DIPARTIMENTO DI SCIENZE AGRARIE ALIMENTARI E AMBIENTALI

MASTER COURSE IN: FOOD AND BEVERAGE INNOVATION AND MANAGEMENT

HOW DO CONSUMERS PERCEIVE PALM OIL IN FOOD AND ITS IMPACT ON THE ENVIRONMENT? EVIDENCE FROM AN EXPLORATORY STUDY

THESIS TYPE: Experimental

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To the life.

Thank you for teaching me a new lesson every day.

And to the people who make the world a better place.

Thank you for brightening the way.

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ACRONYMS AND ABBREVIATIONS

BP	Before the present
CPO	Crude Palm Oil
CPOPC	Council of Palm Oil Producing Countries
CSPO	Certified Sustainable Palm Oil
EFSA	European Food Safety Authority
EPOA	European Palm Oil Alliance
ESPO	European Sustainable Palm Oil
ESPOAG	European Sustainable Palm Oil Advocacy Group
EU	European Union
FAO	Food and Agriculture Organization
FFB	Fresh Fruit Bunch
GHG	Greenhouse gasses
HCV	High Conservation Value
HCS	High Carbon Stock
IDH	The Sustainable Trade Initiative
ISCC	International Sustainability Standard and Carbon Certification
ISPO	Indonesian Sustainable Palm Oil Certification
ITC	International Trade Centre
MMT	Million metric tons
MPOB	Malaysian Palm Oil Board
MSPO	Malaysian Sustainable Palm Oil Certification
NGO	Non-governmental Organizations
PO	Palm Oil
POIG	Palm Oil Innovation Group
PKO	Palm Kernel Oil
RBD	Refined, Bleached, Deodorized

RED	Renewable Energy Directive
RSPO	Roundtable on Sustainable Palm Oil
SMEs	Small and medium sized enterprises
UK	United Kingdom
USA	United States of America
USDA	United States Department of Agriculture
WHO	World Health Organization
WTP	Willingness to pay
WWF	World Wide Fund for Nature

INTRODUCTION AND THESIS PURPOSE

Palm oil is one of the most important agricultural commodities globally for the volume of production, consumption and trade. Among the industrial oil crops, oil palm is one of the most productive and important ones, due to its high yields with less land use, low prices, and versatility. Over the years, with a rising global population, oil palm plantation has significantly expanded and palm oil became the foremost among other vegetable oil competitors.

Although it is mostly used by the food industry, it is also used in various products such as personal care products, cosmetics, chemicals, pharmaceuticals and also as a biofuel.

However, palm oil is one of the most controversial commodities in the world due to its indefinite social, environmental and health impacts. In order to meet the world's increasing demand for palm oil, a large number of tropical forests and peatlands have been converted into oil palm cultivation either sustainably or not. Rainforests and natural habitats of animals are destroyed uncontrolled in order to cultivate more oil palm. Consequently, this causes the loss of biodiversity and threatens the life of endangered species.

Even though there are many studies about its negative impacts, oil palm cultivation is still an important resource for the economic development of producing countries, but while smallholders keep maintaining their livelihoods, also the environment should be protected. Producing palm oil in a sustainable way which means producing without destroying valuable forests and habitats and is an important step for preserve the environment.

Considering this, consumers' preferences can have an influence to support a sustainable environment in oil palm production. In recent years, while many companies decided to eliminate palm oil completely from their products, many others continue to use palm oil either sustainable, certificated or not.

This study aims to analyze the consumers' perceptions, awareness and attitudes about the presence or absence of palm oil in food products as well as sustainability schemes. In addition, this study wants to determine the willingness to pay (WTP) for sustainable palm oil.

The research questions aimed to be answered in this study are:

- Which factors influence consumers' purchasing behavior?
- Are consumers aware of the effects of palm oil?
- Do consumers recognize and give attention to the sustainability certifications?
- Are consumers willing to pay a premium price for sustainable certified palm oil products?

To find an answer to all these questions, an online survey has been conducted, while for determinate the WTP has been used a contingent valuation method with double-bounded dichotomous choice questions. Descriptive statistical analysis was carried out by using GRETL.

After the assessment, the profile of the typical consumer who purchases palm oil products with or without certification and the consumers who purchase palm oil-free products is outlined. This information provides important data to the companies for making decisions about the use of palm oil in their products. The findings of the study are important for the future development of the palm oil sector.

Specifically, the structure of the thesis consists of 5 chapters in which the main aspects of palm oil are treated. The first chapter is an overview of the palm oil supply chain including history, characteristics, production process and uses of palm oil. The second chapter describes the palm oil market, with an emphasis on the market statistics on the production, imports and exports, consumption and prices globally and in the European Union and, particularly, in Italy. Chapter 3 presents the regulatory framework for palm oil, highlighting the policy implications, regulations and certification schemes. The fourth chapter reviews the main impacts of palm oil production and consumption, the sustainability of palm oil and actions against negative impacts. In this section, a brief literature review on consumer perceptions and concerns about palm oil is presented. Chapter 5 introduces the case study, the methodology and then discusses the results. Finally, the thesis concludes by summarizing the findings of the case study.

Chapter 1
PALM OIL SUPPLY CHAIN

1.1 **Palm oil**

Palm oil is a vegetable oil rich in saturated fatty acid, which is extracted from the fruit pulp of oil palm tree (Elaeis guineensis) belonging to the Palmaceae family. Oil palm tree consists of 5 meters long leaves and large olive sized fruits; these fruits have a pulp and kernel (or seed) inside. Each palm fruit contains approximately 30-35 percent of oil (EPOA, 2019a; Pande et al., 2012).

30 months after cultivation, the oil palm tree starts to give fruits and continues to bear fruits 25-30 years. Each fresh fruit bunch (Figure 1-1) is harvested every 10-15 days and weights between 25-30kg with 1000 to 3000 fruits (MPOC, 2020).

Figure 1-1: Fresh fruit bunches in oil palm tree (MPOC and MPOB, 2007)

Three main species belong to the genus *Elaeis*; *E. guineensis* also known as African oil palm and it is the major trading oil palm, *E. oleifera,* also known as American oil palm and finally *E.*

odora, which is not a domesticated species. *Elaeis guineensis* is the only oil palm cultivated on a broad scale in this genus (Henson, 2012). From all these species extracted oil has different chemical compositions and fatty acid levels. Oil with the richest unsaturated fatty acids is obtained from *E. oleifera*. Plant breeders are working on hybridizing the species in order to obtain better features (Rival & Levang, 2014).

From palm fruit can be produced two types of oils: crude palm oil and palm kernel oil. While crude palm oil is produced from the flesh of palm fruit, palm kernel is produced from oil palm tree fruit's kernel or seed. These two oils also differ in their fatty acid composition (Mba et al., 2015; Pande et al., 2012).

Palm oil contains saturated fatty acids, in the percentages of 44% palmitic acid and 5% stearic acid, and unsaturated fatty acids in the percentage of 39% oleic acid and 10% linoleic acid. The remaining 2% consists of myristic and lauric acid. On the other hand, palm kernel oil contains mostly saturated fatty acids, such as 48% lauric acid, 16% myristic acid, 8% palmitic acid, and unsaturated fatty acids such as 15% oleic acid and 3% linoleic acid (Rival & Levang, 2014).

Palm oil and palm kernel oil are significant ingredients for several edible and non-edible products, such as personal care products, and biofuels. Palm oil is a versatile vegetable oil thus it can be used for different purposes to produce a wide range of products from food to fuel and oleochemicals.

1.2 **History of oil palm**

The first findings of plant fossils similar to *Elaeis guineensis* date back 15 million years BP. Palm oil plantation for commercial use starts in the early 1800s in West Africa (process is shown in Figure 1-2) and, even it is imported to Southeast Asia in 1848, industrial plantation there starts at the beginning of the 20th century. The installations of industrial plants and the expansion of exports create an important market in West Africa and Southeast Asia (Henson, 2012).

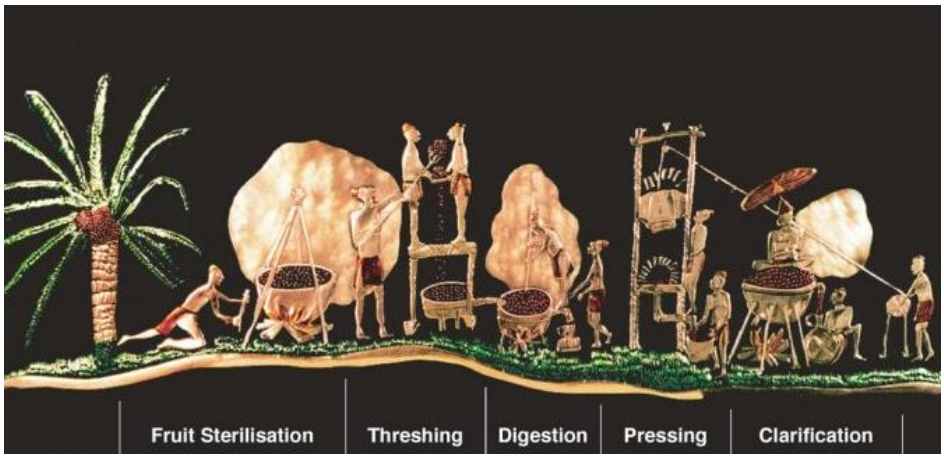

Figure 1-2: Original African processing steps to extract palm oil (MPOC, 2020)

Oil palm plantation started to expand in 1960s in Malaysia and, in the 70s of the Twentieth century, it was relocated in Indonesia, starting to expand globally. After such an expansion and economic liberalization, in the late 1980s oil palm attract the private sectors' attention with it is profitable appearance. Also, after governments realized the potentiality in generating revenues, they started to give incentives like cheap lands and economical sources for developments (Sodano et al., 2018).

Oil palm plantation needs long term investment in the plantation area, materials and transportation to processing (Henson, 2012).

At the beginning of its history, palm oil was just used locally for cooking and medicinal use in Africa. In the 1870s it is manufacturing in the Europe for edible use, especially in margarine production, started. Recently, recently palm oil expanded in a wide range of food and nonfood uses, like biodiesel and various oleochemicals, and demand of its products has proven that the oil palm plantation will continue to expand (Henson, 2012).

1.3 **Palm oil characteristics**

The oil palm fruit (Figure 1-3) is a drupe formed, elongated shape, small fruit which grows in large tight bunches. The fruit size is ranging between 2-5 cm. The unripe fruits are black but color turns to reddish when ripe.

The fruit is composed of a hard kernel in the middle is surrounded by a shell (endocarp), and fleshy mesocarp is surrounded by a thin outer layer (exocarp).

Palm oil fruit has a high level of beta-carotene which gives the red color to this fruit. Because of the color given by high carotenoids levels, crude palm oil is also called red palm oil.

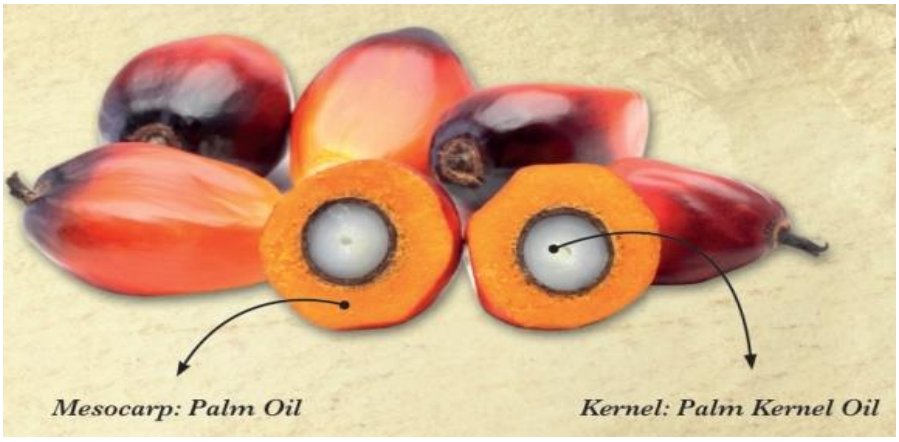

Figure 1-3: Palm fruit (MPOC and MPOB, 2007)

Palm oil has a specific fatty acid composition consisting of almost equal amount of unsaturated and saturated fatty acids together and this combination provides specific characteristics. At room temperature this composition provides a 'melt in the mouth' texture, thus it is used as an alternative to butter in many food products (Rival & Levang, 2014).

A great technological advantage is that, while in the process; other oils such as sunflower, soybean, rapeseed needs to be hydrogenated to avoid trans fatty acids, palm oil does not need it; due to the fact that it has very little or no trans fatty acid in composition (Rival & Levang, 2014).

Oil palm is a significantly productive oil crop. Comparing with other oilseed crops, up to 10 times more oil per hectare is produced from palm oil. Having the highest oil yield per unit of the cultivated area makes oil palm plantation to be critically important for world trade (Mba et al., 2015).

Due to the high yields oil palm, it needs less area than other oil crops and this attracts the attention of smallholder farmers and provides regular income with year round harvest (Barthel et al., 2018).

Oil yield is affected by cultivation parameters such as plantation density, irrigation systems and fertilization, and the presence of intercropping. While the oil yield can even reach more than 10 tonnes per hectare in well managed plantations, the global average of yield is 3.8 tonnes per hectare (Figure 1-4) (Rival & Levang, 2014).

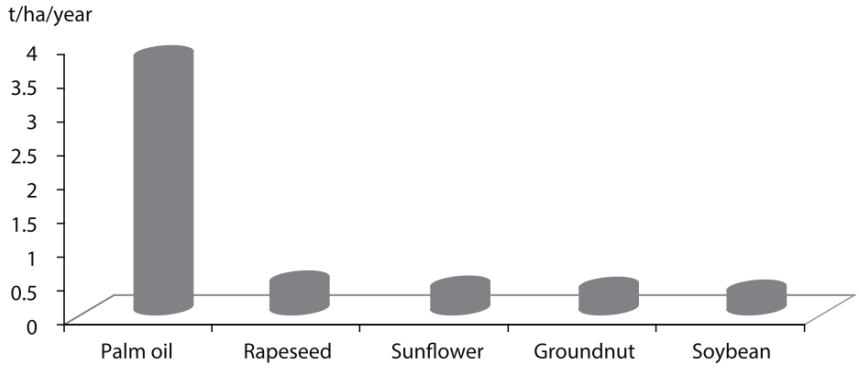

Figure 1-4: Oil yield of the main oil crops (t/ha/year) (Rival & Levang, 2014)

Oil palm constitutes more than a third of vegetable oil production on a much lower proportion of land use than other oil crops. Also, palm oil has the lowest production costs comparing with others; (it has 20% lower production costs than its biggest rival, the soybean) (Rival & Levang, 2014).

Due to these high yields Rival and Levang (2014) remarked palm oil as a "natural oil machine" and "miracle plant".

Combination of this high land productivity, almost 6- 10 times more than its rivals, and cheaper vegetable oil prices makes palm oil one of the most important commodities in the market. In 2005, palm oil became the main edible oil in the world, surpassing soybean oil.

1.4 **Cultivation area**

The oil palm tree grows in significant environmental conditions; therefore its growth is limited in specific areas in the world. It is a tropical tree and because of the demand of intense sun light and high humidity in the cultivation process, it is cultivated mostly in Equator area.

The oil palm tree has strong survival properties such as the ability to resist very dry season, to grow a few years without fertilizer, competing with other crops. However it is really sensitive to temperature and it cannot grow at a temperature of less than 15 ˚C(Rival & Levang, 2014).

Recently, palm oil accounts for 35% of the total produced vegetable oil globally. The five major vegetable oils include palm, soybean, rapeseed, sunflower and palm kernel oil, covering 91 percent of the total world vegetable oil production in 2019/20 (Figure 1-5) (USDA, 2020).

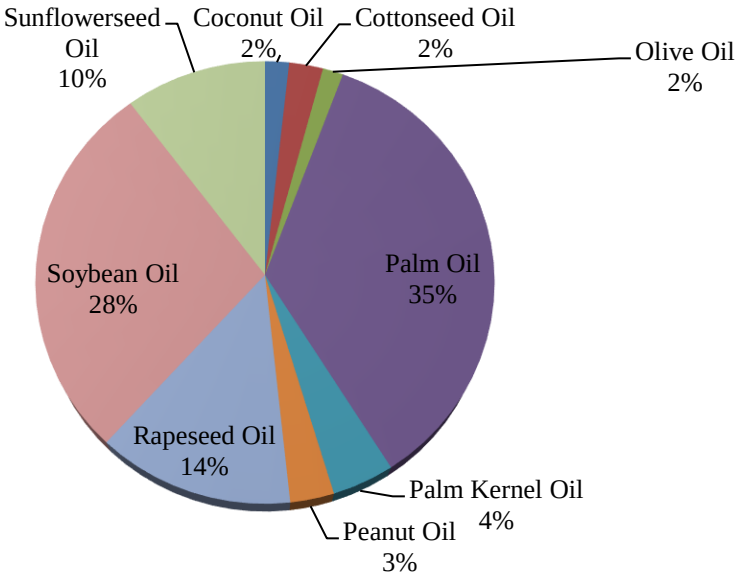

Figure 1-5: Major vegetable oils production percentages in 2019/20 (Data from USDA, 2020)

Most of the world's palm oil production comes from Indonesia and Malaysia, as seen in Figure 1-6, followed by Thailand, Colombia, Nigeria, Guatemala, Honduras, Ecuador, Papua New Guinea, and Ghana.

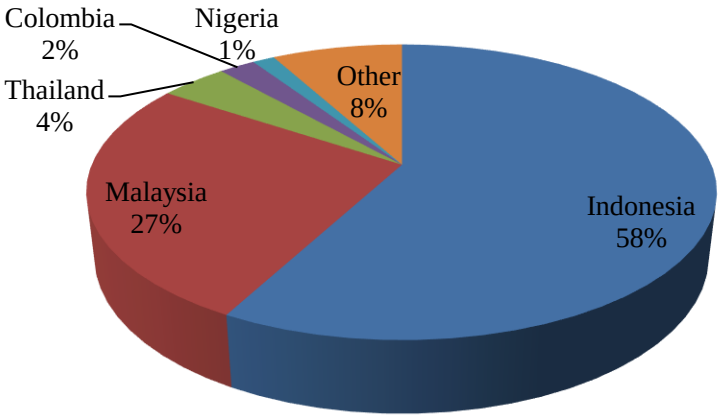

Figure 1-6: Major palm oil producing countries and percentages in October 2020 (Data from USDA, 2020)

While Indonesia and Malaysia are the most significant countries for the world production of palm oil (as seen in Figure 1-6), the major countries of the domestic consumption of palm oil are Indonesia, India and China (showed in Figure 1-7).

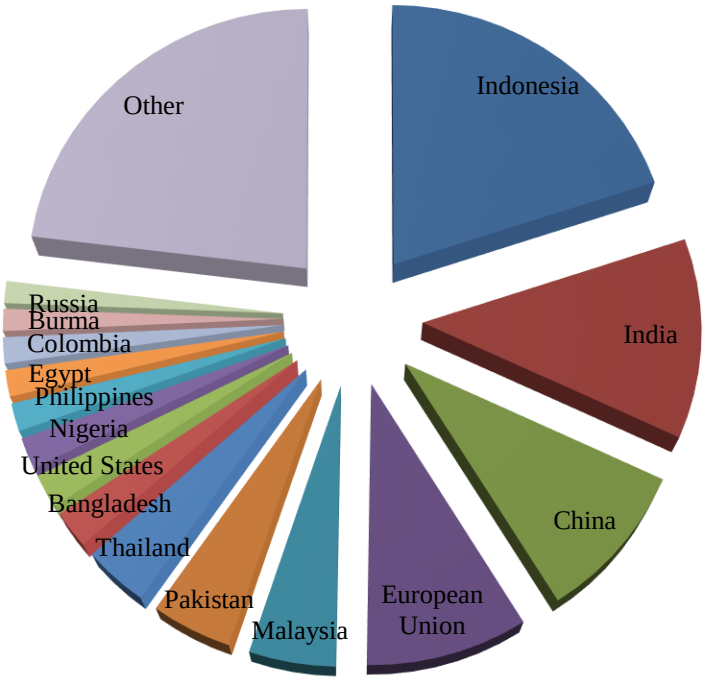

Figure 1-7: Main palm oil consuming countries in October 2020 (Data from USDA, 2020)

The common point for leader consumption countries is demographic variables; indeed, these emerging countries such as Indonesia, India and China have large populations. However, European Union consumption comprises just 9% percent of the total world consumption (Voora et al., 2019).

1.5 **Palm oil supply chain**

The supply chain begins with oil palm producers which can be independent smallholders, tied smallholders with land development schemes and private estates. The other main stakeholders of the supply chain are palm oil processors or traders who process palm oil, consumer goods manufacturers who manufacture palm oil products, and retailers who sell palm oil products to consumers (Figure 1-8).

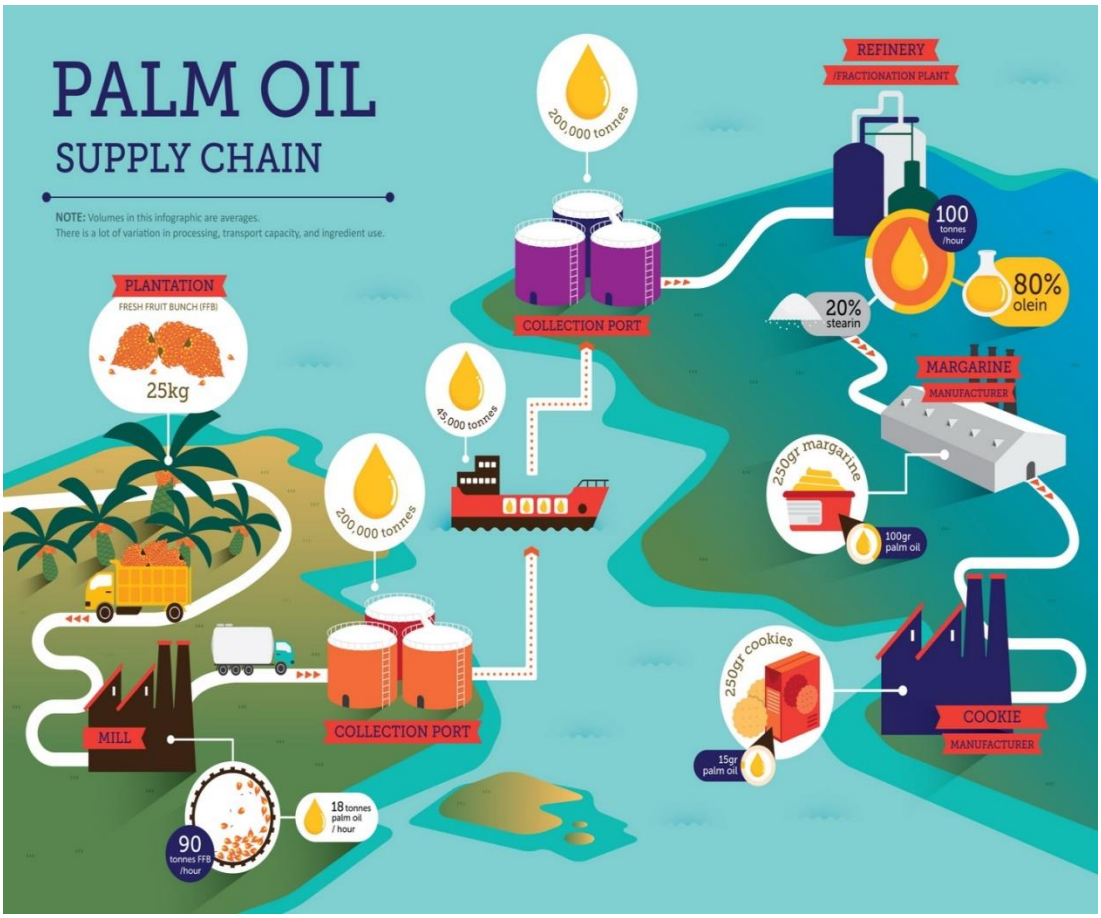

Figure 1-8: Palm Oil Supply Chain Infographic (RSPO, 2020)

Within the supply chain, there are also other stakeholders, such as banks and investors who make investments in the palm oil industry for improvement, environmental and social NGOs who represent public opinion on the aspects of industry and governments who regulates the industry by releasing regulations and policies. And finally, consumers are the key actors for industry with their purchasing decision (Figure 1-9).

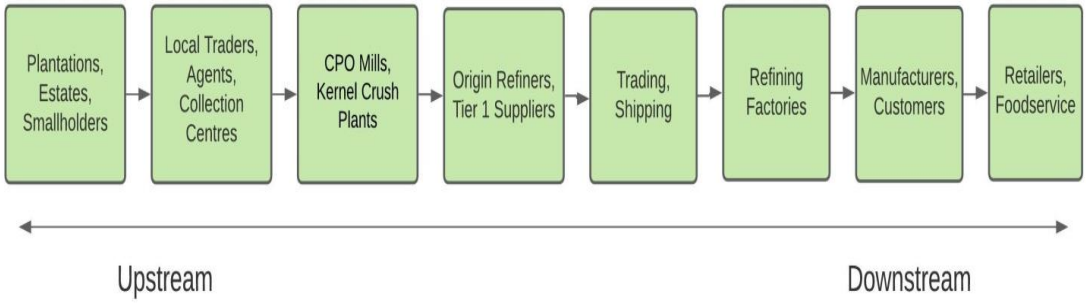

Figure 1-9: Palm oil Supply Chain Actors (Data from EPOA and IDH, 2019)

1.6 **Production process of palm oil**

Palm oil processing contains milling process, consisting of fruit sterilization, and stripping off fruits from bunches, also digestion, pressing, clarification and drying steps for producing crude palm oil (Figure 1-10). At the same time, in similar way palm kernel oil is produced. During all these steps byproducts like fibre, shells, effluent are sent to factories to be used for other purposes. After further processes, different types of refined palm oil and palm kernel oil and their mixes are produced for edible uses in the food industry or non-edible uses such as the production of oleochemicals and biodiesel.

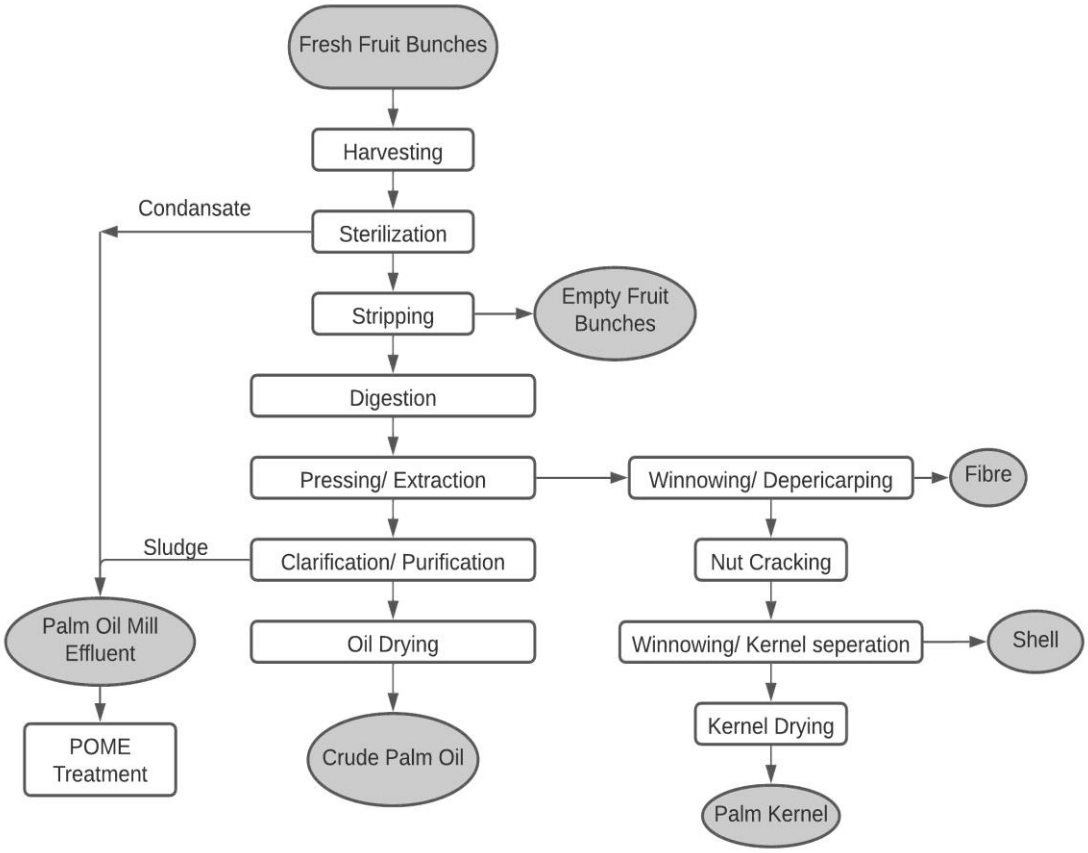

Figure 1-10: Palm oil extraction process (Data from Hashim et al., 2012; Poku, 2002)

Palm oil milling efficiency is about 90-93%, relying upon the recovery rate of remaining oil, equipment and process management. The oil extraction rate for crude palm oil is about 18-23% and for palm kernel oil is about 4-6%. The quality of these oils depends on free fatty acid content, moisture and impurities level (Hashim et al., 2012).

1.6.1 *Harvesting and handling*

Ripe palm fruit contains about 56-70% oil (Mba et al., 2015). This part can be extracted by using traditional, small, medium or large size industrial mills (Poku, 2002).

When fruit palm reaches maturity, ripe fruits are harvested by detaching from the bunch. During this process if fruits are damaged, free fatty acid content increases, and as a consequence quality decreases. The free fatty acid composition of the bunch is affected by the level of bruises in the fruit (Poku, 2002).

After harvesting, fresh palm tree fruit bunches are transferred to the plant for the milling process. Transportation should be fast and in the limited area (around 50-100 km), because fresh fruit bunches deteriorate rapidly (Pacheco et al., 2017).

And for the better final quality of oil, the increase of free fatty acid level overtime should be minimized by limiting the degradation. In this step, as well as age and genetic properties of palm oil tree, also harvesting technique, environment, handling and transportation conditions affect the final quality of the product (Hashim et al., 2012; Poku, 2002).

Arrived bunches are selected according to their maturity level. The ripeness of the fresh fruit bunches is the major factor for determining the final oil quality.

Fruits from many farms are accumulated in the receiving area of the factory and later, with conveyors, they are delivered to the sterilizer.

1.6.2 *Fruit sterilization*

Sterilization of fresh fruit bunches should be done as soon as possible after harvesting.

Initially, fruit bunches are entered to sterilization for heat treatment by pressurized steam. The aim of this stage use the heat to kill the bacteria, stop the lipolytic enzyme activity and degradation, and also minimize the increase of free fatty acids which can eventually degrade the final quality of oil and coagulate proteins (Hashim et al., 2012; Mba et al., 2015).

Heat treatment by high pressure steam in sterilization causes also moisture expansion, which subsequently helps the loosening of shells from the kernel when the pressure is removed. Also this moisture plays a role in the chemically break down of gums and resins which are the reasons for oil foam during frying. So these broken down compounds can be removed later by oil clarification (Poku, 2002).

While the sterilization step provides a lot of important attributes to the product, there are some details that should be considered such as air removal from the sterilizer. Because air increases the risk of oil oxidation and also can disrupt the heat transfer during sterilization, it should be removed properly. Also over sterilization should be avoided due to causing poor bleach properties of oil and discoloration of palm kernels (Poku, 2002).

1.6.3 *Fruit stripping or loosening*

The sterilization step helps to remove fruits from the bunch by shaking or tumbling. From sterilized fruit bunches, fruits are stripped off in a rotating drum by mechanized systems or by

manual threshing. Empty fruit bunches are sent to other factories for other uses like mulching or as organic fertilizer (Hashim et al., 2012; Poku, 2002).

After fruits are sorted from the stalks, loose fruit is transferred for the next step while waste stalks are sent for other use purposes.

1.6.4 *Digestion*

Stripped fruits are transferred to the digester and are prepared for the extraction step. By using steam, fruits are heated and stirred in the digester. In the steam heated digester, at high temperature, fruits are pounding to help removing mesocarp of fruit, reducing oil viscosity by breaking oil cells and completing the oil cell disruption. It also helps to release crude oil before pressing. Iron contamination from vessels should be avoided in order to protect the oil from oxidation (Hashim et al., 2012; Poku, 2002).

1.6.5 *Pressing and oil extraction*

In pressing step digested fruits are squeezed to extract the oil.

Crude palm oil can be obtained by dry method or wet method. The dry method is performed through mechanical pressing: oil is extracted by squeezing the mash of oil, moisture, fibre and nuts by using a hydraulic press or centrifuge (Poku, 2002).

In wet method, with a help of hot water or steam, oil is extracted from milled palm fruits by destroying oil cells, hydrolyzing gums, resins and starch and also, during this process, proteins are coagulated to be removed in the next steps. Afterward moisture is evaporated from oil (Mba et al., 2015).

The efficiency of mechanical pressing or solvent extraction methods are different: in the mechanical press the efficiency of palm oil extraction can reach 90% (Mba et al., 2015).

During fruits digestion and crude palm oil extraction, fibre and nuts which have still retain oil together with kernel go through a similar process to obtain palm kernel oil which will mention later.

1.6.6 *Clarification, Purification*

After the extraction crude palm oil contains desirable compounds such as phytosterols, triacylglycerol, carotenoid, vitamin E, as well as undesirable compounds like free fatty acids,

phospholipids, gums, and lipid oxidation products. The aim of the oil refining process is to remove these impurities from crude palm oil (Mba et al., 2015).

After pressing palm oil, water, cell debris, fibrous material and other not oily solids mixture enter into clarification step. Hot water is added to the mixture to dilute and separate some impurities, and then it is boiled with the aim of maximizing oil yield and decreasing moisture by removing water soluble gums and resins in the oil (Poku, 2002).

In the clarifier tank crude oil and its solid fractions in water are separated: the impurities remain in the speed purifiers and a part of the remaining moisture is removed before drying (Hashim et al., 2012).

Impurities are then removed in a centrifuge and are filtered out. The sludge removed from the clarification stage are sent to be used as palm oil mill effluent (POME) for waste water treatment factory (Hashim et al., 2012).

1.6.7 *Oil Drying*

After centrifugation, oil is sent to vacuum dryer for further purification. Vacuum is used to maintain the oil quality by limiting the level of degradation to free fatty acids (Mba et al., 2015).

After the drying step, dried oil is sent to the tank for storage. In storage solidification and fractionation of oil should be avoided by keeping the temperature under control (Poku, 2002).

1.6.8 *Palm kernel*

At the same time with the crude palm oil process, after the press and extraction step, fibre and palm nuts are transferred for another operation. This residue from the press is also called press cake which contains fibre and palm nuts.

The press cake which is discharged from the extraction process goes to the winnowing process in depericarper. In this process fibers are separated from palm nuts (Hashim et al., 2012).

Separated fibers are left to rest for maintaining their own internal reactions which provide heat for a couple of days. Later fibre is pressed for recovering more oil which is classified as second grade due to low quality and used in soap production. This second pressing of oil provides an additional 3- 4% oil but with lower quality due to free fatty acid level and rancidity (Poku, 2002).

Fibre can be also sent to a steam boiler together with kernel shells for use as fuel for boilers to generate steam and electricity. Meanwhile, nuts are dried and cracked until kernels are obtained. In this process breakage of kernels should be minimized for better quality. Kernel shells are separated from kernels by the winnowing process and shells are transferred to drier (Hashim et al., 2012; Poku,2002).

After shells are separated, kernels are transported to the palm kernel mill and crushed, and palm kernel oil is extracted. Palm kernel oil is stored in big tanks or other containers and transported to the other factory for refining. Empty fruit bunches, fibers and shells are sent to be used as factory fuel or compost to use at the plantation.

1.6.9 *Palm Oil Refining Process*

In the refining process (Figure 1-11), crude palm oil is further processed with the aim of removing fatty acids, color and flavour. Because crude palm oil contains impurities that should be removed, such as water soluble impurities, pigments, volatile and physical components, at the refinery it is treated to make it more suitable for different use and consumption.

Refining can be done either physical with steam or chemical with alkali solution.

In chemical refining crude palm oil is washed with sodium hydroxide or sodium carbonate solution with the aim of decreasing free fatty acids level and removing phospholipids and gums. For refining the oil, this step should be followed by neutralization in which residual phospholipids and metals are removed (Mba et al., 2015).

In earth bleaching stage, oil is mixed with the earth which is bound to impurities such as pigments, residual soaps and phospholipids and then they filtered out from oil. Bleached oil goes to deodorization stage: there, by using steam, volatile compounds and other contaminants are removed under vacuum.

In physical refining of crude palm oil, oil is washed with water to get rid of water soluble components in the oil phase. Then by phase separation, the oil and water mixture is separated. Oil goes to the bleaching step where oil is mixed with the earth to bound impurities and then the earth is filtered out from oil. Pigments are removed by bleaching and in the deodorization step, by steam at high temperatures, volatile oxidation components are removed under vacuum.

In physical refining, compounds are volatilized at high temperatures and low pressures and the volatile compounds are removed (Mba et al., 2015).

The final product is a safe, healthy, clean and colorless oil with good stability.

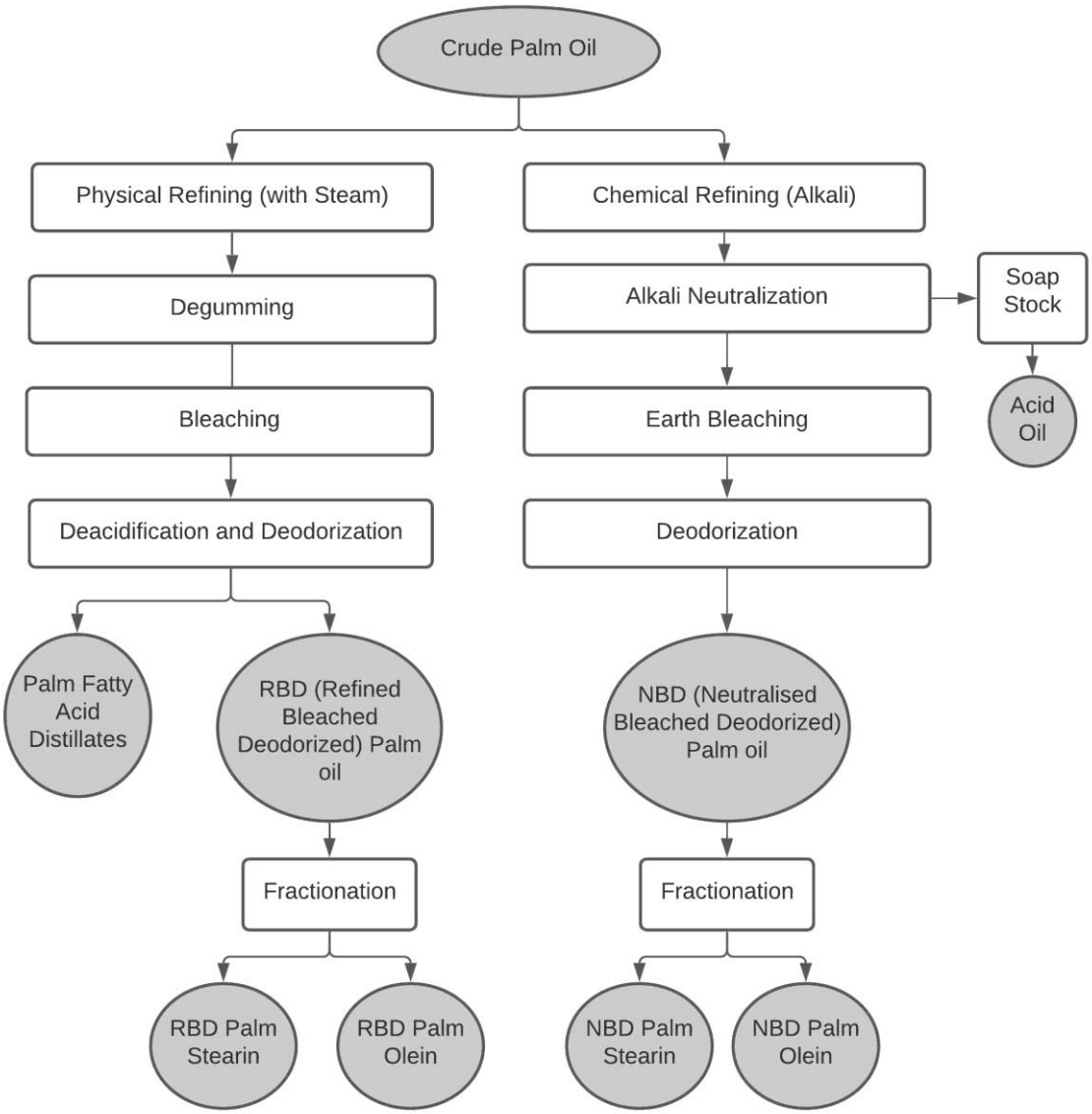

Figure 1-11: Diagram of palm oil refining process (Data from ITC, 2012; Mba et al., 2015; MPOC, 2020)

1.6.10 *Fractionation of palm oil*

In fractionation step, palm oil is separated into two fractions:

- the liquid fraction called palm olein;
- the solid fraction called palm stearin.

All fractions have different chemical and physical properties.

The aim of fractionation process is to change physicochemical characteristics of oil such as for decreasing unsaturated acyl group levels. Fractionation increased the added value of oil. And can be done by using different crystallization and filtration techniques (Mba et al., 2015).

Palm oil can be fractionated in three different ways:

1. dry fractionation which is crystallization of refined oil without using chemicals;
2. detergent fractionation where is used a detergent solution;
3. solvent fractionation where are used solvents like hexane or acetone (International Trade Centre, 2012).

Fractionated oil has different uses, "Refined, Bleached, Deodorized" (RBD) palm stearin is used generally for food products like shortenings and margarines. While RBD palm olein is used as frying and cooking oil (Mba et al., 2015).

1.6.11 *Palm kernel oil extraction process*

Stored palm kernels from crude palm oil production process are transferred for further process to produce palm kernel oil (Figure 1-12).

Palm kernels are sent into screw press: at the end of the process, crude palm kernel oil is extracted in two stages while palm kernel cake is discharged. From the first stage of extraction about 45-49% oil is maintained. While in the second stage, discharged kernel cake is sent to screw press again for second extraction and from this process about 6-7% oil is maintained (Hashim et al., 2012; Poku,2002).

After extraction, palm kernel oil is transferred through screens to observe existence coarse solid impurities in the oil and then pumped to filtration. In filtration, remaining solids and residual dirt are cleaned by filters. Filtered clean oil is stored in tanks while discharged cakes are sent to press for recovering rest oil (Hashim et al., 2012; Poku,2002).

Palm kernel cakes are sold to ruminant industry for using as feed meal due to its high protein, fibre and fat content.

Solvent extraction for producing crude palm kernel oil is not used anymore due to its safety issues, high cost in terms of big solvent loss and environmental pollution considerations (Hashim et al., 2012).

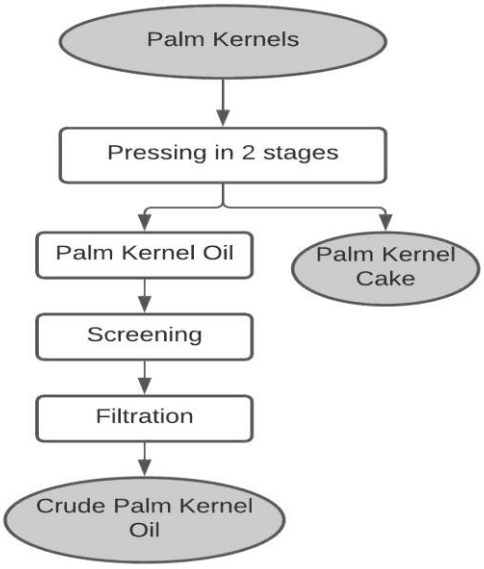

Figure 1-12: Diagram of palm kernel oil extraction process (Data from Hashim et al., 2012)

1.7 **Quality of palm oil production process**

Quality is a subjective parameter and depends on final consumers' expectations. For providing better oil quality, process control is critical as well as used equipment. According to Poku (2002), rapid sterilization after oil palm harvesting, efficient clarification step and crude palm oil drying stages are the most substantial parts of the process for maintaining a good quality for industrial use. On the other hand, if crude palm oil is produced for domestic use, harvested bunches can rest for a couple of days before sterilization, and also herbs can be added to the drying phase for giving different flavor. Hence, quality requirements, key factors and stages' changes depend on the purpose of use. Consequently, equipment selection, capital investment, plant size, needed technology and labour force should be selected according to the aim.

For the refining process of crude palm oil to use as edible oil, free fatty acid and oxidation products contents should be low for reaching the desired quality of the product. Because removing free fatty acids during refining process increases the cost of process and additionally, oxidation products can cause off-flavors (Poku, 2002).

The processing capacity of palm oil mills varies from 10 tons per hour to 96 tons per hour. Over years, the amount of mills and refineries has increased in Indonesia and this induced an improvement in efficiency and growth in sector integration (Pacheco et al., 2017).

Large scale and integrated mills have more efficient results than smaller and less integrated mills. Moreover, mills located closer to the production area have better results in the terms of quality and extraction rate. However, only the main brand groups are able to have their own refining capacity, which supplies them more control over the market (Pacheco et al., 2017).

For maximizing the rate of oil extraction and to guarantee optimum oil quality, efficient plantation management and process are critical as well as strict harvesting standards (Barthel et al., 2018).

For the plantation of palm oil with a higher yield, a regular water supply is needed (Henson, 2012).

The success of oil palm cultivation depends on the existence of proper facilities for extracting oil and kernels from harvested fruits. Extraction methods affect the quality of the oil by affecting its free fatty acids content (Henson, 2012).

1.8 **Uses of palm oil**

Palm oil is an important versatile vegetable oil widely used in various products in the food and non-food industries thanks to its consistency, texture and structure. Having a high amount of saturated fat content gives its creamy texture to palm oil and this enabled it to be used in many products. Also, palm oil is a fractionated oil and its fractions are used in different food products.

Approximately 70% of palm oil is used in food industry while remaining 30% is consumed for industrial uses such as biofuels, industrial lubricants, and cosmetics including personal care and cleaning products (Figure 1-13) (Statista, 2019)

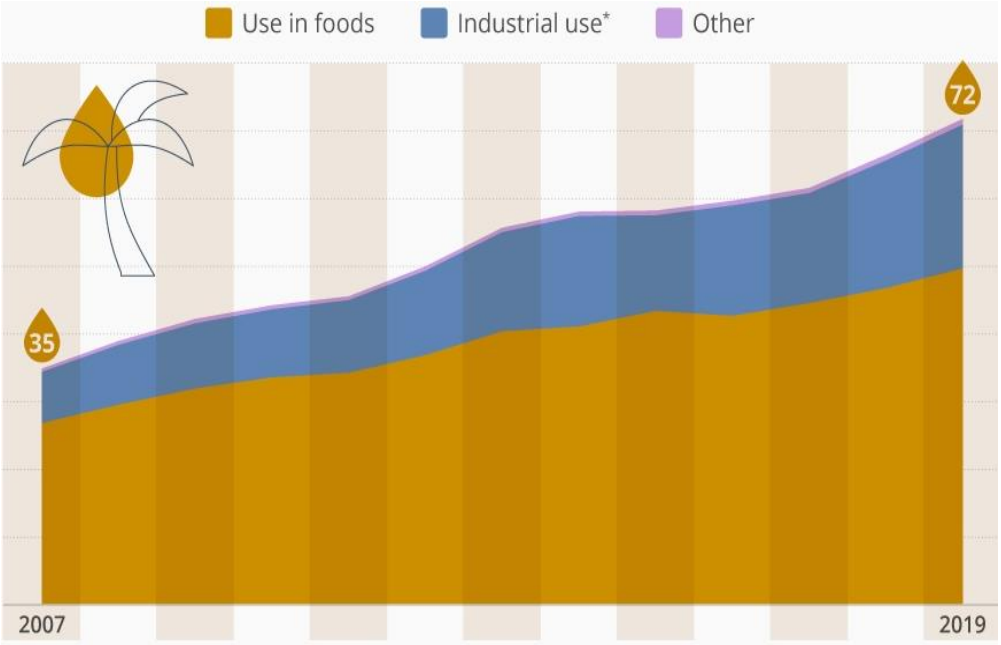

Figure 1-13: Global consumption of palm oil (in million metric tons) (Data from Statista, 2019)

Palm oil is used in many food products such as chocolate spreads, margarine, biscuits, shortenings, ice cream, chocolate, bakery products, cereals, instant noodles and soup, chips, crisps, chewing gums, desserts, filled milk powders, powdered coffee whiteners, whipped toppings, cocoa butter equivalents, salad dressings, confectionaries, emulsifiers, dry soup mixes and also as table or frying oil (Aguiar et al., 2018; Disdier et al., 2013; Pande et al., 2012).

Moreover, it is used in other industrial products like biodiesel, personal care products and oleochemicals such as cosmetics, soap, shampoo, cream, toothpaste, lubricants, candles, pharmaceuticals, leather, surfactants, agrochemicals, paint, printing ink , detergents, electronics, engineering thermoplastic etc. (Aguiar et al., 2018; Pande et al., 2012; Rival & Levang, 2014; Sodano et al., 2018).

Palm oil can replace some traditional fats in the food industry with its competitive price, consistent supply and favorable characteristics due to its high fat content and low melting triacylglycerol level. Furthermore, it has a long shelf life due to its high stability against oxidation (Pande et al., 2012).

Palm oil has a particular composition of fatty acids and triacylglycerol and that makes it desirable in the production of many food products. Having almost equal amounts of saturated and unsaturated fatty acids makes palm oil unique. Crude palm oil has both liquid and solid

fractions with different chemical and physical properties. While the liquid fraction consists of palm olein, the solid part consists of palm stearin (Mba et al, 2015).

Palm oil is semi-solid at room temperature without the need for artificial hardening with hydrogenation. Additionally, it is rich in carotenoids like β-carotene and lycopene and also vitamin E. Because vitamin E has antioxidant properties, it provides palm oil higher oxidative stability during frying and other food applications (Mba et al, 2015; Pande et al., 2012)

Palm oil is used in many countries for cooking and frying due to its high smoke point around 230 ˚C (Mba et al., 2015). Also, not having trans-fatty acids makes palm oil a proper frying oil. Moreover, it is resistant to oxidation, polymerization and foaming. For the choice of which oil to be used during frying, their economic, nutritional, physical and chemical properties are taken into account and due to its lower melting points, palm olein is the most used commercial frying oil. Palm oil also extends the shelf life of a fried products, and does not leave residues in equipment (Pande et al., 2012). On the contrary, in Europe it is used as solid fat at room temperature or in a processed products which is not a substitute for traditional oils like olive oil, sunflower oil (Rival & Levang, 2014).

Palm oil and palm olein are used in chocolates as cocoa butter replacers. Cocoa butter together with sugar gives the characteristics of chocolate such as smooth texture, flavour, melting and crystallization properties. Palm oil is used as cocoa butter equivalent due to its similar melting point, processing and rheological characteristics (Pande et al., 2012).

Another use of palm oil is as a dietary supplement. Components like carotenoids, vitamin E, Co Q10 are isolated from palm oil and used for fortifying food or as a dietary supplement (Pande et al., 2012).

Thanks to palm oils high carotenoid composition, it can be used as a source of vitamin A. After processes such as bleaching and deodorization of palm oil, red palm oil, which is rich in carotenoids is produced. Red palm oil is cholesterol free and it could be used as a functional food ingredient in bakery products, as margarine colorant and as cooking and frying oil (Pande et al., 2012).

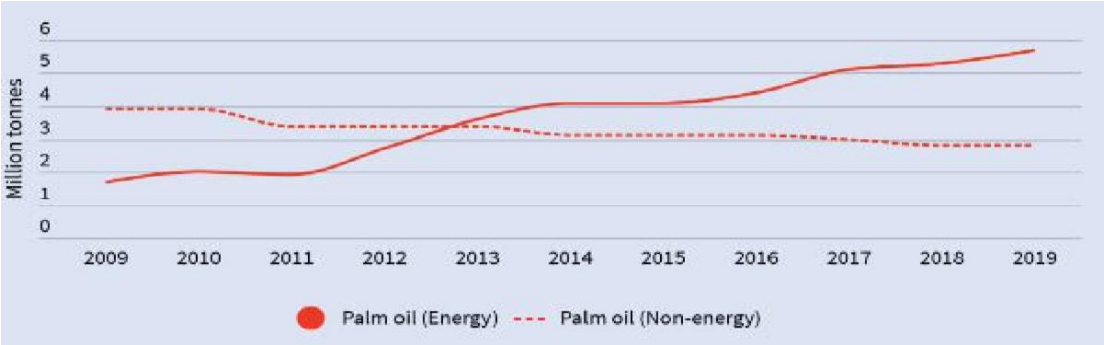

Figure 1-14: Final use of palm oil in Europe (Transport& Environment, 2020)

As it is seen in Figure 1-14, palm oil's use for energy such as biofuel, for heating or electricity production has increased with time, whereas the amount for non-energy uses such as food, feed, or oleochemical has decreased a little but has not changed significantly. The biggest reason for the change in the use of palm oil in 2013 is due to antidumping duties on Indonesian palm oil as biodiesel, imposed by European Union to protect the trade (Transport& Environment, 2020).

While in 2009 just 24% of palm oil was used to produce biodiesel, it doubled in ten years and in 2019 became 53% in Europe.

Biofuels got from palm oil and different biomass can be utilized as an option to replace fossil fuels. As a substitute, palm oil is less favored than other vegetable oils due to its high viscosity and lower energy density. Nevertheless, oil palm provides high yields with low cost which makes it significant for fulfilling biofuel needs (Fitzherbert et al., 2008).

In the European Union, the consumption amount of palm oil as a biofuel is much more than use in food or cosmetics. Specifically, in 2019 palm oil used to produce biodiesel is 22 times higher than the volumes that Ferrero Company (Nutella, Kinder) used, 15 times higher than Mondelez group (Oreo) used and 4 times higher than Unilever (Axe, Dove, Knorr) used (Transport& Environment, 2020).

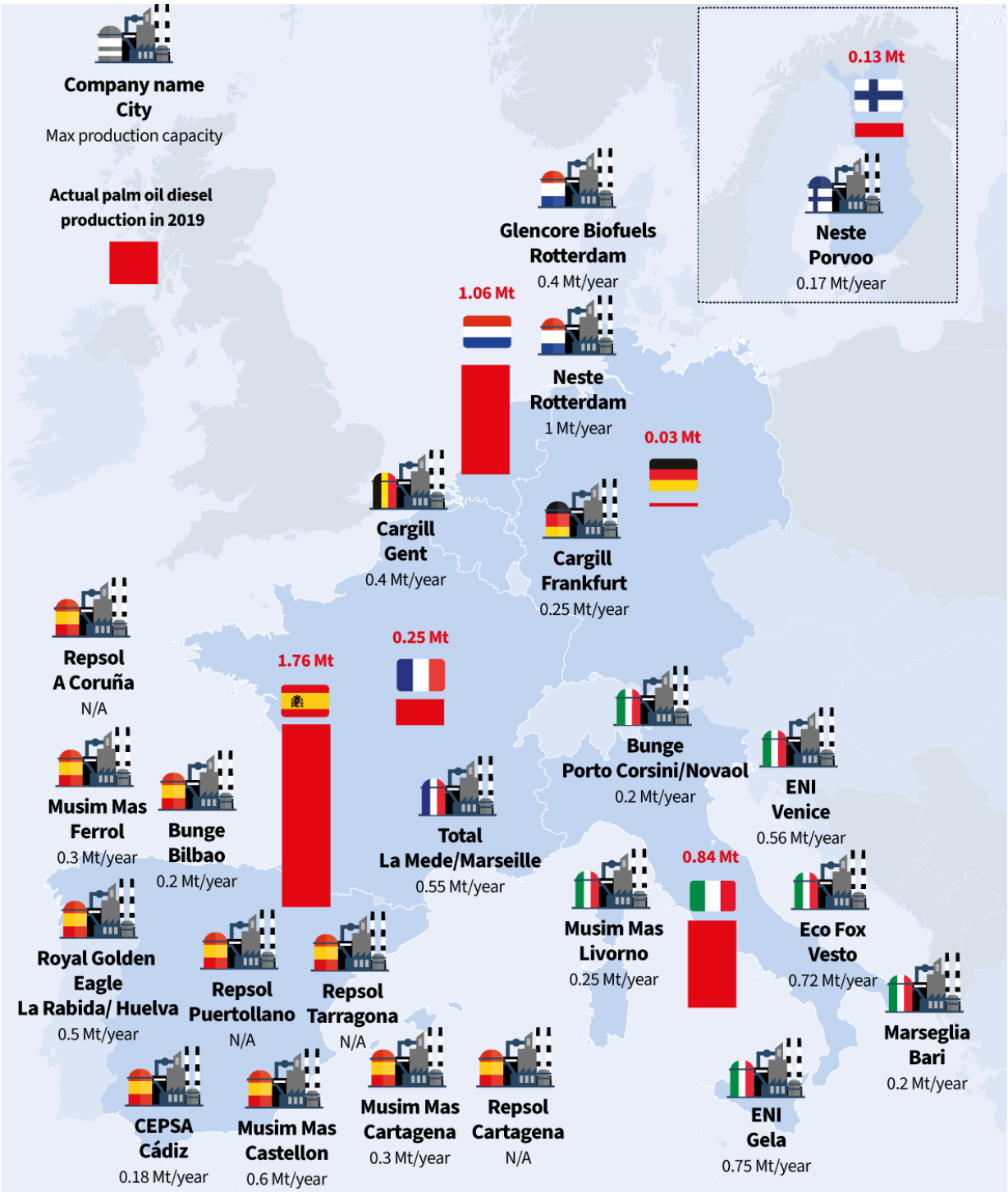

Figure 1-15: Palm oil diesel factories in Europe (Data from Transport& Environment, 2020)

Spain, Italy and the Netherlands are the biggest producers of palm oil diesel in Europe. Italy has 6 biodiesel plants with 2.68 million tonnes per year capacity, followed by Spain with 10 plants and the Netherlands with 2 plants (Figure 1-15) (Transport& Environment, 2020) .

European Union promotes biofuel use and demands the use of sustainable certificated palm oil due to environmental concerns. Biofuels are more carbon neutral in contrast to fossil fuels. Nonetheless, just if plantations are made on degraded forest land, otherwise forest clearance and utilization of fossil fuels cause huge greenhouse gas emissions. If oil crops are not replacing forests, utilization of biofuel from palm oil and different vegetable oils is going to worsen climate change, speed the biodiversity loss and increase food prices (Fitzherbert et al., 2008).

Finally, while crude palm oil is used in different products from biodiesel to food, also palm kernel oil is processed into products like shampoos and liquid detergents as it is the primary feedstock for fatty alcohol production (Barthel et al., 2018).

Palm kernel oil is preferred to produce mostly non- edible products like detergents and cosmetics because of its fatty acid composition. Also, the kernel residues after extraction are used for animal feeding purposes (Henson, 2012).

Palm kernel oil is also used as cooking oil or in the production of margarine, soap, cosmetics, and oleochemicals (Rival & Levang, 2014).

Biomass from oil palm also can be used for producing some other products or for other purposes in order to minimize waste. Oil palm leaves can be used as cattle feed; timber or fibreboard can be produced form the trunk and, finally, fresh fruit bunches can be used as fertilizer or to recover fibers (MPOC and MPOB, 2007).

Chapter 2
THE PALM OIL MARKET: AN OVERVIEW

2.1 **Introduction**

Palm oil is one of the most important globally traded commodities with its highly profitable characteristics for the global agro-industry. Over the past years, oil palm cultivation and market have expanded importantly. This high rate of expansion and also increase in global demand due to its versatility, results into significant growth in palm oil trade. Moreover, palm oil is one of the cheapest vegetable oils in the world market with lower prices than rapeseed, soybean and sunflower oil. To meet the increasing demands due to growing world population, increasing product variety and its comparatively low prices, palm oil production is growing more and more.

Palm oil is the most produced vegetable oil in the world, followed by soybean oil (28%) and rapeseed oil (14%) (USDA, 2020).

Both palm oil and palm kernel oil play a significant role in global vegetable oil market comparing with other oils (Pacheco et al., 2017).

Even though palm oil markets cope with some difficulties, palm oil is a commodity with high profit due to its characteristics with high yields and also its cultivation needs fewer requirements comparing with others in the meaning of fuel, fertilizers and pesticides (International Trade Centre, 2012)

Oilseed production in 2019-2020 globally is lower while palm oil trade is increased about 1million tons.

Global demand for palm oil has increased from 24 million tons in 2000 to 75 million tons in 2020 (USDA, 2020). The demand for palm oil for food industry will remain significant as the population grows. Replacing totally palm oil as a food ingredient is really challenging due to wide range of use in multiple products. Moreover, the demand of palm oil for biodiesel use is increasing (CPOPC, 2020).

2.2 **Palm oil global market**

According to data from USDA (2020), in 2019/2020 term, 73.02 million metric tons of palm oil was produced in the world, accounting for the 35% of the total major vegetable oils.

Most of the palm oil produced is exported: more specifically, in 2019/2020 period, 49.26 million tons of palm oil was exported, about 67% of the total palm oil production and 47.82 million tons of palm oil was imported in all around the world (USDA, 2020).

Indonesia and Malaysia are the biggest producers of palm oil, covering together 85% of the total global production (USDA, 2020).

71.62 million tons of palm oil was used for domestic consumption in the world in 2019/2020, while 68% of it was consumed for food use (48.44 tons), 31% was used for industrial purposes (2.47 tons) (USDA, 2020).

Palm oil is the cheapest vegetable oil on the global market. More specifically, when the average vegetable oil prices from 2008 to 2018 are compared, palm oil from Malaysia (778 U.S. dollars per metric ton) was the cheapest one comparing to soybean, cottonseed, sunseed, peanut, canola, coconut and corn oil (USDA, 2020).

2.2.1 *Production*

Global palm oil production has grown from 11 million tons in 1990 to 75 million tons in 2020, with an increase of 581%. (Figure 2-1).

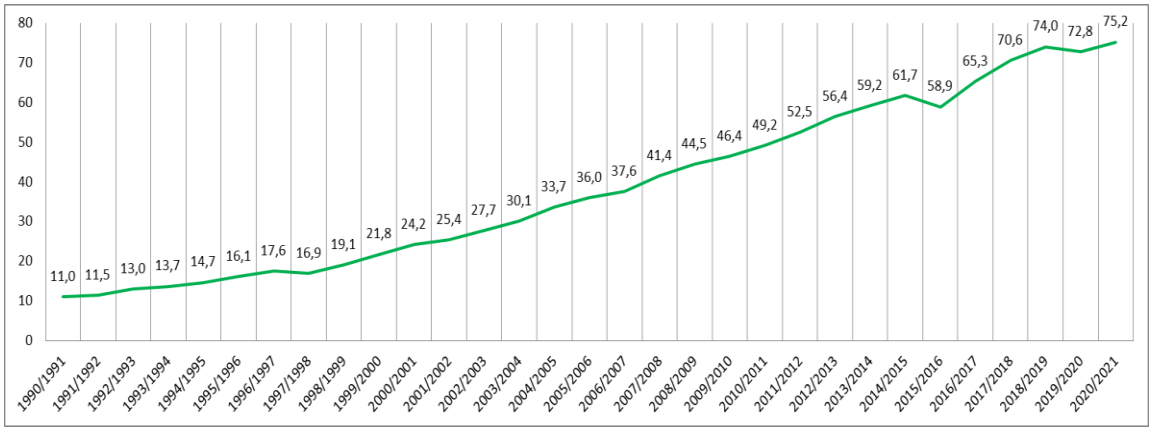

Figure 2-1: World total palm oil production by years in million metric tons from 1990/91 to 2020/21 (Data from USDA, 2020b)

The main production area of palm oil is located in Southeast Asia. Half of the land designated to palm oil production is in Indonesia, while the 23% of the total planted area is in Malaysia.

Indonesia overtook the place of Malaysia in 2006 and since then it became the biggest palm oil producer in the world. In 2019, 58% of the palm oil was produced in Indonesia and 26% in Malaysia, followed by Thailand (4%), Colombia (2%) and Nigeria (2%) (Table 2-1).

Table 2-1: Palm Oil World Production by years (USDA, 2020)

Production (Thousand Metric Tons)	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**Oct 2020/21**
Indonesia	36,000	39,500	41,500	42,500	43,500
Malaysia	18,858	19,683	20,800	19,250	19,900
Thailand	2,500	2,780	3,000	2,800	3,100
Colombia	1,146	1,627	1,632	1,529	1,670
Nigeria	990	1,025	1,015	1,015	1,015
Other	5,845	5,960	6,077	5,927	6,013
Total	65,339	70,575	74,024	73,021	75,198

While Indonesia is the biggest producer of palm oil, Indonesian palm oil production is significantly connected with Malaysia in terms of harvested area for palm oil and palm oil consumption. In the same line, Malaysian palm oil production level is effected by Indonesia's production (Bentivoglio et al., 2018).

While production in Indonesia and Malaysia allows to meet the demands of domestic market and export, in some other countries, such as Thailand, Ecuador and Colombia almost all the production is used for domestic markets (Pacheco et al., 2017)

Due to the remaining limited proper land in Southeast Asia, investments start to change direction towards Africa and South America. Liberia, Nigeria, Cameroon, Brazil and Colombia started to play a role in the palm oil sector but improvements also depend on the actions of the governments, because they can limit the amount of production to protect forests using policies. In 2010, in order to conserve tropical forests, the Brazilian government has introduced a program limiting the expansion of oil palm cultivation to 5 million hectares of non-forested land, even though there are 29 million hectares suitable area for oil palm cultivation. (Vis et al., 2012).

The total global palm oil production is continuously increasing over years and the production by countries slightly changes. Indonesian's palm oil production has grown 21% from 2016 to

2020, while Malaysian's palm oil production has only increased 5% over the same period. In the other countries, production amount over the same period has also increased: Thailand 24%, Colombia 45% and Nigeria 3% (Figure 2-2).

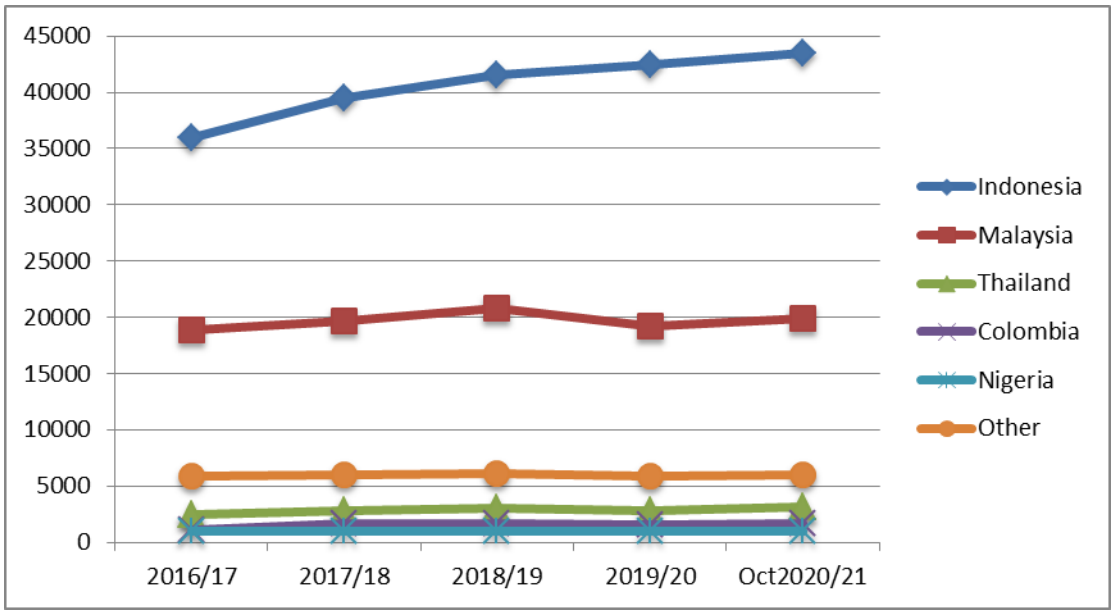

Figure 2-2: World total palm oil production by years and countries (Data from USDA, 2020)

A significant amount of palm oil is produced in small farms. The contribution of smallholders in the sector plays an important role as well at global level oil production (Rival & Levang, 2014). 60% of the palm oil production in the world is produced by private or governmental plantations while the rest is produced by smallholders. 3 million and more of smallholders and small-scale farmers contribute to palm oil production all around the world (RSPO, 2020).

Indonesia and Malaysia have improved palm oil yields per hectare over time. In the 1960s, oil palm yield was around 2 tons per hectare; over time it increased to 4.3 tons per hectare in Malaysia, while world's average increased to 2.4 tons per hectare thanks to the studies in plant breeding and genetics. Thanks to experimental conditions, even 6 tons per hectare was reached. These results show that better results can be reached with oil palm intensification rather than with oil palm expansion (Pacheco et al., 2017).

Even though in the trials high yields are obtained by breeding and variations of plant, far fewer yield is obtained in the field. Pacheco et al. (2017) emphasized that the reasons for the gap

between yield in the field and during trials are inefficiencies during plantation, inadequate nutrient supply and poor management practices in plantation (Pacheco et al., 2017).

2.2.2 *Import*

India, China and European Union are the biggest buyers of palm oil; together they cover 45% of the total global imports.

According to the data from USDA (2020), the main importing countries of palm oil are India (18%), China (14%), European Union (13%), Pakistan (7%), Bangladesh, United States and Philippines (3%), Egypt, Burma, Kenya (2%), Vietnam, Russia and Japan (1%) (Table 2-2).

Table 2-2: Palm Oil World Imports (USDA, 2020)

Imports (Thousand Metric Tons)	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**Oct 2020/21**
India	9,341	8,608	9,710	8,300	8,700
China	4,881	5,320	6,795	6,650	6,900
European Union	7,217	7,079	7,297	7,000	6,350
Pakistan	3,075	3,093	3,175	3,175	3,450
Bangladesh	1,347	1,637	1,569	1,550	1,650
United States	1,367	1,527	1,526	1,516	1,500
Philippines	1,165	1,167	1,055	1,130	1,225
Egypt	1,323	1,095	1,023	1,075	1,200
Burma	809	847	945	900	980
Kenya	767	764	915	920	960
Other	14,685	15,369	16,324	15,599	16,281
Total	45,977	46,506	50,334	47,815	49,196

The total global palm oil imports are increasing over years and the annual growth rate of countries are changing. In 2020, growth rate of palm oil imports for India increased 14%, for China increased 3%, for European Union it decreased 8% and for Pakistan it increased 9% (Index Mundi, 2020) (Figure 2-3).

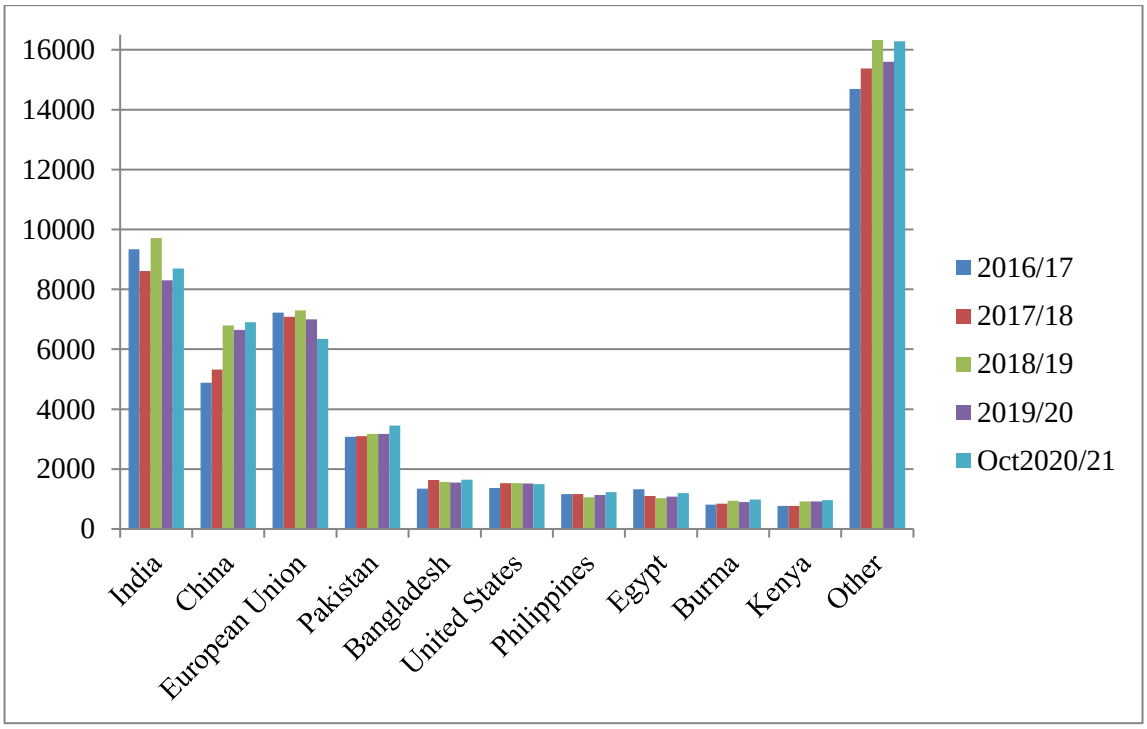

Figure 2-3: World total palm oil imports by years and countries (Data from USDA, 2020)

2.2.3 *Export*

Indonesia and Malaysia are the main palm oil exporting countries in the world; together they correspond to 91% of the total world exports.

Indonesia exports 57% of total palm oil in the world, followed by Malaysia with 34%, Guatemala 2%, Colombia and Papua New Guinea 1% and countries that exports less than 1% are Honduras, Thailand, Ecuador, Cote d'Ivoire, Costa Rica, Benin, United Arab Emirates, Kenya, Ghana (USDA, 2020) (Table 2-3).

Table 2-3: Palm Oil World Exports (USDA, 2020)

Exports (Thousand Metric Tons)	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**Oct 2020/21**
Indonesia	27,633	26,967	28,279	27,500	28,750
Malaysia	16,313	16,472	18,362	16,950	17,225
Guatemala	724	802	828	810	810
Colombia	502	697	677	770	775
Papua New Guinea	664	684	720	565	570
Other	3,052	3,031	2,634	2,667	2,714
Total	48,888	48,653	51,500	49,262	50,844

Total global palm oil exports are increasing over years and also annual growth rate of exports by countries are changing. In 2020, annual growth rate of palm oil exports for Indonesia increased 7%, for Malaysia increased 0,35%, for Guatemala did not change and for Colombia it increased 19% (Index Mundi, 2020) (Figure 2-4).

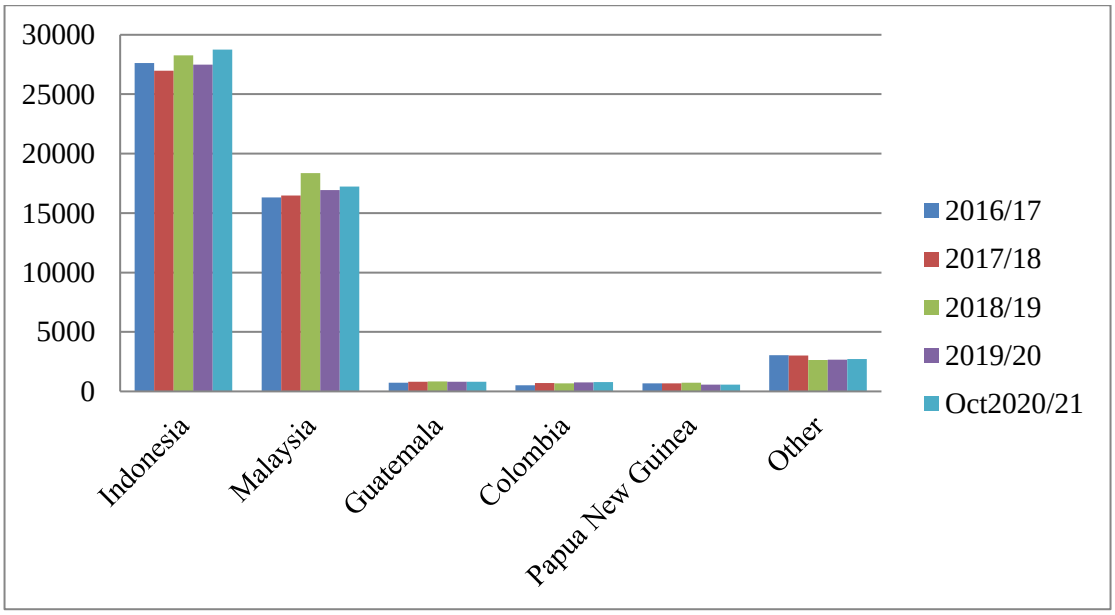

Figure 2-4: World total palm oil exports by years and countries (Data from USDA, 2020)

2.2.4 *Consumption*

Asia is the biggest consumer of palm oil. India, China and Indonesia together consumed 41% of the total consumed palm oil and the rate continues to grow fast. The growth of consumption in China and India is associated with changes of consumer preferences to more processed food due to increasing welfare level in these countries (Voora et al., 2019)

Indonesia, covering 20% of the world domestic consumption, is the leader country in palm oil consumption, followed by India, China and European Union (Table 2-4). In particular, demand in the European Union accounts for 9% of total palm oil consumption.

Table 2-4: Palm Oil World Consumption (USDA, 2020)

Domestic Consumption (Thousand Metric Tons)	**2016/17**	**2017/18**	**2018/19**	**2019/20**	**Oct 2020/21**
Indonesia	9,125	11,565	13,721	13,680	14,875
India	9,350	9,270	9,605	8,810	8,930
China	4,750	5,100	7,012	6,462	6,903
European Union	6,900	6,950	6,960	6,900	6,775
Malaysia	2,622	3,238	3,573	3,275	3,625
Pakistan	2,995	3,145	3,245	3,290	3,400
Thailand	2,135	2,343	2,640	2,640	2,750
Bangladesh	1,364	1,580	1,600	1,600	1,650
United States	1,355	1,563	1,496	1,507	1,495
Nigeria	1,240	1,290	1,390	1,390	1,400
Philippines	1,220	1,250	1,260	1,220	1,250
Egypt	1,150	1,155	1,175	1,150	1,175
Colombia	965	1,030	1,085	1,155	1,165
Burma	800	850	900	940	990
Russia	835	915	900	1,050	985
Other	14,793	15,727	16,290	16,550	17,203
Total	61,599	66,971	72,852	71,619	74,571

Asian countries use palm oil widely in food consumption such as cooking oil, thus changes in direction of palm oil use from food industry to biofuels caused changes in the price of palm oil and it affected Asian domestic food consumption (Voora et al., 2019).

Even though most of the processing and refining plants of palm oil is located in Indonesia, Malaysia and Singapore, manufacturing is located in the consumption countries, mostly in China (Pacheco et al., 2017). Western markets are also important for manufacturers and retailers.

2.2.5 *Price*

In last decade, increasing demand for vegetable oils create an accelerating effect on palm oil prices. Due to the expansion in the use of vegetable oil with different purposes, such as biodiesel and direct fuel, the palm oil prices and sector are triggered. Use of palm oil as a fuel gives a guarantee for producers to prevent collapse of prices. In 2001 in Malaysia palm oil started to be used as an energy fuel which provides keeping the prices at a level to make an economical profit (Rival & Levang, 2014).

Palm oil is a desired commodity due to its low market prices which is less than its competitors. Increasing demand for palm oil directly affected the world prices for palm oil and prices boosted the usage. The volatility in the world annual prices for palm oil by years is considerably high (Fig. 2-5). Palm oil prices are influenced by various conditions such as economic and political situations and policies, tariffs, restrictions, trade operations, changes in production quantity due to weather, pests and diseases.

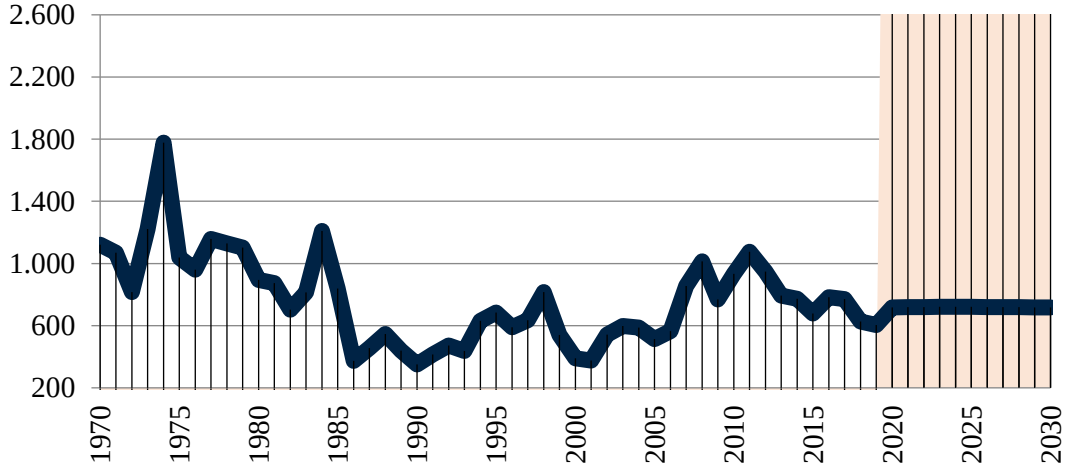

Figure 2-5: World Annual Constant Prices for Palm Oil (US $/mt) (Data from World Bank, 2020)

The palm oil price in the world became flat at the beginning of 2020 and is expected to remain flat due to dry weather and low fertilizer applications during the current year. Crude palm oil prices were forecasted by the CPOPC (2020) to remain at elevated levels in the end of 2020 due to lower production and new biodiesel restrictions.

Unfortunately, the pandemic of Covid-19, started in 2020 and expected to last at least another year, had a negative impact in all sectors and palm oil production is not exempted. In 2020, because of Corona virus affected countries' economy, especially the Chinese economy which is a key contributor in the market, it created slowdown effect in global economy. Consequently, it reduced demands and caused a jump in prices in palm oil, badly affecting markets in South Asia (LMC, 2020).

Other probable cause of fluctuation in the prices in the future are decision of the European Union to phase out palm oil use in biofuel and the decision of Malaysia to make national sustainable certification scheme mandatory next year for production.

Fluctuations in the Malaysian prices are shown in Figure 2-6. As an important exporting country of palm oil, Malaysian government took decisions and imposed taxes in order to support domestic producers, consequently causing changes in prices. Due to these taxes, export amount from Malaysia decreased and global prices of palm oil increased. Consequently, these high prices caused a decrease in the global demand and palm oil was sold in local markets with lower domestic prices to try to cover the costs of production (International Trade Centre, 2012).

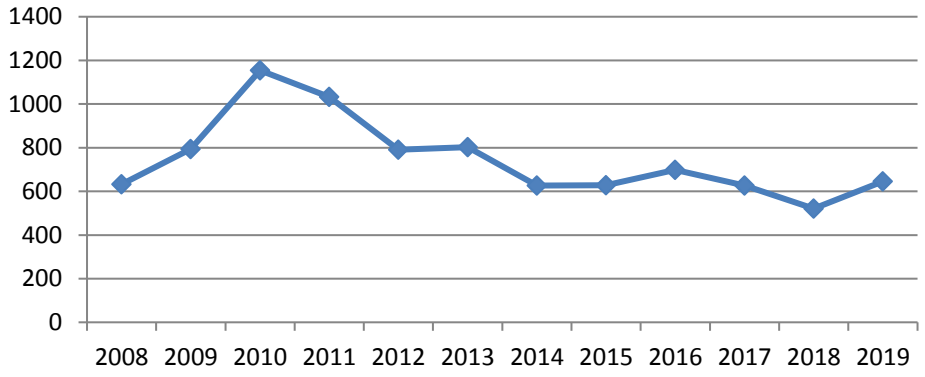

Figure 2-6: Malaysian palm oil prices (U.S. Dollars per Metric Ton) (Data from USDA, 2020)

2.3 **European palm oil market**

Palm oil is the most imported oil in the European Union. According to USDA (2020) data, in 2020, 6.700 thousand metric tons of palm oil was imported from other countries to European Union, covering the 61% of the total oil import to EU and 13% of the total world palm oil imports (USDA, 2020). Most of the imports of palm oil to EU came from Malaysia and Indonesia.

Domestic consumption of palm oil in 2020 was 7.100 thousand metric tons. 2.875 thousand metric tons of it, was consumed for food use in EU while 3,700 thousand metric tons was used for industrial domestic consumption (USDA,2020). An important data is related to the fact that in the European Union the use of palm oil as biodiesel increased over years rapidly, from 24% in 2009 to 53% in 2019.

Also palm oil imports for energy use, for producing heat and power has increased and now they cover 67% of total palm oil imports. Spain, Italy and the Netherlands are the biggest producers of palm biodiesel in Europe (Transport and Environment, 2020).

The private companies in the Netherlands, United Kingdom, Germany, France, Denmark, Norway and Italy, with governmental support, are envisioned to provide sustainable palm oil supply in Europe by 2020. In 2019, crude palm oil imports increased specifically in Spain (+0.8 MMT), the Netherlands (+0.25 MMT), and Italy (+0.2 MMT) while refined palm oil imports decreased. The main reason for increasing imports is RED II will be enter into force and will limit the consumption of palm oil biofuels.

European market is the leader, especially for sustainable certified palm oil trade and consumption. 99% of palm oil in Europe can be traced from oil mills to the consumers and, 86% of imports to European Union are sustainably certified (EPOA, 2019), while 42% of the palm oil used in the European market is uncertified (WWF, 2020).

2.3.1 *Italian Scenario*

Italy, together with Spain and The Netherlands, has the largest amount capacity for producing palm oil biodiesel in Europe (Transport and Environment, 2020).

Changes in the amount of imported palm oil to Italy by years are shown in Figure 2-7.

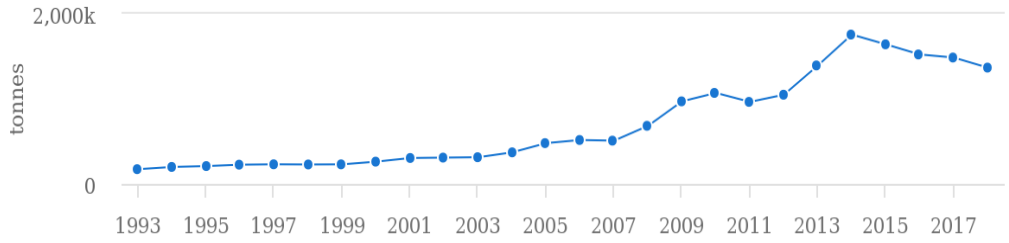

Figure 2-7: Italian Palm Oil Import amount (Data from FAOSTAT, 2020)

In 2018, 78% of imported palm oil was used for industrial purposes, while 14% was used in food sector, 8% was used for cosmetic. 92% of total palm oil imports were sustainable certified, while 78% of these were covered by International Sustainability & Carbon Certification (ISCC) and 10% was certified by RSPO (Unione Italiana Olio di Palma Sostenibile, 2019). In 2019 1,521,176 tonnes of palm oil was imported to Italy (FAO, 2020).

To meet the consumers growing concerns toward palm oil issues and its sustainability, many important brands in Italy have eliminated palm oil from their food products (Sodano et al., 2018)

In 2017, Italy signed the Amsterdam Declaration and predicted that it will ensure 100% sustainable palm oil use by 2020.

According to WWF Palm Oil Buyers Scorecard, which evaluates companies according to their contribution to sustainability, Ferrero is the assessed leader of consumer goods manufacturer in Europe with its 100% RSPO certified palm oil use commitment and deforestation free supplier policy (WWF, 2020). Moreover, Italy was the 5th country with its 216 RSPO certified companies after United States, Germany, United Kingdom and Netherlands in 2019 (RSPO, 2019).

Chapter 3
REGULATORY FRAMEWORK

3.1 **Policies about palm oil in European Union and their objectives**

Multiple policies and regulations have emerged with an aim of improving the palm oil sector in global, national, and subnational levels (Pacheco et al., 2017).

Policies are implemented to solve negative problems and issues as well as to improve welfare of consumer and producer.

Palm oil policies have been developed in order to maintain sustainability, support economic development and reduce to poverty by public and private interventions (Pacheco et al., 2017).

Legislations are one of the main key prerequisites to make palm oil sustainable while protecting and restoring the forests. Even though there are many voluntary standards for oil palm production, mandatory standards are important to ensure that there is no deforestation. Recent studies show that deforestation caused by large scale production is decreasing thanks to restrictions imposed by government regulations and buyers with no deforestation policies, meanwhile on the contrary small scale plantations cause increase in deforestation due to methods like conversion to grassland by fire.

86% of the palm oil imported in Europe for food, feed and oleochemicals is already certified sustainable due to voluntary commitments.

In the 2000s, many initiatives started to develop with an aim of improving the sustainability. Indonesian Sustainable Palm Oil (ISPO) standard and Malaysian Sustainable Palm Oil (MSPO) standard are launched by governments. ISPO is a mandatory standard with third party audited verification system that aims to ensure compliance of oil palm cultivation to laws and policies in Indonesia, while MSPO is a voluntary national certification in Malaysia (Pacheco et al., 2017).

In 2015, governments of Malaysia and Indonesia decided to create together a new standard and: The Council of Palm Oil Producing Countries (CPOPC), a mix of ISPO and MSPO. Later, other palm oil producing countries joined to this form in order to improve palm oil sector (Rival et al., 2016)

Various numbers of policies about palm oil's impact in global greenhouse gas emissions and climate change has released by Indonesian government in order to protect primary forests and peatlands together with regulations for land use planning, protection of peatlands (Pacheco et al., 2017).

Also consumer countries have taken action about palm oil issues. One of the most important one is the European Union Renewable Energy Directive (RED) (Directive 2009/28/EC) about biofuels. According to the basis of this directive, International Sustainability and Carbon Certification (ISCC) standard was issued in 2010. While this standard is voluntary for producers, it is mandatory for European Union renewable fuel market consumption (Pacheco et al., 2017).

National and regional levels of actions are taken by governments against palm oil concerns as well as international agreements and conventions are made. EU's policy, to ban palm oil imports in its biofuels by 2030 from European Union and its member states because of environmental concerns, is not just important for EU but also for international environmental commitments (Voora et al., 2019).

Reducing Emissions from Deforestation and Forest Degradation (REDD) is an agreement created by Parties of United Nations Framework Convention on Climate Change (UNFCCC) with the aim of preventing climate change by controlling emissions. Reducing emissions from deforestation and thus low carbon release is an important step for sustainability. Developing countries take financial support for their collaborations with REDD to conserving forests and enhancing carbon stocks of forest (Ivancic & Koh, 2016). With all these attributes according to the Ivancic and Koh (2016), REDD has a great capability for the process of sustainable plantation of oil palm with improvements over time.

European Union Renewable Energy Directive (RED) requires all biofuel used in EU should meet the sustainability criteria. In December 2018, the EU published a new Directive RED II which will be enforced in 2021(United States Department of Agriculture, 2020).

REDII regulates and categorized indirect land use change (ILUC) emissions of biofuels as high and low risk; since palm oil is labelled as high ILUC risk feedstock, it has been decided to stop the use of palm oil biodiesel starting from 2023 until 2030 totally. ILUC emission of palm oil is three times more than fossil diesel emissions and also it is significantly linked to deforestation. These environmental impacts make Europe to take measures against to its consumption as biodiesel (Transport& Environment, 2020).

The EU Renewable Energy Directive (RED) set goals for replacing minimum of 20% of its energy needs with renewable alternative until 2020. This renewable alternative should originate from feedstocks. Due to this policy, exports of palm oil for biodiesel use are increased. But in 2015 after its impacts, the limit for biofuels from crops is revised to maximum 7% (Pacheco et al., 2017)

Even though all these measures and limits in consumption of biofuels, European Union has produced more biodiesel every year and palm oil consumption has increased also in 2019. 67% of the palm oil imports to European Union are used for energy production in 2019 which is more than previous years (Transport& Environment, 2020).

European Sustainable Palm Oil (ESPO) initiative is created by companies and manufacturers of biodiesel in Europe in order to provide 100% sustainable palm oil in 2020. And for this purpose, Amsterdam Palm Oil Declaration is signed in 2015 to support sustainable palm oil in Europe (Pacheco et al., 2017)

Even if there are national policies that encourage sustainable production of palm oil there are many manufacturers and retailers that have been using conventional unsustainable palm oil. Ostfeld et al. (2019) suggested for governments to take actions in implementation of sustainable palm oil policies, starting from encouraging companies to purchase and use 100% certified palm oil, and consequently governments can meet the national targets for use level of sustainable palm oil. Moreover, governments should ensure about transparency and traceability of used palm oil through all supply chain, and should reveal the found information with public (Ostfeld et al., 2019).

Roundtable on Sustainable Palm Oil (RSPO) was established in 2008 to work together with members of supply chain. Sustainable palm oil criteria, supply chain certifications and scheme for labelling were created (Disdier et al., 2013; Gassler & Spiller, 2018).

3.2 **Regulation for labelling of palm oil**

Regulation No. 1169/2011 of the European Union on the provision of food information to consumers entered into force in 2004. According to it, vegetables oils and fats used in products should be written with the indication of the type of vegetable oils used in. Regarding this regulation, palm oil must be emphasized as “vegetable fat” or “vegetable oil” in the labelling.

After regulation (EU) No 1169/2011 became effective, for the first time, palm oil is written in the packaging instead of labelling as a 'vegetable oil' and it started to seen by consumers, and most of the important multinational companies like Nestle, Unilever, Kraft Foods decided to use sustainable palm oil in their products after consumers attention towards it (Gassler & Spiller, 2018). For these big companies avoiding misunderstanding from public is really important for the image of the company in the market, and in order to preserve positive image, environmental friendly choices are followed. Assessing consumers' preferences wrongly or creating bad image causes financial losses for companies (Disdier et al., 2013).

An important aspect is related to the "No palm oil" campaign. In particular, Regulation (EU) No. 1169/2011 states that, in the label "self-evident" or "misleading" information should be avoided. According to many researchers "No palm oil" labels are violating this regulation (Rival et al., 2016)

Many food companies are using "no palm oil" food claims on the labels and in their advertisements. This kind of claims can be wrongly interpreted by consumers. The "no palm oil" labelled food can be seen better and healthier than products with palm oil. This kind of claims should be used responsibly and should be supported by evidence. The "no palm oil" claim is not listed in EU Food Information Regulation due to lack of scientific evidence against adverse health effects of palm oil (Lovells, 2011). As Regulation 1169/2011 provides basis for consumers to make their choices after objective information is provided to them, in many researches it is addressed that "no palm oil" claims should be reconsidered. Nonetheless, nowadays companies are still relying on the effect that "no palm oil" has on the consumer and on the importance that buyer gives to the absence of this notorious fat.

3.3 **The case of Nutella tax in France**

In 2012 at France anti-palm oil campaign was conducted, suggesting to put additional tax on food products with palm oil. The tax, 300 Euro per ton, for palm and palm kernel oil for food consumption, nicely nicknamed 'Nutella tax', was thrown out later (Rival & Levang, 2014). Rival and Levang (2014) highlighted that public health issues cannot be solved by banning an ingredient, and taxing fats did not have good results in the past (Rival & Levang, 2014). In 2016 due to strong protests from Indonesia and Malaysia, the tax was dropped (Russell, 2018).

Nevertheless, in March 2016, France issued a tax for noncertified sustainable palm oil imports (Pacheco et al., 2017).

Disdier et al. (2013) showed that per unit tax on palm oil products has weak impact on consumer welfare. Due to the lack of information not provided, consumers cannot internalize the damage or benefits of palm oil. Creating campaigns for giving information about palm oil and palm oil-free products by policymakers provides higher welfare impact, even if it is more difficult to do. Consumers internalize information given by campaigns faster and more than a regulatory instrument such as additional tax (Disdier et al., 2013).

3.4 **Tariffs**

Many countries have ad valorem tariffs in the import of crude palm oil and refined palm oil, with the purpose of decreasing imports from abroad and so to improve domestic production. Import tariffs are useful for develop domestic economy and provide fair trade practice (International Trade Centre, 2012)

India applies higher tariffs to import palm oil from Malaysia and Indonesia in order to protect its domestic vegetable oil industry. Indonesia applies no tariffs for export in order to promote investment in processing plants and to increase global demand (Pacheco et al., 2017)

Applying tariffs or the introduction of countervailing duties for preventing unfair trade practices have significant economic results on the sector. Applied tariffs on palm oil and import policies for supporting local production in India, which is the biggest palm oil importer in the world can cause increase in domestic oilseed prices and changes in demand (Voora et al., 2019)

In 2019 European Commission issued a regulation on impose of countervailing duty on palm oil for biodiesel imported from Indonesia in order to protect its domestic production. Indonesia have reacted European Commissions' decision by changing its trade direction to China and Russia (Voora et al., 2019).

Regulations are generally giving importance to improve consumers' surplus. And regulatory interventions took responds differently from different participants. (Disdier et al., 2013)

Consumers' perception about palm oil is important for non- governmental organization as well as policy makers. Non-governmental organizations arrange campaigns for more sustainable foods and organize boycotts against products that are harmful to environment, health and social.

Policy makers take decisions and create regulations according to public opinion and needs (Disdier et al., 2013).

Due to inadequate and slow national policies and regulations on negative impact of oil palm cultivation, NGOs and civil society groups have created campaigns against palm oil use. These campaigns targeted the corporate brands, and frightened the consumers thus caused the establishment of private and market based policies and standards for sustainability. (Pacheco et al., 2017)

Moreover, it can be said that palm oil industry is under influence of strong lobbying in the European Union. Policy making processes are affected negatively by palm oil industry (Kadandale et al., 2019).

3.5 **Certification Schemes for sustainability in palm oil sector**

In recent years consumers' preferences change direction to a healthier, environmental friendly and social responsible way. As a consequence of palm oils harmful effects on health and environment, many companies changed palm oil with an alternative fat source in their food products, while others decided to use certificated palm oil. Consumers start to purchase products with sustainable certifications and this cause an increase in voluntary sustainability standards.

Banning or boycotting palm oil is not a good option in terms alternative oil crops need more area for cultivation, leading to deforestation. Also it is an important livelihood for many people in production countries. Thus sustainable production of palm oil respectfully to environment would be better option (Borrello et al., 2019; Ostfeld et al., 2019)

Increasing demand from consumers, producers and buyers due to environmental and social concerns, led the increase in the area certificated (Meier et al., 2020; Willer et al., 2019)

Demand for certified sustainable palm oil significantly relies on consumer awareness about sustainability and impacts of food product on health, society and environment.

Certification demand in Asian market is a big challenge, due to consumers are less aware of negative impacts related to palm oil thus not prefer to pay premium for certified palm oil. Moreover, palm oil in these countries is a staple food which is used for everyday cooking as a most affordable vegetable oil. As Asia is the biggest consumer of palm oil, these challenges should be overcome for increasing sustainability in the world (Voora et al., 2019).

Sustainability standards grow every year all around the world. Voluntary standards play an important role as well as mandatory standards in order to protect environment, maintain better social and economic conditions.

Voluntary standards are set up by industry and associations, while mandatory certification schemes are led by governments. While mandatory national standards apply to the entire sector and contribute to the general development of the industry, on the contrary, voluntary standards are limited to operators who agree to comply with these standards. The ISPO and the MSPO are national mandatory standards, while the RSPO and the ISCC are voluntary industry standards.

Certifications force enterprises to provide their commodities to consumers by using more environmental friendly and social responsible way. They also help to environmental improvement like reduction in the use of chemicals and protection of valuable biodiversity while maintaining increasing yields.

Sustainability standards are developed by public or private organizations and can cover local, national or even international area. Also NGO's help to develop of voluntary sustainable standards and that way promote sustainability. For improving standards policymakers, producers and buyers should work together.

Globally the most used sustainability certification scheme about palm oil is the Roundtable on Sustainable Palm Oil (RSPO) which is followed by the International Sustainability Standard and Carbon Certification (ISCC)**,** the Indonesian Sustainable Palm Oil (ISPO) and the Malaysian Sustainable Palm Oil (MSPO).

There is no official label for palm oil-free products in Europe; manufacturers use their own signs for emphasizing the product does not contain palm oil.

In 2017, the European Parliament recommended that all palm oil entering in the EU sustainable. The governments and several major companies have committed to only import from sustainable RSPO certified producer. Also the European Parliament supports new and stricter standards and certification schemes to replace RSPO and similar schemes (Russell, 2018).

Finally it is also important to ensure about these certifications' enforce compliance with their criteria. Nonetheless, some aspects should be reconsidered such as RSPO not preventing land grabbing from smallholders, while some companies with ISPO certification still have caused deforestation outside of their concession area. So according to prevent these issues, improvements should adopt constantly. (Voora et al., 2019)

All actors in supply chain of certified palm oil must provide full compliance with standards.

WWF Palm Oil Buyers Scorecard provides scores for companies according to their contribution with RSPO and CSPO for evaluation (WWF, 2020). After investigating the sustainability scores and companies relationship Mirzaei and Parvin Hosseini (2019) found that scores are connected with values of company and affect company's efficiency. By these sustainability scores, companies can create environmental friendly image in public and in this way increase their profit (Mirzaei & Parvin Hosseini, 2019).

Chapter 4
SUSTAINABILITY OF PALM OIL AND CONSUMER PERCEPTION

4.1 **Sustainability and sustainable palm oil**

To protect the planet and hand it down to the next generations, attention should be given to sustainable production, consumption and trade. Sustainable palm oil production means cultivating oil palm while respecting the environment and local communities.

Sustainable production should be maintained in order to protect the environment as well as to fight against climate change. Palm oil can be produced sustainably in the meaning of fulfilling the environmental and social requirements of voluntary and mandatory standards in the cultivation of palm oil.

How said in chapter 2, the demand for palm oil is increasing every year. Global palm oil production is estimated to reach 85 million tons or more by 2025 (EPOA, 2019). For satisfying the demands, cultivation areas are increasing rapidly. Uncontrolled expansion of cultivation areas can cause environmental damage. To protect nature in cultivation countries that have high biodiverse areas, sustainable production should be supported (EPOA, 2019).

Sustainable palm oil helps to protect the rainforest from deforestation and biodiversity losses, and also provide good socio-economic conditions to producers.

The palm oil trade is an important contributor to the economic development of palm oil producing countries. In fact, it is a source of income for most of the smallholders. In order to maintain good conditions for producers, decreasing poverty in these countries without damaging nature, sustainable production is the only solution.

For ensuring sustainable production, consumption and trade, governments, businesses, NGOs, smallholders and consumers are equally responsible and should have equal rights.

Consumer reactions and buying habits led companies to change their production in a more responsible and ethical way. Governments and consumers should support and promote producers who practice sustainable production.

In 2004, the first sustainability standard about palm oil production and its use was created by the Roundtable on Sustainable Palm Oil (RSPO) organization. Later on, producing countries have developed their own standards.

According to the International Trade Center's data from Willer et al. (2019), a minimum of 2.537 million hectares harvested oil palm area is certified by 3 standards which are 12% of the total global share; the 12% of this total certified area was certified by RSPO, while the small remaining amount was certified by Rainforest (0.4%) and Organic (0.1%). Between 2013 and 2017 total certified harvested oil palm area increased of 26%. The number of certified area for oil palm increases every year (Willer et al., 2019).

From 2014 to 2018 certified area of oil palm grew of 7 %. Minimum certified oil palm area is 2.864.161 hectares which cover 15% of the global area, which almost all is certified by RSPO. But also organic certified area is increased in 2018 (Meier et al., 2020). The total agricultural land area certified by sustainability standards continues to increase also in 2020. In fact, certified oil palm area is increased to 2.9 million hectares, representing the 15% of the total oil palm area in the world (Meier et al., 2020).

Consumer behavior and choices promote sustainable production of food in the manners of environmental and social, besides to provide decent working conditions. Consumers have the right to learn how, where and who produced the food they purchased. Consumers can protest against unsustainable food and bad working conditions with their power of choosing to purchase sustainable products from respectful companies.

Recently sustainable products and their markets are expanding in the European Union (Willer et al., 2019).

According to European Palm Oil Alliance (EPOA) and The Sustainable Trade Initiative (IDH) (2019) 86% of European palm oil imports are certified as sustainable.

It is essential for all supply chain members to support sustainable palm oil to reach aims. To increase sustainable palm oil use in Europe, many companies make a commitment to support RSPO standards. Also, associations in the European sector are organized together.

European Sustainable Palm Oil Advocacy Group (ESPOAG) was created by European food sector actors in 2013 in order to support sustainable palm oil and stop deforestation. The commitments of this group are supported by some European governments. All actors signed the "Amsterdam Declaration in Support of a Fully Sustainable Palm Oil Supply Chain by 2020".

4.2 **Impacts**

In recent years environmental, social and health impacts of palm oil production, processing and trading becomes a controversial subject. Even though there are many researches that emphasized the positive and negative sides of oil palm cultivation, the impacts are still ambiguous and questionable.

In the palm oil industry, the major stakeholders are trying to improve their value in the trading and maximizing the profit by increasing the cultivation. This situation conduces toward environmental and social impact by jeopardizing the oil palm smallholders and forests by major stakeholders (Mirzaei & Parvin Hosseini, 2019).

As well as oil palm cultivation promotes socio-economic development for producing countries with its expanded growth due to consumption, there are a lot of research showing its negative environmental, health and social effects, such as destruction of forests, labor abuses and gender discrimination.

4.2.1 *Environmental Impacts*

Several studies highlighted the environmental impact of palm oil including deforestation, degradation of peatlands, pollution problems, land use changes, loss of animal species, rare vegetal plants and biodiversity (Barthel et al., 2018; Fitzherbert et al., 2008; Hinkes & Christoph-Schulz, 2020; Russell, 2018; Sodano et al., 2018; Voora et al., 2019; Wilcove & Koh, 2010; WWF, 2020).

Suitable growing areas for palm oil are in humid tropical conditions that are rich in biodiversity and consist of endangered species. The conversion of tropical forests and peatlands to oil palm cultivation areas is affecting almost 200 endangered species including orangutans, Sumatran tigers and pygmy elephants. (Voora et al., 2019)

To meet the need for new lands for expanding the oil palm cultivation area, tropical forests have been cleared and peatlands have been burned (Fitzherbert et al., 2008; Hinkes & Christoph-Schulz, 2020).

This rapid and uncontrolled expansion of oil palm cultivation costs rich tropical forests in South Asia and resulted in loss of 80 percent of endangered animal species (Fitzherbert et al., 2008; Sodano et al., 2018; Wilcove & Koh, 2010). Loss of carbon rich tropical forests also promotes greenhouse gas emissions and consequently climate change (Fitzherbert et al., 2008; Hinkes & Christoph-Schulz, 2020; Voora et al., 2019).

Tropical forests are rich in biodiversity and have High Conservation Value (HCV) and High Carbon Stocks (HCS). Between 1990 and 2015, 150 million hectares (an area nearly 5 times the size of Italy) of tropical forest was lost and 5 % of this loss is directly connected with palm oil expansion. If oil palm is cultivated on former plantations or degraded land, it will not cause deforestation. (EPOA, 2019b)

Especially replacing peatlands with oil palm areas and using fire for clearing the lands cause a high amount of carbon emissions (Pacheco et al., 2017). Peatlands are huge stores of carbon conversion of these areas leads to severe carbon release into the atmosphere. Drainage of peatlands prompts aerobic decomposition of peat material, resulting in CO_2 emission.

Deforestation is a major concern not just because of loss of animal species but also because the oil palm tree has less above-ground biomass than rainforest trees and this causes less carbon dioxide absorbing capacity. Thus, to cultivate oil palms, carbon-rich peaty soils are drained, exposing the peat to oxygen and causing the release of a large amount of carbon dioxide into the atmosphere. Draining peats in Southeast Asia is the cause of approximately 2% of global fossil fuel CO_2 emissions (Russell, 2018).

Especially for Indonesia and Malaysia, as the major producers of palm oil, is important to protect the forest: indeed, 11% of tropical forests of the world, consisting of biodiversity hotspots, endemic and rare species, are located in these areas. These tropical forests are significant for the protection of biodiversity as well as anticipating floods, producing oxygen and being a food source for locals. Moreover, cutting and burning of forest and peatland causes discharge of carbon dioxide, release of greenhouse gas and consequently contribute to global warming (Ivancic & Koh, 2016).

Deforestation caused by oil palm cultivation in Southeast Asia, Central and Western Africa is a significant issue. More than half of the deforestation on the Borneo Island in Indonesia between 2005 and 2015 was due to palm oil cultivation (Voora et al., 2019).

The main impacts of palm oil on biodiversity starts from the preparation of plantation land. In some cases, there are producers that use fire with the purpose of clearing the land, and later these uncontrolled fires can cause the death of animals and seeds. Thus, environmental protection should start with avoiding utilization of fire for land preparation (Fitzherbert et al., 2008).

The fires that are started for clearing lands cause destroy of vast areas with all species inside. In 2016, 11% of recorded fires in Indonesia were connected with oil palm expansion (EPOA, 2019b). During forest fires in Indonesia in 2015, huge amounts of greenhouse gases have been

released and spread of choking haze due to fire caused 100 000 premature deaths in all Southeast Asia (Russell, 2018).

Despite these entire negative impacts of oil palm cultivation, it contributes more on carbon sequestration and soil protection than annual crops (Fitzherbert et al., 2008) Furthermore, there is no better substitute of palm oil. All other alternatives of palm oil such as cotton, rapeseed, soy, sunflower oil have problems about land use because for the production of the same amount of oil much more land is needed (Disdier et al., 2013).

The most important environmental issues for which precautions should be taken are to end deforestation, to protect peatlands and oil palm lands from fire, and thus preventing biodiversity losses, protecting endangered species and minimizing greenhouse emissions (RSPO, 2019).

4.2.2 *Social Impacts*

Expansion of oil palm cultivation provided a significant economic development for the producing countries, such as reducing rural poverty and provide local developments; in contrary, its development contributed to important issues of human rights.

There are many researches mentioning the negative social impacts of oil palm cultivation, such as land tenure rights violation, exploitation of workers, problems of smallholders, human rights violation.(Pacheco et al., 2017; Sodano et al., 2018; Vis et al., 2012; Voora et al., 2019; WWF, 2020)

Smallholder is a farmer that cultivates less than 50 hectares of land.45% of the palm oil in Indonesia is produced by smallholders. Despite the palm oil production improves smallholder's life, it is associated with many other social problems.

Palm oil production is more labor intensive compared to other agricultural practices and thus has more employment opportunities. Also, expansion in cultivation has provided positive outcomes such as poverty reduction, growth in local economy, developments of infrastructures (Pacheco et al., 2017).

Also plantation has induced internal migration and so, seasonal workers move from more populated areas to others in Indonesia and even from Indonesia to Malaysia. This way, oil palm cultivation helps growth in income in rural areas and increases job opportunities. Mainly oil palm is produced by large plantations or wealthy smallholders with migrant labor, leading to income inequalities (Pacheco et al., 2017).

Despite the fact that extension of oil palm plantation has provided job opportunities and has promoted economic development in developing countries, it also caused social inequalities and problems. The main negative social issues connected with oil palm are labor exploitation, gender discrimination and land use problems. Labor abuses have occurred during oil palm process such as forced or child labor, low amount of wages, employment agreements with heavy penalties or workers paid on completed task instead of hourly based (Sodano et al., 2018)

In some cases local people have been forced to leave their lands by big companies for expansion of oil palm land (Pacheco et al., 2017)

There are lot of cases of land-grabbing, especially in Africa, where smallholders' farmers are persuaded by big companies that lease their lands is an important issue. These agreements caused loss of land access and control by smallholders and took their possibility to grow other commodities in their land.

Moreover, there are several cases that show human right violation against palm oil workers in big plantations, such as forced work for long hours and be exposed to hazardous chemicals (Voora et al., 2019).

Another problem connected with expansion of oil palm cultivation is maintaining food security, which can be a problem when important food crops such as rice are displaced by palm oil due to its profitability. Since domestic rice consumption has significant numbers for many countries, governments have taken actions about this subject with agricultural policies (Pacheco et al., 2017).

4.2.3 *Health Impacts*

In many studies health-related aspects of palm oil consumption have been investigated, even though it is still a controversial subject and debates are still ongoing. While in many researches palm oil is associated with negative health impacts due to its higher saturated fat composition than other vegetable oils (Disdier et al., 2013; Sodano et al., 2018), other studies (Mukherjee & Mitra, 2009) have shown that there is no significant correlation.

The ban of trans-fats from food industry due to their negative health impacts, such as heart disease and stroke risk, stimulates use of palm oil in processed food products as a substitute of trans-fats (Kadandale et al., 2019; Voora et al., 2019).

The World Health Organization (WHO) highlighted how the cardiovascular disease risk is increased with saturated fat consumption. So palm oil consumption, due to its high content of

saturated fats, can increase low density lipoprotein cholesterol level into the blood and can cause ischemic heart disease (Kadandale et al., 2019).

Another health risk associated with palm oil is due to contaminants such as glycidol and free esterified 3- monochloropropane-1, 2-diol (3-MCPD) that are generated during process. EFSA (The European Food Safety Agency) assessed toxicity of these two substances and found the toxicity to affect kidneys and testis, and middle bound mean of occurrence of these substances in palm oil is more than other oils (Sodano et al., 2018).

In 2016 EFSA presented that palm oil may contain harmful substances, but research is still going on. There is no official statement against palm oil from WHO (Fabbrizzi et al., 2019).

Mancini et al. (2015) investigated the correlation between obesity and palm oil consumption, founding that palm oil rich diets can cause changes in gut microbiota and so cause lipid accumulation.

According to Mancini et al. (2015), for finding a clear association between palm oil rich diet and health risks such as cardiovascular disease, cancer and obesity, further researches are needed, because results are controversial due to difficulty in studies in terms of heterogeneity of study groups, selection criteria, wide age ranges, effect of additional risk factors on diet (Mancini et al., 2015).

After all, many scientific researches (Lovells, 2011; Mancini et al., 2015; Mukherjee & Mitra, 2009) highlighted that there are no evidences or direct correlation between consumption of palm oil in normal amount in healthy diet and its adverse effects on human health, especially on cardiovascular diseases.

Imoisi et al. (2015) emphasized that compared to other oils and fats, palm oil has a neutral effect on blood cholesterol in the normal amount of consumption. Excessive consumption may cause raises in cholesterol levels and consequently can increase heart disease risks. Many studies showed that palmitic acid, a saturated fatty acid, can cause increase in blood cholesterol more than other saturated fats, but due to antioxidant presence in palm oil, effects of palmitic acids can be neutralized, unless it is not oxidized. Consequently, excessive take of palm oil in diet should be avoided (Imoisi et al., 2015).

Palm oil has also been associated with some health benefits due to its high vitamin E content, which has antioxidant properties and helps to reduce in serum cholesterol (Imoisi et al., 2015; Mukherjee & Mitra, 2009). Vitamin E has, as well as the antioxidant effects, anti-cancer and

anti-thrombotic effects. Also red palm oil is rich in carotenoids and can be used against vitamin A deficiency in food products (Daud et al., 2012).

4.3 **Actions against negative impacts**

Palm oil has several impacts on different aspects of the human life. Nowadays, the biggest concern is related to the environmental aspect. For this reason, the solutions that producers can apply, in order to try to contain and control the adverse impacts that the production of palm oil exerts on the environment, are of two types:

- promoting the use of sustainable palm oil and improving sustainability standards, or
- replacing the palm oil with its alternative oils and fats (Hinkes & Christoph-Schulz, 2020).

The private sector as well as governments tried to counteract the negative effects of palm oil production. To meet the increasing concerns of consumers towards palm oil, many food manufacturers have eliminated palm oil completely from their products (Sodano et al., 2018).

Replacing palm oil with other oils is not the best option because palm oil has higher yields than its rivals and this cause less land need for cultivation. Moreover, oil palm cultivation is an important livelihood for smallholders.

With a true management of plantation, such as improving productivity of oil palm and consequently reduce the land need, biodiversity losses can be prevented while maintaining high yields. Also governments should take actions about forest law and enforcement to preserve forests from oil palm destruction (Fitzherbert et al., 2008).

Negative impacts of palm oil should be minimized with collaboration of governments, environmental and social NGO's, producers, buyers, retailers, manufacturers and consumers all together. Sustainable practices should be promoted, monitored and enforced by regulations, treaties and campaigns (Fitzherbert et al., 2008; Ivancic & Koh, 2016)

Even though there are a lot of campaigns against oil palm cultivation due to its environmental damage, it is still expanding. Wilcove and Koh (2010) suggested the reason for this unstoppable expansion is due to palm oil's high profitable characteristics and versatility.

At the end of 1990s a growing number of palm oil campaigns increased the consumer awareness on its environmental impact. Those, later on, promoted more tangible commitments on sustainability by private sector and governments. Differently from developed countries,

Indonesian government did not support all those public and private standards due to the economic advantage that palm oil provided. Imposition of this standards is considered as a risk for smallholders and SMEs (Small and medium sized enterprises) for their activities on global markets and also for economic development of rural areas. Consequently, governments with more certain policies tried to put in place effective incentives and enforcement to support smallholders and protect them from exclusion in global supply chains (Pacheco et al., 2017).

To reduce the negative social impacts of palm oil operations, worker rights should be respected and actions to improve working conditions should be taken. Forced labor use and any conflicts over worker rights should be avoided. Plantation workers should be included in decision making process (Voora et al., 2019).

Smallholders should be informed as well as large plantations' owners about productions standards and cultivation impacts and they also should be supported financially by governments to provide them better livelihoods and facilitate their activities on international markets.

4.3.1 *Roundtable on Sustainable Palm Oil (RSPO)*

RSPO is a multi-stakeholder international organization that established in 2004 with the aim of development and promoting the production and use of sustainable palm oil. RSPO (Figure 4-1) created the first voluntary palm oil certification schemes and, with a contribution of industry and governments, it improved over years.

Figure 4-1: RSPO Trademark logo (RSPO, 2020)

Today RSPO has reached 4941 members from 99 different countries across the world in 2020 (RSPO, 2020), but only 19% of the palm oil production globally was certified by RSPO in 2019 (EPOA, 2019).

Palm oil producers, processors, traders, manufacturers, retailers, banks and investors, social and environmental non- governmental organizations are stakeholders of RSPO and work together for improvement of sustainable oil palm standards.

RSPO sets environmental and social principles and criteria for producers to reduce degradation of forests and reduce negative impacts. It releases standards for sustainable oil palm production and supply chain certification.

RSPO is promoting sustainable palm oil as well as improving transparency through all chain in the industry. RSPO is labelling palm oil as certified sustainable palm oil (CSPO) if it is produced according to the criteria of RSPO (Ivancic & Koh, 2016). In 100% RSPO segregated certified palm oil, from cultivation to production; palm oil is traceable in every step.

3.27 million hectares of oil palm cultivation area is certified by RSPO all around the world: 51% is located in Indonesia, 42% in Malaysia. 17.11 million tons palm oil is certified globally corresponding to the 19% of the total (RSPO, 2020).

Top countries with the highest RSPO membership numbers are: United States (540), Germany (477), United Kingdom (452), Netherlands (233), Italy (216), France (187) and Japan (177) (RSPO, 2019).

Most of the members of RSPO community are consumer goods manufacturers(870), processors and traders(638) and oil palm producers(181) in 2019 (RSPO, 2019).

RSPO is aiming to reduce poverty and provide sustainable livelihoods to oil palm workers by supporting smallholder and providing better labor rights and conditions. Furthermore, it aims to preserve and protect environment and species for the next generations. At the same time, RSPO is trying to validate if the members are behaving ethically, respectful towards workers' rights and also transparently. In addition, RSPO is trying to improve and provide to the members high productivity and efficiency with the aim of maintaining sustainable and resilient sector.

To provide sustainable palm oil worldwide, RSPO wants to ensure to obtain healthy working and living environment for everybody and, for this purpose, all members of palm oil production should provide equal opportunities (RSPO, 2019).

In 2019, the number of the total certified smallholders was 157,580, which continues to increase over years. RSPO organizes training programs to smallholders about sustainability in addition to support projects and provide funds to support the certified smallholders (RSPO, 2019).

RSPO is trying to decrease negative environmental impact of oil palm production and for this purpose, it works together with its stakeholders from each step to make decisions and improvements. Within this collaboration, its principles and criteria are to improve with new requirements for growers and to protect High Conservation Value (HCV) lands, High Carbon Stock (HCS) areas and rare, threatened or endangered (RTE) species. Also, RSPO create a new planting procedure (No Deforestation New Planting Procedure) for farmers to provide guidance for respectful planting to forest and wildlife. Moreover, RSPO helps to the reduction of greenhouse gas emissions and pollution as well as protect biodiversity while minimizing the resources.

In order to protect areas, RSPO banned the use of fire and create fire hotspots, actively monitoring all these hotspots. In the case of a fire starting in these areas, investigations are made about causes, locations and evidences (RSPO, 2019).

It has been also highlighted that RSPO certified sustainable palm oil has less impact on global warming (35% lower) and biodiversity (20% lower) than uncertified palm oil (RSPO, 2019).

Even though RSPO has a significant coverage of the global market, severity of its principles and criteria and its power to ensure compliance of companies is a controversial subject. (Pacheco et al., 2017)

Standards of RSPO are sometimes violated by some already certified producers and some areas are taken from indigenous communities by force (Russell, 2018).

It is really important to increase awareness of consumer about certified sustainable palm oil with correct information; scaring consumers and causing them to purchase palm oil free products should be avoided due to high land need of alternative oils, increasing deforestation (Ivancic & Koh, 2016).

Even though all these efforts of RSPO, there are some studies and some NGOs have shown that some RSPO members are still connected with deforestation, child labor and labor right violations (Kadandale et al., 2019)

Palm Oil Innovation Group (POIG) is an initiative that is connected with the RSPO and works to improve sustainability. The Palm Oil Innovation Group (POIG) is a multi-stakeholder initiative that strives to achieve the adoption of responsible palm oil production practices by key players in the supply chain through developing and sharing a credible and verifiable benchmark

that builds upon the Roundtable on Sustainable Palm Oil (RSPO), and creating and promoting innovations.

4.3.2 *European Palm Oil Alliance (EPOA)*

The European Palm Oil Alliance (EPOA) is an initiative established by producers and refiners in order to maintain sustainability in palm oil production process while protecting biodiversity and enhancing the socio-economic conditions.

Figure 4-2: EPOA logo (EPOA, 2019)

EPOA (Figure 4-2) supports sustainable palm oil market across Europe. All the members of this initiative supply certified sustainable palm oil in Europe and support deforestation- free palm oil trade and consumption.

4.3.3 *International Sustainability Standard and Carbon Certification (ISCC)*

ISCC's aim is creating sustainable, traceable and deforestation-free supply chains while trying to reduce GHG (greenhouse gas) emissions. Also, ISCC (Figure 4-3) is trying to provide safe working conditions and protect labor and land rights. All supply chain must have compliance with standards in order to be certificated (ISCC, 2020).

Figure 4-3: ISCC's logo (ISCC, 2020)

ISSC EU certification is applied in biofuels in EU. It is one of the first certification schemes that show compliance with European Commission's Renewable Energy Directive about sustainability.

4.3.4 *Indonesian Sustainable Palm Oil (ISPO)*

Indonesian Sustainable Palm Oil is a mandatory national palm oil certification scheme in Indonesia.

In 2011, Indonesian government issued national sustainable palm oil scheme. While RSPO is voluntary scheme, ISPO is mandatory and has more specific and detailed criteria than RSPO. Ivancic and Koh (2016) suggested that with improvements and regular third party auditions this national scheme can help to create better conditions for palm oil industry (Ivancic & Koh, 2016).

4.3.5 *Malaysian Sustainable Palm Oil (MSPO)*

In 2015, Malaysian government has issued Malaysian Sustainable Palm Oil (MSPO) certification scheme (Figure 4-4) which is a voluntary national certification. MSPO has less strict sustainability criteria than RSPO. For this reason, it has been criticized by many NGOs. The MSPO certification has become mandatory from 2020 for oil palm plantations, smallholders, and palm oil processing facilities in Malaysia.

Figure 4-4: MSPO certification logo (MPOC, 2020)

According to the Ivancic and Koh (2016), companies should comply with international standards such as RSPO certification as well as national standards such as MSPO certification.

In 2015, Council of Palm Oil Producer Companies (CPOPC) is created by Malaysian and Indonesian governments, which is a mix of ISPO and MSPO certifications.

4.3.6 *European Sustainable Palm Oil (ESPO)*

With the support of palm oil manufacturers, refineries and retailers, European Sustainable Palm Oil (ESPO) (Figure 4-5) has been established in Europe in order to provide 100%

sustainable palm oil in 2020. It is enforced by the Netherlands, Denmark, France, Belgium, Germany, the UK, Italy, and Sweden (Pacheco et al., 2017).

Figure 4-5: ESPO certification logo (ESPO, 2020)

It is supported by European Sustainable Palm Oil Advocacy Group (ESPOAG) which was established in 2013 by European important food sector organizations such as CAOBISCO (Chocolate, Biscuits and Confectionery of Europe), FEDIOL (EU Vegetable Oil and Proteinmeal Industry), IMACE (European Margarine Association), AIBI (International Association of Plant Bakers) and FEDIMA (Federation of European Union Manufacturers and Suppliers of Ingredients to the Bakery, Confectionery and Patisserie Industries).

4.3.7 *The Italian Union for Sustainable Palm Oil (Unione Italiana per l'Olio di Palma Sostenibile)*

The Italian Union for Sustainable Palm Oil (Figure 4-6) was created by some food companies and associations that use palm oil in 2015. All members are committed to sustain 100% sustainable palm oil.

Figure 4-6: The Italian Union for Sustainable Palm Oil certification logo (The sustainable palm oil choice, 2020)

The main aim of the association is maintaining 100% certified sustainable palm oil use in Italian food industry. Almost 43% of the palm oil used in Italian food sector has sustainable certification. Improving demand for sustainable palm oil in Italy is wanted.

4.4 **Consumer Perception about Certification schemes**

The only way to support certified sustainable palm oil is to increase demand of consumers and to do this, consumers should be aware of palm oils' sustainability and its impacts on health, society and environment. Additionally, certifications should be easily recognizable and trustable by consumers.

Concerns of consumers towards impacts of palm oil on environment, health and social issues lead companies to take actions. While some companies respond the demands by replacing palm oil with its alternatives and label as "palm oil-free", others decided to use certified sustainable palm oil (Vergura et al., 2019). Research results are really important to shape manufacturers' decisions when they release new product or revise older product with demanded alternative.

Consumers' preferences, awareness and willingness to pay for products with or without palm oil and certificated palm oil is assessed in many researches (Aguiar et al., 2018; Borrello et al., 2019; Capecchi et al., 2019; Disdier et al., 2013; Fabbrizzi et al., 2019; Gassler & Spiller, 2018; Hartmann et al., 2018; Hinkes & Christoph-Schulz, 2020; Rival et al., 2016; Vergura et al., 2019; Verneau et al., 2019).

While most of these studies have conducted quantitatively by online surveys (Borrello et al., 2019; Capecchi et al., 2019; Fabbrizzi et al., 2019; Gassler & Spiller, 2018; Hinkes & Christoph-Schulz, 2020; Vergura et al., 2019; Verneau et al., 2019), there are also few qualitative studies (Aguiar et al., 2018; Zoller & Dray, 2016).

Studies are distinguished by their focuses; while some of them investigate consumer perceptions on palm oil generally, others give details about sustainable palm oil, certifications and palm oil-free products.

Even though 2/ 3 of palm oil is consumed in Asia, willingness to pay in Asian market is less for sustainable product (Russell, 2018). According to Wilcove and Koh (2010) the biggest markets of palm oil, such as India and China, were not eager to purchase certified sustainable palm oil due to its higher cost. Also NGOs in these countries are not as strong as their European and American counterparts, so public support is not enough for sustainable palm oil. Consequently, the most powerful movements for sustainable palm oil were taken by consumers in Europe, the USA and Australia (Wilcove & Koh, 2010).

European consumers are worried about cultivation of palm oil and its adverse effects, but still certified sustainable palm oils are not attracting enough attention in the market. Supply and demand for sustainable palm oil should be increased (Gassler & Spiller, 2018). While 16.64

million tons palm oil is certified globally by RSPO, just 7.06 million metric tons of it were taken up by market in 2019. Even the numbers are increased 13% more from last year, industry use is still needed to be promoted (RSPO, 2019)

According to some studies, consumers have negative perception of food products with palm oil in terms of environmental, health and social impacts (Aguiar et al., 2018; Borrello et al., 2019; Disdier et al., 2013; Hartmann et al., 2018; Ostfeld et al., 2019). This negative perception affects the food companies to release new or reformulated products with "palm oil-free" label to emphasize absence of palm oil. Especially after entry into force of EU labelling Regulation (No.1169/2011) which obligate to declare the name of vegetable oils on the packaging, producers started to specify "palm oil-free" products voluntary (Borrello et al., 2019).

There are some studies about free-from labels and how they are perceived by consumers. Free-from labels are simplifying the complexity of ingredient list and draw attention of consumer immediately. Consumers tend to prefer free-from label as a consequence of their affinity to "avoid something" (Borrello et al., 2019; Hartmann et al., 2018)

Palm oil free products are seen as trendy, healthy and expensive by consumers (Fabbrizzi et al., 2019).

Article 2(2)(4) of the EU Regulation 1924/2006 on nutrition and health claims made on foods stated " 'nutrition claim' means any claim which states, suggests or implies that food has particular beneficial nutritional properties."

In recent years companies are using nutritional claims in food packages more and more, with the intention to inform and meet the demands of consumers. Many researches reviewed consumers' reactions to nutrition claims in food products and few of them on different palm oil claims on packaging (Hartmann et al., 2018; Vergura et al., 2019)

Vergura et al. (2019) assessed Italian consumers' reactions about food products labelled as "palm oil free", "with sustainable palm oil" and without any palm oil claim. It has been found that participants preferred "palm oil free" products over "with sustainable palm oil" products. Vergura et al. (2019) suggested that the reason for consumers to prefer "palm oil free" products is their concerns about the possible health risk of palm oil. Additionally, it has been found that "palm oil free" claim is evaluated better than others in the terms of appeal, satisfaction, desire and quality evaluation by respondents. Risk perception was lowest for products labelled as "palm oil free". Also, consumers perceived tastiness equal for all products. Thus it is an

important finding for manufacturers that replacing palm oil with alternative oil is not affecting the consumers' perception about taste. (Vergura et al., 2019)

Hinkes and Christoph-Schulz (2020) investigated consumers' attitudes and preferences towards palm oil free, RSPO-certified and conventional palm oil products by web based survey. It has been found that German consumers prefer palm oil free products over products with certified sustainable palm oil, and both palm oil free and certified products are preferred over products with palm oil. Eventually, these results confirmed the findings of Vergura et al. (2019).

Ostfeld et al. (2019) assessed British consumers' awareness of palm oil, its impact and their recognition level of ecolabels such as RSPO. It has been found that consumer awareness of palm oil is high (77%) and consumers have opinion about palm oil as an environmentally unfriendly ingredient more than other oils. RSPO label recognition was found low (5%) while other ecolabels such as Fairtrade (82%), The Forest Stewardship Council ecolabel (34%) were recognized higher by participants. In this study it has been indicated that consumers who purchase more products with ecolabels are female, have higher socio-economic situation and have higher education level. (Ostfeld et al., 2019) It has been concluded that RSPO certificated products are not widespread enough to take consumers attention yet (Ostfeld et al., 2019). This study also found that even consumers are aware of eco-labels, it is not guaranteed that they purchase these products. (Ostfeld et al., 2019)

According to the researches that Gassler and Spiller (2018) and Hinkes and Christoph-Schulz (2020) made about German consumers' preferences on palm oil, it has been discovered that consumers preferred products labelled with "RSPO certified" over products labelled with "RSPO mixed". Hinkes and Christoph-Schulz (2020) conclude that WTP for palm oil free products is higher than products with RSPO certified, with or without information about RSPO is provided to the attendants of questionnaire.

Hartmann et al. (2018) investigated European consumers' perception about "free-from labelling" in different countries. Results reveal that consumers from UK, Poland, Sweden and France perceive free-from labels healthier than without label ones, effect size depended on country. It has been emphasized that information-seeking and knowledge about nutrition are important indicators for healthiness assessment and all these indicators together with preference for more natural products are important contributors to understand eagerness of consumer to pay premium price for "free-from" labelled products. Results also demonstrate that gender and trust in food sector actors were not relevant with label (Hartmann et al., 2018). Hartmann et al. (2018)

suggested that the reason for negative image of palm oil can be caused by public debate and the bad image driven by media and more specifically contemplated tax ban about palm oil in France. The absence of something that gives negative impression to consumer can be evaluated more positively.

Findings from Gassler and Spiller (2018) showed that consumers perceived palm oil negatively, even though palm oil was not searched in ingredient list and certifications about sustainable palm oil had not been recognized by participants.

Trustable and recognizable standards and certifications are demanded not only by consumers but also by traders and investors (Rival et al., 2016). Regardless these standards are developed in the Europe, also in developing countries they should be promoted.

If certified sustainable oil product prices in market are too high, consumers will not demand them. So cost reduction in supply chain to provide proper prices is one of the key components that promote sustainable products (Gassler & Spiller, 2018).

4.5 **Consumers' concerns about palm oils' impact and their reaction**

Aguiar et al. (2018) investigated British consumers' awareness on palm oil edible and non-edible products in UK without considering any certifications and concluded that participants are not aware of presence of palm oil as an ingredient in the products consumed. Specific attributes about palm oil presence in products were perceived by consumers differently. While consumers are concerned about environmental issues and unsustainability and perceived palm oil negatively, on the contrary it has a positive image about providing socio-economic improvement, job opportunities and better life conditions for locals in producing countries (Aguiar et al., 2018). The main problem was that this study focus on a small group of participants, so wider population's results may differ.

Consumers are more concerned about environmental issues than social and other issues of palm oil (Aguiar et al., 2018; Disdier et al., 2013). This information is important for palm oil producers, processors, retailers, traders as well as policymakers. Increasing environmental consciousness is forcing the market to take action about using palm oil as an ingredient.

The study Verneau et al. (2019) did concluded that health concerns of consumers are the most important reason for them to information seeking and consequently preferring to reduce

palm oil consumption. In addition consumers' attitudes about environment and social fairness also affect directly their intention to reduce palm oil consumption (Verneau et al., 2019).

Oppositely, findings from Fabbrizzi et al. (2019) showed that consumers are purchasing palm oil free products due to their concerns about environmental impact, followed by health concerns.

Consumers' information seeking in the meaning of their interests about palm oil issues and their efforts to reach information about palm oil has a direct effect on their purchase intention. Verneau et al. (2019) conclude that consumers who concerned about their health are seeking for more information and as a result deciding to purchase food products without palm oil. This result is supported by Borello et al. (2019) which found that the more consumers search for information on food products, the more palm oil-free products are preferred.

On the contrary, Borello et al. (2019) stated that general health interest, sustainability concerns in general food choices, socio-demographic characteristics, education, personal health status are not affecting the palm oil-free food product preference. These results are interpreted as palm oil-free food products preferences are connected with consumers' negative image about palm oil which is a result of public opinion (Borrello et al., 2019; Fabbrizzi et al., 2019; Hartmann et al., 2018)

Consumers have rights to evaluate palm oil properties better; for this purpose it is important to communicate and provide information that will not led misleading. For this reason, palm oil-free label should be used carefully in order to not causing "health-halo effect" which is consumers' misperception of palm oil-free product as healthy without considering nutritional value (Borrello et al., 2019).

It is important to consider consumers' interpretation about labels; misperception of labels can lead results that are not intended in consumers' purchase behavior. Consumers can interpret palm oil free label as a sign of unpalatable or healthier product (Hartmann et al., 2018)

Recently, increasing awareness about palm oil issues had influence on public opinion and consumer choices. Consumers start to perceive palm oil-free food products as healthier and more sustainable (Borrello et al., 2019).

Information against palm oil is provided to consumers via different channels such as internet, newspaper, television and social media (Fabbrizzi et al., 2019)

In Italy, after complaints of non-governmental organizations and public opinion about palm oil issues, some brands decided to remove palm oil from their ingredients, and after consumers respond positively and purchase palm oil-free products, other brands adapt their strategies and

introduce palm oil-free products into market (Verneau et al., 2019). One of the most significant actions is taken by Ferrero SpA, leading chocolate and confectionery products manufacturer in Italy, which has decided to continue using palm oil in their products, especially its famous hazelnut spread, Nutella®. The palm oil used in Nutella® is 100% RSPO certified sustainable palm oil and can be traced back to the mills.

Borrello et al. (2019) surveyed the consumers about their perception of palm oil-free food products and found that participants choose palm oil-free products due to perception of these products as healthier and eco-friendly. According to this study, the main reasons to purchase palm oil-free products are relevance of information, beliefs of participants about palm oil environmental, social and health impacts, respectively.

Participants are influenced by the information on palm oil free foods and as a result palm oil free food products are chosen (Borrello et al., 2019; Hartmann et al., 2018; Sodano et al., 2018).

Capecchi et al. (2019) carried out a survey to understand Italian consumers' awareness and attitudes regarding to palm oil issues and their purchasing decisions, and concluded that participants are worried about palm oil issues and this affects their purchasing decision (Capecchi et al., 2019).

Sodano et al. (2018) investigated the factors that influence Italian consumers' intention towards food product with palm oil and also their perception about environmental, social and health impacts of palm oil production and consumption. Results revealed that participants have high intention to reduce palm oil consumption due to health and environment associated beliefs while they were less concerned about social issues. Participants are mostly concerned and intended to reduce use of palm oil due to health impact of palm oil consumption while environmental concerns were also significant. It suggested that these results could occur due to information about health that had spread by media channels.

Consumers' willingness to pay for palm oil free and sustainable palm oil products are assessed in many researches (Aguiar et al., 2018; Borrello et al., 2019; Disdier et al., 2013; Hartmann et al., 2018; Vergura et al., 2019)

Health and environment concerns about palm oil production affect consumers' willingness to pay negatively. Disdier et al. (2013) investigated French consumers' willingness to pay for products with and without palm oil. Their awareness about effects of the palm oil production on environment and health, and impacts of these affect the purchase of these products. According to this research, consumers are mostly concerned about environment than other issues. However,

providing information about environment, health and issues like deforestation, land use change, affects willingness to pay of participants negatively (Disdier et al., 2013).

Gil et al. (2000) investigated Spanish consumers WTP for organic products and highlighted that consumers are concerned about environmental and health issues of food products they consumed and consequently, they are willing to pay a high premium for organically grown products (Gil et al., 2000).

Consumer food choices are more aware than before due to increasing concerns about nutrition, health and food quality, leading to food consumption into a more diversified way. While consumers are showing interest to environmental friendly food products, the main obstacle is the difficulty in selling them in the supermarket. Even tough consumers have increasing interests on diverse, high quality and healthier food products, consumers purchase less new products due to high prices (Gil et al., 2000).

If certified sustainable oil product prices in market are too high, consumers will not demand them (Gassler & Spiller, 2018).

4.6 **Effect of Providing Information on Consumers' Decision**

Vergura et al. (2019) suggested that for encouraging sustainability, certifications should be improved as well as consumers should be informed properly. For providing better information to consumers, communication strategies via different media channels should be developed. Proper marketing strategies and campaigns can influence consumers to evaluate information better and purchase products in more conscious way.

In similar way, Borrello et al. (2019) found that consumers have lack of information about palm oil as an ingredient, which can mislead their purchasing behavior. To avoid this, public information and campaigns should be provided, especially focusing on there has been no scientific proofs of adverse health effect of palm oil consumption yet (Borrello et al., 2019).

Information provision during questionnaire to the attendants about palm oil certification shows high influences on the choices of consumers. This conclusion is supported by the researches of Hinkes and Christoph-Schulz (2020) and Disdier et.al (2013). After information provided about sustainable palm oil and certification, the coefficients and identified premiums are increased for palm oil free and certified palm oil products, so participants preferred willing to pay premiums more than before, when information was provided.

Disdier et.al (2013) conclude that respondents changed their WTP after information about environmental issues, land use and health effects of palm oil were delivered, and palm oil free label alone is not providing enough information to consumers to internalize it. While information about environment and health cause decrease in WTP for palm oil products, land use information have small but negative effect on WTP for palm oil free product (Disdier et al., 2013). Since in the real purchasing case no information is provided to the consumers in the market, Hinkes and Christoph-Schulz (2020) stated that the WTP value before the information was given was more realistic and reflected the purchasing situation better.

Most of the people in Europe were not aware of RSPO certification. In the research that Hinkes and Christoph-Schulz (2020) did in Germany is showed that consumers are not aware of RSPO certification. 86% of the respondents had never heard RSPO certification before, while most of them recognized EU organic and Fairtrade labels. This result confirms the research of Gassler and Spiller (2018) which have been found that 80% of respondents had never seen and recognized RSPO certification and after the information about RSPO, their perception had changed in positive way to support certified sustainable products. Consequently, communication about sustainable palm oil with consumers should be necessary to increase awareness and demand for sustainable palm oil.

The increasing number of “without palm oil” campaigns have changed the perspective of consumers and have affected their purchasing choices towards the palm oil free products (Fabbrizzi et al., 2019).

4.7 **Effect of Transparency**

Gassler and Spiller (2018) investigated the importance of transparency in palm oil markets through evaluating consumers’ choices to the mass balance production. Mass balance palm oil products are produced by mixing sustainable certified palm oil and uncertified palm oil together without needs of segregation. Mass balance production provides benefits to the producer by reducing the costs for transaction and segregation, but at the same time it reduces the market transparency for consumers by mixing certified and non-certified palm oil together and labelled as sustainable certified. Consequently, it is really important for industry to understand consumer preferences over mass balance production due to orient itself about the use of certification in supply chain.

There are two main supply chain methods in palm oil market that are segregation and mass balance. In the segregation supply chain, certified palm oil products and uncertified palm oil products are separated carefully and not mixed. Separation process with verifications, monitoring and other stages increase the costs. Products derived from segregation are labelled 'RSPO Certified' and from mass balance are labelled 'RSPO Mixed'. 'RSPO Mixed' label informs consumers that palm oil is produced in a sustainable way, but no information is given about the certified sustainable palm oil amount in the product (Gassler & Spiller, 2018; RSPO, 2020)

If consumers are willing to pay more premiums for better credibility and transparency, producers will change their production system that will cost more but also provide higher returns to them.

Gassler and Spiller (2018) present that consumers preferred segregated supply chains over mass balance supply chains thus willing to pay more premiums for 'RSPO certified' products than 'RSPO mixed' products. In any case both certified products are preferred over uncertified palm oil products. This result confirmed that consumers desired stricter transparency in palm oil markets.

The study showed that consumers want to see product's claims that show percentage of sustainable palm oil in mass balance certification products to provide credibility. For further researches policy makers should ensure about sustainability level of mass balanced product labelling emphasized truly without causing misleading or fraud (Gassler & Spiller, 2018).

4.8 **Preference Heterogeneity**

Different consumer segments are identified in different researches. Prevalence of preference heterogeneity is measured in order to find drivers for preferences in various researches (Borrello et al., 2019; Hartmann et al., 2018; Hinkes & Christoph-Schulz, 2020; Verneau et al., 2019)

In different researches respondents are classed based on their preferences, qualifications and some socio-demographic characteristics for latent class analysis. Segmentation is generally made according to their behavioral characteristics about sustainability and its certification. Segments are compared with each other to understand correlation of different attributes. For instance, Gassler and Spiller (2018) stated that older people are less sensitive to price than others; in contrast Hinkes and Christoph-Schulz (2020) stated the opposite. Moreover, Capecchi et al.

(2019), Gassler and Spiller (2018) and Ostfeld et al. (2019) found gender and education are relevant with consumer choices, on the contrary Hinkes and Christoph-Schulz (2020) assessed that are not relevant.

Findings from Gassler and Spiller (2018) showed that willingness to pay and tendency to the purchase of consumers differ according to their socio-demographic attributes such as age, gender, education and also other characteristics of consumers like price sensitivity, trust in certifications and claims (Gassler & Spiller, 2018).

Capecchi et al. (2019) found a remarkable heterogeneity related to education, gender and economic conditions. In detailed, women, elderly people and participants with satisfying economic conditions are appear to be less heterogeneous in the reaction to expressing greater awareness (Capecchi et al., 2019)

Vergura et al. (2019) stated that product brand is not relevant within the consumer choices about palm oil.

Sodano et al. (2018) found that between all sociodemographic factors such as gender, age, income, having children and knowledge about subject, just education level showed significant impact on intention. Meanwhile, about concern levels, it has been found that females and elderly people are more concerned about health issues of palm oil consumption and, in addition, people with higher income are more concerned about health, environment, and social issues of palm oil. Knowledge only affects environmental and health concerns. Individual beliefs affect the intention of purchasing products without palm oil and reducing palm oil consumption (Sodano et al., 2018)

4.9 **Companies**

To provide sustainability, commitments of manufacturers and retailers play a fundamental role and the major NGOs have targeted important brands like Nestle, Unilever, Dunkin Doughnuts. Unilever is the one of the biggest consumer of palm oil (Pacheco et al., 2017).

According to Pacheco et al. (2017) due to highly fragmented characteristics of palm oil, palm oil industry is not dominated by individual consumer, goods manufacturers and retailers, thus they have a limited effect on sustainability. Furthermore, most of the palm oil manufacturers located in India and China and consumers in these countries are more sensitive about price than sustainability concerns (Pacheco et al., 2017).

Companies made commitments to consumers for providing sustainable and certified palm oil in order to protect themselves from reputational risk and prevent supply disruptions. Also companies are trying to ensure transparency by providing information about palm oil's supply chain, source of origin and growing conditions in order to promote consumers purchasing behavior. (Voora et al., 2019)

Chapter 5
CASE STUDY: CONSUMER PERCEPTION AND BEHAVIOR FOR PALM OIL IN FOOD PRODUCTS

5.1 **Introduction**

Palm oil industry's rise will continue to expand due to palm oil's favorable, versatile and profitable characteristics. The unique solid content profile of PO, and its excellent oxidative stability, high nutritional value (free of trans fatty acids and cholesterols, and rich in micronutrients), and competitive price makes PO as one of the most utilised oils by food manufacturers (Dian et al., 2017). However, nutritional guidelines and environmental issue influenced palm oil image among consumers (Mozzon et al., 2018). Nevertheless, consumers have different opinions and preferences, uses of palm oil in many products continue to increase.

This study firstly aims to investigate consumers' perceptions, awareness, and attitudes about the presence or absence of palm oil in food products. Secondly, this research want to estimate the willingness to pay for foods product contains certificated sustainable palm oil versus a product without palm oil.

Thanks to the assessment, the profile of the typical consumer who purchase palm oil products and who purchase palm oil free products is outlined. Which provides This research could provide helpful information for companies for their decision making process. To understand consumer behavior and collect data, an online survey has been conducted.

5.2 **Method of analysis: Contingent analysis**

The Contingent Valuation Method (CVM) is an approach based on estimating the stated willingness to pay (WTP) of respondents for a hypothetical question about a non-market good or service to determine their possible level of acceptance (OECD, 2018).

CVM is applicable for various scenarios thanks to its flexibility which provides wide range of application area for non-market goods or changes in past, current or future. While most of the

applications are focused on environmental economics, also there are many other application areas like health economics, cultural economics, and sports economics (OECD, 2018).

Contingent valuation method has been in use for a long time and there are many studies in this subject. It has been used in many environmental issues, policy evaluations and public improvements (Carson, 2000).

In the contingent valuation surveys, participants are directly asked to emphasize their preferences with an aim of understanding their future intentions for a non-market good or service in a hypothetical market. In the questionnaire, respondent's willingness to pay is investigated in monetary terms, more specifically in their preferences how much money it would be worth for having a good or avoiding from a good (OECD, 2018).

The responses given by survey participants are analyzed like preferences of consumers in actual markets. Economic value is obtained from preferences monitored in the hypothetical market in the survey like as in a real market. From contingent market created in the survey, total economic value as willingness to pay or willingness to accept is estimated (Carson, 2000).

The contingent evaluation method allows a direct estimation of willingness to pay by means of different elicitation techniques. The choice of elicitation technique has a significance importance as different techniques produce different estimates.

The elicitation question can be asked in various ways including open ended questions, payment card, single-bounded dichotomous choice, double-bounded dichotomous choice and different specifications of bidding games (OECD, 2018).

The design of the hypothetical scenario and of the value elicitation questions are the key elements of the contingent valuation method (OECD, 2018). The choice of elicitation technique depends on several factors such as the nature of the good being investigated, cost of the survey and nature of the respondents.

As with other survey techniques, a key element in any CV study is a properly designed questionnaire: i.e. a data-collection instrument that sets out, in a formal way, the questions designed to elicit the desired information(OECD, 2018).

The questionnaire used in the following study and the methodology chosen will be described in the following paragraphs.

5.2.1 *Questionnaire*

The research was carried out through an online questionnaire, which can be found in Annex I. Data were collected from questionnaire anonymously; in a second phase, they were aggregated and showed trough graphs.

The use of online questionnaires has various advantages as well as disadvantages. In fact, an online survey has a higher diffusion speed, lower cost the data collection and interpretation are easier. But, it fits properly just for people who use this technology and consequently in results, there is a risk of not representing the reference population. The link to the questionnaire has been posted on various pages on social media. In 9 months of survey time, we were able to collect data that represents different socio-demographic groups in the total population.

The questionnaire consists of 6 sections with 42 questions, including 4 open-ended questions and 38 closed-ended questions. More in detail, there are 26 single-select multiple-choice questions, 8 multi-select multiple-choice questions and 4 multi-point scale matrix table multi-choice questions.

The main sections of the questionnaire are:

1- Socio-demographic characteristics of the participants,
2- Consumers' purchasing behavior,
3- Consumer awareness of palm oil as a food ingredient,
4- Consumers' knowledge about impacts of palm oil,
5- Consumers' knowledge of sustainable palm oil and sustainable certification schemes,
6- Consumers' willingness to pay.

The first part of the questionnaire consists of socio-demographic questions such as age, gender, education, occupation, marital status, number of adults and children in household, income and country.

In the second section, the participants are questioned about the purchasing behavior in the terms of reading labeling, the factors that affecting purchasing decision and their importance level on a Likert Scale.

The Likert scale is a widely used psychometric scale in the scientific researches in order to measure human attitudes. Participants have shown their level of agreement from not agree to strongly agree on a metric scale (Joshi et al., 2015). In our case, the scale is from 1 to 5, where 1 corresponds to "not important" and 5 corresponds to a "very important factor".

In the third section, consumer's awareness of palm oil as an ingredient in food products is investigated. Firstly, participants are asked if they know what palm oil is, their impression about it and whether they have the habit to checked its presence in the label. Secondly, after being asked whether they bought products with palm oil, according to the answer, they are sent to a different part of the questionnaire. If their answer is "yes, I buy", they are asked the reasons behind the purchase, the importance of the factors (according to the Likert Scale) and the types of product bought. On the contrary, if the answer is "no", the frequency and place of buying of palm oil-free products are asked to them, together with the types of free products and the reasons behind the non-purchasing behavior.

Section four consists of questions to understand participants' opinions related to impacts of palm oil: their awareness, if they are informed and where the get the information, the palm oil issue which concern them the most.

In the fifth section, participants' knowledge of sustainable palm oil and sustainable certification schemes are assessed. Also, they are asked which certification schemes they know and how credible these schemes are for them, the effect of the certifications on purchasing decision and their knowledge about campaigns and EFSA's report.

Finally, in the last section respondents are asked to answer the question "would you be willing to pay a premium price for certified sustainable palm oil?". After information about certified sustainable palm oil are provided, participants are showed two packages of biscuits:

- Packet A contains biscuits with certified sustainable palm oil that is oil comes from a plantation that has no impact on deforestation, preserves biodiversity, limits its carbon footprint by treating all its waste through environmentally friendly practices and protects the rights of local populations and workers, respecting the principle of free, prior and informed consent of those communities.
- Packet B contains biscuits without palm oil.

In the first question is asked if they prefer to pay a little bit more for the product with certified sustainable palm oil. According to their answer, if the answer is yes, the offer is increased and they are asked again if they even willed to pay this amount. While if they answer no, they are asked if they want to pay the same amount of money for certified or not.

5.2.2 *Choice of methodology*

In this study, double-bounded dichotomous choice questions are used for eliciting participants' willingness to pay. In this way, respondents have to answer if they purchase a good or not at a certain price. This method provides to avoid non-responses.

Firstly, respondents are asked if they would pay the given amount of money which is determined according to the actual market price for purchasing the product. According to the answer, the following question is asked. If the response is "yes", then respondents are asked if they would pay a higher amount. And if the response is "no" respondents are asked if they would pay the lower amount. Consequently, value is enclosed between two binds.

There are four possible results from this model; both answers "yes", firstly "yes" and secondly "no", firstly "no" and secondly "yes", both answers are "no". Dichotomous Choice CVM is a proper method when the consumer does not have enough information to valorize the product in the real market.

Hanemann et.al. (1991) showed that double bounded dichotomous choice CVM is asymptotically more efficient and requires less sample for accurate results than the single bounded dichotomous choice model. And also, with its reduced confidence intervals, the double bounded model provides improved information (Hanemann et al., 1991)

The efficiency of the double bounded dichotomous choice method is confirmed by Calia and Strazzera (2015), even though for the larger sample with reliable pre-test, the single bounded model is suggested due to the double bounded model can cause bias because of follow-up questioning. However, it is confirmed that the double bounded model provides more information and estimates WTP more accurately with lower confidence intervals than the single bounded model. Both in the single bounded and double bounded models, the estimated values are more precise for a bigger sample size (Calia & Strazzera, 2005).

While the quality of the contingent valuation study is assessing, firstly survey instrument is evaluated. In the survey, participants should be informed enough with a description of the good. The survey should consist of questions about respondent characteristics, attitudes, and socio-demographic information. With focus groups and pilot studies, the survey can be developed. Even though online surveys are preferred due to cheaper cost, they can create sample selection bias due to respondents of surveys are generally more interested in the topic and provide higher WTP than the random individual. Good survey practices are the key elements for proper results (Carson, 2000).

Reliability of the responses is also an important variable, the divergence between the hypothetical scenario in the survey and the respondent's perspective of this scenario should be minimized. Collecting information about the reason for the responses helps to the explanation of results (Hoyos & Mariel, 2010).

The econometric model used in this study is formulated as following (Bentivoglio et al., 2020; Calia & Strazzera, 2005; Cameron & James, 1987).

$Y = x'\beta + \varepsilon$

Y corresponds to the true willingness to pay of an individual and it is assumed to depend on vector x' which contains individual socioeconomic characteristics. x' is a vector of explanatory variables. ε is the stochastic error with zero mean.

According to the possible answers, the probability can be written as:

$\Pr(\text{yes, yes}) = \Pr(E \geq t^a_i \geq t_i) = 1 - F(t^a_i)$

$\Pr(\text{yes, no}) = \Pr(t_i \leq E \leq t^a_i) = F(t^a_i) - F(t_i)$

$\Pr(\text{no, yes}) = \Pr(t^b_i \leq E \leq t_i) = F(t_i) - F(t^b_i)$

$\Pr(\text{no, no}) = \Pr(E \leq t^b_i \leq t_i) = F(t^b_i)$

The log likelihood function is:

$\text{LogL} = \Sigma^n_i = {}_1 I_i I_i^a \log[F(t^a_i)] + I_i(1 - I_i^a)\log[F(t^a_i) - F(t_i)] + I_i^b(1 - Ii)\log[F(t_i) - F(t^b_i)] + (1 - I_i)(1 - I_i^b)\log[F(t^b_i)]$

where t_i corresponds the starting price (1,95 EUR), t^a_i is the given price in following first positive answer (2,05 EUR), and t^b_i is the given price in following first negative answer (1,85 EUR). I_i, I_i^a and I_i^b are the dichotomous variables, 1 or 0 according to follow-up answer.

It is decided to exclude some observations from the analysis with different reasons. In details, from the sample of 352 consumers were eliminated:

- 3 respondents who indicate "Prefer not to say" in gender;
- 128 respondents who don't buy products with palm oil;
- 2 missing responds

Thus the final sample size is reduced to 219 people. The explanatory variables considered in the estimation are:

1. Socioeconomic variables affecting the respondent:

- Age: in 4 groups (1= 18-25; 2=26-40; 3=41-60; 4=60 +);
- Gender: 1 = Female and 0 = Male;

- Education: in 5 groups (1 = Middle school, 2 = High school, 3= Bachelor's degree, 4 = Master's degree, 5 = Doctorate or higher)
- Occupation: in 10 groups (1 = Student; 2 = Office worker; 3= Researcher, Teacher; 4 = Engineer, Technician; 5= Unemployed; 6 = Self-employed; 7 = Retired; 8 = Housewife; 9 = Businessperson; 10 = Worker);
- Marital status: 1= married, 0= single;
- Children: 1= yes, 0= no;
- Income: 1 = Below than € 10.000; 2 = Between € 11.000 - € 20.000; 3 = Between € 21.000 - € 35.000; 4 = Between € 36.000 - € 50.000; 5 = Between € 51.000 - € 75.000; 6 = More than € 75.000;
- Country: 1= Italy, 0= otherwise;

2. Variables connected to the respondent's purchasing behavior:

- read_labeling: 1 never, 2 Hardly ever, 3 Sometimes, 4 Often
- origin: Likert scale 1 to 5
- brand: Likert scale 1 to 5
- price: Likert scale 1 to 5
- quality_labels: Likert scale 1 to 5
- ecological_issue: Likert scale 1 to 5
- ingredients: Likert scale 1 to 5
- health_effects: Likert scale 1 to 5
- production_methods: Likert scale 1 to 5
- packaging: Likert scale 1 to 5
- working_conditions: Likert scale 1 to 5
- shelf_life: Likert scale 1 to 5
- figures: Likert scale 1 to 5
- allergen_statements: Likert scale 1 to 5
- free: Likert scale 1 to 5

3. Variables connected to the respondent's awareness of palm oil as a food ingredient:

- know_palm_oil: 1 yes 0 no
- impression: 1 negative, 2 Indifferent, 3 Positive
- check: 1 Never, 2 Rarely, 3 Sometimes, 4 Very Often, 5 Always

- tastier_y: likert scale 1 to 5
- cheaper_y: likert scale 1 to 5
- higher_quality_y: likert scale 1 to 5
- no_effects_health_y: likert scale 1 to 5
- no_effects_environment_y: likert scale 1 to 5
- no_effects_social_y: likert scale 1 to 5
- media_overreacting_y: likert scale 1 to 5
- no_find_without_y: likert scale 1 to 5
- agree_company: 1 Strongly Disagree, 2 Disagree, 3 Undecided, 4 Agree, 5 Strongly Agree

4. Variables connected to the respondent's knowledge of palm oil effect:

- aware_debate: 1 yes 0 no
- how_much_informed: 1 Not at all, 2 Not very well, 3 Fairly well, 4 Reasonably informed, 5 Very well informed
- Health_i likert scale 1 to 5
- Environmental_i likert scale 1 to 5
- Production_i likert scale 1 to 5
- Sustainability_i likert scale 1 to 5
- free_labels_i likert scale 1 to 5

5. Variables connected to the respondent's knowledge of sustainable palm oil certification schemes:

- know_certifications 1 yes 0 no
- c_affect_purchasing 1 I don't know these certifications, 2 Doesn't effect, 3 Very little, 4 Sometimes, 5 Extremely effects
- c_credible 1 Doesn't effect, 2 Not at All, 3 Very little, 4 Somewhat, 5 To a Great Extent

5.3 **Results**

In the following chapter, the main results, obtained from the online survey questionnaire, are examined. Data were collected through Google survey platform from March 2020 to December 2020. Survey has been distributed via different social media channels and has 352 responses.

5.3.1 *Socio-demographic characteristics of the sample*

The vast majority of the consumer's sample are female (66 %). While almost half of the participants (49%) are between 18 and 25 years old, 37% are between 26 and 40 years old, 8% are between 41 and 60 years old and the remaining 6% are over 60 years old.

The education level of the sample is high, 43% of the participants have a bachelor degree, 33% have a master degree and 6% have a doctorate or higher degree, while 18% have a high school diploma.

More than half of the respondents (53%) are students, followed by office workers with 13%, engineers and technicians with 9%, researchers and teachers with 7%, and self-employed, unemployed and retired participants all are 5%.

The great majority of the respondents (80%) are single. 31% of the participants have 4 members in their household, followed by 2 members (25%), 3 members (22%), just 1 member (11%), 5 members (8%) and 6 members (3%). In most of the households (78%) there are no children, 13% have 1 child and 7% have 2 children.

The 25 % of the sample has between € 21.000 and € 35.000 annual household income, 23 % between € 11.000 and € 20.000, 20 % has an income lower than € 10.000, 20% has between € 36.000 and € 50.000, 7% has an income between € 51.000 and € 75.000 and remaining 5% has more than € 75.000 annual household income. Socio-demographic analysis of the survey is shown in table below (Table 5-1).

Table 5-1: Summary of socio-demographic data

Variables	**Categories**	**Frequency**	**Percentage**
Age	18-25	171	49%
	26-40	131	37%
	41-60	28	8%
	60 +	22	6%
Gender	Female	233	66%
	Male	116	33%
	Prefer not to say	3	1%
Education	No formal education	0	0%
	Primary school	0	0%
	Middle school	1	0%
	High school	65	18%
	Bachelor's degree	150	43%
	Master's degree	115	33%
	Doctorate or higher	21	6%

Occupation	Student	185	53%
	Housewife	3	1%
	Office worker	45	13%
	Researcher, Teacher	24	7%
	Engineer, Technician	32	9%
	Businessperson	3	1%
	Self-employed	16	5%
	Unemployed	19	5%
	Retired	19	5%
	Other	6	2%
Marital status	Married	72	20%
	Single	280	80%
Adult members in household	1	40	11%
	2	88	25%
	3	77	22%
	4	110	31%
	5	27	8%
	6	9	3%
	7	1	0%
Number of children in household	0	275	78%
	1	47	13%
	2	25	7%
	3	3	1%
	4	0	0%
	5	2	0%
Household income	Below than € 10.000	71	20%
	Between € 11.000 - € 20.000	81	23%
	Between € 21.000 - € 35.000	87	25%
	Between € 36.000 - € 50.000	72	20%
	Between € 51.000 - € 75.000	23	7%
	More than € 75.000	18	5%

Questionnaire has respondents from 40 different countries (Figure 5-1).

Figure 5-1: Sample distribution on world map

Among them 57% of the sample is from Italy. In particular, 29% of this Italian sample is from the Marche region, followed by Lombardia (16,2%) and Emilia Romagna (7,1%) (Figure 5-2).

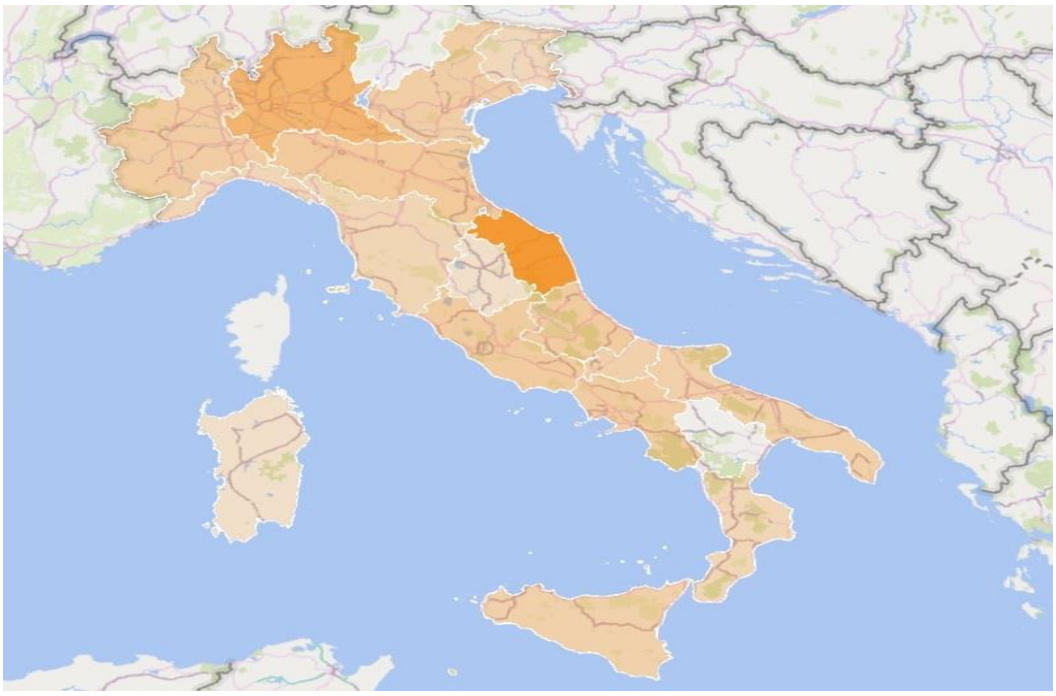

Figure 5-2: Sample distribution on Italy map

5.3.2 *Descriptive statistics*

In this paragraph the results of sections 2, 3,4 and 5 of the questionnaire will be described.

The second section of the survey aimed to discover consumers' purchasing behavior in general. Consumers declared that when they purchase food and beverage products, 51% had read the label often while 39% sometimes, 9% hardly ever and 1% have never read the label (Figure 5-3).

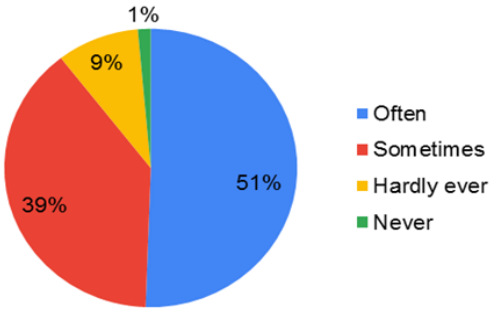

Figure 5-3: Level of reading labels

Then, respondents were asked to choose the factors or attributes that influence their purchasing decisions for food and beverage products. For the 65% of the respondents, the most important factor to take the decision to purchase is the price. It is followed by the list of ingredients (39%), the origin (34%) and the brand (34%), the shelf life (30 %), the presence of specific quality labels/certifications (PDO, PGI, STG, Organic, etc.) (18%), ecological or environmental issues (18%), health effects (17%), absence of GMOs, palm oil etc. (14%), the packaging (9%), allergen statements (3%), production methods (3%), figures or pictures (2%) and working conditions (1%) (Figure 5-4).

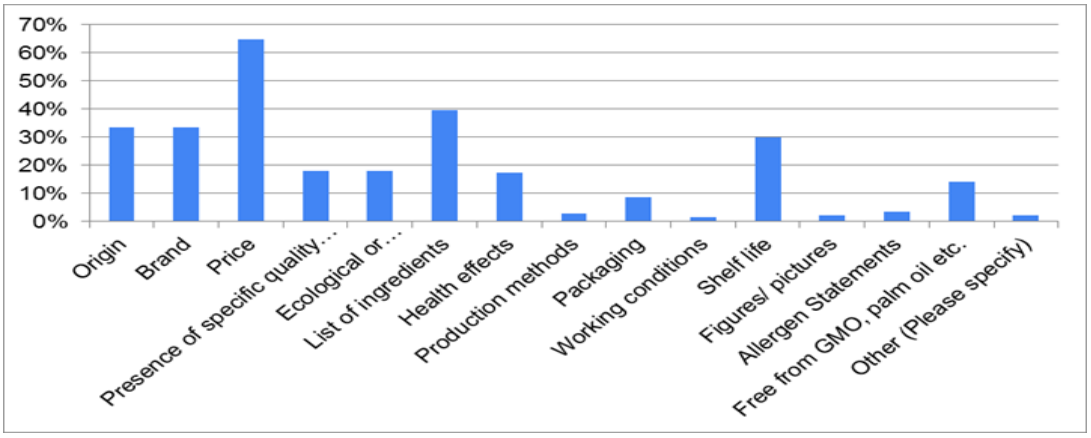

Figure 5-4: Factors that influence purchasing decision

To determine the value of the importance of these factors, respondents were asked to indicate scores for each factor on a Likert scale from 1 to 5[11]. Detailed results are shown in Figure 5-5.

More important factors by consumers on purchasing decision were the list of ingredients (38%), the price (35%), the shelf life (34%), the health effects (32%), the origin (25%) and the ecological or environmental issues (24%).

More than average importance (important - very important) is given by respondents to the list of ingredients (70%), the price (69%), the health effects (64%), the shelf life (62%) and the origin (54%).

The least important attributes in the purchasing decision were found to be figures/ pictures (34%) and allergen statements (25%).

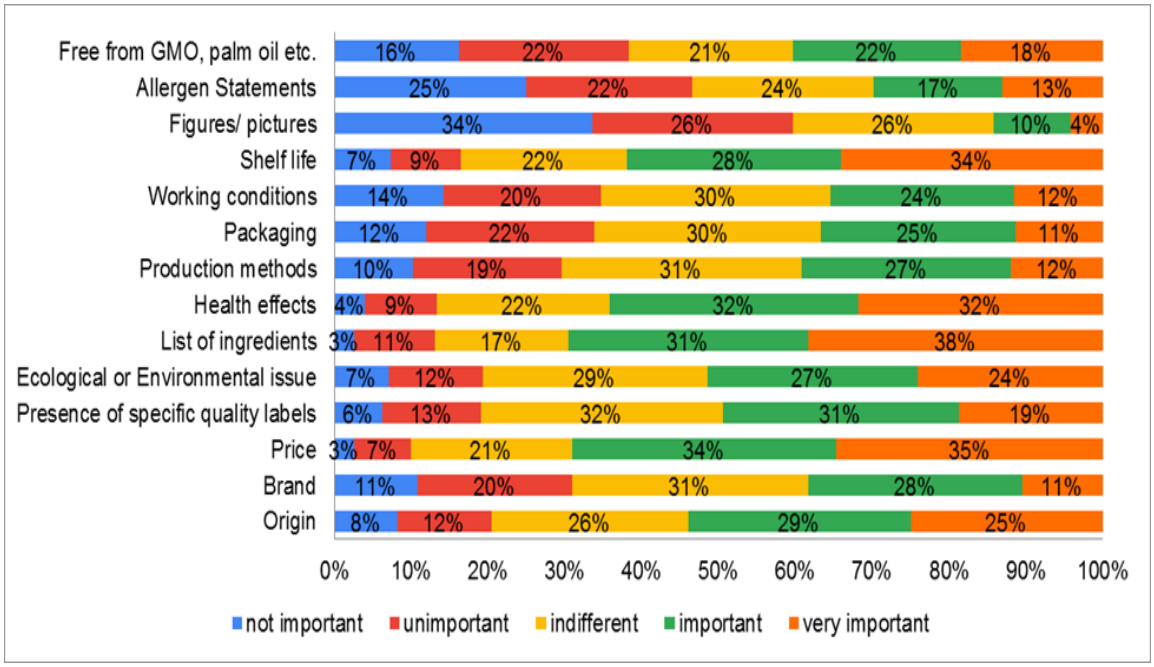

Figure 5-5: Summary of quantitative analysis for importance of each factor on decision

The third part of the questionnaire is aimed to understand consumer awareness of palm oil as a food ingredient. Most of the participants (92%) stated that they already known what palm oil is (Figure 5-6).

[1] Where: 1: not important; 2: unimportant; 3: indifferent; 4: important; 5: very important

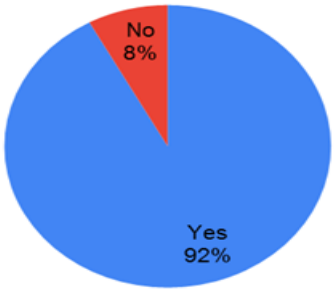

Figure 5-6: Palm oil knowledge of the sample

Considering the perception of palm oil in food, 48% of the sample perceives it negatively, while 43% perceives it indifferently and just the 9% of the respondents has a positive impression (Figure 5-7).

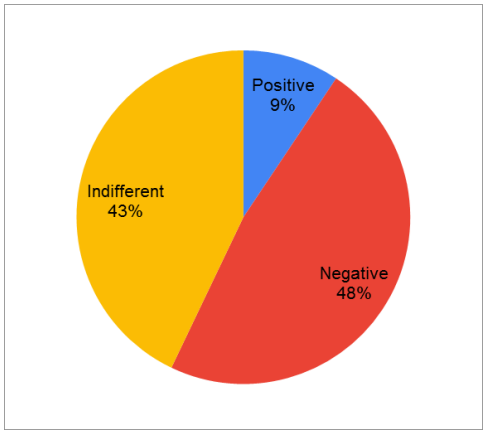

Figure 5-7: Perception of palm oil

Respondents were then asked if they check the presence or absence of palm oil in the products they purchase. 27% of the sample states that they check sometimes, while the 23% never check and just the 12% of the sample always checks the presence of palm oil. (Figure 5-8).

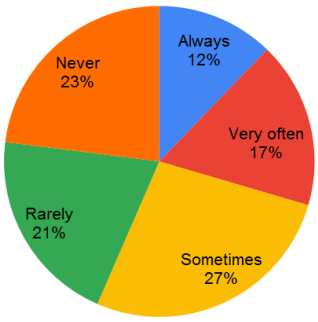

Figure 5-8: Frequency of checking palm oil as an ingredient in food product

63% of the respondents states that they buy products with palm oil. According to the answer to this question, the questionnaire was then divided into two different sections and respondents were sent to the section according to their preference (Figure 5-9).

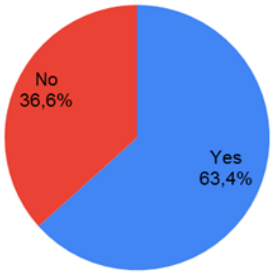

Figure 5-9: Purchasing products with palm oil

If respondents stated that they buy products with palm oil, reasons to purchase, product type and their level of agreement have been asked to them. 37% of the sample states that they buy products with palm oil because they do not believe that it negatively affects the health; the 34% of sample believes that the media are overreacting. The 28% of respondents purchases products with palm oil due to their taste; the 16 % of the sample considers them cheaper; the 18% of the respondents answered that the reason for purchasing is the difficulty in finding products without palm oil in supermarkets; the 6% of the consumers states that the reason to purchase is connected to the fact that they do not believe that palm oil has a negative effect on the environment; the 4% says that they don't believe its effect on social fairness issues; just the 3% of respondents buy palm oil products because they consider that it has a higher quality; the remaining 19% of the sample wrote other reasons such as they buy products without giving

attention to palm oil as an ingredient or by mistake or they purchase just products with sustainable palm oil (Figure 5-10).

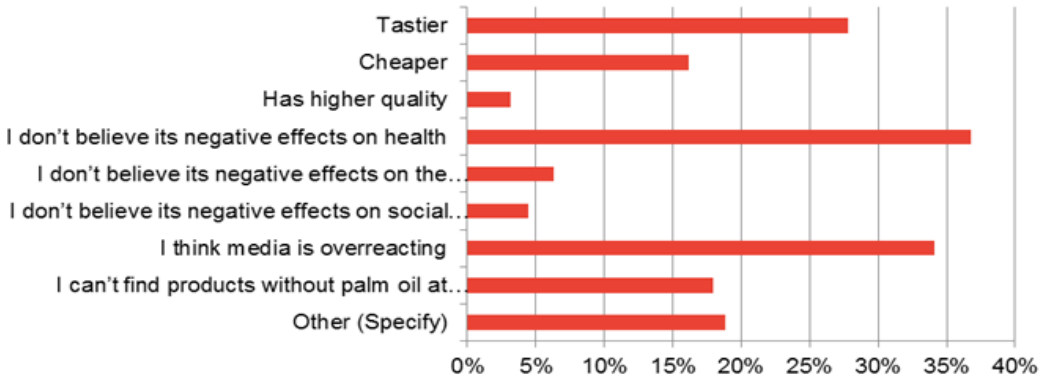

Figure 5-10: Reasons to purchase food products with palm oil

To determine the consumers' motivations for purchasing food products with palm oil, respondents were asked to indicate scores for each factor on a Likert scale from 1 to 5[2]. Detailed quantitative analysis results are shown in Figure 5-11.

Considering the importance of the values as purchasing motivation for products with palm oil, 22% of the respondents stated that they think media is overreacting and this is very important for their purchasing decision, and 18% consider this as an important value. 17% of the respondents that stated they do not believe palm oil's negative effects on health indicated this value as very important while 20% indicates it is important.

Respondents stated that they gave an above-average value (important - very important) to the following statements: "I think the media is overreacting" (40%), "I do not believe in its negative effects on health" (37%), followed by 36% preferred them because they are tastier, 24% preferred them because they are cheaper, and 23% stated they could not find them at the supermarket. While the 15% preferred them because they have higher quality, 14% stated that they do not believe in its negative effects on social fairness issues, and the remaining 13% stated that they do not believe in its negative effects on the environment.

The least important factors in the purchasing decision are found to be: believing that it has a negative effect on the environment, considering the product to be of high quality, and believing that it has social fairness issues.

[2] Where: 1: not important; 2: unimportant; 3: indifferent; 4: important; 5: very important

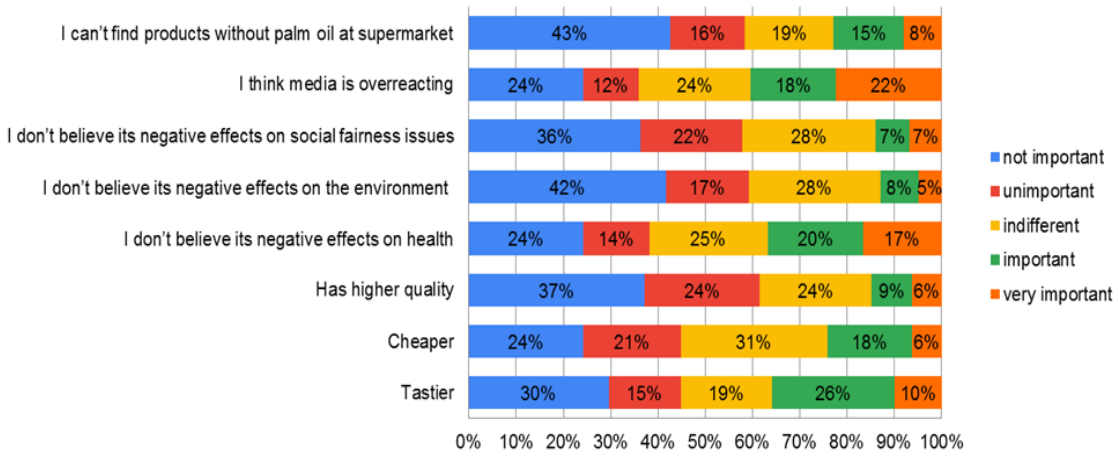

Figure 5-11: Importance of motivations for purchasing food products with palm oil

Among the participants, the products containing palm oil mostly purchased are cookies, biscuits, chocolate and nut butter and creams (spreads) (Figure 5-12).

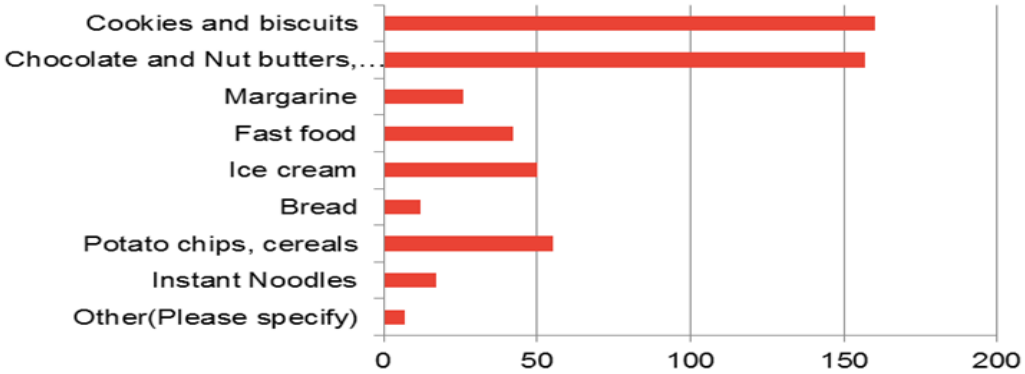

Figure 5-12: Type of purchased products with palm oil

Considering the level of agreement with the food companies that have modified their recipes to eliminate palm oil, 20% of the sample states they strongly agree, 29% they agree, 32% they are undecided, while the 11% disagree and 8% is strongly disagreed (Figure 5-13).

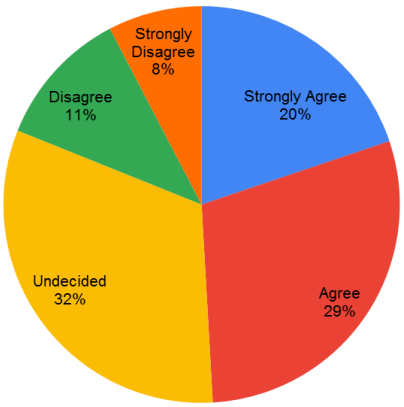

Figure 5-13: Level of agreement with companies that eliminated palm oil in their products

With regard to respondents who said they did not consume palm oil. The 52 % of the respondents states that they prefer them because they are healthier; at the same time the 43% prefers them considering environmental friendly; the 22% find them more sustainable; the 19% of the sample purchases palm oil free products because they think that they are more natural; the 18% chooses them for supporting campaigns against palm oil; the 11% thinks they have higher quality; the 7% finds them tastier while for 4% they are cheaper and just the 3% prefers them for the popularity of idea and because it is trendy (Figure 5-14).

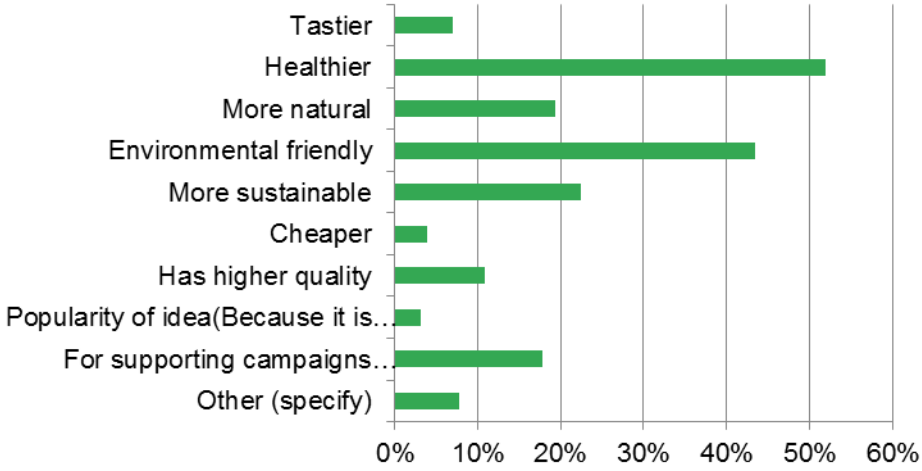

Figure 5-14: Reasons to purchase food products without palm oil

To determine the consumers' motivations for purchasing food products without palm oil, respondents were asked to indicate scores for each factor on a Likert scale from 1 to 5[3]. Detailed quantitative analysis results are shown in Figure 5-15.

Considering the value of importance for choosing palm oil-free products, half of the participants stated its "environmental-friendly" attribute is very important, while for 18%, it is important. For "healthier" and "more sustainable" attributes was indicated each by 47% of respondents as very important.

Respondents stated that they gave an above-average value (important - very important) for purchasing palm oil free products to the following statements: palm oil free products are more environmental-friendly (68%), healthier (66%), more sustainable (64%), more natural (56%) and have higher quality (47%). Moreover, 36% of the sample gives above-average value for supporting campaigns against palm oil, while 28% find them tastier, 15% find them cheaper and 12% preferred for the popularity of the idea.

The reasons that are least important to the consumers are due to the popularity of the idea (47%), followed by because they find it cheaper (29%) and tastier (23%).

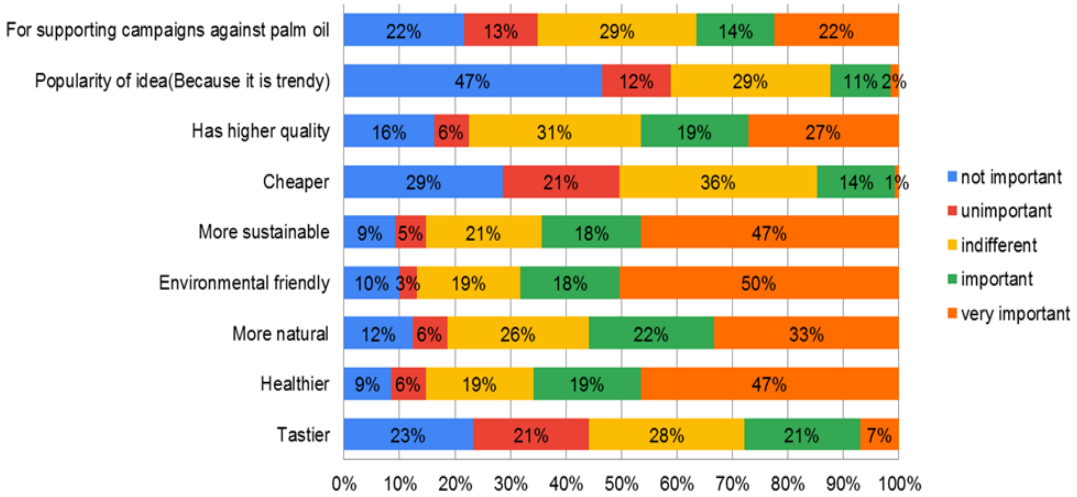

Figure 5-15: Importance of motivations for purchasing food products without palm oil

[3] Where: 1: not important; 2: unimportant; 3: indifferent; 4: important; 5: very important

Regarding purchasing palm oil-free products, most of the participants stated that they mostly buy cookies and biscuits, chocolate and nut butters, creams (spreads) without palm oil (Figure 5-16).

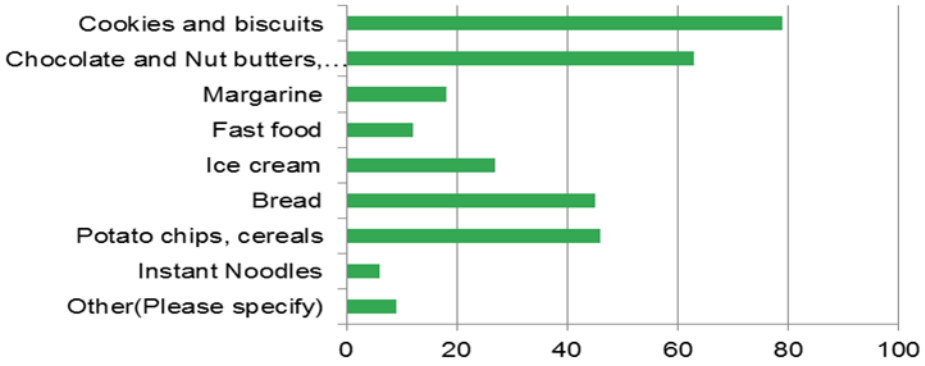

Figure 5-16: Type of purchased palm oil-free products

Considering the frequency of purchasing palm oil free products, 34% of the respondents purchases them once a week, while 33% purchase more than once a week. Most of the participants (84%) usually purchases palm oil free food products at the supermarket (Figure 5-17).

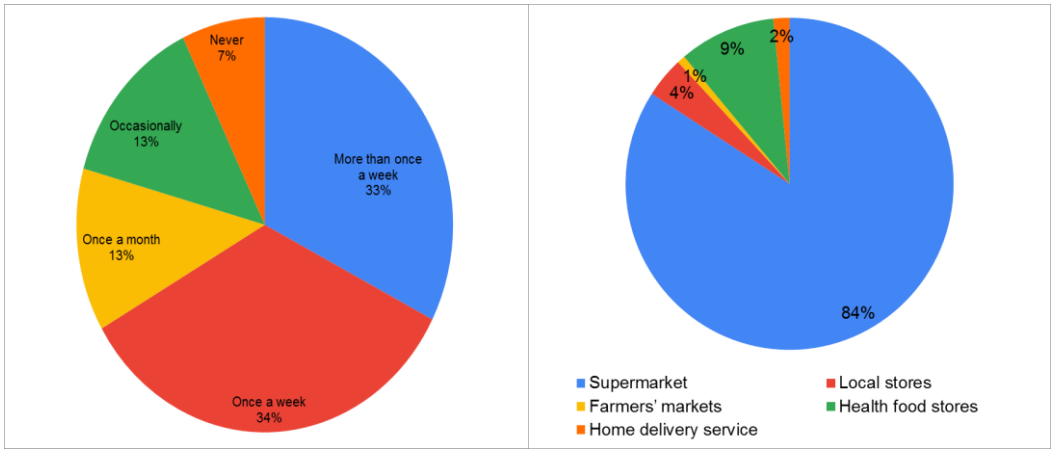

Figure 5-17: Frequency and place for purchasing palm oil-free products

The section 4, it is aimed to investigate consumers' knowledge about impacts of the palm oil. 73% of the respondents indicated that they are aware of the current debate on the environmental, health and social impacts of palm oil. In particular, 37% of the participants indicated that they

feel reasonably informed about the effects of palm oil, while the 27% feels not very well informed, the 21% feel fairly well informed, the 7% very well informed and the 8% feel not informed (Figure 5-18).

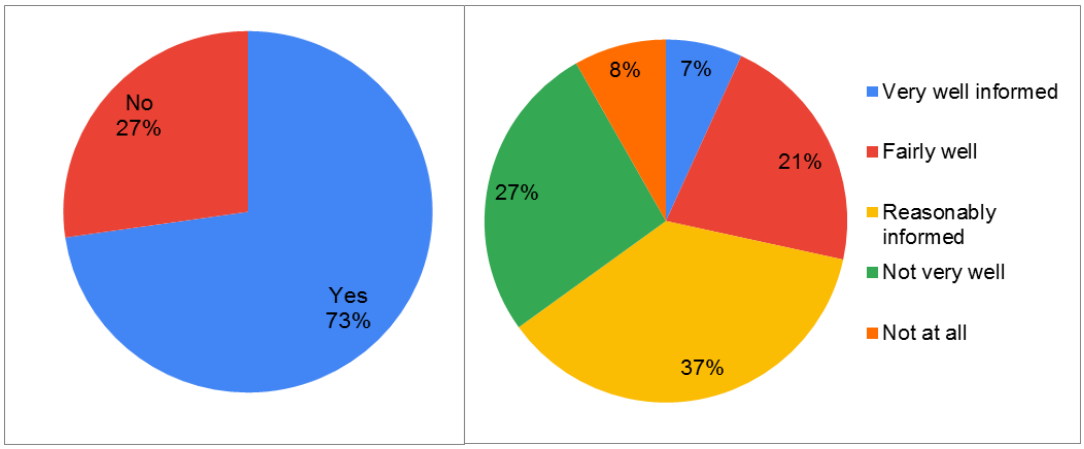

Figure 5-18: Awareness and information level on impacts of palm oil

As shown in Figure 5-19, participants indicated their information level about different statements of palm oil on a five point Likert scale from "not at all" to "very well informed" [4]. 22% of the participants feel informed very well about environmental effects while 25% feel fairly well informed. Regarding the health effects, 17% feels very well informed, while 24% feels fairly well informed about the health effects of palm oil.

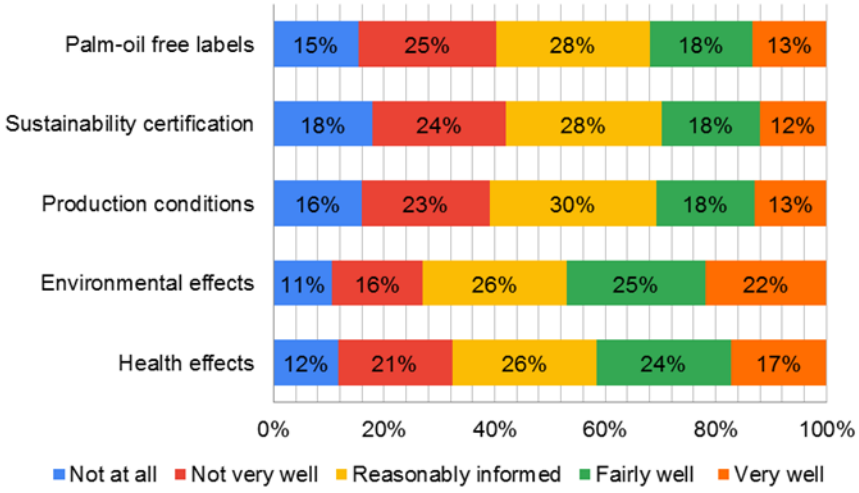

Figure 5-19: Consumers' information level of statements about palm oil

[4] Where: 1:Not at all, 2: Not very well, 3:Reasonably informed, 4: Fairly well, 5: Very well informed

Participants' concerns about palm oil issues were assessed (Figure 5-20). 57% of the respondents are concerned about deforestation issues. While 27% of respondents states that they are concerned about negative health aspects (cardiovascular diseases, obesity...), 26% is worried about the loss of biodiversity and 24% is concerned about killing endangered species. Other issues such as lack of regulations for cultivating and producing (14%), child labor and human rights violations during production (12%), global warming (11%), bad working conditions on the plantation (10%), and greenhouse gas emission (3%) go as stated.

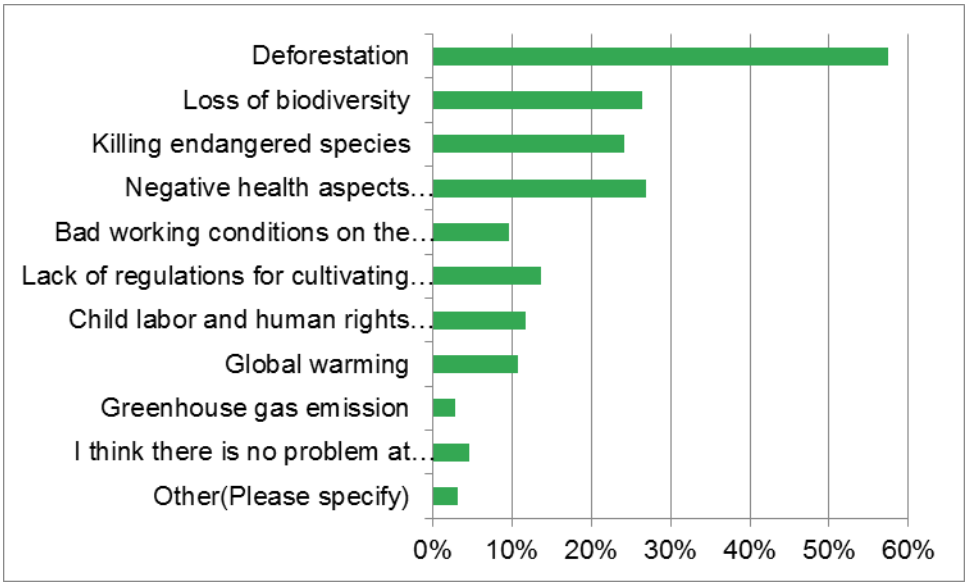

Figure 5-20: Consumers' concerns about palm oil issues

Regarding getting the information about palm oil, 64% of the sample stated that they get information mainly from the internet, followed by social media sites (e.g. Twitter, Facebook, etc.) (31%), academic resources (26%), newspapers and articles (24%) (Figure 5-21).

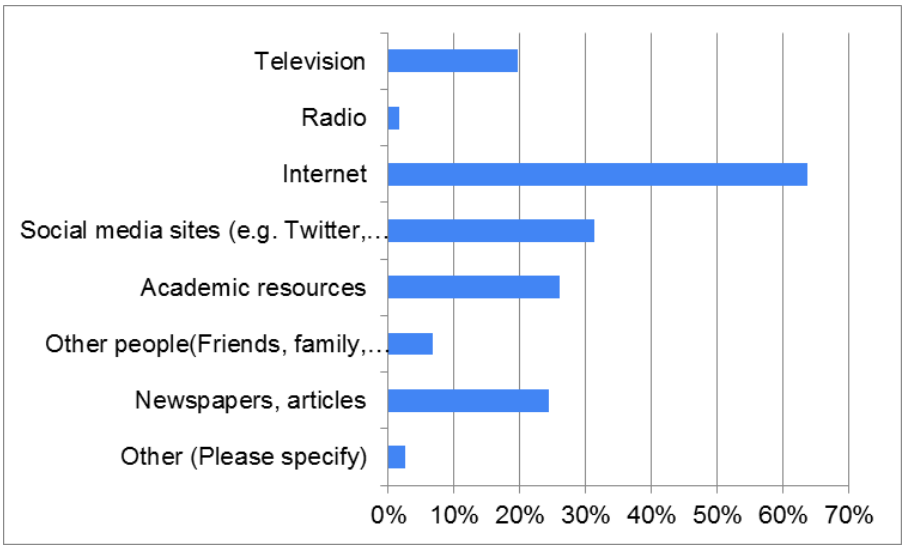

Figure 5-21: Where consumers get information about palm oil

In section 5 consumer knowledge about sustainable palm oil and sustainable certification schemes is investigated. Regarding the knowledge of certifications that guarantee standards of social, economic and environmental sustainability for the production of palm oil, 75% of the respondents stated that they don't know them. Recognition of sustainable certification labels was very low and 71% of the participants stated that they do not recognize any of the certifications, although 17% indicated that they know GreenPalm certification, 11% knows RSPO, 7% knows MSPO and another 7% knows ISPO (Figure 5-22).

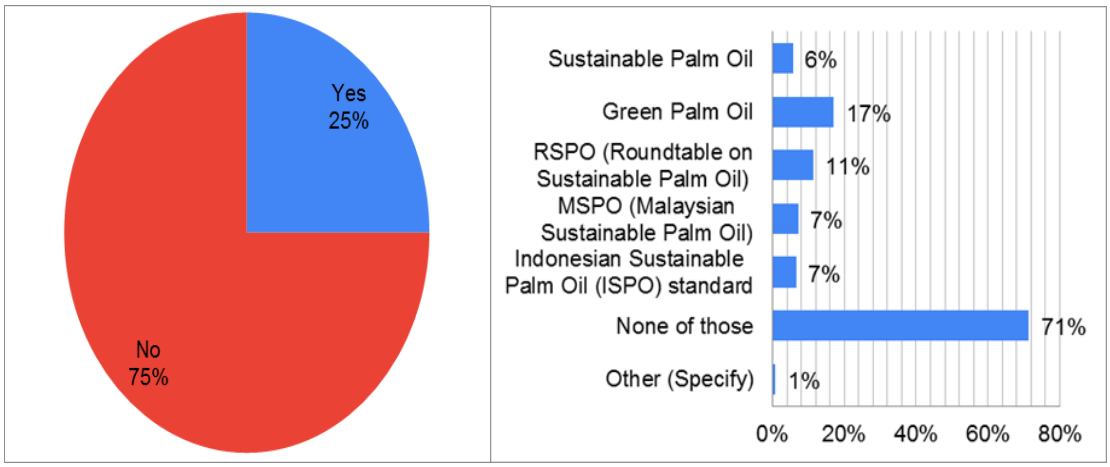

Figure 5-22: Consumers' knowledge about sustainable palm oil certifications

Regarding the influence level of certifications on purchasing decisions, 26% of the respondents stated that certifications have not influenced their purchasing decision. While for other 26% it sometimes influences, for 20% of the sample certification affects a little and for the 8% it extremely effects the purchasing decision. The 20% stated that they do not know any of these certifications (Figure 5-23).

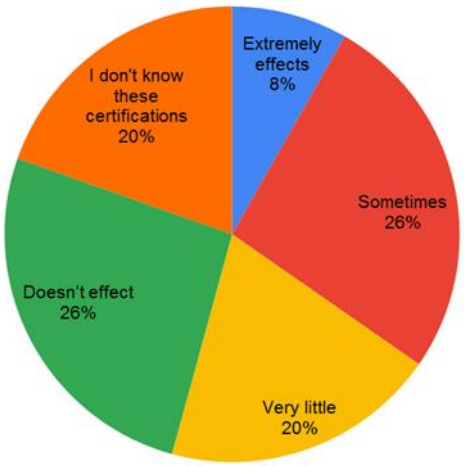

Figure 5-23: Influence level of certifications on purchasing level

Considering the credibility of palm oil certifications and consumers' trust in the reliability of these certifications, 49% of the sample indicated that they somewhat believe while 26% believe very little and 15% do not believe at all. Just the 10% of the participants responded that they believe to a great extent the credibility of these certifications (Figure 5-24).

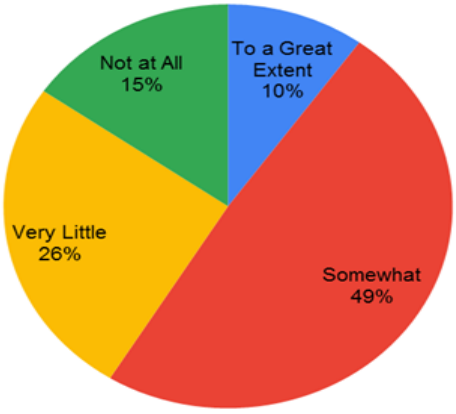

Figure 5-24: Credibility of sustainable palm oil certifications

Respondents are asked if they have ever heard of Non-governmental Organizations (NGOs) that have conducted campaigns against palm oil use, and half of the participants responded positively (Figure 5-25).

Moreover, respondents are asked if they have ever heard about EFSA's claim /report about palm oil, and 68% of the participant stated they do not have ever heard about that (Figure 5-25).

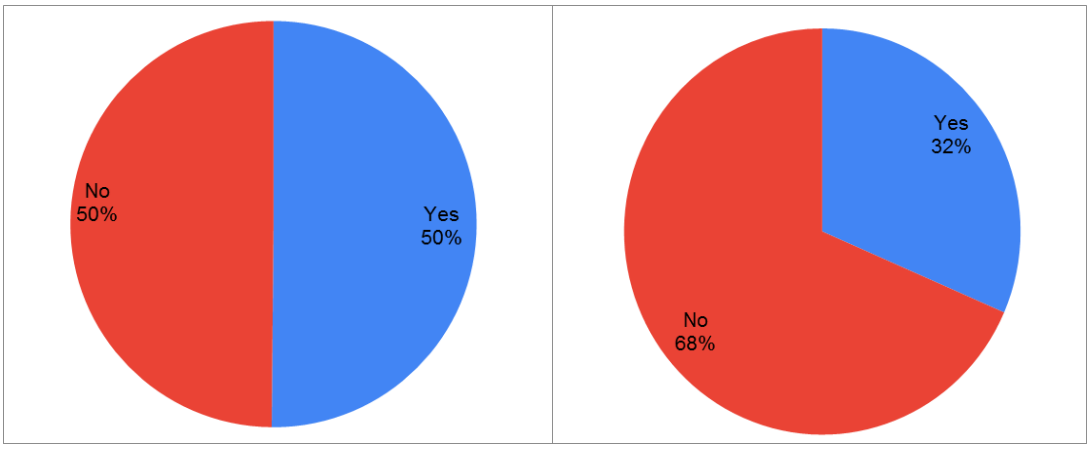

Figure 5-25: Consumers' knowledge about NGOs campaigns and EFSA's report

Finally, the level of agreement with the company that decides to continue to use palm oil in their products is asked to the participants. 39% of respondents replied "undecided", while 19% replied "disagree" and another 19% "agree", 18% replied "strongly disagree". And 5% stated that they strongly agree with this decision (Figure 5-26).

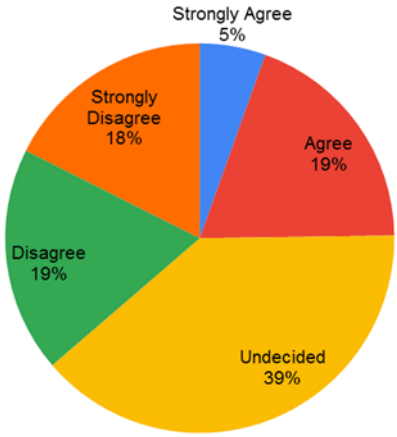

Figure 5-26: Level of agreement with company that use palm oil as an ingredient

5.3.3 *Parametric estimate of the willingness to pay*

In section six of the questionnaire, consumers' willingness to pay is assessed, after the information about sustainable palm oil is provided. Based on market research, the starting average price for a packet of biscuits without palm oil is €1,85. Participants are asked if they would willing to pay € 1,95 for a packet of biscuits with certified sustainable palm oil instead of a packet of biscuits without palm oil. If the answer was yes (68% of the sample), it has been asked if they would be willing to pay €2,05 for the same packet of biscuits with certified sustainable palm oil and 49% of the sample responded yes.

If the answer was no (32% of the sample), it has been asked if they would be willing to pay the same price (€1,85) for the same packet of biscuits with certified sustainable palm oil instead of without palm oil and 19% of the sample stated no (Table5-2).

Table 5-2: Consumers' willingness to pay distribution relative to the price offered.

Offered Price	NO-NO	NO-YES	YES-NO	YES-YES	TOTAL
1.95	19%	12%	20%	49%	100%

The final econometric model aimed at analyzing the WTP is presented below in Figure 5-27. The estimates are obtained through the software Gretl version 1.9.4. Some of the explanatory variables are eliminated to obtain a better restricted model. The complete econometric model is shown in the Annex II.

	coefficiente	errore std.	z	p-value	
const	2,03829	0,119999	16,99	1,05e-064	***
age	0,00601892	0,0213445	0,2820	0,7780	
gender	0,0180827	0,0259918	0,6957	0,4866	
education	−0,0241920	0,0159440	−1,517	0,1292	
occupation	0,00125517	0,00687544	0,1826	0,8551	
marital_status	0,0174093	0,0385385	0,4517	0,6515	
children	0,0162059	0,0309306	0,5239	0,6003	
income	−0,000900906	0,00941652	−0,09567	0,9238	
country	0,00512568	0,0274554	0,1867	0,8519	
read_labeling	−0,0246174	0,0184678	−1,333	0,1825	
price	−0,0290998	0,0126732	−2,296	0,0217	**
ecological_issue	0,0263026	0,0127319	2,066	0,0388	**
production_metho~	0,0250835	0,0125371	2,001	0,0454	**
know_palm_oil	0,00846197	0,0510101	0,1659	0,8682	
impression	0,0374972	0,0209064	1,794	0,0729	*
agree_company	−0,0144831	0,0121146	−1,196	0,2319	
aware_debate	0,0465073	0,0328661	1,415	0,1571	
how_much_informed	−0,0273477	0,0144303	−1,895	0,0581	*
health_i	0,0198642	0,0126217	1,574	0,1155	
production_i	0,0323619	0,0166028	1,949	0,0513	*
sustainability_i	−0,0307065	0,0159520	−1,925	0,0542	*
know_certificati~	−0,0268072	0,0310000	−0,8647	0,3872	
c_affect_purchas~	0,0185219	0,0116669	1,588	0,1124	
c_credible	0,000166399	0,0116241	0,01431	0,9886	

(Significance: *** at 1%; ** at 5%; * at 10%)

Figure 5-27: Econometric model

The significative variables are:

- Price (significative at 5% and negative): inversely proportional. Price is a significant but with a negative coefficient. This indicates that those who base the choice to buy a food product on price is not willed to pay more for a product with certified sustainable palm oil. In line with the literature, this variable is one of the most important extrinsic attributes influencing consumers' purchasing decisions for food products. In accordance with different studies (Boccia and Sarnacchiaro, 2018; Siro et al., 2008) the price exerts a negative influence on the decision-making process for individuals. In such circumstances, consumers may also know the benefits of certification schemes, but that does not always translate to purchase behavior.
- Ecological issue (5% and positive): directly proportional. This indicates that who pays attention to the ecological issue are more willed to pay more for a product with certified sustainable palm oil. Disdier et al. (2013) showed that consumers are concerned mostly about environment and this affects their WTP.

- Production method (5% and positive): directly proportional. This data shows that who give importance to the production methods are willing to pay more for sustainable certified product.
- Impression (10% and positive): directly proportional which indicates that people who have positive impression about palm oil in food is willed to pay more for product with certified sustainable palm oil. Borello et al. (2019) stated that negative impression about palm oil that consumers have, led them prefer palm oil-free products.
- How much informed (10% and negative): inversely proportional. This indicates that those who feel very well informed about palm oil effect is not willed to pay more for a product with certified sustainable palm oil. This finding is in line with the study of Verneau et al. (2019) which showed that consumers who search for more information about palm oil decide to reduce consumption of products with palm oil.
- Production (10% and positive): directly proportional. This indicates that those who feel very well informed about production conditions of palm oil is willed to pay more for a product with certified sustainable palm oil. This result is consistent with Disdier et al. (2013) which revealed that information about land use negatively affects the WTP of consumers for palm oil-free product.
- Sustainability (10% and negative): inversely proportional. This indicates that those who feel very well informed about sustainability certifications of palm oil is not willed to pay more for a product with certified sustainable palm oil. This is probably because consumers well informed about certification label do not really believe that the certification is applied.

The results show that surveyed consumers are willing to pay a premium of € 0.20 with respect to a package of biscuits without palm oil (Table 5-3).

Table 5-3: Descriptive statistics of the variable estimated WTP

Average	**2.051300**
Median	2.007900
Minimum	1.712100
Maximum	2.368600
Standard deviation	0.149060
Coeff. of variation	0.072664
Asymmetry	-0.500600
Curtosi	-0.911800
5th percentile	1.768200
95th percentile	2.220500
Interquartile Range	0.276020

5.4 **Discussion**

The data indicate that consumers are mainly females (66%), with a high level of education (43% have bachelor, 33% have a master and 6% have a higher degree), between 18 and 25 years old (49%), single (80%), student (53%), with 4 adult members in the households (31%), without children in the household (78%), with stated income mainly between 21.000-35.000 €. Even though the sample is distributed throughout 40 different countries, 57% of the sample is from Italy, with a particular concentration in the center of Italy.

Our explorative analysis highlights that most of the consumers (92%) know what palm oil is, this result is in line with the positive trend of the palm oil market (CPOPC, 2020).

Consistent with previous studies (Aguiar et al., 2018; Borrello et al., 2019; Disdier et al., 2013; Hartmann et al., 2018; Ostfeld et al., 2019), it is found that almost half of the respondents (48%) perceive palm oil negatively.

When they purchase food products, 27% of the sample sometimes checks for the presence of palm oil, 29% more than sometimes checks it, while 23% never check. These results are in line with Gassler and Spiller (2018), which stated that even though consumers had a negative perception about palm oil, only a small part had searched for palm oil in the list of ingredients and most were unaware of sustainable palm oil.

63% of the sample buys products containing palm oil. Regarding the reason for the purchase, 37% of the sample states that they buy products with palm oil because they do not believe that it negatively affects the health; 34% of the sample believe the media is overreacting. Considering

the importance of the values as purchasing motivation for products with palm oil, 22% of the respondents stated that they think media is overreacting.

Almost half of the sample (49%) agree with the food companies that have modified their recipes to eliminate palm oil.

Regarding the type of food product, most of the participants purchase cookies, biscuits, chocolate and nut butter and creams (spreads) with or without palm oil.

52 % of the respondents purchase palm oil-free food products because they consider them healthier, 43% prefer them considering environmental-friendly, 22% find them more sustainable. This result is consistent with the previous studies (Borrello et al., 2019; Hartmann et al., 2018).

Considering the value of importance for choosing palm oil-free products, the respondents gave an above-average value to the palm oil free products being more environmental-friendly (68%), healthier (66%), more sustainable (64%), more natural (56%) and have higher quality (47%).

33% of the sample buy palm oil free products more than once a week, 34% buy it once a week, while 7% never buy. Most of the palm oil free product (84%) is purchased in supermarkets.

73% of the respondents indicated that they are aware of the current debate on the environmental, health and social impacts of palm oil, while the %65 feels informed about its effects. In particular, respondents feel more than reasonably informed about environmental effects (73%) and health effects (67%). These results are in contrast to the study provided by Borello et al. (2019) which showed that consumers are uninformed about palm oil.

64% of the sample get information mainly from the internet, consistent with the study of Borello et al. (2019).

Considering the concerns of participants about palm oil issues, 57% of the respondents are concerned about deforestation issues. While 27% of respondents concerns about negative health aspects and 26% are worried about the loss of biodiversity. These results are in line with previous studies (Aguiar et al., 2018; Disdier et al., 2013; Fabbrizzi et al., 2019) which stated consumers are concerned more about environmental issues than social and other issues of palm oil.

Regarding the consumer knowledge of sustainable palm oil, 75% of the sample do not know the sustainable certifications. Confirming the findings of Gassler and Spiller (2018), Ostfeld et al. (2019), Hinkes and Christoph-Schulz (2020), RSPO trademark recognition and awareness

were found low. 11% of the sample recognize RSPO, while 71% of the participants do not recognize any sustainable palm oil certifications.

54% of the sample stated that certifications have influenced their purchasing decision at different levels. 15% do not trust in the reliability of palm oil certifications while 49% somewhat believes them.

Half of the sample know NGOs campaigns against palm oil use, while just 32% know the report of EFSA about palm oil. These results are in contrast to the study provided by Capecchi et al. (2019) which stated that consumers' buying intentions have been triggered by the campaigns and by the study of EFSA in the way to avoiding its use or preferring to the certified palm oil.

24% of the sample agree with the company that decides to continue to use palm oil in their products, where the major part was undecided (39%).

Of the sample,49% declared that they were willing to pay 1,95 EUR for the purchase of a packet of biscuits with sustainable certified palm oil, also accepting the following proposal of 2,05 EUR; meanwhile, 20% were willing to pay only the first amount. Relating to the part of the sample that refused the initial offer of 1,95 EUR, 12% were willing to pay at a lower price of 1,85 EUR, while 19% also refused the second offer. These results are in contrast to the studies provided by Vergura et al. (2019) and Hinkes and Christoph-Schulz (2020) which stated that consumers prefer "palm oil free" products over "with sustainable palm oil" products.

According to the econometric model, the present findings showed that consumers' intentions to purchase products with sustainable palm oil were not influenced by socio-demographic variables. This result is in line with the studies provided by Borrello et al. (2019) and Christoph-Schulz (2020).

However, the significant variables that may affect consumers' WTP for products with certified sustainable palm oil are found as price, concerns about ecological issue and production method, impression about palm oil, information level, provided information about production conditions and sustainability certifications. This result is in line with the Disdier el al. (2013) who suggested providing information to the consumers about palm oil issues through advertisements on television, internet and in the supermarkets will increase the consciousness and willingness to pay.

Finally, the price that consumers are willing to pay for product with certified sustainable palm oil is estimated. The sample has indicated an average WTP of about 2.05 EUR for a pack

of biscuits with certified sustainable palm oil. Consequently, premium price for a pack of biscuits with certified sustainable palm oil is found 20 cents.

The mean WTP value is found € 2.05 for a packet of biscuits (350g). While Gassler and Spiller (2018) derived a mean WTP €0.85 for RSPO certified palm oil for a package of chocolate bars (100 g) and Hinkes and Christoph-Schulz (2020) derived €0.11 for a package of chocolate cookies (200g) with RSPO-certified palm oil. These differences can be result from different focuses, used models and designs of these studies.

CONCLUSION

In recent years palm oil has become an important and controversial subject. Increasing consumer concerns about the health, environmental and social impacts of palm oil have stimulated the demand for palm oil-free products. This has led the food industry to change the food products and their marketing strategies. Indeed, the increasing global demand for vegetable oil makes the use of palm oil a better option for the environment than other oil crops due to its high yields and less area needs. Moreover, oil palm cultivation is an important economic resource for producing countries. Therefore, in order to protect the environment and livelihood of smallholders, supporting sustainable certified oil palm cultivation is a significant and better solution than boycotting palm oil. However, the debate on the health impacts of palm oil cannot be resolved in this way, but there are no scientifically proven negative health effects related to palm oil consumption for now.

The findings of the study highlight that even though consumers know palm oil and perceived it negatively, they are unaware of the sustainable certifications. Thus, it is important to provide accurate information to consumers through the right marketing and communication strategies for ensuring better evaluation of palm oil properties and making more conscious choices.

In contrast to previous studies, the findings show that the participants self-reported that they are aware of the current debate and they feel informed, especially about environmental and health aspects of palm oil. The degree of knowledge and information plays an important role in the choice of purchase.

This study highlights that consumers are willing to pay a premium price for certified sustainable palm oil. The findings obtained from the estimation depend on the characteristics of the respondent and other explanatory variables considered in the estimation.

The results obtained from the econometric model show that consumers' socio-demographic characteristics are not relevant to their WTP. Therefore, there is no specific market segment in terms of these characteristics that has a stronger influence on purchasing behavior. This leads to

a suggestion for future researches to assessing other characteristics of consumers such as personal beliefs, lifestyle, etc. that may impact their preferences.

Price, environmental issues, their impression and information level about palm oil are key elements for determining WTP. These results can be taken into account by producers and retailers when creating proper marketing strategies. Increasing consumers' knowledge and awareness about palm oil issues and sustainable palm oil certification schemes is an important approach. Therefore, in order to improve sustainability standards public and private efforts should be supported.

Finally, this study had several limitations. The results of this study cannot be strictly considered as referred to the whole population. Respondents are younger and more educated than the natural population due to data are collected by an online survey. Moreover, for "palm oil-free" labeled biscuits, it was not specified which alternative oil was used which can influence consumer preferences. Purchasing products with certified palm oil is an option for consumers who are concerned about environmental issues but concerns about potential health effects cannot be overcome in this way. Also, it should be considered that the structure of the questionnaire had an influence on the results.

Moreover, it is hard to find products with sustainable palm oil certification at the supermarket. Consequently, a problem commonly found in a large number of WTP measurement surveys is that stated rather than actual preferences are given by participants, resulting in over-ambitious estimations of WTP. Additionally, given the hypothetical nature of our elicitation method, more research is needed using non-hypothetical methods to test the robustness of our findings. Lastly, palm oil is used in various products like personal care products and as biofuels, so the consumers' perception of certified sustainable palm oil for non-food products also should be considered in future research.

This study contributes to the literature on consumer preferences by considering their awareness and purchasing decisions about certified sustainable palm oil and palm oil-free products.

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ANNEX I
QUESTIONNAIRE

Welcome to the online questionnaire aimed to investigate consumers' perceptions, awareness, and attitudes about the presence or absence of palm oil in food products.

We kindly ask you to answer some questions. Completing it through just a couple of minutes will be a great help in developing research at UNIVPM-D3A.

We underline that the questionnaire is anonymous and the data collected will be processed in compliance with the law on privacy*.

Thank you in advance for your cooperation and availability.

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*REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation).

1. Which language do you prefer to complete the questionnaire?
    - Inglese/ English
    - Italiano/Italian
2. Age
    - 18-25
    - 26-40
    - 41-60

- 60 +

3. Gender
- Male
- Female
- Prefer not to say

4. Education
- No formal education
- Primary school
- Middle school
- High school
- Bachelor's degree
- Master's degree
- Doctorate or higher

5. Occupation
- Student
- Housewife
- Office worker
- Researcher, Teacher
- Engineer, Technician
- Businessperson
- Self-employed
- Unemployed
- Retired
- Other (Please specify)

6. Marital status
- Married
- Single

7. How many adult members are there in your household? (Indicate the number)

8. How many children are there in your household? (Indicate the number)

9. What is your annual household income?
- Below than € 10.000
- Between € 11.000 - € 20.000
- Between € 21.000 - € 35.000
- Between € 36.000 - € 50.000
- Between € 51.000 - € 75.000
- More than € 75.000

10. Your country
:

11. If your country is Italy, please also specify your region.
:

12. When you purchase food/beverage products, do you usually read the labeling?
- Often

- ○ Sometimes
- ○ Hardly ever
- ○ Never

13. When you choose food/beverage products, what factors/attributes influence your purchasing decisions? (indicate 3 factors)

- □ Origin
- □ Brand
- □ Price
- □ Presence of specific quality labels/certifications (PDO, PGI, STG, Organic, etc)
- □ Ecological or Environmental issue
- □ List of ingredients
- □ Health effects
- □ Production methods
- □ Packaging
- □ Working conditions
- □ Shelf life
- □ Figures/ pictures
- □ Allergen Statements
- □ Free from GMO, palm oil etc.
- □ Other (Please specify)

14. Please indicate the value of importance. On a scale of 1-5, how important are the following factors to you when buying products?
(1: not important; 2: unimportant; 3: indifferent; 4: important; 5: very important)

	Not important 1	2	3	4	5 very important
Origin	○	○	○	○	○
Brand	○	○	○	○	○
Price	○	○	○	○	○
Presence of specific quality labels/certifications	○		○	○	○
Ecological/Environmental issue	○	○	○	○	○
List of ingredients	○	○	○	○	○
Health effects	○	○	○	○	○
Production methods	○	○	○	○	○
Packaging	○	○	○	○	○
Working conditions	○	○	○	○	○
Shelf life	○	○	○	○	○
Figures/Pictures	○	○	○	○	○
Allergen Statements	○	○	○	○	○
Free from GMO, palm oil etc.	○	○	○	○	○

15. Do you know what palm oil is?

- ○ Yes
- ○ No

16. What kind of impression do you have about palm oil in food?

- ○ Positive

- ○ Negative
- ○ Indifferent

17. When you purchase food/beverage products do you check if it contains palm oil?

- ○ Always
- ○ Very often
- ○ Sometimes
- ○ Rarely
- ○ Never

18. Do you buy products with palm oil?

- ○ Yes →Go to question 19
- ○ No →Go to question 23

19. Why do you buy products with palm oil? Indicate 2 motivations.

- □ Tastier
- □ Cheaper
- □ Has higher quality
- □ I don't believe its negative effects on the health
- □ I don't believe its negative effects on the environment
- □ I don't believe its negative effects on the social fairness issues
- □ I think media is overreacting
- □ I can't find products without palm oil at the supermarket
- □ Other (Specify)

20. Please indicate the value of importance. I choose to consume products with palm oil because...

(1: not important; 2: unimportant; 3: indifferent; 4: important; 5: very important)

	1	2	3	4	5
Tastier	○	○	○	○	○
Cheaper	○	○	○	○	○
Has higher quality	○	○	○	○	○
I don't believe its negative effects on health	○	○	○	○	○
I don't believe its negative effects on the environment		○	○	○	○
I don't believe its negative effects on social fairness issues			○	○	○
I think media is overreacting	○	○	○	○	○
I can't find products without palm oil at supermarket		○	○	○	○

21. What kind of products do you usually buy with palm oil?

- □ Cookies and biscuits
- □ Chocolate and Nut butters, creams (Spreads)
- □ Margarine
- □ Fast food
- □ Ice cream
- □ Bread
- □ Potato chips, cereals
- □ Instant Noodles
- □ Other (Please specify)

22. Do you agree with the food companies that have modified their recipes to eliminate palm oil?

- ○ Strongly Agree
- ○ Agree
- ○ Undecided
- ○ Disagree
- ○ Strongly Disagree

23. Why do you choose to buy palm oil-free products? (Indicate 2 motivations)

- □ Tastier
- □ Healthier
- □ More natural
- □ Environmental friendly
- □ More sustainable
- □ Cheaper
- □ Has higher quality
- □ Popularity of the idea (Because it is trendy)
- □ For supporting campaigns against palm oil
- □ Other (specify)

24. Please indicate the value of importance. I choose to consume palm oil-free products because it is...

(1: not important; 2: unimportant; 3: indifferent; 4: important; 5: very important)

Not important	1	2	3	4	5very important
Tastier	○	○	○	○	○
Healthier	○	○	○	○	○
More natural	○	○	○	○	○
Environmental friendly	○	○	○	○	○
More sustainable	○	○	○	○	○
Cheaper	○	○	○	○	○
Has higher quality	○	○	○	○	○
The popularity of idea (Because it is trendy)	○	○	○	○	○
Supporting campaigns against palm oil	○	○	○	○	○

25. What kind of products do you usually buy without palm oil?

- □ Cookies and biscuits
- □ Chocolate and Nut butters, creams (Spreads)
- □ Margarine
- □ Fast food
- □ Ice cream
- □ Bread
- □ Potato chips, cereals
- □ Instant Noodles
- □ Other (Please specify)

26. I usually purchase palm-oil free food products at

- ○ Supermarket

- Local stores
- Farmers' markets
- Health food stores
- Home delivery service

27. I usually purchase palm-oil free food products

- More than once a week
- Once a week
- Once a month
- Occasionally
- Never

28. Are you aware of the current debate on the effect (nutritional, environmental and social aspects) of palm oil?

- ○ Yes
- ○ No

29. How much do you feel informed about palm oil effect?

- Very well informed
- Fairly well
- Reasonably informed
- Not very well
- Not at all

30. How well informed do you feel about following statements of palm oil?
(1:Not at all, 2: Not very well, 3:Reasonably informed, 4: Fairly well, 5: Very well informed)

	Not at all 1	2	3	4	5 Very well informed
Health effects	○	○	○	○	○
Environmental effects	○	○	○	○	○
Production conditions	○	○	○	○	○
Sustainability certification	○	○	○	○	○
Palm-oil free labels	○	○	○	○	○

31. What issue of palm oil production concerns you more? Indicate 2 motivations.

- □ Deforestation
- □ Loss of biodiversity
- □ Killing endangered species
- □ Negative health aspects (cardiovascular diseases, obesity..)
- □ Bad working conditions on the plantation
- □ Lack of regulations for cultivating and producing
- □ Child labor and human rights violations during production
- □ Global warming
- □ Greenhouse gas emission
- □ I think there is no problem at palm oil production
- □ Other (Please specify)

32. Where do you mainly get information about palm oil?

- □ Television
- □ Radio

- □ Internet
- □ Social media sites (e.g. Twitter, Facebook, etc.)
- □ Academic resources
- □ Other people(Friends, family, colleagues)
- □ Newspapers, articles
- □ Other (Please specify)

33. Do you know the certifications that guarantee standards of social, economic and environmental sustainability for the production of palm oil?

- o Yes
- o No

34. Which certification labels do you know about palm oil?

- □ Sustainable Palm Oil
- □ Green Palm Oil
- □ RSPO (Roundtable on Sustainable Palm Oil)
- □ MSPO (Malaysian Sustainable Palm Oil)
- □ Indonesian Sustainable Palm Oil (ISPO) standard
- □ None of those
- □ Other (Specify)

35. How much these certifications affect your purchasing decision?

- o Extremely effects
- o Sometimes
- o Very little
- o Doesn't effect
- o I don't know these certifications

36. How credible are these palm oil certifications for you? Do you trust in the reliability of these certifications?

- o To a Great Extent
- o Somewhat
- o Very Little
- o Not at All

37. Have you ever heard of Non-governmental Organizations (NGOs) that have conducted campaigns against palm oil use?

- o Yes
- o No

38. Have you ever heard EFSA (European Food Safety Authority) claim /report about palm oil?

- o Yes
- o No

39. Are you agreeing with the company that decides to continue to use palm oil in their products?

- o Strongly Agree
- o Agree
- o Undecided
- o Disagree

- Strongly Disagree

Product:

Suppose that you are at the supermarket and there are two packets of biscuits (350g/package)

- Packet A contains biscuits with certified sustainable palm oil that is oil comes from a plantation that has no impact on deforestation, preserves biodiversity, limits its carbon footprint by treating all its waste through environmentally friendly practices and protects the rights of local populations and workers, respecting the principle of free, prior and informed consent of those communities.

- Packet B contains biscuits without palm oil.

Please reply to the next questions according to this.

40. Given that the average price of a packet of biscuits without palm oil is around €1,85, would you be willing to pay € 1,95 for a packet of biscuits produced with certified sustainable palm oil?

- Yes →Go to question 41
- No →Go to question 42

41. On the other hand, I offered you a price of € 2,05 for the same packet of biscuits with certified sustainable palm oil , would you be willing to buy it anyway?

- Yes
- No

42. On the other hand, I offered you a price of € 1,85 for the same packet of biscuits with certified sustainable palm oil, would you be willing to buy it?

- Yes
- No

ANNEX II
ECONOMETRIC MODEL

```
intreg lim_INF lim_SUP const age gender education occupation marital_status children
income country read_labeling origin brand price quality_labels ecological_issue
ingredients health_effects production_methods packaging working_conditions shelf_life
figures allergen_statements free know_palm_oil impression check tastier_y cheaper_y
higher_quality_y no_effects_health_y no_effects_environment_y no_effects_social_y
media_overreacting_y no_find_without_y agree_company aware_debate how_much_informed
health_i environmental_i production_i sustainability_i free_labels_i
know_certifications c_affect_purchasing c_credible

yhat = $yhat
uhat = $uhat
sigma = $sigma

ldp = yhat + uhat
dp = exp(ldp + 0.5*sigma^2)
dp2 = exp(ldp)

Modello 1: Stime per intervallo, usando le osservazioni 1-219
Limite inferiore: lim_INF, Limite superiore: lim_SUP
Errori standard basati sull'Hessiana

                      coefficiente  errore std.      z       p-value
  ---------------------------------------------------------------------
  const                2,07826      0,137025     15,17      5,85e-052 ***
  age                  0,0185198    0,0221704     0,8353    0,4035
  gender               0,0223730    0,0268475     0,8333    0,4047
  education           −0,0222786    0,0166315    −1,340     0,1804
  occupation           0,00113432   0,00699293    0,1622    0,8711
  marital_status       0,0137386    0,0388584     0,3536    0,7237
  children             0,0287527    0,0319240     0,9007    0,3678
  income              −0,00469043   0,00980085   −0,4786    0,6322
  country              0,0158857    0,0332524     0,4777    0,6328
  read_labeling       −0,0195564    0,0204672    −0,9555    0,3393
  origin               0,00132961   0,0112719     0,1180    0,9061
  brand                0,00712565   0,0127033     0,5609    0,5748
  price               −0,0286004    0,0148318    −1,928     0,0538    *
  quality_labels       0,00143163   0,0152640     0,09379   0,9253
  ecological_issue     0,0245371    0,0150877     1,626     0,1039
  ingredients          0,000143808  0,0154917     0,009283  0,9926
  health_effects       0,00665664   0,0131394     0,5066    0,6124
  production_metho~    0,0426683    0,0172392     2,475     0,0133    **
```

packaging	−0,0117558	0,0125445	−0,9371	0,3487	
working_conditio~	0,00669907	0,0148484	0,4512	0,6519	
shelf_life	−0,0223762	0,0119447	−1,873	0,0610	*
figures	0,0215171	0,0131880	1,632	0,1028	
allergen_stateme~	−0,000722589	0,0115616	−0,06250	0,9502	
free	−0,0188984	0,0139383	−1,356	0,1751	
know_palm_oil	−0,00614207	0,0508457	−0,1208	0,9039	
impression	0,0512392	0,0270768	1,892	0,0584	*
check	−0,00159982	0,0153711	−0,1041	0,9171	
tastier_y	0,0210210	0,0124344	1,691	0,0909	*
cheaper_y	0,00465176	0,0130736	0,3558	0,7220	
higher_quality_y	−0,0266029	0,0150740	−1,765	0,0776	*
no_effects_healt~	0,00866133	0,0125989	0,6875	0,4918	
no_effects_envir~	−0,0289331	0,0178910	−1,617	0,1058	
no_effects_socia~	0,00674674	0,0174106	0,3875	0,6984	
media_overreacti~	−0,00554778	0,0116382	−0,4767	0,6336	
no_find_without_y	−0,00493745	0,00965220	−0,5115	0,6090	
agree_company	−0,0190697	0,0123449	−1,545	0,1224	
aware_debate	0,0380415	0,0334924	1,136	0,2560	
how_much_informed	−0,0324916	0,0148865	−2,183	0,0291	**
health_i	0,0217113	0,0137307	1,581	0,1138	
environmental_i	0,0121616	0,0151877	0,8008	0,4233	
production_i	0,0178118	0,0179074	0,9947	0,3199	
sustainability_i	−0,0216479	0,0169194	−1,279	0,2007	
free_labels_i	−0,00608468	0,0133365	−0,4562	0,6482	
know_certificati~	−0,00730759	0,0309110	−0,2364	0,8131	
c_affect_purchas~	0,0136659	0,0116693	1,171	0,2416	
c_credible	−0,00513656	0,0120128	−0,4276	0,6689	

Chi-quadro(45)	51,74303	p-value	0,227351
Log-verosimiglianza	−235,0535	Criterio di Akaike	564,1070
Criterio di Schwarz	723,3933	Hannan-Quinn	628,4380

Note: SQM = scarto quadratico medio; E.S. = errore standard