more time than any of the other sustainability indexes. I had to put a lot of consideration into this one because there were so many factors at play. I could not just make arrows across the entire spectrum of sustainability and had to narrow it down to the factors that stood out the most to me.

There seemed to be a lack of information on specifics of social sustainability, so for my third meta-analysis and sustainability index, I chose a study that focused on exploitative practices within the palm oil industry. This study stood out the most to me as much of my own personal research prior to my independent study has focused on environmental issues and this opened my eyes to the social issues at play as well. At this point in my methodology, my results were focusing much more on environmental and social sustainability. Because of this, I chose a study that focused more on the economic pillar of sustainability and sustainable development for my fourth meta-analysis. This sustainability index takes into consideration the banks and financiers of the palm oil industry, specifically in Bumitama; a well-known location in the palm oil industry that's further explained in my results. The benefit behind this study is that it opened my eyes to the fact that these supporters of the industry enable many of the unsustainable practices to happen and should be just as equally responsible for every issue and unsustainable factor at play. Again, most of my knowledge prior to my independent study stemmed from environmental issues, so it was a benefit to explore the economic issues a play as well. For my final meta-analysis and sustainability index, I chose a study that takes the focus back onto the environmental pillar of sustainability and sustainable development. Similar to the fourth meta-analysis, this focused more on one specific region as well so that the reader could understand the

civil regimes at play that alter the plantations operation decisions. The land conversion from deforestation and carbon emissions from the palm oil industry have always been very important to me personally, so it was a great opportunity to dive deeply into the industry's effects on the environment that I've cared so much about through my desires to protect the natural habitats of biodiverse species. The benefit behind this study is that it helped to wrap things up by taking the reader back to the conclusions drawn from my first meta-analysis and how the industry could be much more sustainable, in my opinion.

Lastly, I made one final sustainability index that represents all five meta analyses compiled into one. The benefit behind this step in my methodology is that the reader can more easily understand the entire palm oil industry's current sustainability and potential future direction of sustainable development. Furthermore, they don't have to go back to each individual sustainability index to understand the industry as whole. The drawback behind this was that with the color schemes taking up so much space, the index became much larger than anticipated. For that reason, I got rid of the text boxes and explained some of my conclusions below the final sustainability index. The benefit behind this is that it also made it easier to distinguish conclusions between the separate sustainability indexes. However, it was difficult to fit the citations within arrows, and especially the chevrons. Because of this, the chevrons show the numbers of the sustainability index they're representing, and the arrows (if applicable) with the authors of that study's grading were placed adjacent (horizontally) to these chevrons. Hopefully, this made things easier for the reader to understand when looking at my final concluding sustainability index. The benefit behind this part of my methodology is that it also made for an easier transition into my conclusion chapter from both a reader's perspective and my own as the researcher and the one writing my independent study.

Results

Meta-Analysis 1: "What Are the Limits to Oil Palm Expansion?"

Johannes Pirker, Aline Mosnier, Florian Kraxner, Petr Havlík, and Michael Obersteiner

Many studies have linked the expansion of palm oil plantations to the loss of tropical forests, particularly in Indonesia and Malaysia. One estimate from 2011 found that 17% of new plantations in Malaysia and 63% in Indonesia from 1990 to 2010 came at the direct expense of biodiversity-rich tropical forests. This is an indication that the palm oil industry currently displays weak signs of environmental sustainability. A notable study titled "What Are The Limits to Oil Palm Expansion?", by researchers at the International Institute for Applied Systems Analysis(IIASA), provides an in-depth assessment of how palm oil can be expanded and what the limits to this expansion might be using a set of sustainability criteria. Here, we attempt to perform a meta-analysis of the case study in order to quantitate the environmental, social, and economic levels of sustainability currently and the potential direction the industry is taking or could take based on the findings shown in Sustainability Index 1 below.

The study begins by identifying all suitable and available land, mainly determined by climatic conditions, resulting in 1.37 billion hectares of suitable land for oil palm cultivation concentrated in twelve tropical countries. After applying a set of 8 sustainability criteria to this biophysically suitable land, only 17% of that overall land, or 234 million hectares, remains available for palm oil cultivation. Suitable land is classified from 1 being marginally suitable to 5 being perfectly suitable for sustainable oil palm growing and cultivation. In order to find the biophysically suitable land, the study uses four climate, three soil, and two topography criteria to define an optimal range and minimum and maximum sustainability value for oil palm growing

conditions. Soil and climate criteria are necessary as these are necessary resources that determine the growing conditions of the oil palm tree. Topography is particularly important for the oil palm as the crop requires good manageability for its mechanized production system. Because the study uses Liebig's "Law of the Minimum", the overall suitability score reflects the score of the least suitable bio-physical variable for palm oil cultivation. In other words, if one or more of the criteria has a value of zero, overall suitability is zero. Based on the criteria in Figure 4 from the study below, all "suitable land" in the study is purely from a bio-physical standpoint resulting in the previously mentioned 1.37 million acres for potential oil palm cultivation. The case study creates a map of the globe showing the physical locations of marginally to perfectly suitable land seen in the figure. However, the study estimates half of bio-physically suitable land is allocated to other uses such as protected areas alone covering 30% of this overall suitable land. This leads to the next set of criteria provided by the study on environmental sustainability.

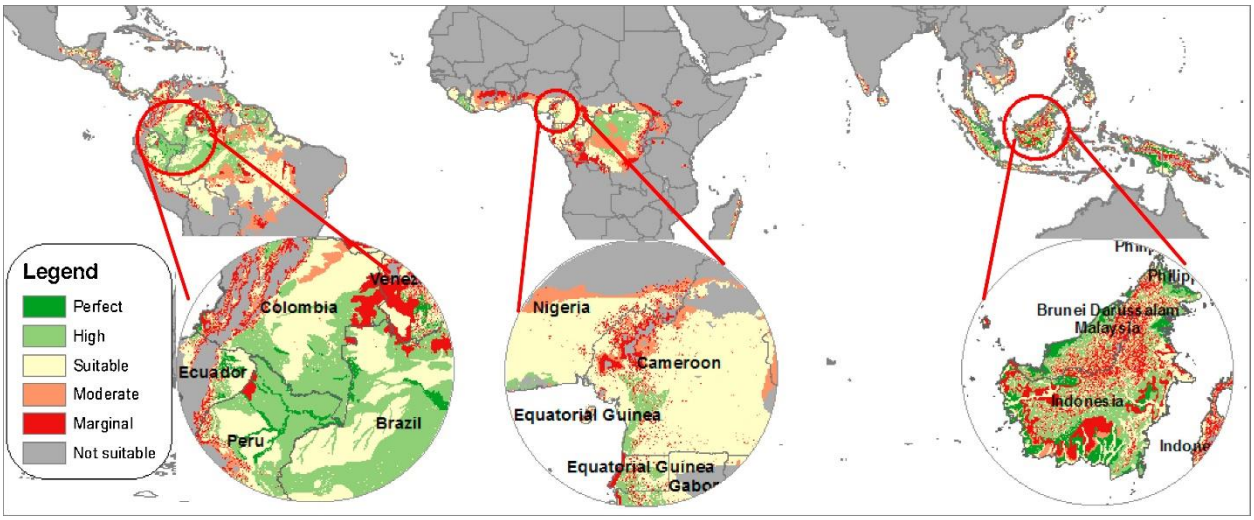


Figure 4. Source: Pirker et al.; Available from: https://www.sciencedirect.com/science/article/pii/S0959378016300814#fig0005

The study applies a second set of sustainability criteria that limit oil palm expansion and exclude some of the otherwise suitable land. The three types of limits are land that's prevented from conversion due to prior building and infrastructure, land used for cropland or pasture, and non-protected areas which are important for biodiversity conservation and carbon storage. For

land prevented from conversion to oil palm plantations, the study uses the World Database on Protected Areas(WDPA, version June 2015) to find location and extent of protected areas where the law prevents land conversion and lower status PAs that might deliver some conservation value despite not being legally recognized as a PA. By preventing conversion of PA lands to palm oil plantations, the potential for palm oil to become more environmentally sustainable in the future increases. Because discovering all "built area" around the entire world would be seemingly impossible for one study to find, it uses a crowdsourcing-based hybrid land cover map to exclude urban areas from biophysical suitability. This eliminates 723 million hectares of suitable area for oil palm expansion, reducing the overall land availability by half.

The researchers find that High Conservation Values (HCV) are dominating discussion around sustainable palm oil and HCV assessments are necessary for some sustainability certifications. HCV is a local and case-to-case applicable method of sustainability assessment, so the study bases its assessment on the requirement that at least four of the six 'terrestrial biodiversity priority areas' all around the globe must be overlapping. These biodiversity hotspots include: "Conservation International's Hotspots (Mittermeier et. Al, 2004), WWF's Global 200 terrestrial and freshwater ecoregions (Olson and Dinerstein, 2002), Birdlife International's Endemic Bird Areas (Birdlife International, 2008), WWF/IUCN's Centers of Plant Diversity (Davis et. Al., 1998) and Amphibian Diversity Areas (Duellman, 1998)" (qtd. from Pirker et al., 2016). This assessment of highly biodiverse areas covers 125 million hectares of the overall 1.37 billion hectares of suitable land for palm oil cultivation.

The HCV assessment is only a moderate improvement toward future environmental sustainability, as the study could at least lessen the requirement from four of the six biodiversity hotspots to only two or three of these. Terrestrial biodiversity is of significant importance

because many species are currently endangered due to human development. However, even requiring four of the six biodiverse areas to overlap would make substantial strides compared to the currently widespread absent protection for biodiversity in much of the palm oil industry. Not only are these species of immense importance, but so are the biodiverse ecosystems and forests they live within.

In many cases, the biodiverse ecosystems that palm oil plantations are converted from often contain massive amounts of carbon stored in tropical rainforests and peatland soils. The study uses the sustainability commitment to permanently spare high carbon stock (HCS) forest with above and below ground carbon. The proposal considers HCS to be any above ground biomass (AGB) greater or equal to 100 tons per hectare and peat soil exceeding 12.5 centimeters thickness. This eliminates 1 billion hectares of the overall 1.37 billion hectares of suitable land and is the most constraining sustainability criterion. This significantly contributes to the analytical evaluation of potential future environmentally sustainable development graded at a strong level in my assessment below. By preventing HCS forest from conversion to palm oil plantations, even more biodiverse ecosystems are also saved in the process.

The study also uses a rudimentary measure of economic sustainability by considering how economically sustainable the location of certain areas will be for palm oil cultivation and plantation revenue. The economic sustainability factor considers the time to access the closest city above 50,000 inhabitants to assess how economically attractive (from a business perspective) the suitable areas are. Considering the economic factor, only 18% of suitable areas are within two hours transportation of a city and 50% are less than five hours from the nearest city. However, I cannot assess the complete economic sustainability of the palm oil industry just based off one criterion.

After applying all the above sustainability criteria to every hectare of biophysically suitable land globally, the overall potential availability of suitable land is 17% (233.82 million hectares). From the 'very suitable' areas that would likely produce the most yields, only 5% of this land remains - meaning about 19.3 million hectares is available for sustainable palm oil cultivation, but this more than doubles the 2016 extent of 18.1 million hectares worldwide. Overall, the study provides the most useful set of information regarding future palm oil expansion with environmental sustainability objectives. It contributes significantly to the debate on palm oil sustainability by assessing bio-physical palm oil suitable areas globally providing a map to show this. The researchers find that they might not be considering the factor of competition for land for other uses; particularly with a continually growing global population, they state their might be an underestimate in area allocated to other uses and overestimate in areas available for future palm oil expansion. The study also requests increased security of protected areas as 30% of suitable land lies in protected areas.

One of the strongest environmental sustainability factors, the HCS forest assessment, eliminates important land storing mass amounts of carbon - covering 73% of all suitable land for palm oil cultivation. Buffer zones around villages and rivers are also included in sustainability criteria. The researchers also state that "diverting oil palm production to lower suitable areas will also lead to lower economic profitability which could be partly offset by higher plantations area. A careful cost-benefit analysis must be done to ensure that new palm oil plantations meet the three dimensions of sustainable development" (Pirker et al., 2016). The study concludes stating that the findings support the feasibility of several countries palm oil plantation expansion plans but that they "should be considered as an upper boundary to sustainable palm oil expansion as fine-scale economic and social criteria must also be taken into account" (Pirker et al., 2016). This

leads into the next meta-analysis of a case study covering environmental, social, and economic sustainability and sustainable development in the palm oil industry.

Sustainability Index 1

	Level of Sustainability				
	None	Weak	Moderate	Strong	N/A
Social Sustainability					Social sustainability is never mentioned in this study except to state that it should be further explored if someone were to expand on the research
					Not Assessed
Environmental Sustainability & Sustainable Development			The study uses several strong sustainability criteria to assess potential areas where land is both biophysically suitable for palm oil cultivation and where it's strongly environmentally sustainable for potential future production		
	⟷			⇨ ⇨ ⇨	
Economic Sustainability & Sustainable Development					The full economic sustainability sector can't be entirely assessed. The only variable is the availability of businesses to use suitable land within 2 and 5 hours transportation of a city (50,000+ people)
					Not Assessed

Pirker, Johannes, et al. "What Are The Limits to Oil Palm Expansion?" *Global Environmental Change*, Pergamon, 21 July 2016, Available from: https://www.sciencedirect.com/science/article/pii/S0959378016300814

Meta-Analysis 2: "Study on The Environmental Impact of Palm Oil Consumption and on Existing Sustainability Standards"

Written by Mark Barthel, Steve Jennings, Will Schreiber, Richard Sheane and Sam Royston (3Keel LLP) and James Fry, Yu Leng Khor, Julian McGill (LMC International Ltd). (February, 2018)
For European Commission, DG Environment

This study provides a very broad scale analysis of the environmental, social impacts, and market aspects of palm oil. The study is very detailed while encompassing all three pillars of sustainability. In fact, it breaks down the impacts into various sections in order to understand the

levels of environmental, social, and economic sustainability separately. Overall, the study reaches nearly four hundred pages in length. For that reason, this meta-analysis is broken down into three different sections assessing each individual pillar of sustainability rather than one long assessment of everything all together.

A. **Social Sustainability:**

The main social impacts from palm oil production are conflicts over land use including the rights of ownership, as well as forced and child labor. In particular for workers, palm oil plantations show signs of weak social sustainability that include issues with health and safety, and for smallholders their livelihoods, income, and wellbeing are at high risk. Most often, these signs of little to no social sustainability (shown in Sustainability Index 2) begin with the expansion of the palm oil industry and plantations directly causing disputes over land use rights.

Large-scale plantations driven by profit often don't care for local and indigenous peoples losing their customary land that's part of their traditional livelihoods and social culture. It's estimated the palm oil industry was attributed to around half of Indonesia's 8,000 land conflicts in 2012 (The National Land Bureau of Indonesia). This study attributes that to the government following a pattern where it "sees its role as 'opening up' land for development and grants concession licenses to companies for palm oil development" (Barthel et Al., 77). Concessions are licenses providing the right to use a specific area of land for a specified purpose provided by the government. However, these concessions are abused when national legal rights improperly give these to companies to build palm oil plantations where customary legal rights already own the land; determining who, when, and what the land can be used for has caused issues as the 'use rights' haven't been formally identified to the government and many licenses are located on land owned by local and/or indigenous groups. With dozens of land use conflicts occurring each day

in Indonesia alone, this is evidence of no effort for social sustainability existing as zero signs of preventing these cases and making the necessary changes has happened. Following a negotiation meant to reach an agreement, the indigenous peoples and local communities are typically entitled to compensation for their land being converted to a plantation company's by Indonesian law. However, this compensation is very often inadequate and has caused land rights to be Indonesia's most common cause of conflict in West Kalimantan - accounting for 53 of 119 (45%) recorded conflicts between plantation companies and local/indigenous communities from 1999 to 2009. However, land rights issues are widespread across the whole country and not just prevalent in West Kalimantan. Without proper enforcement to ensure compensation is given to local and/or indigenous communities there cannot be moderate or strong social sustainability in the palm oil industry.

Indonesia has a complicated regulatory environment, and while Malaysia's regulations might seem complicated, they are a bit less weak in terms of social sustainability. Protected land rights require forests to be published and state government sanctioned clearing must take place. Malaysia's Federal Government has strong control over its 11 state governments besides the state of Borneo remaining more independent. Particularly, with policy on forestry, land allocation, and agriculture there are regional differences in regulations and their enforcement. The study summarizes Malaysian land use rights in Sarawak within Borneo:

> The most controversial aspect of land use concerns the application of Native Customary Land Rights (known as NCR) in Sarawak. Local tribes have long been considered to have rights over both their farmland and primary forest on communal land, with a sizeable proportion on deep peat soils. A Federal court ruled in 2016 that their rights did not apply to primary forest, putting the State government under pressure to change the Land Code to permit the development of such primary forest. Forty of the more than one hundred land rights cases in the courts of Sarawak reportedly concerned the palm oil sector
> (Barthel et. Al., 78).

The Roundtable for Sustainable Palm Oil (RSPO) requires compliance with the law including respect for customary law and an absence of land conflicts, a demonstrable right to use the land, and no reduction in the value of customary rights without free, prior and informed consent (FPIC). However, the study claims that there have also been allegations that some RSPO plantations have broken this rule and communities have lost customary land without FPIC. Although this may not be widespread across the palm oil industry, this is very weak in terms of social sustainability. The RSPO defines smallholders as family-based enterprises of no more than 50 hectares of oil palm cultivation. With stricter enforcement and punishments against those that break the rules, the RSPO could move the potential future social sustainability closer to strong sustainability.

Smallholders account for 40% of land used for oil palm cultivation in Indonesia and Malaysia and a third of the countries' output. Whereas, up to 90% of oil palm cultivated in West Africa for regional and domestic markets comes from smallholders. Because there is so much variation in the organization of smallholder oil palm cultivation, this study breaks it down in the table below to make it easier to understand:

Mode of production	Variants	Where found
Estates	Private and/or state-owned National and/or foreign company State land (with or without customary land claims)	Malaysia Indonesia
Managed smallholder schemes	Resettlement schemes for landless/land poor or in situ schemes for existing landholders Landholders manage own lots or agency manages whole scheme on an estate basis Large-scale or small scale schemes (mini-estates)	Malaysia
Nucleus estate and smallholder schemes	Private or state-owned plantation company as nucleus (providing mill and other infrastructure) "Plasma" smallholders comprising settlers and/or local (customary) landholders (70% of land) Smallholder cooperatives dealing directly with plantation company (70% of land)	Indonesia
Joint-venture schemes	Customary land is consolidated in a trust held by a government agency which forms a joint-venture company with a private investor (Sarawak model) Customary landlords issued with command title, conditional on development by a private or state-owned plantation company (Sabah model) Partnership schemes whereby company develops and manages 20% of land for farmers and pays "rent" on basis of land contributed (Indonesia model)	Malaysia Indonesia
Assisted smallholders	Smallholders given planting grants (subsidized inputs) and technical advice Smallholder groups linked to input supplies, credit, technical advice, fruit bulking facility, and processor	Malaysia
Independent smallholders	Self-managed and self-funded (may receive some inputs on short-term credit but many unable to afford inputs) Smallholders who have graduated from NES schemes and have become independent	Malaysia Indonesia,

Table 16 – modes of oil palm production. Available from: https://ec.europa.eu/environment/forests/pdf/palm_oil_study_kh0218208enn_new.pdf

The most successful scheme for managed smallholders in Malaysia known as FELDA(Federal Land Development Authority) settled 122,000 families on around 470,000 hectares of land between 1959 and 1990. The debt these farmers incur from financing the agricultural inputs must be repaid before they gain the title for the land which usually takes around 15 years. The study claims "an equally important, long lasting, model" is Indonesia's Nucleus Estate and Smallholder (NES) scheme in which an estate provides services to smallholders - often migrants (Barthel et al., 81). These services include converting the land for cultivation, sometimes supporting smallholders with technical advice and inputs on growing, and then providing a market for smallholder plantations to sell their oil palm (Barthel et al., 81). At first, this seems like a strong model for social sustainability. Overtime the initial plantation costs and ongoing input materials are repaid the same way except in some scenarios where estates will

only offer 70% of the land to smallholders and keep the remaining 30%. In these cases, the outcome of NES varies based on the quality of land given to smallholders and the amount of service/support provided to the smallholder. Because of this, the model diminishes to moderate to weak social sustainability. After early NES schemes resulted in smallholders having insufficient land and overworking themselves without any time with their families, practices such as intercropping and flexible labor schemes began.

Some smallholders are also known as assisted smallholders and receive aid from a government agency such as the Malaysian Palm Oil Board (MPOB). The MPOB "provides technical advice to members of farmer's organizations and arranges a mechanism with fertilizer companies and mills for farmers to receive credit" (Barthel et al., 82). Income and yield were improved significantly whereas the Indonesian government provides little aid to smallholders. Alternatively, independent smallholders are those that have "invested capital and labor into cultivating oil palm" (Barthel et al., 82). However, they often obtain yields far less than estates and other small holders. For the countries besides Indonesia and Malaysia that are cultivating palm oil, independent smallholders are the majority. Fortunately, they comparatively make more income than some other smallholders over time. However, if estate and government assisted smallholder schemes provided greater assistance and education on oil palm agriculture and yields without any interest in profiting off these smallholders, the sustainability index would be closer to strong rather than between moderate and strong for future social sustainability in the palm oil industry.

The United Nations and major producing countries have limited official data on incidents of forced or child labor. However, an investigation by Amnesty International in December 2016 revealed the world's largest processor of palm oil, Wilmar, "finding serious human rights abuses

in the plantations of Wilmar and its suppliers. These included forced labor and child labor, gender discrimination, exploitative and dangerous working practices that put the health of workers at risk." (Barthel et. al., 85). This investigation also found that the five plantations were paying workers below the minimum wage where three of these had RSPO certifications. The study also claims that most of these reports relate to individuals or a small number of companies or geographical areas rather than being sector wide. While it is hard to represent a small number of studies on the entire industry's social sustainability of these oil palm plantations and businesses, there are also likely many cases that go unreported. For these reasons, Sustainability Index 2 has a ranking of none to weak for current social sustainability.

B. Environmental Sustainability & Sustainable Development:

Environmental impacts from palm oil production include deforestation, biodiversity loss, peat land conversion, greenhouse gas emissions from land use changes, the use of fire and impacts from slash-and-burn, and lastly water and air pollution which includes haze (Barthel et al., 48). The main environmental impact discussed in the report focuses on deforestation of tropical forests to make room for palm oil cultivation. Palm oil plantation area "has increased from 2.6 million hectares in 1990 to over 15 million hectares in 2014" (Barthel et al., 241). Surprisingly, the study suggests higher crude palm oil prices lead to more palm oil plantations. This is likely due to an increased interest among independent smallholders to join the palm oil industry after being drawn to higher incentives with greater potential profits. A reliable study suggests 45% of Southeast Asian palm oil plantations came at the direct expense of forests. For Indonesia and Malaysia, "the estimates were 54% and 40% respectively" (Barthel et al., 51). This is extremely unsustainable for the environment, leading to a ranking of none to weak for environmental sustainability in Sustainability Index 2 below. Other regions of the world appear

to have much lower rates of planting on forested areas, from South America having 31% down to Central America having 2%. Two-thirds of forested land is estimated to be for global trade when converted to plantations. Simply from this one source of production, the EU, estimated responsibility is 0.9 million hectares of deforestation through palm oil imports from 1980 to 2000. Overall, there's a high degree of confidence that the expansion of the palm oil industry has led to significant deforestation in Indonesia and Malaysia (Barthel et. Al., 241). The study goes on to cite the previous case study on the limits to palm oil expansion and claims that plantation area could double without deforestation but the reality of this actually happening seems very unlikely. In Brazil, however, initiatives to restrict plantations from cultivation on previously deforested areas has seen some initial successes in reducing the environmental impacts. Because these two sources on potential expansion of the palm oil industry becoming more environmentally sustainable are the only information available, this is the only part of Sustainability Index 2 that remains not assessed.

One of the biggest concerns from the industry's massive deforestation is the resulting biodiversity loss that has greatly diminished the extent and quality of biodiverse habitats. Palm oil is predominately cultivated in the lowland tropics where most of Earth's species rich forests exist. Tropical forests in Southeast Asia are amongst the most biodiverse of them all and include endangered species such as the orangutan, Asian elephant, Sumatran tiger, birds of paradise and three species of rhinoceros (Barthel et. Al., 242). Covering only 1.3% of Earth's total land surface, Indonesia holds 10% of all flowering plant species, 17% of all bird species, 12% of all mammals, and 16% of both overall reptile species and amphibians (Barthel et al., 242). Converting forested lands to agriculture, plantations, and other such uses results in a significant loss of species which further contributes to the weak grading in Sustainability Index 2 below.

Indonesia, Malaysia, and Papua Guinea together cover 27.1 million hectares of the world's tropical peatlands. The study claims only 36% of the original peat land forested area remains, and only 9% is currently in designated protected areas. Not only do these forested areas contain many threatened species, but the peatlands contain mass amounts of carbon higher than any other soils. The study states that "once drained, decomposing organic matter by oxidation results in carbon dioxide emissions, and drained peat is highly flammable: once alight, peat fires can burn for months or even years" (Barthel et. Al., 243). Including every palm oil plantation area in Indonesia and Malaysia, 3.1 million hectares of the overall 14.75 million hectares of once existed peat lands has been destroyed for industrial palm oil plantations by 2015. Peat thickness can range from less than a meter to more than 12 meters (Barthel et al., 243). Overall, there can't be weak to strong environmental sustainability unless deforestation and peatland conversion is put to an end. Peatland conversion especially emits mass amounts of greenhouse gas emissions that are not environmentally sustainable whatsoever.

Peatlands play a very important role in balancing the earths most important ecosystems as they store so much of the world's important carbon stocks. So much so that "tropical forests store around 46% of the world's living terrestrial carbon, and 25% of total net global carbon emissions may stem from deforestation" (Barthel et. Al., 243). Greenhouse gas emissions from palm oil cultivation stem from land use changes and plantation activities. Land use changes result in extreme greenhouse gas emissions; a single hectare of South East Asian tropical forest might contain 400 tons of carbon AGB, but a mature palm oil plantation may only contain 91 tons of carbon. There's at least 163 tons of carbon dioxide (CO_2) released into the atmosphere per hectare of palm oil plantations after conversion. Clearing land via forest fire is estimated to release an additional 207 to 650 tons of carbon emissions per hectare (Barthel et al., 244). After a

habitat of peat swamp forest is drained of peat soil and goes through oxidation, 1300 tons of CO2 emissions occur through the life cycle of oil palm plantations before replanting. Alternatively, establishing palm oil plantations on degraded grasslands can replace the 39 tons of released carbon per hectare with the AGB carbon stock from the crop in roughly 10 years. Plantation activities result in greenhouse gas emissions from methane emissions, nitrous oxide from "nitrogen fertilizers, and carbon dioxide from using fossil fuels" (Barthel et al., 244). Forest conversion, however, causes far greater emissions. The use of fire to convert forested land for agriculture is a "major source of greenhouse gas emissions, air pollution, biodiversity loss, and reducing carbon storage" (Barthel et. Al., 245). These forest fires are particularly severe during droughts in an El Nino event such as in 2015 where between 1.62 and 1.75 billion tons of CO2 emissions effectively tripled Indonesia's greenhouse gas emissions. Although the study only lists haze pollution from conversion using fires as an "occasional but severe problem in Southeast Asia over the past 20 years", severe haze lasting three months in 2015 resulted in an estimated 100,300 deaths across Indonesia, Malaysia, and Singapore (Barthel et. Al., 245). Not only is this extremely unsustainable socially and environmentally, but also contributes to a weak economic sustainability grading from to palm oil production. This leads to the next section as haze pollution can also cause disruptions to transportation and tourism affecting economic sustainability.

C. Economic Sustainability & Sustainable Development:

The economic sustainability and issues from palm oil production section of the study begins by claiming the broader welfare issues of income and wealth distribution can be concluded with these three key points:

> First, overall oil palm is more profitable than other crops, and this has been good for income levels, but the nature of the crop (high capital cost and the need to

process immediately) means that it favors wealthier farmers and large processors. Second, there are issues revealed by case studies that are separate from the economics of the crop (poor labor laws and corruption). Third, smallholder systems have helped to alleviate poverty, e.g., through the FELDA scheme in Malaysia and corporate-led development of smallholder schemes in Indonesia. Table 22 below summarizes the most important positive and negative effects on income growth and inequality from oil palm cultivation (Barthel et. al., 88).

Table 22: Positive and negative implications of oil palm on income and wealth distribution

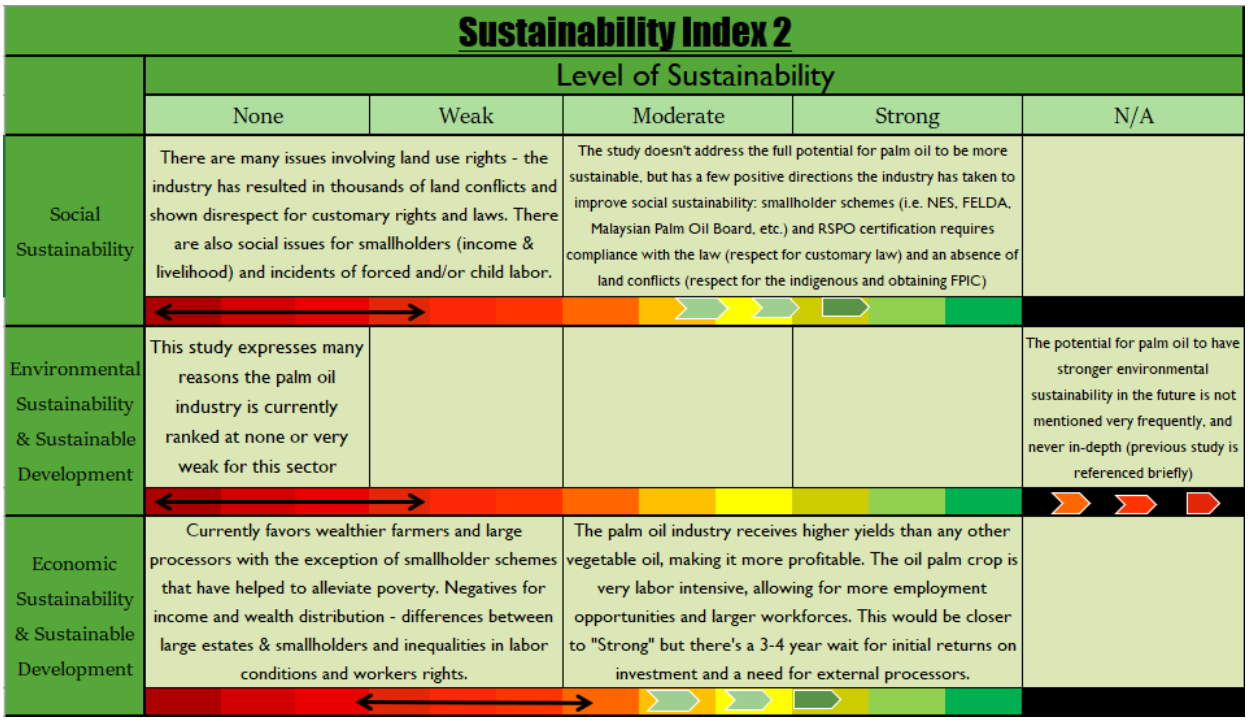
Positive	Negative
Oil palm is labour intensive, providing large amounts of employment.	Oil palm growers are highly dependent on external processors due to the need to process the fruit from the palms within 24 hours.
Oil palm has consistently been more profitable than competing crops.	Oil palm has high capital costs for entry (the costs of waiting 3-4 years for the first income). This is a barrier to poorer farmers.
Oil palm is a cash crop providing revenue for schooling and medical care.	Monoculture oil palm farming can create over-dependence on one crop with volatile prices.
Oil palm plantations require large workforces, giving work to those without their own farms.	Labours conditions and workers' rights have been violated on some plantations.

Table 22. Available from: https://ec.europa.eu/environment/forests/pdf/palm_oil_study_kh0218208enn_new.pdf

The market aspects of palm oil include analysis of incomes and wealth distribution, and how markets have developed differently in Indonesia, Malaysia, and other countries. According to the study, smallholder income estimates place palm oil farmers receiving more income than similar rice and rubber holdings. While this may seem economically sustainable, smallholder's yields often depend on the assistance they receive such as higher-yielding planting materials, credit, fertilizer, and technical advice. Poorer households that are unable to manage debt or access technical support might find it more difficult to make revenue. This creates an inequality between smallholders and large estates as there's less opportunity for those that need the assistance. Furthermore, while the oil palm crop is more profitable than competing vegetable oils, it will be less economically sustainable than other vegetable oils until the 3-4 years that it starts to become productive. This further reinforces the need for smallholders to receive assistance as they cannot make any profit for a few years making them vulnerable to debt and dependency on larger plantations. Additionally, Indonesian palm oil workers in Malaysia will

only receive two-thirds of the pay of a Malaysian, and merely a third if they're unregistered migrants (Barthel et. Al., 249). When an Indonesian is unregistered in Malaysia, plantations will be more likely to pay them below the minimum wage. Because large estates employ far more workers, there's a much larger gap in salaries and higher likelihood to undercut some employee salaries. The Amnesty International report on five palm oil plantations found workers being "paid below the legal minimum wage, potential breaches of regulations on overtime pay, insufficient training on use of hazardous chemicals and inconsistent use of safety equipment and the potential exclusion of women from permanent employment" (Barthel et. Al., 249). Overall, there's some positives in terms of the economic sustainability such as the larger yields and increased profit margin compared to other vegetable oils and crops, and a need for large workforces (employment) because it's labor intensive. These are good signs for the potential of the oil palm to be moderately economically sustainable, considering the need to wait 3-4 years for the first income and dependency on processors (See Table 22 above from the study). However, the palm oil industry currently appears economically unsustainable as there are many negatives for income and wealth distribution considering differences between large estates and smallholders and the inequalities in labor conditions and worker's rights. This also negatively impacts the social sustainability of palm oil. However, smallholder systems put in place by governments have also led to alleviating poverty and improving smallholders' conditions and equality with the provided support. The palm oil industry is moderate in terms of economic sustainability because of relatively high profits compared to other crops, but Sustainability Index 2 extends slightly lower into the weak ranking because of these inequalities and a high initial capital cost when starting a plantation for oil palms.

"Study on the environmental impact of palm oil consumption and on existing sustainability standards" Written by Mark Barthel, Steve Jennings, Will Schreiber, Richard Sheane and Sam Royston (3Keel LLP) and James Fry, Yu Leng Khor, Julian McGill (LMC International Ltd). (February – 2018). Available from: https://ec.europa.eu/environment/forests/pdf/palm_oil_study_kh0218208enn_new.pdf



Sustainability Index 2					
	Level of Sustainability				
	None	Weak	Moderate	Strong	N/A
Social Sustainability	There are many issues involving land use rights - the industry has resulted in thousands of land conflicts and shown disrespect for customary rights and laws. There are also social issues for smallholders (income & livelihood) and incidents of forced and/or child labor.		The study doesn't address the full potential for palm oil to be more sustainable, but has a few positive directions the industry has taken to improve social sustainability: smallholder schemes (i.e. NES, FELDA, Malaysian Palm Oil Board, etc.) and RSPO certification requires compliance with the law (respect for customary law) and an absence of land conflicts (respect for the indigenous and obtaining FPIC)		
Environmental Sustainability & Sustainable Development	This study expresses many reasons the palm oil industry is currently ranked at none or very weak for this sector				The potential for palm oil to have stronger environmental sustainability in the future is not mentioned very frequently, and never in-depth (previous study is referenced briefly)
Economic Sustainability & Sustainable Development	Currently favors wealthier farmers and large processors with the exception of smallholder schemes that have helped to alleviate poverty. Negatives for income and wealth distribution - differences between large estates & smallholders and inequalities in labor conditions and workers rights.		The palm oil industry receives higher yields than any other vegetable oil, making it more profitable. The oil palm crop is very labor intensive, allowing for more employment opportunities and larger workforces. This would be closer to "Strong" but there's a 3-4 year wait for initial returns on investment and a need for external processors.		

Meta-Analysis 3: "Exploitative Labor Practices in the Global Palm Oil Industry"

Prepared by Accenture for Humanity United

The study "Exploitative Labor Practices in the Global Palm Oil Industry", by Humanity United, aims to accurately depict the palm oil supply chain from beginning to end while analyzing the global palm oil industry for exploitative labor practices. However, the study doesn't hesitant to admit that palm oil is essential to meeting the global demand for vegetable

oils. In fact, the study claims the oil palm is the most prolific producer of oils as it produces fruits year-round with three to four annual harvests per tree unlike other alternatives. Additionally, the oil palm fruit can produce two types of oil making it even further profitable. Although all of this is true, the study fails to acknowledge that the oil palm requires a 3-4 year wait from planting until the first harvest. This study looks at how businesses have continued investing in palm oil plantations as the industry continues to grow:

> "The consumption of palm oil has increased at a compound annual growth rate of 7.8 percent between 1970 and 2010. In 2012, 53.89 million MT of palm oil was consumed globally. In relative terms, palm oil accounted for only 9.6 percent of total global vegetable oil consumed in 1970. By 2010, palm oil accounted for 33.7 percent of the total global vegetable oil consumed — more than any other vegetable oil (see Figure 5)" (Humanity United, 10).

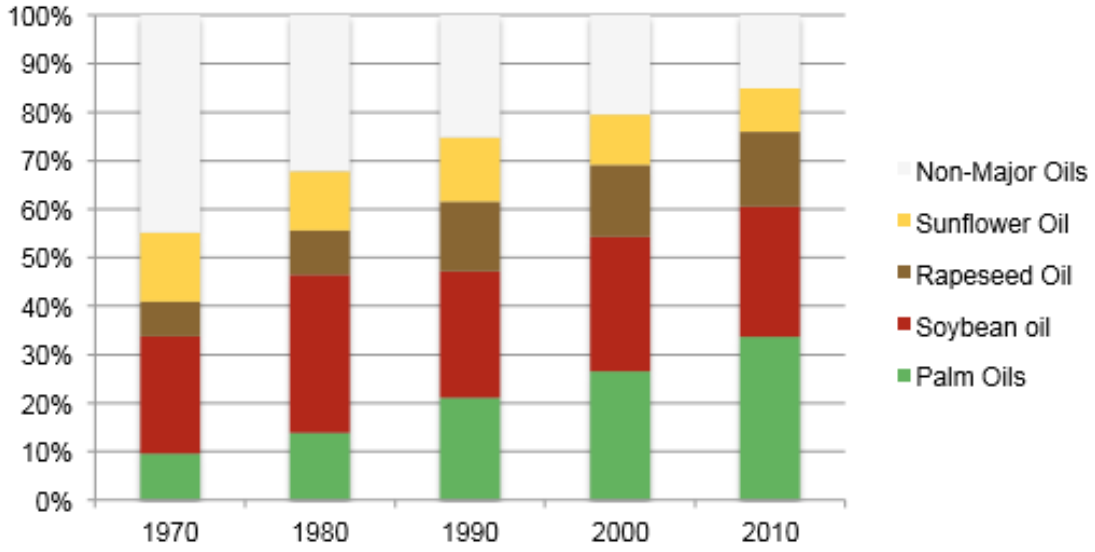


Figure 5 – Relative Consumption of Major Vegetable Oils (Percent of Total Vegetable Oils), 1970-2010 (FAOSTAT)[15]

Available from: http://humanityunited.org/pdfs/Modern_Slavery_in_the_Palm_Oil_Industry.pdf

Not only did palm oil account for a higher percentage of vegetable oil consumption than any of the others, but by 2010 it had risen nearly 25 percent in consumption compared to other vegetable oils that remained relatively the same or even decreased. The study claims that few countries produce more oil than they consume because of the tremendous land resources required

to produce vegetable oils. Furthermore, it goes on to explain that because oil palm trees have such high productivity it is so widely distributed across the world. “From 2011 to 2012, palm oil accounted for 67.5 percent of the vegetable oil traded in the open international market. During the same period, 75 percent of palm oil produced was traded internationally” (Humanity United, 11). According to the USDA, palm oil covered 67.5% of all global exports of vegetable oils from 2011-2012, and by 2010 the oil palm doubled in metric tons of FFB per hectare since 1961 as displayed in figure 11 below from the study. Additionally, figure 12 shows how the world total metric tons of palm oil produced per metric ton has also doubled since 1961 from roughly 11% to 22% yield palm oil per metric ton of oil palm fruit. If the world totals for figures 11 and 12 continue to increase at this rate, palm oil will become more and more productive proving to outsource other vegetable oils.

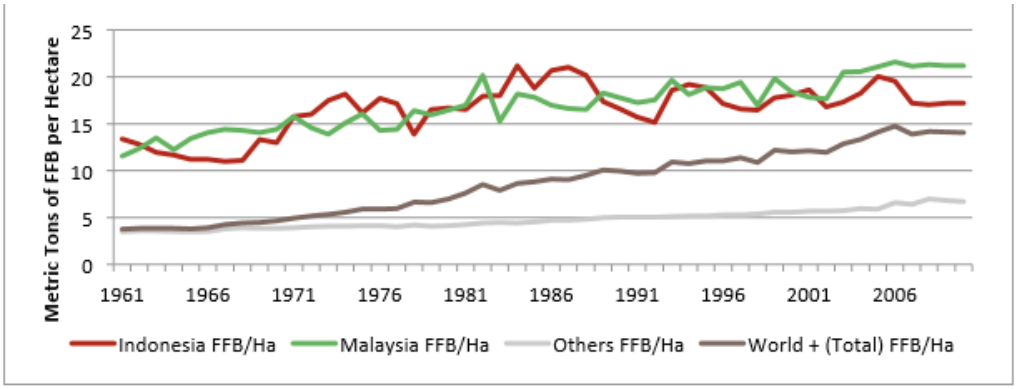


Figure 11: Plantation Yield (MT of FFB per ha), 1961-2010 (FAO, 2010a)

Available from: http://humanityunited.org/pdfs/Modern_Slavery_in_the_Palm_Oil_Industry.pdf

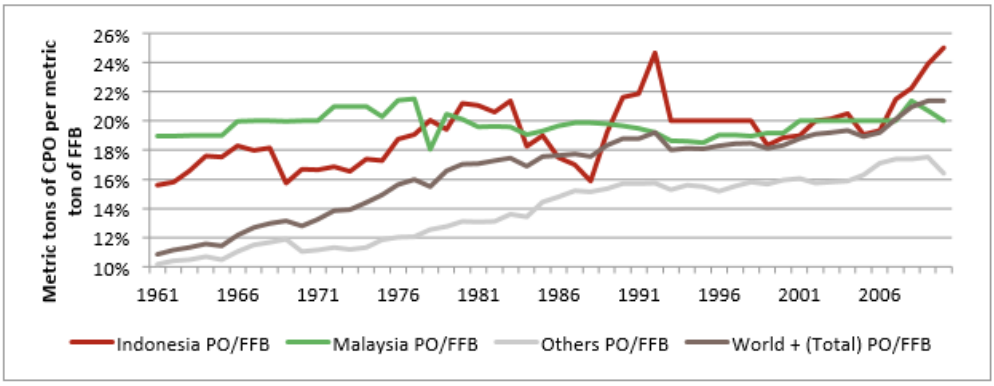


Figure 12: Oil Extraction Rate (MT of CPO per MT of FFB), 1961-2010 (FAOSTAT)[24]

Available from: http://humanityunited.org/pdfs/Modern_Slavery_in_the_Palm_Oil_Industry.pdf

Growing the oil palm is a very labor-intensive process that's resulted in the creation of many jobs within the palm oil industry. Although there are many variations in different businesses agricultural practices, oil palm plantations follow the same general process of planting cultivating and harvesting. And even with advances in agricultural practices and technology, there's still a necessity for unskilled labor including clearing and preparing the land for plantations (removing trees, shrubs, tilling, and irrigation), plant seedling crops, fertilize current crops and manage pests and diseases with pesticides when needed, harvesting mature oil palms FFB with a sickle and collecting any fallen fruitlets, and delivering oil palm fruits to palm oil mills for processing. Because of a necessity for lots of labor, there are many employment opportunities making the industry moderately economically sustainable. However, while there is lots of labor to be done, it can often be difficult for plantations to maintain their communities. Typically, these plantations are in remote, rural areas that "often lack the basic infrastructure that is required to support worker communities, such as housing, markets, schools, hospitals, commercial businesses, utilities, and security. It therefore often falls to plantations to create worker communities, providing the entire infrastructure" (Humanity United, 19). This study states that Indonesia and Malaysia 'outperform other countries' as few others have plantation models with so many FFB per hectare. Here are the numbers:

> The primary output of growing is the FFB that are later processed into palm oil. In 2010 the global output of FFB was 210 million MT, with each hectare of oil palms yielding on average 14.06 MT. In 2010 Indonesia produced 40.8 percent of the global output of FFB, 86 million MT. Indonesian plantations dramatically outperformed the global average yield, producing 17.2 MT of FFB per hectare of planted land. In 2010 Malaysia produced 40.2 percent of the global output of FFB, 84.8 million MT. Malaysian plantations are the most productive plantations globally, yielding on average 21.2 MT per hectare of planted land.
>
> (Humanity United, 20).

The author refers to the second process of the oil palm industry as milling and this was explained in the second chapter where it explains how the oil palm fruit is made into crude palm oil and crude palm kernel oil using automated processes. After growers begin harvesting the oil palm, the palm oil molecules in the fruit immediately begin to break down and cause an overall decrease in the quality of the crude palm oil that's extracted. Thus, the study states it is crucial that FFB are taken for milling within 48 hours of harvesting. Some other sources claim the oil palm FFB must be taken for processing at a palm oil mill within 24 hours. This means oil palm plantations must work closely with milling organizations and facilities. Mills are therefore most frequently located on or extremely close to oil palm plantations and are typically owned by individual growers or grower collectives (Humanity United, 23). Because pam oil mills in Malaysia operate twenty-four seven, they are highly efficient. Malaysia produced 99.4 million MT capacity of FFB across 426 mills in 2011. There's an estimate of over 500 mills in the Indonesia but specific information is not available. Many larger companies buy additional FFB from smallholders or other plantations growing oil palm because capital utilization rates are an important driver of profit that they can't receive from their own FFB alone. The study claims this is only because they need to improve their capital utilization rates and thereby drive the plantation to maximize profits. However, this is socially unsustainable as it takes advantage of smallholders creating inequalities in the industry. In the last few concluding paragraphs, we will

discuss some of the exploitative labor practices happening regularly, and how large estate holders can sometimes take advantage of smallholders.

The study is also known as “Modern Slavery in the Palm Oil Industry” because:

> The palm oil industry is now one of the most significant employers in Malaysia and Indonesia, employing as many as 3.5 million workers123. Many of these workers are victims of serious labor exploitation: Workers are trafficked into bonded labor; forced to work and live under extreme conditions, with limited legal recourse; suffer from abuse or the threat of abuse; or are victims of child labor. These exploitations constitute modern forms of slavery.
>
> (Humanity United, 33).

Exploitative labor practices in the palm oil industry have been reported internationally by “humanitarian organizations such as Amnesty International and Human Rights Watch, and also in government reports on slavery, such as the U.S. State Department’s *Trafficking in Persons Report* and the U.S. Department of Labor’s *Report on the Worst Forms of Child Labor*” (Humanity United, 33). The National Commission on Child Protection in Indonesia claimed Malaysian palm oil practices commonly use forced and child labor. Although this could be propaganda by Indonesia to outsource and compete with Malaysia, isolated palm oil plantations make for a higher likelihood for exploitation. The full spectrum of forced labor is hard to determine solely for palm oil production because figures represent all crops in Malaysia, but the country has a high prevalence of trafficking. Isolated plantations likely increase these negative and unsustainable practices. Additionally, other barriers exist such as the island of Borneo being divided into three separate countries (irregular migration patterns result in more cases of human trafficking). This evidence from the study contributes to the grade of none in the social sustainability sector in Sustainability Index 3.

According to the study, Malaysia is a popular destination for migrants because of the opportunities in many industries for unskilled, manual labor. Malaysia depends on migrants for

its workforce because the country has a low population growth rate. The workforce is estimated around 10.9 million (2007) with the population of Malaysia around 28.4 million (2008). Additionally, the study states:

> Malaysians are relatively wealthy compared to other populations in the region, with per capita income of USD 8,372, making it an upper-middle-income country.128 There is therefore little supply of Malaysian labor for low-wage jobs perceived as dirty, dangerous, or demeaning. This creates a significant need for migrant labor in sectors including agriculture, construction, manufacturing, and some service occupations (Humanity United, 33).

The study then states figures on Malaysia such as documented migrant workers ranging from 1.8 to 2.1 million and that this dropped by 5.6 percent in 2010 because authorities were trying to reduce the dependence on migrant workers for "internal political reasons", but also that registered foreign workers were 15.5 percent of total employment Malaysia remains one of the world's largest destinations for international labor markets to perform jobs Malaysians won't take on themselves. Additionally, the study claims the competitive market with Indonesia and China results in low-skilled migrant workers being confined to manufacturing, plantation, and construction sectors. Undocumented immigrants range from 500,000 to 2 million due to varying statistics. According to the study:

> Malaysia has been subjected to increasing public criticism by labor-supplying countries in the region, such as Bangladesh, for being unresponsive to criticisms in its immigration process and for failing to manage trafficking in people. These claims are substantiated. In 2012 the U.S. Department of Labor classified Malaysia as a Tier 2 Watch List country, due to it being a destination for men, women, and children subjected to conditions of forced labor (Humanity United, 34).

In many cases, palm oil plantation workers migrate to provide for families or communities back home and work and live in closed plantation complexes separated from larger communities. The priority for palm oil plantation owners is to maximize productivity often at the expense of reasonable working and living conditions because they're vulnerable within

segregated plantations. When their rights are abused and the only option is to try and leave the plantations, they are often faced with extortion by police who will return them to the plantation where they're employed. If migrants are found violating immigration laws, they may face "substantial fines, imprisonment, and corporal punishment (about 30,000 undocumented immigrants were caned between 2005 and 2010)" (Humanity United, 36). Upon earning the job, work permits, visas, and passports are submitted to plantation owners in order to prevent workers from leaving by choice. If migrants can successfully escape, they often can only find illegal employment at smallholder plantations with very few visits from government and industry regulatory groups leading to further exploitation and extortion.

While smallholder schemes have been praised for providing a more inclusive palm oil plantation industry, and even the assisting governments and commercial plantations take credit, the study claims there's often exploitation of smallholders taking place behind the scenes. Here's how the study summarizes these claims:

> Smallholder owners typically borrow between USD 3,000 and 6,000 (at 30 percent interest per year) from a commercial grower for seedlings, fertilizers, and other supplies.146 As oil palm plants take 3 to 4 years to bear fruit, in the interim smallholders work as day laborers with wages of USD 2.50 per day on the mature commercial plantations.147 Once their plantation becomes productive, the average income for a two-hectare allotment is USD 680 to 900 per month.148 The low level of income combined with the large start-up costs and relatively high interest payments means that smallholders frequently become indebted to the oil palm company, often for a long time. Rather than demand payment in cash, some of the companies that provide the loans require farmers to sell their palm fruit back to them at prices set not by the market but by the companies themselves.149 Farmers are tied to the core plantation under terms set by the companies until their debts are completely paid off. These claims were substantiated by field interviews, as well as by the testimony of farmers at numerous meetings of the RSPO (Humanity United, 37).

Considering farmers are describing themselves as "ghosts on their own land" due to the constant cycle of debt, there doesn't seem to be as much social sustainability behind the

smallholder schemes as what other studies have pictured. In fact, this study paints a picture of no social sustainability in the palm oil industry creating the grade in Sustainability Index 3. This is representative of smallholder schemes in both Indonesia and Malaysia. It's also widespread among parent companies and large estates. "In the U.S., 87 percent of palm oil is imported by nine companies" (Humanity United, 51). Additionally, the study claims that because of the isolation of plantations in these countries, child labor is very prevalent as the plantations will teach children how to work rather than attend schooling. Particularly in Indonesia, low per capita income makes it highly likely for children to work for the family. The minimum age for work is 15, with hazardous work being permitted at 18 and "light work" permitted at age 13 to 15. A study on 75 child laborers between 9 and 17 found that most had cuts scratches and abrasions, 90 percent had no prior training, 68 percent experienced heat exhaustion at a 'heavy heat-stress level', and children spend 30 to 60 minutes traveling from home to the plantation for over four hours of work and no breaks (Humanity United, 37-38). The study blames this on lack of proper enforcement of child labor laws, but also states that an estimated 30 percent of workers don't have birth registration and ages are difficult to verify. For plantations in Malaysia to meet the daily quota for palm fruit harvested, the study claims to identify "'assistance from the child laborer is the savior'" (Humanity United, 38) where 60% of child laborers are 6-10 years old. Somewhere between 72,000 and 200,000 child laborers work on palm oil plantations in Malaysia.

The palm oil industry consists of many exploitative labor practices in Indonesia and Malaysia. Migrant workers are trapped in cycles of collecting more and more debt due to 'bonded labor' through exploitative labor brokers' schemes that allows labor broker companies to make big profits. In some cases, immigrants are subject to exploitative bonded labor as

smallholders are most vulnerable to the large estate landholders that will make unfair loan agreements, so smallholder farmers are consistently in debt. Finally, child labor, including the worst forms, has been documented in both Indonesia and Malaysia. Although this data may not be true across the entire palm oil industry, the statistics are significant enough to grade social sustainability at the lowest possible ranking in Sustainability Index 3.

Sustainability Index 3

	Level of Sustainability				
	None	Weak	Moderate	Strong	N/A
Social Sustainability	Overall, Humanity United provides numerous sources with claims of many exploitative labor practices and very poor enforcement of regulations to prevent these cases				
Environmental Sustainability & Sustainable Development					While environmental sustainability is addressed sporadically throughout the study, it is not the primary focus and therefore cannot receive a grade
					Not Assessed
Economic Sustainability & Sustainable Development		Before digging into the social sustainability, the study assesses economic sustainability in terms of the global palm oil market and supply chain			

Prepared by Accenture for Humanity United. "Exploitative Labor Practices in the Global Palm Oil Industry." Available from: http://humanityunited.org/pdfs/Modern_Slavery_in_the_Palm_Oil_Industry.pdf

Meta-Analysis 4: "Conflict Palm Oil Case Study: Bumitama Agri LTD - The Banks Behind Bumitama Agri's Destruction of Rainforests, Peatlands, and Orangutan Habitats"

Rainforest Action Network, 2013

This case study introduces palm oil claiming that it's become one of the world's leading causes of rainforest and peatland destruction as well as carbon pollution. In addition to environmental sustainability, the study delves into social sustainability by claiming palm oil is responsible for human rights violations, child labor, and modern forms of slavery. The palm oil industry must face major changes in production in order to protect rainforests and respect the rights of the Indigenous. While the study admits this will not be easy, it can be possible if stakeholders eliminate "Conflict Palm Oil" and shift towards "responsible palm oil". The study then defines these terms:

> Responsible palm oil is palm oil that is produced without contributing to deforestation, expansion on carbon-rich peatlands, and/ or the violation of human and labor rights. Responsible palm oil is produced legally and can be verifiably traced back from the consumer product to the plantation where it was grown.
>
> Conflict Palm Oil is produced under conditions associated with the ongoing destruction of rainforests, expansion on carbon-rich peatlands, and/or human rights violations, including the failure to recognize and respect the customary land rights of forest-dependent communities and the use of forced labor and child labor.
>
> (Rainforest Action Network, 2013).

Bumitama Agri LTD is a company that grows palm oil plantations on over 133,000 hectares of land to produce crude palm oil in Indonesia. The company expects a growth rate of 15,000 hectares or more per year and its goal at the time of this study was to grow to a total plantation area of 200,000 hectares in 2017. This study profiles three of its oil palm plantation subsidiaries. However, the company includes over a dozen subsidiary companies, and one of its largest palm oil plantations still has not received sustainable certification after joining the RSPO

in 2007. Poor governmental regulation of forests has resulted in the destruction of one of the world's most culturally and biologically diverse ecosystems - Borneo includes many iconic wildlife species including the most renowned Borneo orangutans. Field investigators are documenting a growing number of cases of ongoing forest clearance by Bumitama Agri LTD. Furthermore, this is contrary to the commitment in the company's Annual Report to stop "putting at risk areas of HCV interest or habitats important for endangered plant or animal species," and to "take into consideration the environmental impact of any major change in our processes or expansion." (Rainforest Action Network, 2013). Bumitama Agri LTD has expanded plantations to buffer zones of Indonesian national parks and forest reserves, including concerns for Tanjung Puting National Park covering 415,070 hectares of lowland, freshwater swamp, peat and mangrove forests in Borneo. The study claims the national park is a habitat for over 200 bird, 17 reptile, and 29 mammal species. Some of the more iconic endangered species within this habitat are the "estuarine crocodile, clouded leopard, Malayan sunbear and Storm's stork, and endangered primates such as the proboscis monkey, the agile gibbon and Borneo orangutans" (Rainforest Action Network, 2013). Furthermore, the study claims sixty five percent of Tanjun Puting National Park has been degraded for palm oil expansion. Bumitama and other companies have already expanded into buffer zones surrounding the national park resulting in over 100,000 hectares of land destroyed. This now destroyed land once included nesting sites, open spaces between blocks of forest areas, and seasonal feeding spots for Borneo orangutan populations that now have to deal with these detrimental losses.

Independent Indonesian non-profit organizations (NGOs) conducted field investigations in Borneo on three separate palm oil concessions from Bumitama Agri LTD. These investigations find the company has directly caused the destruction of forests with high

conservation values as well as resulted in orangutans harm or death. When this case study was published in 2013, NGO's including International Animal Rescue Indonesia, Friends of the National Parks Foundation, Center for Orangutan Protection and Friends of Borneo, submitted documentation of the loss of orangutan forest habitat on each of the three controversial palm oil concessions to an RSPO Complaints Panel. Their investigations found Bumitama in non-compliance with the RSPO New Planting Procedure and the RSPO Principles and Criteria (Rainforest Action Network, 2013). The study states Bumitama Agri LTD was found accountable for building plantations in buffer zones of forest reserves surrounding Palung National Park where deforestation occurred. Additionally, starving orangutans had to be rescued from one of the investigated concessions. Even when the NGO's sent an urgent request to the RSPO to put an end to the destructive behavior displayed by some of its members, the study claims the RSPO is "reluctant to impose meaningful sanctions on its members or terminate membership even in clear cases of fundamental violations of its rules," and, as a result, any sanctions will be too weak to prevent the non-compliance behaviors from continuing to happen (Rainforest Action Network, 2013). These are clear implications indicating the palm oil industry has very weak levels of social sustainability due to the RSPO's debilitated enforcement mechanisms in place. The Indonesian national park is still under threat, and there's concern among stakeholders that the RSPO will act too late to prevent it from being destroyed.

The Rainforest Action Network study then takes a journalistic approach to show images with captions about the evidence of orangutan endangerment due to expansion of Bumitama Agri LTD's palm oil plantations into buffer zones, national parks, and forest reserves. These gruesome images from the study can be seen below. Additionally, although the images may be hard to look at, they reveal the hidden truth behind the terrible sustainability of palm oil

plantations in the industry. In fact, a darker image can be seen in the actual case study showing an orangutan that died while under the care of a local worker on the plantation.

LEFT: STARVING ORANGUTAN THAT WAS RESCUED FROM THE PT LSM PALM OIL PLANTATION IN WEST KALIMANTAN IN MARCH, 2013. RIGHT: ORANGUTAN CLINGS TO THE LAST TREE LEFT STANDING IN AN AREA CLEARED BY PT LSM FOR A NEW PALM OIL PLANTATION. PHOTOS: *ALEJO SABUGO- YAYASAN IAR INDONESIA*

Figure 6. Source: Rainforest Action Network; Available from: https://www.ran.org/wp-content/uploads/2018/06/Case_Study_Bumitama_Finance.pdf

Several independent field investigations submitted to the RSPO Complaints Panel found that Bumitama Agri LTD's palm oil subsidiaries conducted poor or no HCV assessments prior to clearing forests. Not only were HCV Forests (HCVF) cleared without any care for environmental sustainability, but the study also found they "cleared a total of 3,205 hectares of land in the forest buffer zones of the Sentap Kancang and Gunung Terak Forest Reserves near Gunung Palung National Park in West Kalimantan" (Rainforest Action Network, 2013). The RSPO claims to swear to protect local orangutan populations yet starving orangutans rescued from plantations provided direct evidence that they were clearing HCVF and important habitats to wildlife. Indonesian NGO's reported a Bumitama subsidiary "clearing existing vegetation in the Tanjung Puting National Park and buffer areas, sparking the filing of yet another formal RSPO complaint.

The company intends to establish a palm oil plantation within the national park and adjacent forest buffers, which are important areas for orangutan protection" (Rainforest Action Network, 2013). The company's goal to expand 15,000 hectares per year is a very environmentally weak sustainability plan considering the high costs to important biodiverse rainforests and the integrity of Tanjung Puting National Park. There's also been many findings of palm oil expansion onto carbon rich peatlands. As a result, the palm oil industry has created tremendously high climate emissions. "Scientists have identified palm oil plantation expansion onto peatlands in Indonesia and Malaysia as a globally significant threat to the climate system, projected to contribute more than 400 million tons of CO2 emissions per year from Indonesia alone if further expansion on peat is not prohibited" (Rainforest Action Network, 2013).

The study then transitions into a section on Bumitama's financiers, but much of the section simply lists the major banks holding the company's current loans ($455 million USD). Although going through these would draw away from analyzing palm oil's sustainability, the study states that financiers are also responsible and should be accountable for the destructive environmental practices. Bumitama Agri LTD became listed on the Singapore Stock Exchange in 2012 and pledged that 58% of their overall proceeds ($142 million USD) would be allocated to making new plantations. The study later recommends an economically and environmentally sustainable proposal to financiers in the conclusion:

> Financiers, including banks and investors, should divest from palm oil consumer companies or commodity traders who do not have adequate policies and systems in place to eliminate Conflict Palm Oil from their supply chain and/or are unable or unwilling to implement full traceability systems in their supply chains back to all growers (Rainforest Action Network, 2013).

The study lists several actions that banks, and investors can take to drive the transformation of palm oil production. In order to drive responsible palm oil production, "banks

and investors, consumer goods companies, traders, governments, NGOs, and consumers all need to do their parts to stop the production of Conflict Palm Oil" (Rainforest Action Network, 2013). Here are just some of the highlights from the suggestions for how these parties can make strong environmental sustainability approaches:

1. Current financers must investigate Bumitama's practices and engage with Bumitama Agri Ltd senior management to ensure the following:
    a. No further clearing of Indonesian national parks and surrounding buffer zones
    b. Review and revision of Standard Operating Procedures "relating to environmental human rights and transparency safeguards" with recommended implementations to make changes (Rainforest Action Network, 2013)
    c. Pause on forest clearing until an assessment of all new and existing plantations for HCV areas and HCS values is performed
    d. No clearing of HCV or HCS forests and no expansion onto peatlands
    e. Do not risk the well-being of endangered species such as the Borneo orangutan
    f. Financers threaten to withdraw financial support if the preceding and following is not adhered to
2. Banks and investors in the palm oil industry must develop due diligence procedures for palm oil companies that fail to prevent common social and environmental impacts from palm oil production:
    a. "Avoid investing in or lending to palm oil companies that continue to cause deforestation, high greenhouse gas emissions from plantation development on peatlands of any depth, and human and labor rights violations, and/or that are

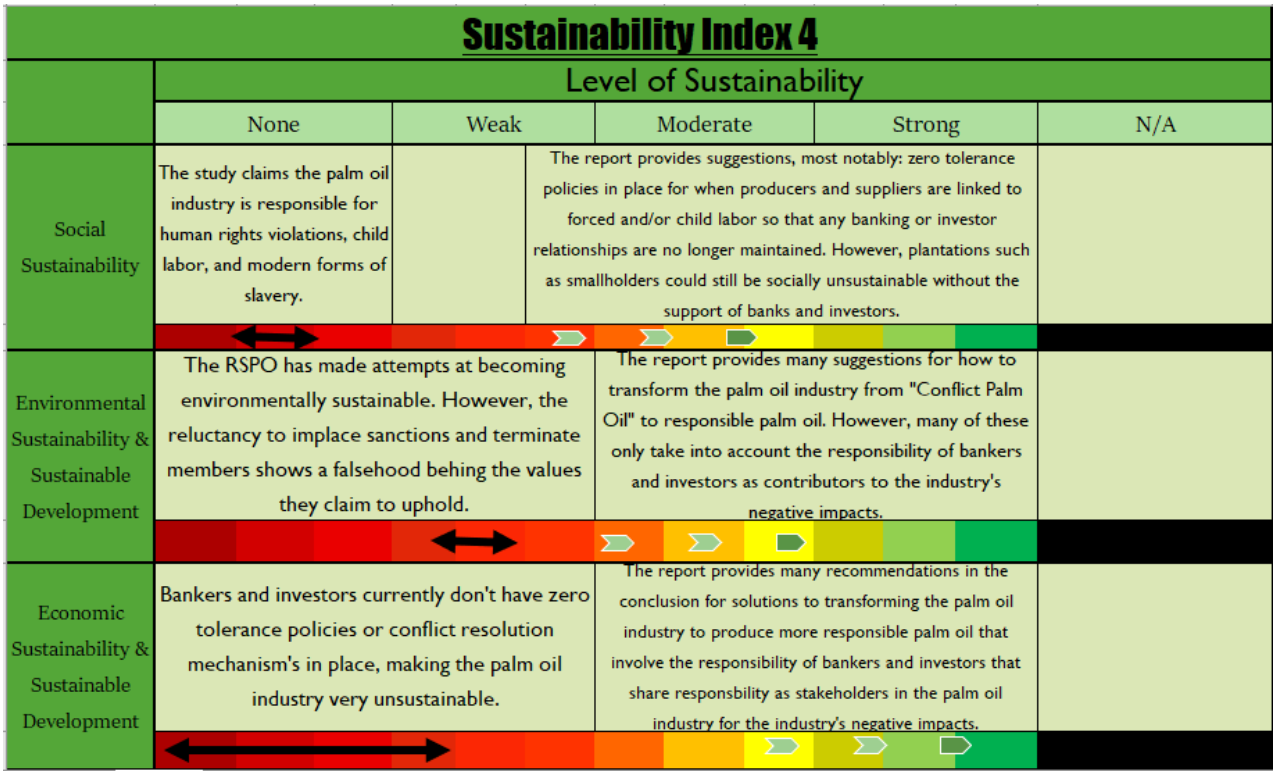
unable or unwilling to implement full traceability systems in their supply chains back to all growers to screen out all sources of Conflict Palm Oil in non-compliance with these standards" (Rainforest Action Network, 2013).

b. Assess the current conflict resolution mechanisms if there are any that exist for plantations in the palm oil industry and "not finance companies without effective conflict resolution mechanisms" (Rainforest Action Network, 2013).
c. Create effective conflict resolution mechanisms to be put in place for palm oil related financing to protect Indigenous Peoples and their customary rights and laws so that they are of higher respect than the desire for land and resources where environmental protection needs to occur.
d. Lastly, put zero tolerance policies in place for when producers and suppliers are linked to forced and/or child labor so that any banking or investor relationships are no longer maintained.

(adapted from pp. 9-10 of RAN, 2013)

Overall, if these suggestions were to actually become implemented as actual environmental regulations, governmental laws, and/or company & financier policies there would almost definitely be signs of moderate to strong environmental, social, and economic sustainability within the palm oil industry.

Rainforest Action Network. "Conflict Palm Oil Case Study: Bumitama Agri Ltd." October, 2013. Available from: https://www.ran.org/wp-content/uploads/2018/06/Case_Study_Bumitama_Finance.pdf



Meta-Analysis 5: "Committed Carbon Emissions, Deforestation, and Community Land Conversion From Oil Palm Plantation Expansion in West Kalimantan, Indonesia"

Kimberly M. Carlson, Lisa M. Curran, Dessy Ratnasarie, Alice M. Pittmana, Britaldo S. Soares-Filhof, Gregory P. Asnerg, Simon N. Triggh, David A. Gaveaub,e, Deborah Lawrencei, and Hermann O. Rodriguesf

The study "Committed Carbon Emissions, Deforestation, and Community Land Conversion from Oil Palm Plantation Expansion in West Kalimantan, Indonesia" from 2012 finds that Indonesia has experienced one of the most rapid plantation expansions worldwide. Agricultural records show oil palm area increased 600% from 1990 to 2010 with a total of 7.8 million hectares, and Sumatra and Indonesian Borneo (Kalimantan) made up over 90% of this development. Roughly 40% of lowland forests were destroyed in these regions from 1990 to 2005. Indonesia remains one of the top 10 national GHG emitters, and the country's annual GHG

emissions are sourced predominantly from land use change due to this extensive deforestation. This 2012 study claims that, “the locations, patterns, and land cover sources for oil palm plantation expansion; the extent and distribution of undeveloped oil palm leases pending near-term development; and carbon emissions from oil palm agriculture remain largely undocumented” (Carlson et al., 2012). While this remains in part still true today, there has been growing evidence of greenhouse gas (GHG) emissions and land cover changes such as deforestation. According to the study, land cover changes contribute 10-20% of total GHG emissions and much of these come from peatland conversion to plantation agriculture. This affects smallholder and community livelihoods by taking extensive arable land away from land availability for local farmers. Locations and land sources for plantations in Indonesia remain largely undocumented, causing high-yield plantations providing food security to overshadow the overwhelming impacts of the palm oil industry on carbon flux and livelihoods.

This case study experiences some limitations as Landsat satellite images can sometimes be interfered by cloud cover blocking emissions despite ‘temporal’ and timeline data. The study attempts to solve these issues with an improved methodology using light detection and ranging (LiDAR) to effectively measure AGB in metric tons of carbon per hectare in tropical forests. Furthermore, it can even measure carbon underneath the ground in peatlands. Unfortunately, this methodology is unable to measure historical conditions prior to the year 2000. “As a result of these limitations, carbon flux estimates from land cover change typically rely on multiplying forest area lost by forest AGB” (Carlson et al., 2012). However, the problem is this doesn’t take into consideration the change in carbon flux before and after deforestation occurs because AGB is treated as a “discrete” rather than continuous variable. Additionally, multiple widely varying land areas could be grouped into a few broad classes of land coverage. Belowground carbon is an

extremely critical variable to consider because clearing and draining peatlands produces massive carbon emissions, and Indonesia harbors the most tropical peat carbon worldwide with Kalimantan containing a third of the country's peatlands (Carlson et al., 2012).

While the palm oil industry continues spreading plantations through Indonesia, the government "has pledged to reduce 26% of their projected business-as-usual (BAU) 2020 GHG emissions (2.5–3 Gt CO2 equivalent)" (Carlson et al., 2012). International sustainability advocates, including Reducing Emissions from Deforestation and forest Degradation (REDD+) and the RSPO aim to diminish the negative impacts from agribusiness in tropical regions and reduce GHG emissions. The study states that land change models are a great tool to evaluate the potential for these proposals to meet their goals. With so much uncertainty involving the expansion that's occurred in the past and future plantation development as well as with carbon emissions from plantations clearing land, the study developed a longitudinal assessment of past and future development in Ketapang District, West Kalimantan from 1989 to 2020. The study assessed the following three sets of data within the district: "(i) evaluate how allocated and planted oil palm, including land cover types converted, vary across both space and time; (ii) assess the relative contribution of oil palm expansion to deforestation and carbon flux; and (iii) model future scenarios of oil palm expansion and forest conservation policies to examine potential effects on land cover, carbon flux, and agrarian community landholdings" (Carlson et al., 2012).

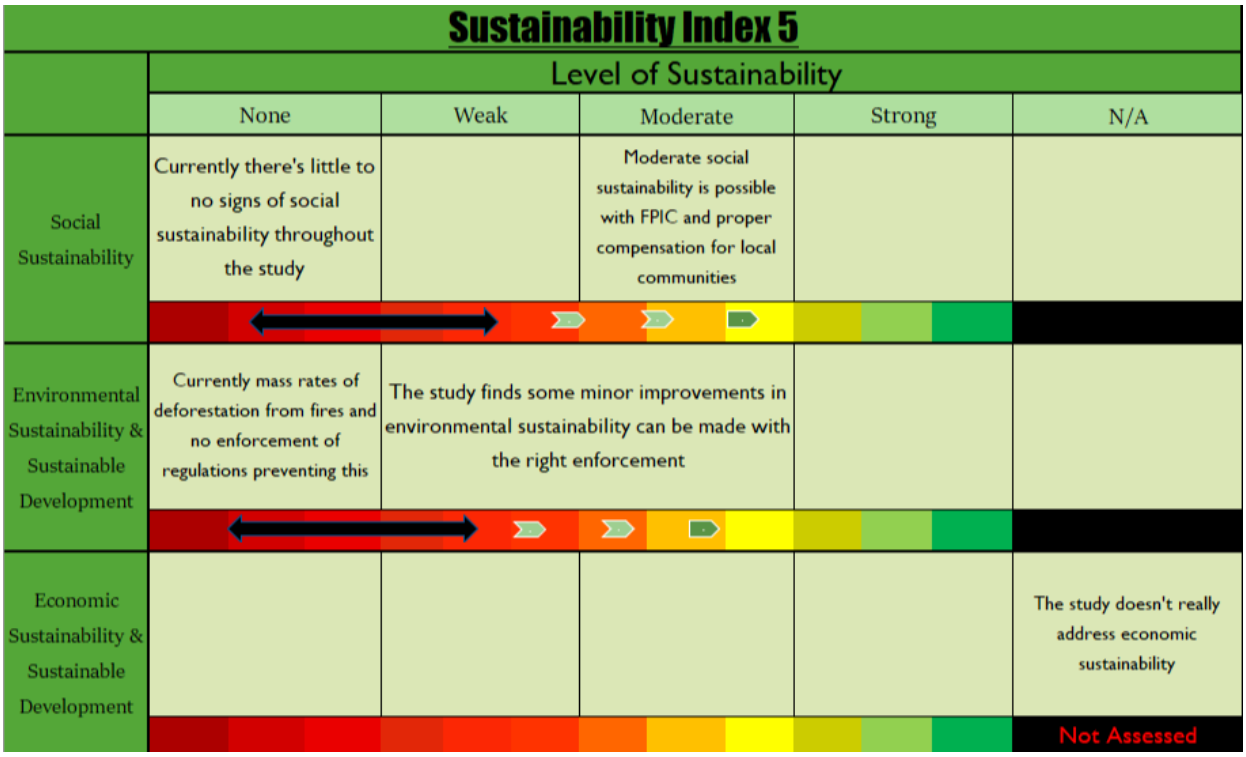
The study finds that from 1989 to 2000 forest fires were 93% of regional deforestation. In 2011, the Indonesian government claimed to end peatland conversion for the expansion of palm oil plantations, but "61% of undeveloped lease area was allocated on peatlands" (Carlson et al., 2012). Under BAU conditions, unless current regulations prohibiting the conversion using fire

for agricultural conversion are implemented, it is estimated that 87% of greenhouse gas emissions come from the conversion of peatlands to palm oil plantations. Essentially, the study finds very weak environmental sustainability currently being practiced and likely to continue under BAU unless legitimate enforcement of environmental regulations preventing fires takes place. However, even with this enforcement the study predicts only a 3-21% drop below BAU due to the prevalence of forest fires and other forest degrading occurrences.

The study also evaluates the region's palm expansion impact on non-PA lands and local community dwellings/villages. The findings were that deforestation consisted of 49% of palm oil expansion during the overall timeframe and 55% from 2001-2008. Additionally, even if a 2-km safe zone around settlements were to be enforced (currently not required by governmental regulations), "28–36% of non-PA lands <5 km from village centers were projected for conversion to oil palm by 2020" (Carlson et al., 2012). The study then goes onto question the definition of "degraded" that governments and palm oil companies have used to describe community managed agricultural land areas. Essentially, they're using a very weak sustainability practice by abusing these local communities for an excuse to call forests "degraded" due to their presence so they can convert them to palm oil plantations despite the reality of their conditions.

The study concludes with implications, stating that "protecting intact, logged, and secondary forests but especially peatlands is most critical for reducing carbon emissions from land cover change in Kalimantan" (Carlson et al., 2012). This is critical for environmental sustainability, and the study also places an emphasis on social sustainability. The study states that although similar studies have been conducted in the past, they are not as strong as they don't take into consideration the local communities that this study considered. The study also stresses a need for further government and private sector transparency surrounding lease allocation.

Sustainable palm oil requires a consideration for FPIC and land use histories as smallholders and local communities play a big part in being socially sustainable especially with fair and agreed upon compensation for their lands. Overall, the study is very concerned with both social and environmental sustainability by taking into consideration land use policies and potential outcomes from converting lands to palm oil plantations.



Carlson, Kimberly M., et al. "Committed Carbon Emissions, Deforestation, and Community Land Conversion from Oil Palm Plantation Expansion in West Kalimantan, Indonesia." *Proceedings of the National Academy of Sciences of the United States of America*, vol. 109, no. 19, May 2012, pp. 7559-7564. Available from: https://www-pnas-org.wooster.idm.oclc.org/content/pnas/109/19/7559.full.pdf

Conclusion

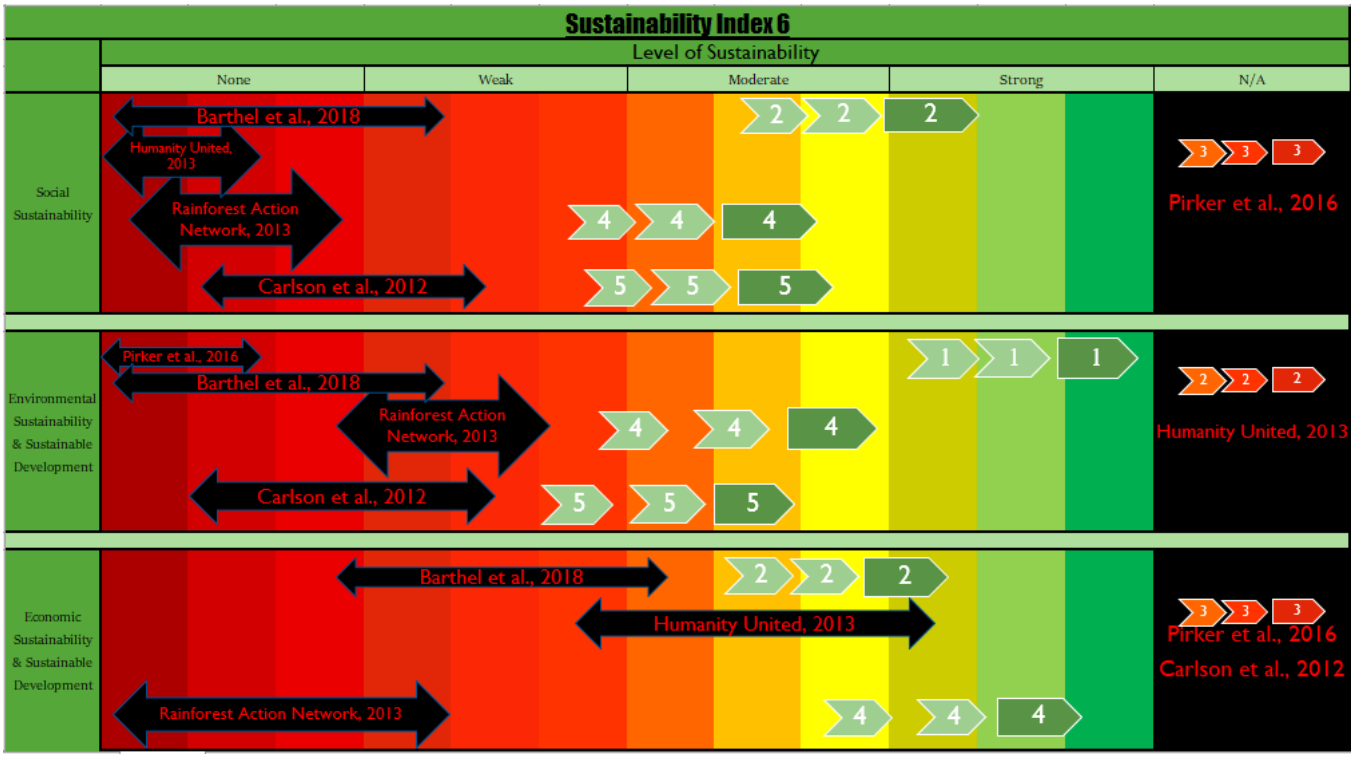
In Sustainability Index 6 below you can see the previous 5 sustainability indexes all compiled into one concluding index. The arrows represent the current levels of sustainability in the palm oil industry with the citations indicating the studies where my gradings are based from. Again, with it being more difficult to put these citations into the smaller chevrons, they show the numbers from which previous sustainability index they originate from. They're also placed horizontally adjacent to the arrows with citations.

Having gone through all of these studies and their meta analyses and sustainability indexes, it is clear that there is almost no social sustainability across the palm oil industry. Two of the four assessments reveal slight signs of weak sustainability while the other two are literally in the none grading for social sustainability. This came as a surprise to me as I've mostly heard of the extremely poor environmental practices by the palm oil industry prior to this. Furthermore, the environmental sustainability grading was not much better. Three of the four assessments start to fall into the weak category for the sustainability grades while the other arrow is entirely in the grade of none. From this, you can most definitely conclude that the palm oil industry is very unsustainable. What also came as a surprise was that many of the statistics that resulted in these gradings were ongoing and not older patterns from plantations. There has been direct evidence that unsustainable practices have been and still are ongoing. This is the reason I still do not consume palm oil even after fifteen years of avoiding products with the harmful ingredient.

What surprised me the most with Sustainability Index 4 from Rainforest Action Network, is that the organization that put out this study is extremely concerned with the impacts the palm oil industry has on the environment. However, in my assessment I gave a grading that's directly in the middle of the weak portion of the sustainability index. Taking a look at the index below,

this arrow is also placed at a relatively higher grading than the other three current sustainability gradings from other studies. With this meta-analysis coming from an organization determined to saving rainforests, and my prior knowledge of the industry's extreme effects on the environment, I would've expected myself to give a much lower grading. However, the study highlighted some key points, particularly from the RSPO, that the industry is attempting to make a fight to get rid of some of the previous negative environmental issues.

On the other hand, economic sustainability seems to be more spread out across three different gradings for three assessments. It surprises me that the Humanity United study has an extremely low social sustainability grade, yet the highest of the three economic sustainability grades at a moderate ranking. The other two studies fall into weak and none economic sustainability gradings. This indicates that there are probably a wide range of sustainable and unsustainable economic practices in the palm oil industry. What surprises me the most, however, is that the chevrons are all placed a good distance apart from the current sustainability rankings across the entire sustainability index. This means that there are a lot of positive directions that the palm oil industry could take in order to become sustainable. Even for environmental sustainability, one of the assessments falls entirely in the strong ranking for potential future sustainable development. I would not have expected this before doing this research, and I am glad that there is some hope that improvements can be made within the palm oil industry in order to become sustainable.


Sustainability Index 6
Level of Sustainability
None
Weak
Moderate
Strong
N/A
Social Sustainability
Barthel et al., 2018
Humanity United, 2013
Rainforest Action Network, 2013
Carlson et al., 2012
Pirker et al., 2016
Environmental Sustainability & Sustainable Development
Pirker et al., 2016
Barthel et al., 2018
Rainforest Action Network, 2013
Carlson et al., 2012
Humanity United, 2013
Economic Sustainability & Sustainable Development
Barthel et al., 2018
Humanity United, 2013
Rainforest Action Network, 2013
Pirker et al., 2016
Carlson et al., 2012

Conclusion

The oil palm tree and the palm oil originating from its fruits have been described throughout history in such a huge variety of ways throughout its history. In every way that it's been described a slightly different model of sustainability has been featured while palm oil has continued to meet the increasing needs of consumers. From the first commercial plantation established in 1917 to large-scale cultivation taking off in the 1960's to no longer needing to self-pollinate the fruits in 1981 and lastly the revelation in the 90's of terrible trans fats palm oil doesn't contain; the oil palm tree has expanded to take over more than 18 million hectares of land coverage for palm oil plantations. Palm oil as an ingredient can take many forms, including palm kernel oil, and disguised under many names; it's in over half of packaged snack foods in supermarkets. It has continued rising in demand across markets all over the world and now supplies nearly 40% or more of the world's vegetable oils. The oil palm is everything from an industrial crop to a cash crop, and nothing's going to stop it from continuing to take over such large shares of the consumer market.

However, the proliferation of palm oil also poses a massive threat to the environment. While palm oil may be a common ingredient in the snack food industry, it's also the cause of the destruction of many of the world's tropical rainforests in order to make room for massive palm oil plantations. The clearing of these forests has caused species such as orangutans, rhinos, elephants, and Sumatran tigers to become critically endangered and has also been a massive factor in global warming. According to Heather Gies, author of "Palm Oil's Corporate Deception: Green-Washing a Dirty Industry," the industry "...green-washes palm oil under the guise of biofuels and so-called sustainable development," when in reality "...a complex mess of deforestation, pollution, 'carbon debt,' and the destruction of biodiversity, wildlife habitat, and

food security, often along with grave human rights abuses" are all significant negative impacts on our world due to the production of palm oil. The snack foods the average American most likely consumes nearly every day have led to the equivalent of 300 football fields of rainforest destroyed every hour for palm oil plantations. This has created billions of tons of carbon pollution and killed endangered wildlife. Today palm oil production is the largest cause of deforestation in countries such as Indonesia, Malaysia, and Sumatra. According to Scientific American, "Indonesia's endangered orangutan population, which depends upon the rainforest, has dwindled by as much as 50 percent in recent years." In order to produce palm oil, companies across Southeast Asia have been clearing thousands upon thousands of acres of biodiversity-rich tropical rainforest in order to create massive palm plantations.

By using Dresner's assessment from weak sustainability to strong sustainability, I was able to develop my own theoretical framework that helped create sustainability indexes for my meta analyses in order to assess case studies from my own personal gradings. Although my assessment is slightly different than Dresner's, his book *The Principles of Sustainability* helped define sustainability and sustainable development; concepts that have also had very many interpretations throughout history resulting in many different models of sustainability practices. By creating this theory on what sustainability means, I was then able to apply this to my results in order to find what sustainable palm oil means. Although some parts of Dresner's assessments, such as his belief that strong sustainability must mean that absolutely no natural capital may be extracted, are not used in my sustainability definitions. Dresner influenced my theory and the way that I would define sustainable palm oil in my results. In my first meta-analysis I grade strong potential future environmental sustainability for avoiding building plantations on PA lands, HCV lands, and HCS forests. Natural capital might still be depleted, but there's minimum

carbon emissions by protecting forests with high carbon stocks, biodiverse species are protected through HCV lands, and PA lands such as national parks continue to remain protected areas.

Other parts of my study revealed many unsustainable practices I was not expecting, despite having done so much research prior to my Independent Study. The third meta-analysis in particular revealed some shocking statistics on modern forms of slavery in the palm oil industry such as human trafficking and up to 200,000 child laborers. Many plantations are isolated from cities, and migrants will often be forced to submit all forms of identification. Plantation owners often abuse their workers with below minimum-wages and don't care for social sustainability whatsoever. Poor environmental sustainability was already well-known to me, but this study revealed shocking issues within the palm oil industry resulting in the grade of zero social sustainability in Sustainability Index 3. Furthermore, my second meta-analysis revealed that smallholders are taken advantage of and forced into years of debt by large estates. Although, there were some positive signs for future sustainability such as smallholder schemes like FELDA and NES that have assisted smallholders in many ways. This analysis also revealed that indigenous peoples and local communities are taken advantage of very frequently by palm oil companies that obtain permission from the government to take their lands 'without knowing' about customary and local laws leading to land use conflicts. There's supposed to be FPIC but this often doesn't actually occur.

Sustainability certification schemes like the RSPO could help with ensuring sustainable practices such as FPIC, but they need to enforce that their members are actually following the 39 principles and guidelines for sustainable practices. There needs to be punishment for those found responsible for breaking these rules, and non-compliance for any members that do not follow the rules and guidelines for being sustainable. A company should not be able to have sustainability

certification while actually performing unsustainable practices whether it be socially, economically, or environmentally.

The fifth meta-analysis revealed some of the extreme carbon emissions caused by just one area within the palm oil industry. Palm oil plantations have contributed tremendously to greenhouse gas emissions through destruction of tropical forests and peatlands in particular. Additionally, plantations have been found spreading onto national park lands and their buffer zones in West Kalimantan. The Indonesian government needs to enforce stricter guidelines in order to protect these lands from further development by conflict palm oil plantations and put an end to this. There has been evidence of orangutans found starving or dead in the care of workers on the plantations because of careless acts by plantation owners towards the environment and the habitats of biodiverse species. This represents clear signs of currently unsustainable environmental practices.

The palm oil industry has continued to expand tremendously each year despite so many claims of unsustainable practices and the massive quantity of resources listing negative issues caused socially and environmentally. Yet, consumers are made unaware of the evidence supporting these claims or even any allegations of the terrible practices occurring in Southeast Asia. The snack food industry's main goal isn't to try and market a product that's great for the environment. Although, some companies and organizations such as Plantations International and the Malaysian Palm Oil Board might try to paint a picture of sustainability claims behind the palm oil industry by green-washing consumers. What the snack food industry is trying to market to its consumers is products that are healthy, or products that taste excellent despite all the issues that happen behind closed doors in order to get that snack onto supermarket shelves and into your pantry. These companies will do everything they can to ensure you continue buying the

products that bring in revenue, and everything they don't have to do to reveal the negative implications behind their products.

In some ways, the period of ecological innocence from the 1970's still has traces that exist today; that people are unaware that some environmental laws still aren't enough, and that everything will be 'fine'. This is especially true of the agricultural and food industries. If the practices of none or weak sustainability were revealed across the palm oil industry, and these were made widespread and well-known among consumers everywhere, perhaps consumers would no longer desire to consume products containing unsustainable products. Maybe younger kids with a love for biodiverse species such as the endangered Orangutan would never want to consume palm oil again. Parents might take steps to buy much less products for their kids to be satisfied. Perhaps adults with an environmental ethic, a green thumb, or a passion for social justice and equality would also stop their consuming habits from the palm oil industry. Others might not care enough and continue consuming the snack foods they love so much. I can only imagine how the consumers would change the palm oil industry if the products contained warnings of every unsustainable practice that went into making them on their advertisements and labels. This may seem quite unlikely but in any possible way that consumers become aware of such unsustainable practices, one of the biggest steps they can take in order to protest is to discontinue contributing to an industry causing so many issues by no longer consuming these products. However, it's not entirely the fault of the consumer for buying into a product where they're unaware of the consequences behind their actions.

Through the data collected from my fourth meta-analysis, it becomes clear that the financiers and banks that buy into the palm oil industry are equally responsible for the negative effects it's causing. Currently, the ones funding Bumitama's palm oil plantations don't

investigate unsustainable practices or ensure from management that they aren't occurring. They're supporting the destruction of national parks, unsustainable operating procedures, species endangerment, and clearing of forests including HCV forests, HCS value areas, and peatlands through millions of dollars that would otherwise make this not possible. If these banks and financiers were to avoid investing or lending to companies causing these effects, high greenhouse gas emissions, human and labor rights abuses (including forced and child labor), conflict with indigenous communities, and other negative effects caused by conflict palm oil then this could change the industry as a whole to transition to moderate and even strong sustainability. What these investors need to do is withdraw financial support to any companies producing conflict palm oil and ensure non-compliance with the aforementioned issues. Additionally, they can help plantations by creating conflict resolution mechanisms that they must adhere to in order to receive financial support. Otherwise, they are equally responsible for the unsustainable practices economically, socially, and environmentally.

So, with all the negative effects of palm oil production, why do industries invest in the industrial crop? Palm oil is seen as a "flex crop" meaning it can be used for food, animal feed, fuel, and industrial products. Palm oil can be used "...for cooking oil, food additives, cosmetics, industrial uses like plastics and explosives, and biofuel." The potential to sell in multiple markets maximizes return on corporate investment. Palm oil is very inexpensive to produce, and it's sold at much higher prices by palm oil plantations. The article "Looking at Oil Palm's Genome for Keys to Productivity," by Carl Zimmer, states that those "...prices will stay high in decades to come, as demand for the oil increases." Although there is currently no known sustainable alternative ingredient to palm oil that can be produced industrially, there are teams working on researching the possibility of such an ingredient. In fact, it's recently been revealed that a team of

billionaires lead by Bill Gates is investing into a small startup working on a safer alternative to the harmful ingredient. However, many scientists have worked on this type of research for years, so the reality of these hopes might not be too bright.

With the massive ways the palm oil industry has expanded over the years, and the reality behind the crop's sustainability compared to other vegetable oils, the oil palm doesn't show any signs of slowing down as an industrial crop. Even if a sustainable alternative were to be invented quickly within the next year, the reality of it taking over a multi-billion-dollar industry that's continuing to grow exponentially seems pretty unlikely at this point. Additionally, the motives behind creating an alternative could be that people desire to save the environment, but it could also be that individuals, especially billionaires, desire to take money from the Southeast and profit off an already huge industry. Therefore, continuing to reinforce the economic inequalities created by the West and keeping big business in the global North. After dedicating what feels like my whole life to a topic I care so deeply about, I am proud to have conducted research at America's premier college for undergraduate research, The College of Wooster, and to have finally finished my Independent Study. However, before starting my research, I would've imagined a sustainable alternative ingredient to be the greatest thing in the world, and that it would be impossible for the palm oil industry to ever be sustainable given all the destruction they've caused to rainforests, grasslands, and peatlands across Southeast Asia. In reality, it is not the oil palm tree itself that is unsustainable, but rather the people behind the growth of the oil palm as a cash crop and the palm oil industry that make it unsustainable.

With 10 tons of fruit producing 3.9 tons of palm oil and 0.5 tons of palm kernel oil per hectare, the oil palm produces yields five to eight times higher than any other vegetable oil. The answer to palm oil's sustainability lies in the potential future direction the industry can take, and

many suggestions on how to do this have been provided by my results. Sustainability Index 6 shows many huge strides the industry could take to become much more sustainable than it currently is. Many of the current sustainability gradings are quite low, at least socially and economically, but the potential future sustainability gradings are much higher. For potential future social sustainability, these range from little signs of weak sustainability into mostly moderate and even some strong sustainability. For environmental sustainability and sustainable development, the potential future sustainable moves are similar. In fact, the first meta-analysis from Pirker et al. shows tremendous leaps the palm oil industry can take to be completely strong in terms of sustainability. If these were to be adhered to, the palm oil industry could transform entirely.

If I were to continue this research, I would perform more meta analyses on a much larger scale of case studies within the palm oil industry. I would like to gather more information on the solid waste palm oil plantations create, and potentially hazardous wastes created by palm oil mills. This would be of particularly high interest to me as this is the career path I plan on taking after graduation in a couple months as an environmental coordinator for a metals company. From my current research, it seems as though there are many wastes the palm oil industry creates ranging from the solid wastes created from massive amounts of above ground biomass to palm oil mills effluents and chemical wastes. My results chapter does have a meta-analysis on air emissions from the palm oil industry due to land conversion and deforestation but doesn't particularly have much on quantities of solid wastes. Additionally, there could be more meta-analysis on pesticides, herbicides, and fertilizers used in the palm oil industry. However, there's a lot of information from my study that could be expanded on in future studies looking to change the agricultural industry to become more sustainable. Especially those looking to change the

palm oil industry, and this starts from making changes at the very beginning of production on the plantations.

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