Czech University of Life Sciences Prague

Faculty of Economics and Management

European Agrarian Diplomacy

Diploma Thesis

The importance of the palm oil in Indonesia

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Faculty of Economics and Management

DIPLOMA THESIS ASSIGNMENT

Monika Vybíralová

European Agrarian Diplomacy

Thesis title

The importance of the palm oil in Indonesia

Objectives of thesis

The main objective of the diploma thesis is by means of econometric modelling and other quantitative techniques to evaluate the significance of palm oil value chain in the economy of Indonesia, with a particular focus on the region of Sumatra. The thesis comprises the whole value chain of palm oil: processing, its industrialization and utilization, which has impact on the economy and environment not only in Sumatra but on whole Indonesia.

Methodology

The theoretical part of the work (as a precondition for processing the empirical part) is based on a thorough examination of relevant theoretical literature, scientific articles, sources, materials and documents acquired during the field research, which are related to the concept of palm oil and the issues related to the sustainable development of palm oil.

Following empirical part will be elaborated in various steps: 1) collection of primary and secondary data from publically available institutions and from the terrain research, 2) analysis of data using econometric modelling with the aim of quantification of macro-level economic and environmental impacts of palm oil, 3) interpretation of the findings with corresponding policy recommendations.

The proposed extent of the thesis

60 – 80

Keywords

palm oil, Indonesia, cultivation, industrialization, environment, kernel, production, education, GDP, unemployment, certification

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Recommended information sources

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Declaration

I declare that I have worked on my diploma thesis titled "The importance of the palm oil in Indonesia" by myself and I have used only the sources mentioned at the end of the thesis. As the author of the diploma thesis, I declare that the thesis does not break copyrights of any their person.

In Prague on 31st of March 2016 _____

Monika Vybíralová

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Důležitost palmového oleje v Indonésii

Souhrn

V současnosti neexistuje žádná náhražka palmového oleje. Proto je cílem této diplomové práce zhodnotit význam palmy olejné v Indonésii, jakožto největšího exportéra palmového oleje na světě. Zhodnocuje dlouhodobou udržitelnost pěstování této olejniny, možnosti její certifikace a zahrnuje i vlivy palmy olejné na životní prostředí. Detailně se zaměřuje na dopady i výhody jejího pěstování nejen pro Indonéskou ekonomiku, ale zároveň také pro zdejší komunity.

Diplomová práce obsahuje ekonomickou analýzu, vytvořenou pomocí ekonometrického modelu se dvěma rovnicemi a SWOT analýzy. SWOT analýza obsahuje silné a slabé stránky produkce palmového oleje a celého jejího procesu. Z analýz následně vyplývají vhodná doporučení pro efektivnější využití palmového oleje.

Klíčová slova: palmový olej, Indonésie, pěstování, životní prostředí, produkce, HDP, certifikace

The importance of the palm oil in Indonesia

Summary

Nowadays there is no substitute of palm oil in international market. For this reason the diploma thesis is focused on the evaluation of the importance of the palm oil. It is concentrated on Indonesia because it is the biggest exporter of it. The thesis evaluates the sustainable development of palm oil and its certification. It includes the impacts of palm oil on environment. This work is focused on costs and benefits of production of palm oil for Indonesian economy and local communities as well.

The diploma thesis includes an economic analysis by econometric model with two equations and by SWOT analysis. The SWOT analysis shows the strengths and weaknesses of palm oil production and its whole process of it. The recommendations are results of analyzes and they focus on more effective production of palm oil.

Keywords: palm oil, Indonesia, cultivation, environment, production, GDP, certification

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1 Introduction

Palm oil production and the consequences of its production is a widely discussed topic not only because of its importance in the global economy but also in connection to its controversial impact on ecology. Growth of world's population leads to the increase of demand for renewable sources, to which vegetables oils rightly belong. Vegetables oils possess different characteristics and so they can offer a wide range of uses. From political perspective the oil it is a market of conflict, because it offers a large profit with many possibilities.

There are a lot of campaigns related to palm oil and its bad impacts on Indonesian ecology caused by deforestation of virgin forest and biodiversity loss. But palm oil industry also contributes to the growth of Indonesian economy, creates jobs for local people and ensures the development of Indonesia in economic and social perspective.

Nowadays palm oil has no substitute to replace its position in international market. So this diploma thesis provides overview of importance of palm oil in Indonesia, where it is an integral part of local population's life and Indonesian economy. The reason for concentration on Indonesian palm oil industry lies in the fact that Indonesia is the largest palm oil exporter in the world and it is also the country where the production of palm oil demonstratively affects the life of its inhabitants. Indonesia and Malaysia provide for over 80 % of world's demand for palm oil. At the same time, a lot of farmers and Indonesian companies are members of RSPO. It is an organization that supports the production and certification of sustainable palm oil.

The diploma thesis analyzes the importance of palm oil in Indonesia, in particular its impact on Indonesian economy, but it also address the environmental issues where its impact will have the repercussions for future generation as well. This diploma thesis includes the quantification of the relationship between the production of palm oil and GDP, which it is provided by econometric model. The final part is devoted to the evaluation of palm oil importance for the country by means of SWOT analysis and recommendations for using the opportunities for Indonesia to defends its leading position among palm oil producers at the same time promoting and supporting sustainable palm oil

development. The evaluations are based on the findings in theoretical and practical part and also on terrain research in Indonesia especially on Sumatra.

Due to the fact that Indonesia is a developing country, there is a possibility of missing statistical data; sometimes the data is not available at all. Partially it is due to current government policy and political regime in the country.

It is widely expected, especially with regards to the growing economies, that there would be controversy between economic and environmental needs. The environmental problems affect large and valuable natural areas. For this reason this diploma thesis is mainly focused on economic aspects of the palm oil industry but the environmental issues and social costs of palm oil production are not overlooked either. Environmental problems are demonstrated by the impacts of palm oil production on biodiversity and natural resources. We also aim to show the double-edged impact of the palm oil production on local communities: the industry does not only bring negative effects, but it also does a lot of good to the local people. The diploma thesis attempts to show the correlation between the development of palm oil production and the economic growth of Indonesia.

2 Objectives and Methodology

2.1 Objectives

The main objective of the diploma thesis is to evaluate the importance of palm oil production in the economy of Indonesia. This main objective will reached by few completing partial objectives. The first partial objective is to describe the economic social and economic environment of Indonesia. The following partial objective is to summarize the utilization of palm oil, which provides the opportunities for downstream industries of palm oil. Last objective is related to the previous objective and it deals with the palm oil certification and also costs and benefits of implementing it. By reaching these objectives, the perspective of dependency between palm oil production and Indonesian economy can be estimated. This diploma thesis intends to find the possible solutions for both sides of this controversy topic.

2.2 Methodology

In this section the methodology of the diploma thesis elaboration is explained. The literature review is structured in two chapters. The first chapter is focused on analyzing the economic situation in Indonesia, on introducing of palm oil with its history, cultivation and process. This chapter includes the utilization of palm oil, world producers and traders with palm oil and the position of palm oil in Indonesia as well. The second chapter concentrates on social, environmental and economic aspects of palm oil with regarding to sustainable development of palm oil, certification and its benefits and costs.

In the practical part, the method of quantitative analysis using econometric modeling is applied. The chapter four describes the econometric model that analyzes palm oil impacts. The hypotheses for the construction of the econometric model are based on the literature review.

The practical part of the thesis also builds on a field trip of the author in Indonesia, carried out in August in the year 2015. The results of the survey provided inputs for on the production and processing of palm oil and contributed to gain understanding of the role of palm oil in the local economy. The surveys and answers are included in appendix 1. The

evaluation of surveys with results of econometric model and summarizing of literature review are included in SWOT analysis.

Econometric model

A two-equation recursive econometric model was used to investigate the relationships among the econometric variables. For parameters estimation of variables in econometric models was used a software Gretl.

The endogenous variables, also known as dependent or explained, are given by Y. The exogenous variables, also called as explanatory variables or independent variables, are presented by X. According to the economic theory, the endogenous is a function of numbers of exogenous variables.

$$Y = f(X_1, X_2, X_3, X_4, \dots, X_k) \quad (1)$$

For construction a logarithm econometric equation it is necessary to involve the relationships between explained variable and explanatory variables by parameters of variables.

$$y_t = \gamma_1 + \gamma_2 \cdot lnx_{2t} + \gamma_3 \cdot lnx_{3t} + \gamma_4 \cdot lnx_{4t} + \cdots + \gamma_k \cdot lnx_{kt} + u_t \quad (2)$$

t……is a relevant observation at time t
u…...is an error term

For good construction of econometric model it is important to follow the points below step by step:

- formulation of an economic model
- collection of statistical data
- estimation of parameters
- economic and statistical verification
- application of the model and simulation of cases (Tvrdoň, 2001).

The inclusion of each variable into the econometric model is based on the following hypotheses.

Hypotheses for first equation

It is assumed that the endogenous variable (y – production of palm oil) is influenced by four exogenous variables (x_1 – harvested area of palm oil, x_2 – export of palm oil, x_3 – average price of palm outputs, x_4 – employment in agriculture sector). All exogenous variables are in position that if the one of them will increase the production should increase as well.

Harvested area represents a link between the production of palm oil and deforestation in Indonesia. As expression of world demand for palm oil was choose the Indonesian export of goods and services, so with increasing growth of population there is also increasing demand for the cheap vegetable oil. If the world demand rises, the export should too and the production would react by increasing. The next variable for this equation is an average price of palm outputs, where belong palm oil, palm kernels and palm fruit. The production should increase with increased price especially when it takes as average price. The last variable is employment in agriculture sector, which should increase with increased production. But it is only in agriculture sector, where it does not include the engineers from palm industries. So the relationship might not be very strong.

Hypotheses for second equation

The second equation describes the position of palm oil production in Indonesian economy. This is a reason for combination of both equations by the first endogenous variable y_1 as one of the explanatory variables. It is expected, that the revenues from palm oil production will be important part of Indonesian GDP and the economy is palm oil dependent. For the best estimation this equation is focused on economic variables. Among these variables belongs gross fixed capital formation (x_7). The GDP should be increased with increasing of investments that is a one of driver of GDP. The economic prosperity of the country is also driven by the employment and with rising of it, it should be seen the GDP growth. The total labor force is the explanatory variable signed by x_8. For better improving the assumption of econometric model, there is included the development flows to agriculture especially to environment (x_9). The development flows to agriculture is one of the indicators for monitoring progress in reaching the 2030 Sustainable Development Goals (Faostat, 2015). It includes the government flows as well as grants from private charities

and foundations. The flows to environment protection should rises with growth of GDP, but it depends on political regime and government decisions.

Parameters estimation

The parameters γ and β shows a direction and strength of the impact of exogenous variables on endogenous variables. This estimation is presented by methods called the ordinary least squares method (OLS). This method is based on finding parameters that minimize the sum of squares of variances of theoretical values of explained variable from its real values. The formula is:

$$\gamma = (X^T \cdot X)^{-1} \cdot X^T \cdot y$$

γ ……is the vector of estimated parameters for exogenous variables
X……is matrix that contains observed values of explanatory variables
y…….is vector containing values of endogenous variable (Čechura, 2009).

Verification of econometric model

For better verification and processing data in equations, it was used a time vector. Thanks to this vector the data are uniquely arranged in terms of time in the direction of the past - present. Verification involves the following stages:

1. Economic verification
   First verification includes the controlling of direction, which is driven by signs in equations and intensity of exogenous variables to endogenous variable.
2. Statistical verification
   Statistical verification were examined a statistical significance of the estimated parameters. T-test serves to examine the significance of parameters. The parameters that are strong significant, are on 0.1 significance level. This significance level shows the level of confidence. For both equations it was determined the level of confidence 95 %, which is significance level with number 0.05. The Coefficient of Determination R^2 determines dependence of the endogenous variable on exogenous variables in percent. It shows the value of explanation of the endogenous variable by changes of explanatory variables. There

is also the adjusted coefficient of determination that reflects better depending in the model because it counts with number of exogenous variables. When the exogenous variables are added into model, then coefficient of determination always to grows, while the adjusted coefficient of determination can decrease as well as increase.

3. Econometric verification

   The first it has to be checked a multicollinearity of predetermined variables that verifies the relationships among variables. For econometric verification it will be used a Durbin-Watson test that shows the autocorrelation of residuals. The multicollinearity presents the correlation between two exogenous variables. There could be found the multicollinearity between explained and explanatory variable, but it is a wanted. The multicollinearity between two explanatory variables in one equation is marked above number 0.8. Thanks to high multicollinearity it is not possible to estimate right parameters of variables. It is main reason for transformation of data. It is used OLS method with robust standard error that prevents the multicollinearity.

Application of model

After all verifications, it is a possible to make an application of model. To apply the econometric model on Indonesian economy it can be used a method of simulation. The production of palm oil is taken as external force that contributes to growth of Indonesian economy expressed by GDP. The results will serve for estimation of perspectives of the Indonesian economy development.

Data sources

The data were collected for 29 years, the time series is from 1985 to 2013. The data were obtained from websites Faostat (2016) and World Bank (2016). Especially the production of palm oil fruit came out from Faostat as harvested area of palm oil fruit, average price of palm outputs (palm oil, palm fruits, palm kernels), development flows to agriculture, exports of palm oil and labor force in agriculture. World Bank was used for collection of data for GDP, labor force in total and for dross fixed capital formation.

3 Indonesia and Palm oil

This chapter focuses on the general description of Indonesia and more specifically on description of the role of palm oil in the life of this country. It touches upon the history of palm oil, main characteristics of its processing, as well as the issued related to palm oil production in the world and in Indonesia.

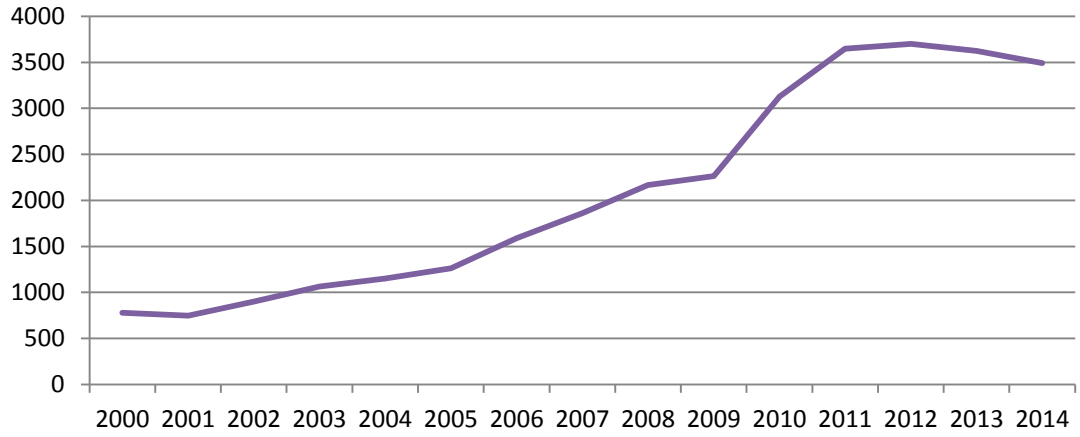
3.1 Indonesia

The Indonesian archipelago is located in Southeast Asia washed by the waters of the Indian and Pacific Oceans. Indonesia shares borders with East Timor, Malaysia and Papua New Guinea. It is comprised of 17 508 islands with total area of 1 890 754 ha and its population is 230 million inhabitants. Indonesia passes through the equator and therefore has tropical climate – it is a hot and wet country. Oil, pulp, coal, gold and silver are mined here. Major part of its terrain is lowland but some islands have their own volcanoes and mountains (Faostat, 2016).

Indonesia has the biggest number of volcanoes in the world out of which 76 are still active. So it is not surprising that the volcanic eruption is one of the most frequent natural disasters occurring in the country which happens mostly on the island Java, in the western part of Sumatra and on the islands of Sulawesi and Sangihe. Drought, floods, earthquakes and forest fires can be listed among other frequent natural phenomena occurring here quite often. Among topical environmental problems one can list deforestation of native forests, water pollution by industrial waste, lack of sanitation and air pollution in urban areas (Investments, 2015).

In the mid-sixties Indonesia was one of the poorest countries in the world with an average income of US$ 50 per capita. But since 1967 the national economy has been growing by 6.5 % per year. During the Asian financial crisis (ACF) in 1998 the country's economy slowed down by 13.6 %. In 2014 GDP increased by 5.2 % (International Monetary Fund, 2015).

Figure 1: GDP per capita in US$



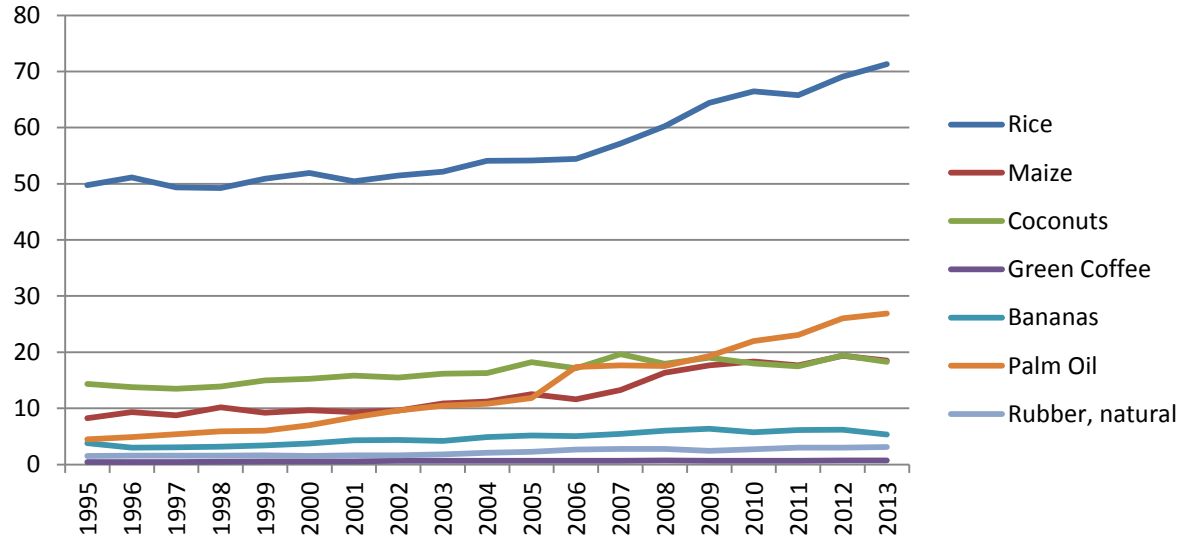
Sources: The World Bank, 2015

Due to the rapid growth of the economy – see Figure 1, which shows the GDP per capita - it is expected that in two years Indonesia will become one of the Asian billion economies and it will rank among the ten largest economies in the world within 10 years. Thanks to investments in its infrastructure and simplification of bureaucracy in its administration system the rate of economic growth at around 8 – 9 % per year should be achieved soon (Businessinfo, 2015).

Agriculture is still the dominant sector of Indonesian economy despite the fact that since 1986 the share of GDP generated by agriculture and the rate of employment in this sphere are on decline – in 2010 it was 38.3 % and in 2014 it constituted only 13.7 %. In comparison to that, industrial private sector contributed to GDP by 43 % in 2014 (The World Bank, 2015).

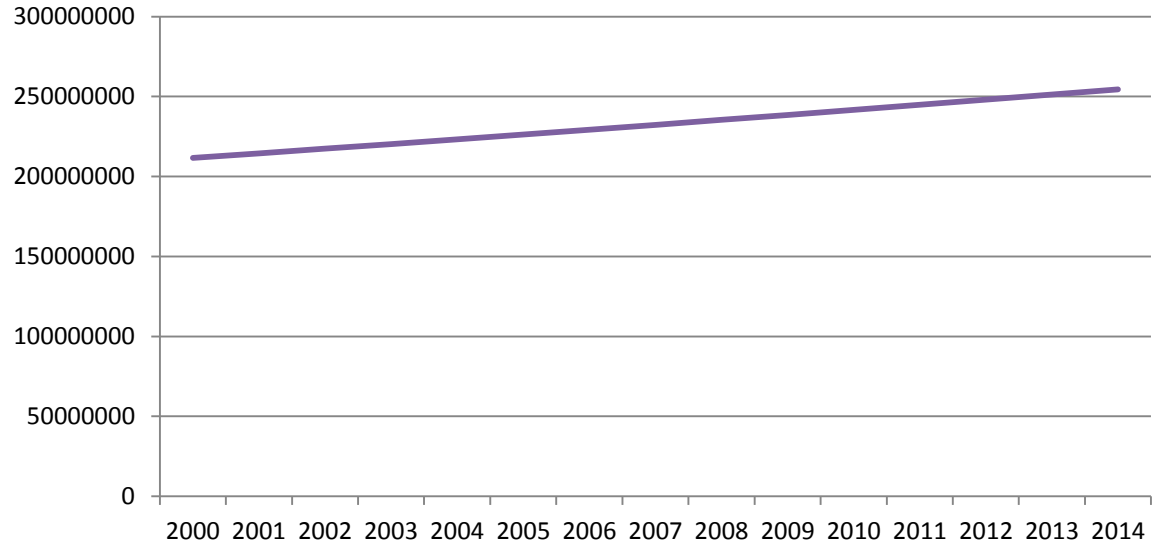
The most important crops are rice, palm oil, rubber, maize, coconuts, coffee and bananas the production of which is shown in Figure 2. Arable land makes up 31.5 % of the total territory and is continuously growing. Since 2000 it has increased by 6.5 % (The World Bank, 2015).

Figure 2: Production of selected crops in MT



Sources: Faostat, 2015

Figure 3: Population in Indonesia



Source: The World Bank, 2015

The growth of population in Indonesia is shown in Figure 3. In 2014 the population was 254.5 million and in 2035 it is expected that the population will amount to around 305 million. In 2014 the number of people living under the line of poverty constituted almost 11 % of the population (the poverty line was set at IDR 312,328 per capita/month). Statistics show that the number of poor is decreasing every year, while the poverty line is raised every year (The World Bank, 2015).

3.2 Palm Oil

3.2.1 History of palm oil in Indonesia

Palm oil was known already in ancient Egypt. In the colonial era palm tree was brought into Asia by the Dutch who planted first four palm trees in the Botanical Garden of Buitenzorg. In Indonesia planting of palm trees started in 1911 on Northern Sumatra and 4 years later the plantations covered 2,760 ha. And since this time the Malaysia begins with cultivation of palm oil as well. Around the year 1940 the palm tree plantation occupied about 110 thousands ha and this figure did not increase significantly until 1970. Significant growth of plantation areas started with the inflow of investments of private companies such as World Bank and Asian Development Bank. These companies have been heavily investing in the development of palm tree plantations since 70s. Since 1980, the government decided to strategically open and close the market for foreign investors in compliance with the needs to gain leadership in the production of oil palm and take away a leadership from Malaysia. Since 1985 Indonesian government began to support small farmers with guaranteed prices for sales of fresh fruit bunch. The growth of palm oil production caused the expansion of palm tree cultivation areas from Sumatra to other parts of Indonesia, e.g. Kalimantan, Sulawesi and West Papua. Thanks to financial supplies of foreign investors the Indonesian market quickly recovered from the crisis (Taniputra et.al., 1988).

3.2.2 Basic information about palm oil

The best conditions for its production are in the tropical zone, in wet climate with an average rainfall around 1800 mm per year. Perennial regular distribution of rainfall is also an important factor. Long dry seasons lasting up to three months affect the revenues from its productions – e.g., annual deficit of 300 mm of rainfall causes the decrease of the yield of the oil by up to 30 %. The temperature suitable for cultivation is between 21 and 32 °C. Oil palms prefer soils with depth profile of more than one meter, with organic contents and good natural fertility. The most preferred landscape profile is a slope of around 12 °. If it is a very hilly terrain, therefore it requires terracing. On the other hand, the flat terrain requires special drainage system (Corley and Tinker, 2003).

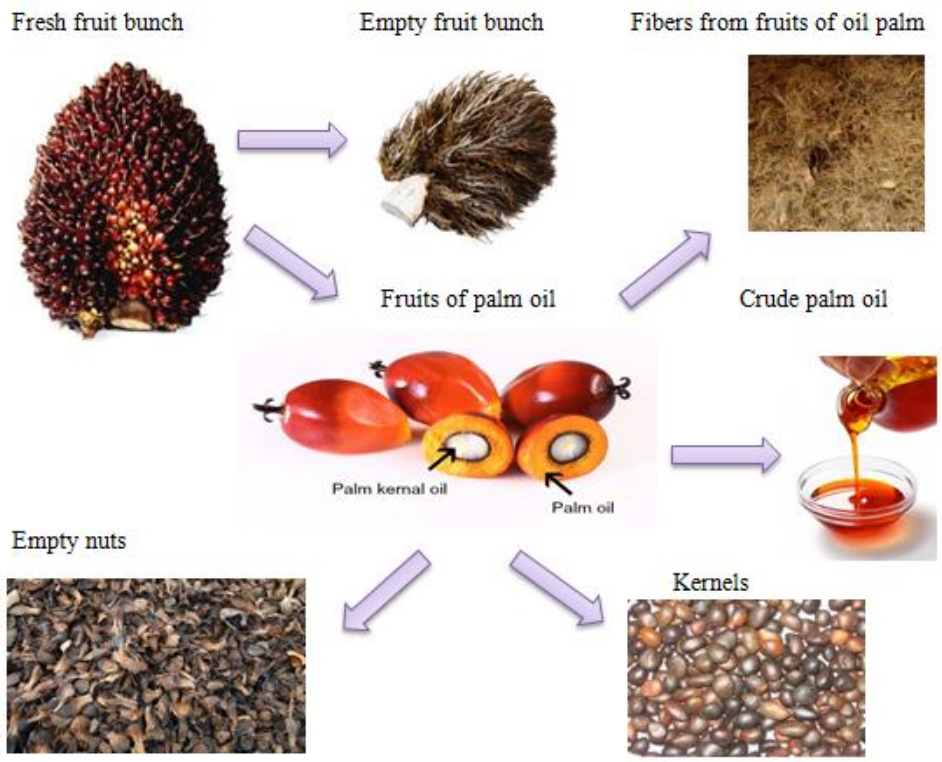
Picture 1: Trees of palm oil and fresh fruit branch

Source: Own picture from Sumatra

Oil palm is a tree that can grow up to 25 meters in height (Picture 1). The higher the tree is, the higher the cost of its harvesting are and therefore this height is an unwritten indicator for re-cultivation of plantations. The trunk grows annually by 35 - 70 centimeters. The harvest period is usually till 25 year of palm tree; it is a perennial plant. Fruits of oil palm form the so-called fresh fruit bunch, which matures for the period of 5 - 6 months, and when ripe weights between 10 - 25 kg. Fresh fruit bunch from older trees can weigh up to 50 kg. An average tree produces from 8 to 13 bunches per year. Fresh fruit bunch consists of two main parts: the fruits and stems as shown in picture 2. Stem carries the fruit and without the fruit it is called the empty fruit bunch. Each fresh fruit bunch carries 1 500 - 2 000 individual fruit. One fruit weights between 8 to 15 g and measures 3 - 5 cm. The weight of fruits is 45 – 65 % of the total weight of the clump (Corley and Tinker, 2003).

Plants from 1 ha area of palm plantations are able to produce up to 4,500 tons of crude palm oil per year and 0.5 tons kernel oil. Picture 3 shows 3 varieties of oil palm fruit. The process of crossbreeding of the varieties dura and pisifera results in the new type of the plant called tenera. It is the most widely grown variety in Indonesia and its industrial extraction yields 22 - 32 % crude palm oil and 5 - 6 % palm kernel oil (Corley and Tinker, 2003).

Picture 2: Composition of fresh fruit bunch



Source: Own processing

Picture 3: Varieties of palm oil

DURA

Thick shell, oil extraction is 16 – 18%
Mother plant for the production of commercial varieties

TENERA

Thin shell, oil extraction is 22 – 32%
Commercial varieties of palm oil

PISIFERA

Without shell
Oil extraction is up to 40%

Source: Escobar et al., 2006

3.2.3 Processes of palm oil

The cultivation of oil palm includes various activities related directly or indirectly to its processing. But even indirect activities must be carried out to ensure the smooth lifecycle of the plantations. Starting with cleaning up of the land through planting and growing plants in a kindergarten, infrastructure construction, planting trees in the plantation, fertilization, tree pruning up to harvesting fresh fruit branch. The process of oil palm cultivation is quite labor intensive. One worker can cultivate only about 10 – 11 ha of land, which is much less in comparison with the cultivation of soya beans, where one worker cultivates up to 160 - 200 ha of land (Escobar et al., 2006).

The quality of seeds is also important; the best ones are obtained from certified sources. Young palm trees are grown in plastic bags 16 x 20 cm of size and the first three months these plastic bags are protected against direct sunlight. In the kindergarten the bags used for planting are bigger (40 x 50 cm) and the plant stays there for 7 up to 10 months. In this phase it is important to keep of the distance between plants in order to ensure as much of the sunlight for the plants as possible. The plants should be planted in such a way so that the distance between individual pits constitutes 0.9 – 1.2 m in any direction (Jacquemard, 1998). In the end of this period the plants are around 0.8 m high and only completely undamaged pieces can be picked up and transported to the plantation by trucks. The total loss of plants at this stage is 15 - 25 % so the plantation covering an area of 1,000 hectares requires 170,600 seeds with 15 % losses (Escobar, 2007).

To create a plantation it is first necessary to clean up the soil, which is the most costly procedure in the cultivation process. The soil can be cleaned using burn and slush technique or using mechanical approach. The burn and slush technique is more cost-effective for large-scale palm oil plantations. Fire reduces pests and diseases, and may increase the soil fertility. On the other hand, burning of the soil is unhealthy and dangerous due to loss of nutrients and soil erosion (Simorangkir, 2006).

Before planting, there is also a need to build transportation and drainage infrastructure. Roads are used primarily for transportation of fertilizers and harvested fresh fruit branches. The drainage infrastructure is used to collect water. Their construction depends on soil type, rainfall rate and topography of the area. The length of major drainages varies

between 400 and 500 m and the length of small drainage systems ranges between 31 - 78 m. Drains are designed to keep the water level at least one meter below the ground (Escobar et al., 2006).

After that the pits of 60 cm of depth and of 90 cm in diameter are made. It is necessary to ensure the growth of plant called Pueraria phaseoloides around the oil palms. The Pueraria has to be planted during the first year of plantation cultivation because it prevents the growth of weeds. The plant also ensures the supply of nitrogen, improves the physical properties of the soil, reduces erosion and helps to maintain the water balance of the trees (Corley and Tinker, 2003).

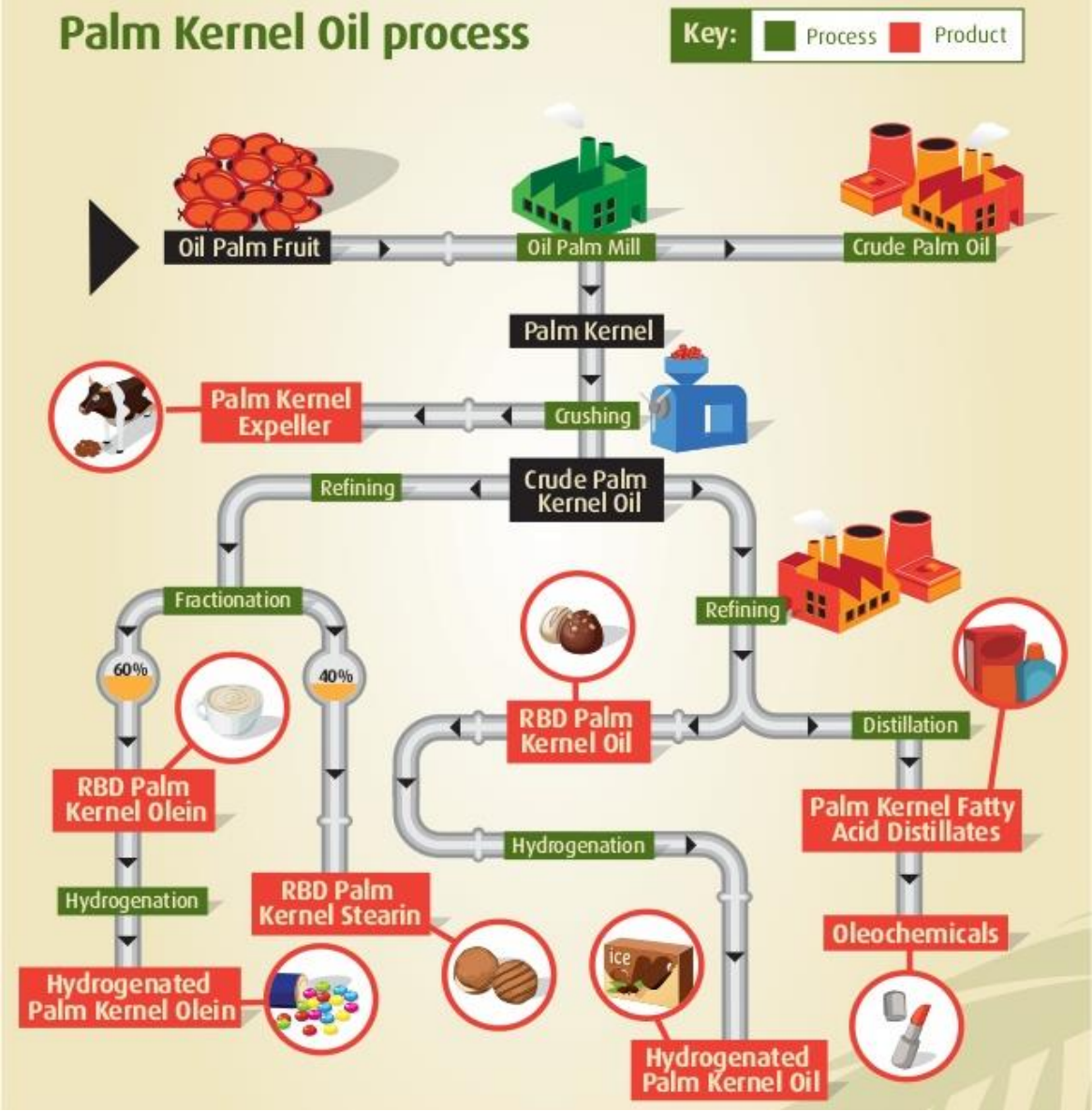
For maximum yield, it is necessary to do the pruning of leaves. Before the first harvest (third year after planting) the old bunches and dead leaves are removed. The first sheets are cut down, when bunches are at least one meter above the ground. This is done with the help of a narrow chisel 5 - 8 cm wide with one-meter metal handle or a small Malaysian crescent knife with a short aluminum handle. During low fresh fruit branch production the pruning is performed once a year. Not only dry leaves are removed but also that leaves under which the branches do not grow. Around 36 – 40 leaves always remain on the palm tree. With each harvested fresh fruit branch one also has to remove the leaf under which this branch grows (Escobar et al., 2006; Corley and Tinker, 2003)

For producing fresh fruit branch it is important to ensure the supply of a certain amount of nutrients and a certain quantity of fertilizer doses. This amount depends mainly on local conditions, expected yields, the chemical composition of the soil and the natural characteristics of the land. Fertilizer program should be adapted on the basis of previous experience of the oil palm cultivation. The amount of the supplied fertilizers increases till the fifth year of the palm growth and it is stabilized between the seventh and eighth year the tree life. Fertilization is performed approximately twice per year, in the first year it is best to fertilize the soil in monthly cycles. The fertilizer is placed in rings around the plants; with older palms fertilizer can be partially placed between the lines (Escobar et al., 2006).

The harvest begins in the third year after planting. First fruits are small and contain a small amount of oil; these fresh fruit branches are usually not harvested. In Indonesia the fruits

are harvested by hand since the human labor is cheap. Bunches are laid out on large metal cages, which are stored at a height of 5 – 6 m above the sterilization section. FFB in the cages of 2 – 10 tons of mass are moved by rail conveyor into a sterilization station for 50 – 90 minutes where the steam has a power from 0.27 to 0.31 MPa (Yee et al., 2009, Escobar et al., 2006).

Picture 4: Palm Kernel Oil Process



Source: GreenPalm, 2015

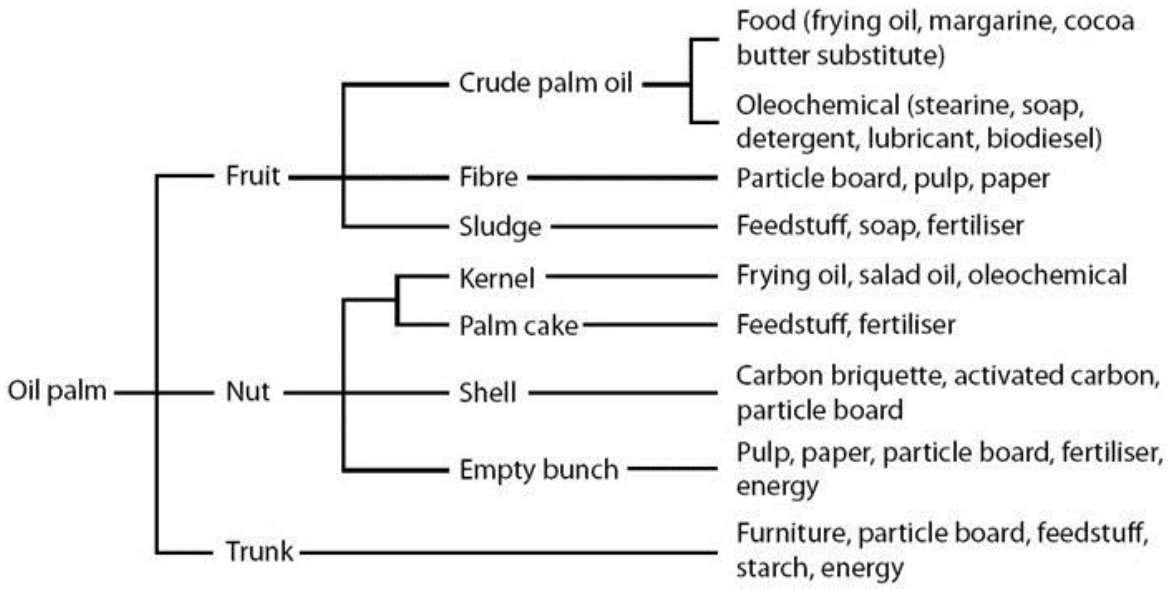
The aim of this process is the destruction of all microorganisms, softening and separation of the fruit from the stem. To ensure the latter the hot and sterezlised FFB os placed into the threshing drum, from which the separated fruits fall into the conveyor. Threshing

capacity varies with the volume of 5 to 45 tons per hour. EFB can be used as a fuel to the boiler, as well as fertilizer by composting. Separated fruits are again treated by steam for further softening and separation the pulp from the core to form a homogeneous mass. The mass then goes to the press with the help of which the maximum possible amount of oil is extracted. Kernels go to the hydrocyclone, where they are heated in silos and where the shells and cores are separated. Cores are stored in the expeditionary box for further processing or sale. Picture 4 shows the individual stages of palm oil fruit processing (Escobar et al., 2006).

3.3 Utilization of palm oil

Problems related to environmental issues in recent years are mainly associated with globalization and increasing demand for food supplies. Vegetable oils are probably the most demanded commodity, therefore their world production is increasing. In 2014 the production of vegetable oils was 160 Mt and the estimations for in 2020 amount to 230 Mt (J.Kaatz, 2013).

Picture 5: Utilization of palm oil



Source: Etawau.com, 2016

The continued expansion of palm plantations it is not just for utilization of palm oil but also it can be used sap, leaves and woods. The possibilities of utilization of palm oil can be

seen in Picture 5. Sap is obtained from the cut sprouts and is later used for palm wine processing or sugar production. The wood is used as a construction material or as fuel, and the leaves are used to produce the knitted goods, or as fertilizer (Venter et al., 2009). The parts of the cores, which remain after extraction of the crude palm oil, are used as an ingredient of animal feed for feeding and fattening of pigs, poultry, horses or others animals. In the form of briquettes it is used as biomass, as fuel in boilers to produce electricity. Empty fresh bunch serves as a source of cellulose for paper or biogas production (UNEP, 2011; RSPO, 2016).

3.3.1 Biofuels based on vegetable oils

The basis for obtaining biofuels is the extraction of oil from plants. The most common plants used for that are oil palm, sunflower, rapeseed and soybeans. Without structural modifications of internal combustion engines it is not possible to use vegetable oils as a substitute for diesel. However, one can also use biofuels by means of altering the structure of the oil in one of the two ways: trans esterification of triglycerides or esterification of fatty acids to methyl esters of fatty acids contained in the oil (Salwi and Panwar, 2012).

3.3.2 Share of biofuels in European market

European Commission set a minimal percentage share of biofuels by the directive EU – RED on use of biofuels or others renewable fuel in transportation from 2009. In the end of 2010 the minimal obligatory share of biofuel was 5.75 %. In accordance with the directive on the promotion of energy from renewable sources from 2009 by the end of 2020 10 % of energy in transportation should be taken from renewable sources (Eur-lex.europa.eu, 2016).

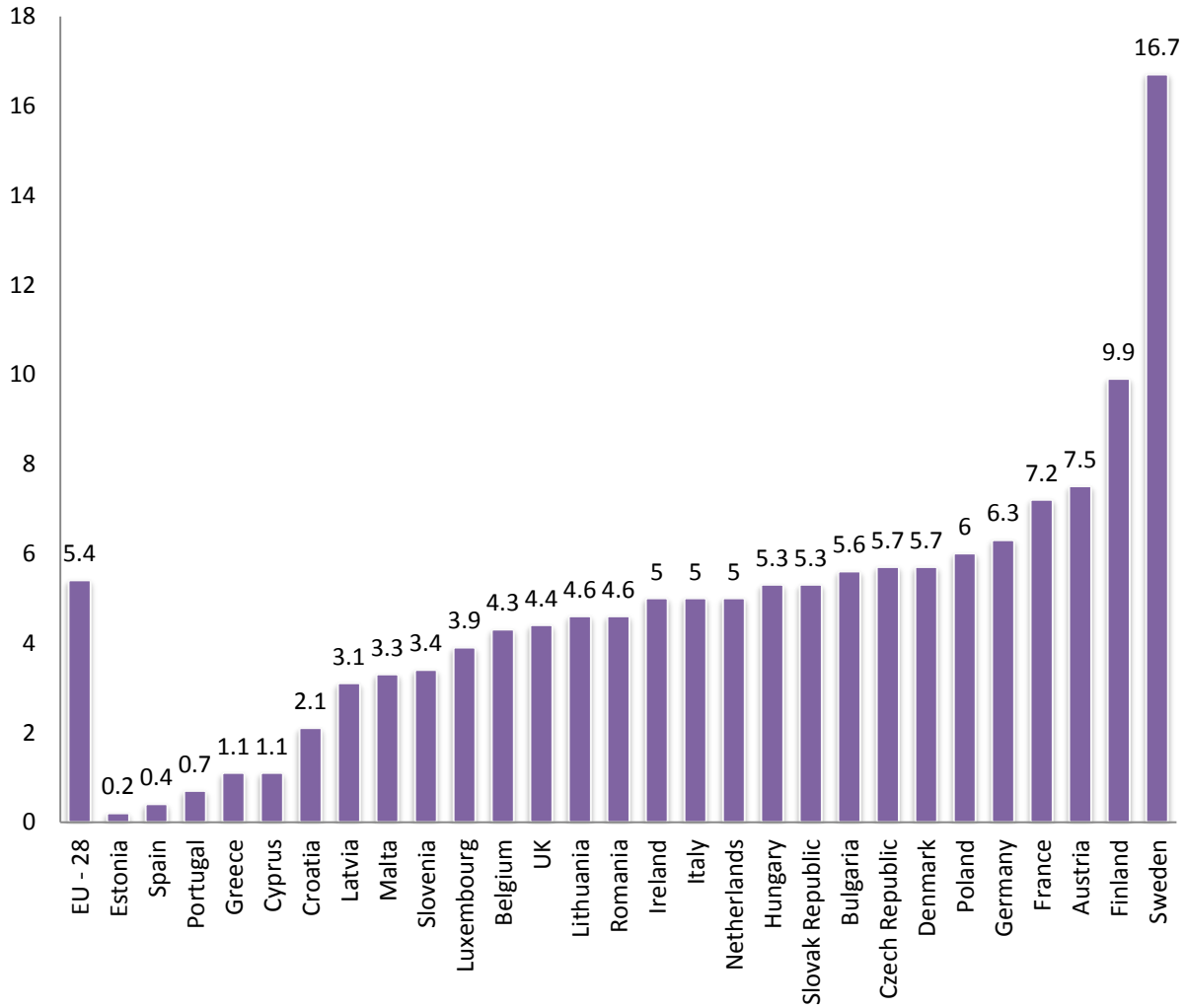
This requirement must be complied with in all EU countries. The world's largest producers of palm oil such as Indonesia and Malaysia can expect a rapid increase in demand for biofuels in from Asia, because Europe does not have the necessary area of land for growing biomass. It will lead to a high increase of consumption from 7.7 billion liters to 23.4 billion liters in 2020 (van Gelder, 2004).

Czech Republic has implemented a strategy of mandatory addition of biofuels to the fuels. Other countries such as France, Austria and Slovakia support the nationwide distribution.

In 2001 the Netherlands added to that commitment an appendix which came in in force in 2015 – all palm oil sold in the country must be produced using sustainable methods of processing. It is pushing the EU to liberate sustainably produced palm oil from import tax which constitutes 3.8 % (Evans and Daniel, 2012).

The Figure number 4 shows renewable energy available for final consumption in transport in selected European countries. According to the website Europa.eu it has increased by 28 % between 2005 and 2013. Between years 2012 and 2013 the renewable energy available for final consumption increased by 3 % (Ec.europa.eu, 2016).

Figure 4: Share of energy from renewable source in transport in 2013



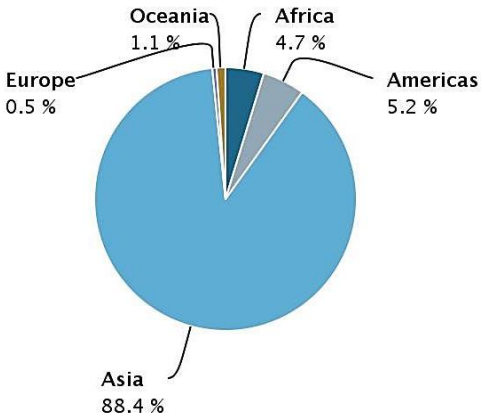
Source: Eurostat, 2016

3.4 Palm oil in the world

Over the last decades palm oil has become one of the fastest expanding equatorial crops. The area for the cultivation of palm oil is almost one tenth of the world's arable land. Such increase of global production has been achieved mainly by increasing the area planted with oil palm instead of increasing the yields by traditional methods (Kongsager and Reenberg, 2012). Since 1980 the total area of oil palm cultivation has more than tripled. The cultivation area is still expanding by the average growth rate of approximately 3 % per year (Wakker, 2005).

Because of its specific requirements the palm oil can be industrially grown only in limited number of places – limited to a tropical climate and latitude approximately 10 degrees north and south of the equator (van Gelder, 2004). Kongsager and Reenberg (2012) refer to the latitude 16 degrees north and south of the equator. Therefore nowadays the oil palm is commercially grown in at least 43 countries, mainly those situated near the equator. Figure 5 illustrates the average palm oil production share by continent.

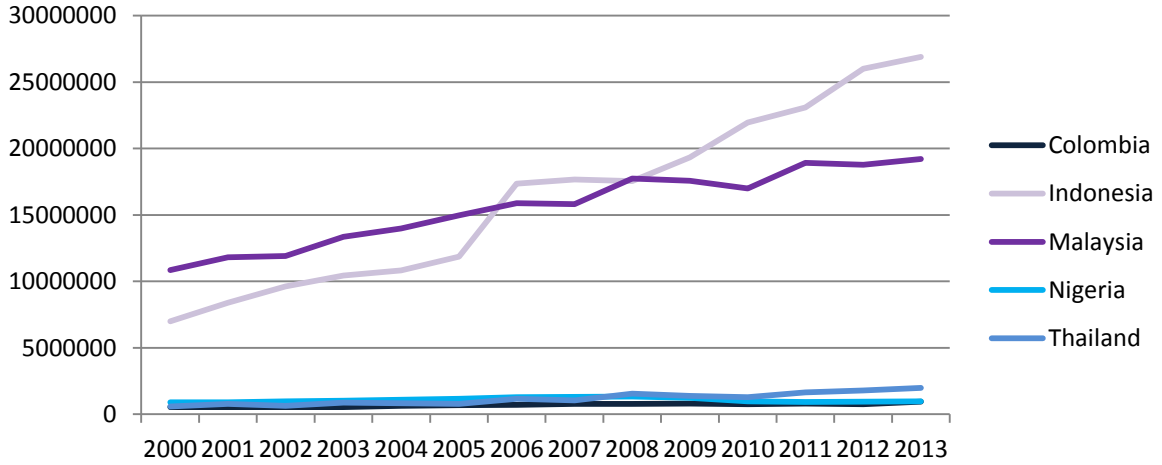
Figure 5: Average palm production share by continents; 2005 - 2014



Source: Faostat, 2015

Figure 6 shows the top 5 world's producers of palm oil in the years 2000 - 2013. Indonesia is the leader followed by Malaysia since 2006 and the Indonesian production continues to increase.

Figure 6: Palm production of top 5 producers; 2000 – 2013



Source: Faostat, 2015

3.4.1 Production in Africa and America

Oil palm is cultivated in 24 states of Africa. The most important producer of palm oil in Africa is Nigeria, where in year 2009 the area of plantations constituted 71 % of all oil palm plantations in Africa and 21 % of them in the world (Kongsager and Reenberg, 2012). In 2014 the harvested area in Africa was 4,562,710 ha and its share in the world's production of palm oil constituted 4.7 % as is shown in Table 1 (Faostat, 2015). Among other important African producers of palm oil one can list such countries as Ghana, Guinea, Côte d'Ivoire and Democratic Republic of the Congo. Table 1 shows selected countries leading the palm oil production in Africa.

Table 1: Palm oil in African States in 2014

	Area harvested (Ha)	Yield (Hg/Ha)	Production (tones)
Angola	23 130	121 288	280 540
Benin	35 940	162 295	583 290
Cameroon	138 000	179 278	2 474 040
Costa Rica	77 750	113 750	884 406
Côte d'Ivoire	277 090	61 787	1 712 060
Congo	277 350	66 171	1 835 250
Ghana	349 040	70 000	2 443 270
Guinea	313 310	26 811	840 010
Nigeria	3 025 950	26 334	7 968 440
Sierra Leone	27 550	75 230	207 260
Solomon Islands	15 510	150 297	233 110
Togo	16 690	86 741	144 770

Source: Faostat, 2015

On the other hand, the Central and South Americas belong to the continents with the smallest harvested areas, and their share in the world's palm oil production constitutes only 5.2 %. In 2014 the harvested area in America was 1,074,015 ha generating 16,158,236 tons the ready product (Faostat, 2015). Colombia, Ecuador, Honduras and Brazil belong to the list of the countries with the biggest harvested.

Table 2: Palm oil in American States in 2014

	Area harvested (Ha)	Yield (Hg/Ha)	Production (tones)
Brazil	126 559	110 136	1 393 873
Colombia	270 000	200 671	5 418 107
Dominican Republic	17 100	153 737	262 890
Ecuador	214 570	119 385	2 561 650
Guatemala	70 000	214286	1 500 000
Honduras	130 650	162 647	2 124 980
Mexico	50 868	133 470	678 935
Nicaragua	5 000	200 400	100 200
Panama	5 510	101 488	55 920
Paraguay	15 960	94 793	151 290
Peru	49 230	12 5459	617 634
Venezuela	40 198	10 1276	40 7111

Source: Faostat, 2015

3.4.2 Production in Asia and Oceania

In the Oceania the oil palm is grown on Papua New Guinea, where the harvested area comprises 157,100 ha and the production volume is 2,158,930 tones which constitutes the share of 1.1 % in the world's production volumes (Faostat, 2015).

Asia is the leader in the world's production of palm oil with its share of 88.4 %. Vietnam belongs to the number of countries where the cultivation of palm oil has started but it is still in the experimental stage with the harvested area amounting only to 650 ha. Another country where the role of oil palm is continuously growing is Cambodia with 118,000 ha of harvested area (Chao, 2012). Despite the fact that palm oil in the Southeast Asia is not an original crop, it has become the dominant monoculture crop in many countries. Nowadays this area represents a worldwide center of oil palm cultivation, production of crude palm oil and palm kernel oil (United States Department of Agriculture, 2013).

Table 3: Palm oil in Asian and Oceanian States in 2014

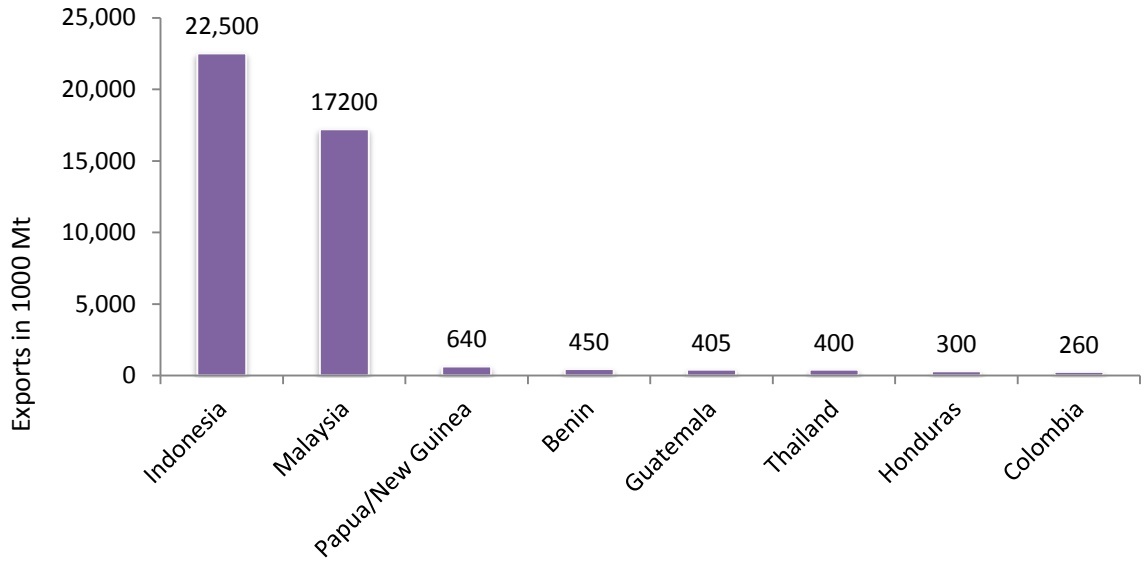
	Area harvested (Ha)	Yield (Hg/Ha)	Production (tones)
China	50 200	134 713	676 260
Indonesia	7 407 090	170 906	126 591 790
Malaysia	4 689 321	204 863	96 066 760
Papua New Guinea	157 100	137 424	2 158 930
Philippines	55 083	79 414	437 434
Thailand	663 707	188 388	12 503 447

Source: Faostat, 2015

3.4.3 International trade of palm oil

Indonesia and Malaysia offer the best conditions for oil palm cultivation which entails in the greatest production of palm oil and accounts for their leading roles in the world export, as is shown in Figure 7. Other countries from Asia and Oceania as well as Africa and America also profile itself in this area although with their volumes of export they fall far below the leaders in this field.

Figure 7: Palm oil export in 2014

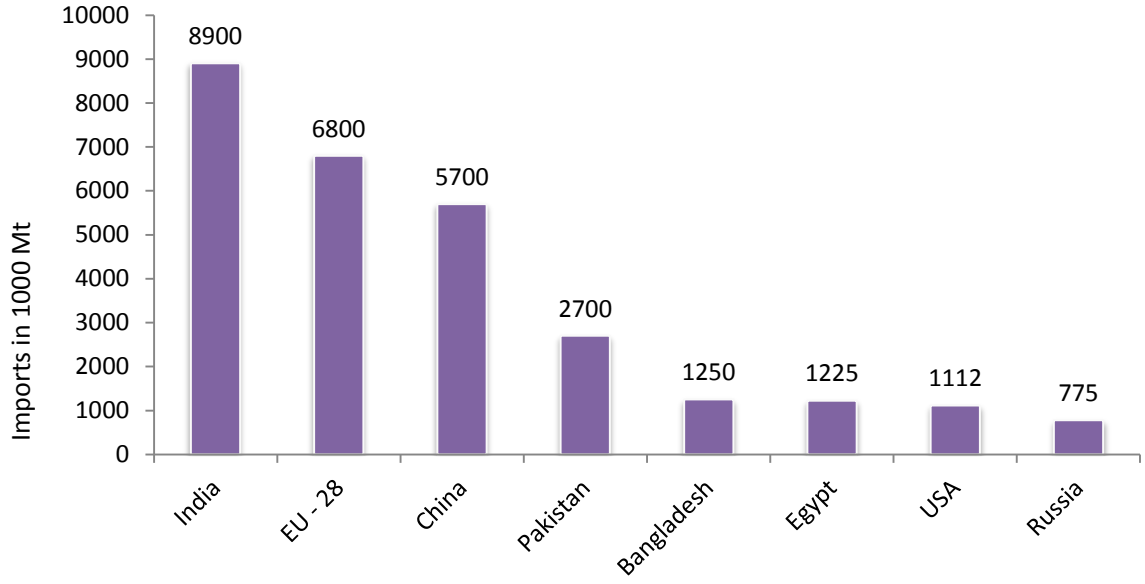


Source: Indexmundi, 2015

According to WWF (2015) Indonesia hosts three biggest buyers and traders, who are responsible for distribution of more than 50 % of the global volumes of palm oil. These companies are Wilmar International Ltd, Musim Mas Group and Golden

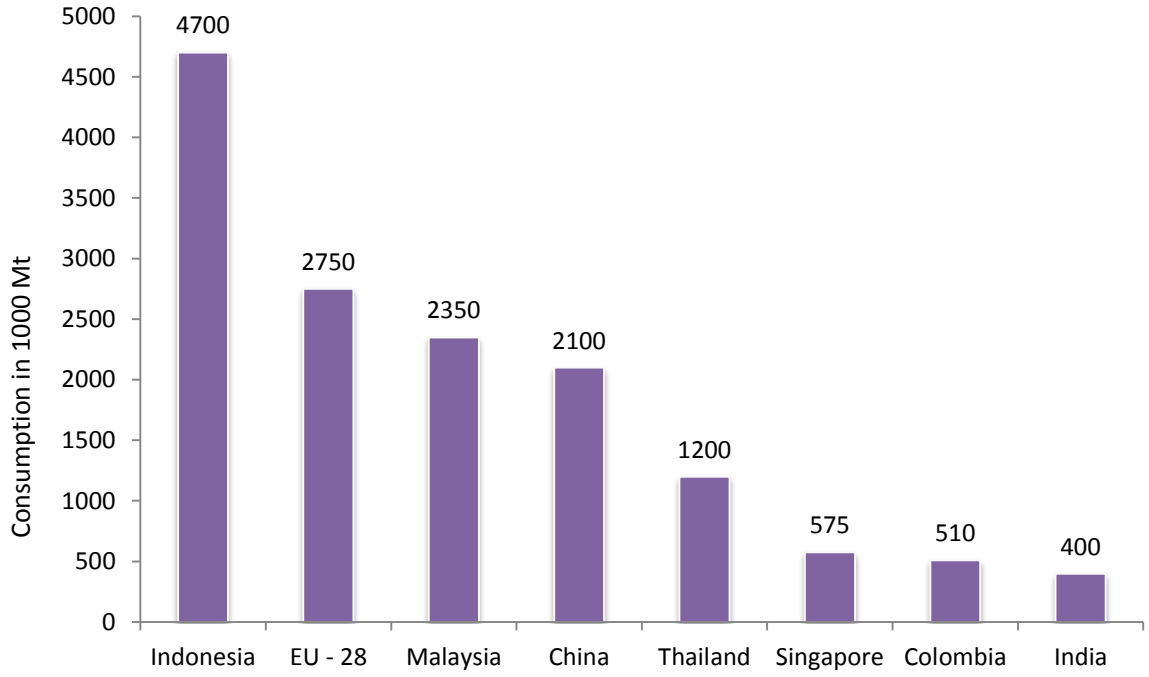
Agri-Resources Ltd (GAR). As far as import is concerted, Figure 8 shows the main importers of palm oil in the world. The biggest importer is India, which could be explained by huge population large part of which suffers from hunger and poverty.

Figure 8: Palm oil import in 2014



Source: Indexmundi, 2015

Figure 9: Palm oil industrial domestic consumption in 2014



Source: Indexmundi, 2015

High production volumes in Indonesia are not only used to saturate export but are also driven by domestic consumption (Figure 9). Indonesia is the leader in domestic consumption of this product and in my terrain research I found out that the oil is mainly used in food industry, cosmetics, traditional medicine and it is also added to the fuel. The second place in palm oil consumption is occupied by EU countries where this product is mostly used in food industry and as an additive to fuel with the aim to maintain low prices.

In the next chapter we will have a closer look on production and consumption of the palm oil in Indonesia.

3.5 Palm oil in Indonesia

As has been mentioned in the preceding chapter, Indonesia is the world's largest palm oil producer and at the same time it is the biggest consumer of industrially processed palm oil. It is not surprising that palm oil industry in Indonesia has become an important part of the Indonesian economy generating an annual average of 5 % of GDP. In Indonesia crude palm oil is used in cooking, in traditional medicine, is added to diesel fuel and is used in cosmetic industry (Evans and Daniel, 2012).

In 2014 the total area used for oil palm cultivation in Indonesia was 10.9 Mha. Palm plantations are concentrated mainly in Sumatra which with is 4.4 Mha of plantations accounts for 2/3 of the total area occupied by palm plantations in Indonesia. Kalimantan with its 1.5 Mha is the second largest island occupied by palm tree plantations. Other cultivations areas are Java, Borneo and New Papua (IPOB, 2010).

Up to 50 % of palm plantations belong to private companies, 40 % is owned by local farmers cropping the fields up to 5 Mha and the remaining share is owned by Indonesian government. The share of plantations owned by private companies is decreasing (58 % in 2000), while the proportion of the land owned by small farmers is increasing (28 % in 2000). Individual farmers in difference from large corporate companies have a better control over the crops in harvest period and therefore the fruit can be harvested at optimum state ripeness. Those farmers who own a plantation far from the processing factories are forced to sell fresh fruit bunch through dealers to large companies at a lower

price. In order to support small farmers Indonesian government introduced a program where the main actors are the large companies and individual farmers. In principle, the big palm companies help small farmers. There are several possible ways of agreement between companies and farmers (World Growth, 2015; Evans and Daniel, 2012). Independent farmers have certain benefits such access to infrastructure, financial credits at better rates, technical support or contractually fixed prices. They may also rent out the plantation lands on contractual terms, which entitle them to a share of the profits from selling fresh fruit bunch grown on their land. Sumatra, for example, strongly supports such agreements, because the farmers have up to 40 % higher yields thanks to supporting system (Lee et al., 2013).

Indonesian government aims to increase the volume of production to 40 Mt of crude palm oil in 2020, which requires increasing the area for oil palm plantations (IPOB, 2010). But according to Indonesia Investments, in 2011 the government signed a moratorium which stops the granting of new permits for cut down of the rainforest with the aim to clear the land for the new oil palm plantations. This then the validity of this moratorium was extended twice. Last time it was done in May 2015 by President Joko Widodo and its validity has been prolonged for the next two years. For this Indonesian government got US$ 1 billion from Norway. The skeptics of the Moratorium point out that government set aside 9 Mha of land for new plantation prior to its signing. In addition, large private companies use only half of their land, which means that there is still opportunity to expand plantations on both private and government owned lands (Investments, 2015).

4 Social, environmental and economic aspects of palm oil

This chapter is devoted to the study of socio-environmental issues related to the palm oil production, but it also points out the benefits that are often overlooked in economic analyses mostly focused on natural resources preservation and environmental problems. Ecological, economic and social factors are the main aspects of sustainable development which we will also show in this chapter.

4.1 Sustainable development

In 1980 the International Union for the Conservation of Nature and Natural Resources introduced a report called 'The world Conservation Strategy'. It was focused mostly on environmental sustainability, which was associated with human activity (Baker, 2006). For the first time the concept of sustainable development was used in Brundtland report in 1987:

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts:

- *the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and*
- *the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs." (UN Documents, 1986).*

It means maintaining a healthy economy in the long term perspective and keeping productive capacity of nature by means of reducing any harmful impacts from the side of humans and keeping the population growth at sustainable levels. In many ways the palm oil industry is related to sustainable development.

4.2 Certification and Partnership

In a globalized world the people are starting to be more and more interested not only in food quality but also in food sustainability. However, most countries being members of the World Trade Organization cannot put restrictions on the import of certain products even though they are ecologically and socially harmful. For these reasons certification of imported products was introduced with the aim to motivate different parts of the supply chain to comply with certain environmental and social standards. It does not affect projects driven by government but motivated by market and according to it also offers positive alternative system for opening the possibilities to increase a market share. But each certificate system does not have the same criteria and principles.

In last ten years the concept of partnered governance gained greater significance. Partnered governance can be defined as an organized cooperation of various private stakeholders in the supply chain, based on an agreement about the parameters of sustainable production. These partnerships often result from a lack of government control in the area of sustainability – e.g. weak environmental policy; it is an important bridge for the gap between industry and sustainability.

The companies, which import goods or raw materials from countries with weak social policies and high levels of corruption, e.g. Indonesia, are highly criticized for the support of these countries and it is expected from them that they propose strategies aimed at correcting the behavior of their suppliers. It was also the main reason for creation of partnership in supply chain of palm oil called Roundtable on Sustainable Palm Oil (RSPO, 2016). There is also a governmental certification plan called Indonesian Sustainable Palm Oil (ISPO). Moreover, RSPO and ISPO have recently agreed to cooperate (Maritz, 2014).

4.2.1 ISPO – Indonesian Sustainable Palm Oil

It is a national non – profit organization with the aim to improve sustainability and competitiveness of Indonesian palm oil industry as well as to provide support in achievement of the targets set by the Indonesian government in the sphere of the greenhouse gases emissions. It was established in 2009 with the aim to help in introduction

of the certification policy by Ministry of Agriculture. It is a part of Sustainable Palm Oil, which wants to improve life conditions, alleviate environmental issues and decrease the greenhouse gases emission by means of the following strategic steps:

- reinforcing the capacity of small farmers by means of effectuation of agricultural practices
- setting better standards for forest protection, improve biodiversity protection and mitigation and monitoring of greenhouse gases emissions
- strengthening and clarifying the framework of ISPO and standards for wider adoption
- elaborating national and provincial concept to assure transparency and to support sustainable palm oil production (SPOTT, 2015).

It aims to strengthen the world competitiveness of Indonesian palm oil industry even in the case more restrictive conditions in relation to the environment are applied. Membership in ISPO is mandatory for all growers since December 31, 2014. In 2011 Indonesian institutions of palm oil producers made formal commitment to apply to the ISPO principles (Evans and Daniel, 2012).

4.2.2 RSPO – Roundtable on Sustainable Palm Oil

It was founded in 2004 as nonprofit organization that deals with the sustainable development of oil palm development. This organization has headquartered in Zurich and two secretariats in Kuala Lumpur and on Java. The association is made up of different organizations and industries within the palm oil industry. Organization helps stakeholders (farmers, producers, investors, retailers, NGOs) to change the current approaches to create and meet global standards for sustainable palm oil production. The certification process for farmers is based on eight key principles (RSPO, 2016).

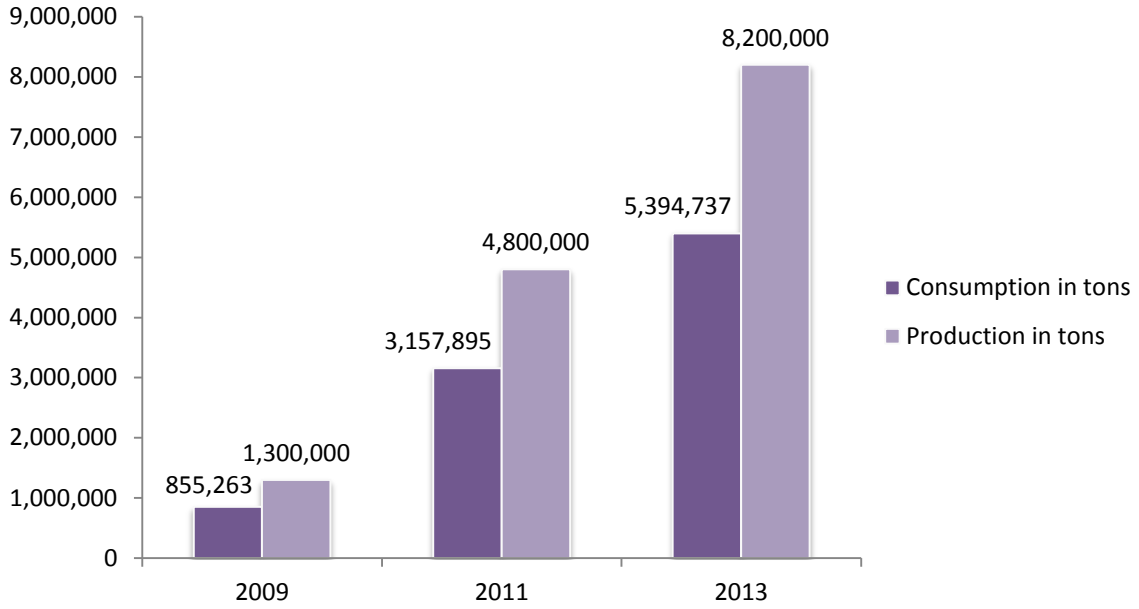
- Commitment to transparency
- Compliance with relevant laws and legal regulations
- Commitment to long-term economic and financial viability
- Use of the best practices

- Responsibility for the environment and protection of natural resources and biodiversity
- Responsible development of new plantation
- Responsible consideration of employment
- Commitment to continuous improvement activities in key areas

In 2013 the established regulations underwent a revision which has brought them in their present-day form. Some of the most significant changes to the document are related to the most controversial topic - greenhouse gas emissions. Although the revised version of the document is generally considered as a step in the right direction, no specific targets in the area of the greenhouse gas emission reduction were set. This in particular concerns the emissions related to land cultivation. RSPO does not require the public reporting of emissions until 2016. There were no limits for greenhouse gas emissions - the document includes only voluntary guidelines for reporting emissions resulting from deforestation, while most harmful practices such as draining of peat lands or use of dangerous pesticides, are still not totally prohibited. The peat lands are the most important reservoirs of carbon on earth: if they are destroyed, the carbon is released into the atmosphere, which significantly contributes to global greenhouse effect and climate change.

However, there is a potential for a change. More specifically protection practices include the use of techniques not based on land burning with the aim to maintain forest protection, waste reduction and avoidance of social conflicts. A membership in RSPO is voluntary and it is expected mostly from the farmers who have contracts with international corporations. Only 5 % of members in RSPO are certificated farmers. Unfortunately in 2009 only 10 % of sold palm oil of total amount 1.5 Mt was certified (Evans and Daniel, 2012). The comparison of consumption and production of certified palm oil is illustrated in Figure 10.

Figure 10: Consumption and Production of Certified Palm Oil



Source: WWF, 2015

In four years, the production of certified palm oil has increased almost 6 times. In 2009 it was 1.3 million tons and in 2013 increased up to 8.2 million tons. According to WWF (2015), only 52 % of the whole production is sold on the market. WWF vice president for US agriculture David McLaughlin said that if the share of certified palm oil in the world's total production increases up to 60 - 70 %, the cost of maintaining such a system would decrease significantly. However the share of certified oil is approximately only 15 %.

Table 4: RSPO certification system

Segregated	Segregated or separate certified palm oil is physically separated from non-certified throughout the whole supply chain. The consumer has a guarantee that the purchased product physically contains certified palm oil. "Identity preserved" means that the origin of the oil is verified.
Mass Balance	It is allowed to have a certified and non - certified palm oil at any point in the supply chain, but it has to be monitored, recorded and controlled according to RSPO rules for the mass balance.
Book and Claim	Through the online market, for each ton of purchased certified palm oil customer obtains the certificate. It does not have to match the physical palm oil, which they get – probably it comes from unsustainable sources. Payment for each certificate goes directly to the producer of certified palm oil.

Source: Maritz, 2014

Table 4 shows different types of certified palm oil. As we can see in Table 4 the system called Book and Claim is often chosen by companies that support cheapest way of palm oil certification. In 2012 approximately 72 % of all certificated palm oil was acquired using this system. Companies that cover their consumption of certified palm oil only by Book and Claim system most probably offer their products with unsustainable palm oil. On the other hand the companies which use segregated system offer their products with sustainable palm oil but usage of this system is 8 – 15 % more expansive than uncertified palm oil implementation (Maritz, 2014).

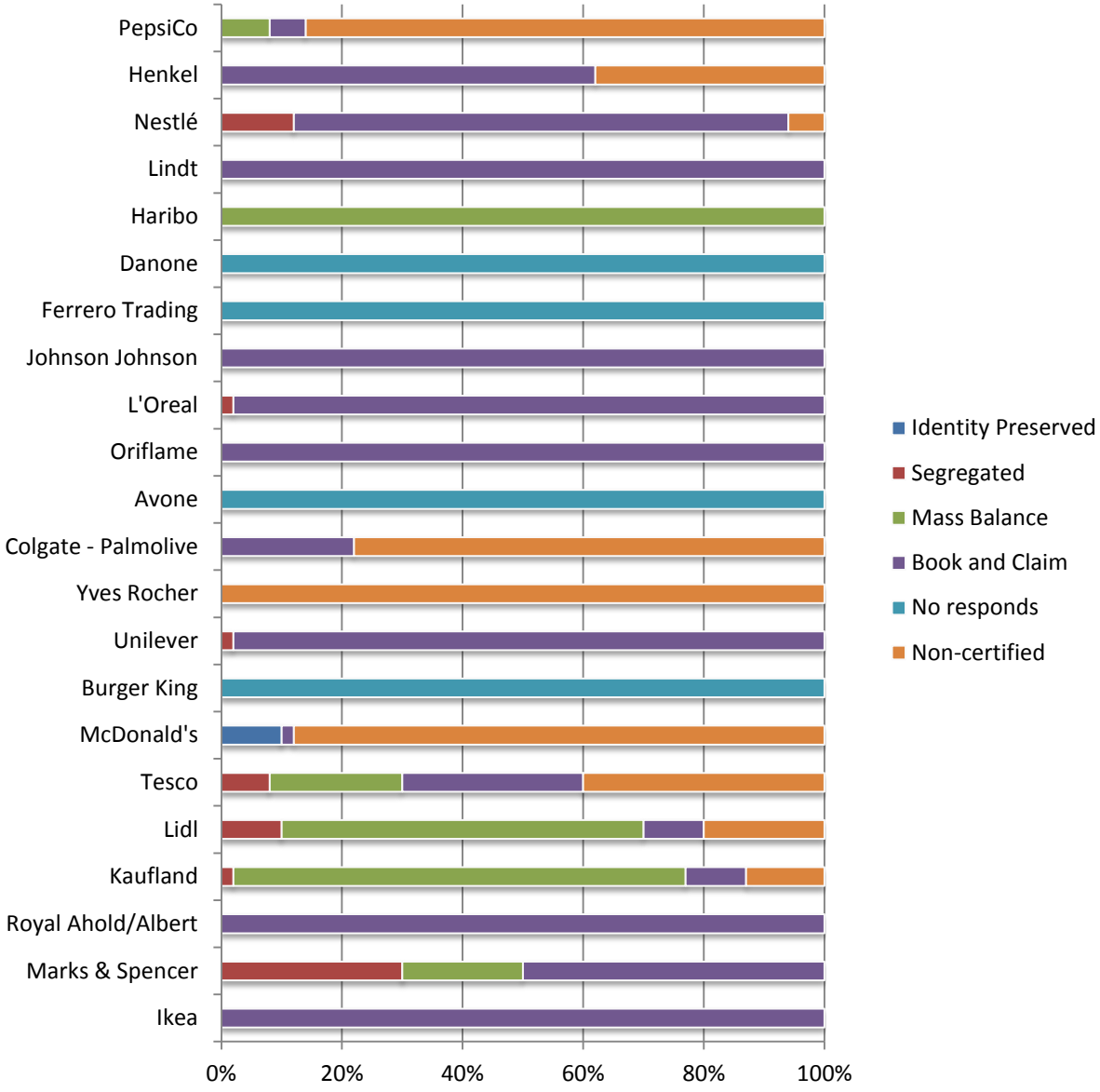
Sustainability maintenance and sustainable palm oil production is a more and more discussed topic not only among consumers, who care about the origins of the products they buy, but also by companies which must adapt to consumers' demands (WWF, 2015).

According to WWF (2015) 21 from 52 retailers use only Certified Palm Oil and 39 retailers state that they partly use non - certificated palm oil. However, 60 out of 78 producers use the certified palm oil but it covers only one quarter of their needs. Figure 11 shows selected retailers and manufactures which use certified palm oil and the extent to which it satisfies their needs.

Worldwide using of certified palm oil is definitely an important step towards in protecting workers, local communities and especially the environment. But as Butler et al (2009) argues RSPO faces the danger that some of its members do not comply with its rules. The status of the organization is weakened by the lack of perspective, the inability to punish members for breaking of its rules and by critics' suspects that its real target is to legitimize the continued expansion of oil palm plantations.

The RSPO has a significant potential to improve the environmental sustainability of palm oil supply chain, but it is necessary to maintain the pressure to use the certified palm oil developed on retailers from the side of conscious consumers (Maritz, 2014).

Figure 11: Retailers and manufactures using certified sustainable palm oil in2013



Source: Maritz, 2014

4.2.3 Costs of Implementing RSPO

According to WWF (2015) farmers of palm oil determine three key areas of certification, which are time consuming and costly:

1. Land Assessment and Management

   It includes identification, preparation, setting aside, active management of planted areas (High Conservation Value_HCV) and costs of Environment and Social Assessments. It is the most expensive part of whole process.

- The costs of the first step, that is identification and preparation, range from US$ 0.80 to US$ 5.00 per hectare.
- Set-aside costs fluctuate from US$0 to US$ 13.41 per hectare with regards to the amount of HCV determined.
- Costs of Environmental and Social Assessments vary from US$ 1.00 to US$ 11.67 and US$ 0.47 to US$ 1.00 per hectare.

2. Certification Process

   This process requires internal and external audits to verify the production standards and also help to improve them.

   - Costs of classic certification without any help range from US$ 2.13 to US$ 3.54 per hectare.
   - The costs of certification with corrective actions to improve standard is estimated in the range from US$ 3.74 to US$ 38.32 per hectare.
   - The cost of help to train the staff, implementers and smallholders varies from US$ 0.09 to US$ 23.10 per hectare.
   - Costs of the certification maintenance is usually up to 57 % lower than the first certification costs – around US$ 2.43 to US$ 13.03.

3. Segregation

   This process is associated with additional transport and storage costs and it is around US$ 0.30 per hectare.

4.2.4 Benefits of Implementing RSPO

The certification of palm oil is however costly procedure it also involves expected and unexpected benefits, which were summarized by WWF (2015).

1. Operations
   - Corrective activities result in improvements which can reduce the expenses for pesticides and herbicides as well as the rate of accidents occurrence up to 42 %.

2. Community Relations
    - Strengthening of the social relations among all communities like local stakeholders, government, labor, inhabitants and local communities and buyers.
3. Staff and Labor
    - Reduction of staff and labor power up to 6 % and bigger motivation for employees to work in offices.
4. Revenues and Market Access
    - This benefit depends on the company's certification. If the company uses Book and Claim palm oil system the revenues are up to US$ 10, in Mass Balance system it is up to US$ 25 and for Segregated palm oil they receive the maximum of US$ 50.
    - It also offers better market access to the EU and North America through companies, which mostly want the certificate palm oil.
5. Access to Capital
    - There is strong pressure to buy the certificate palm oil from responsible investors to ensure the profit for producers of this palm oil.

4.3 Economic and social benefits of palm oil

One of the greatest advantages in the cultivation of oil palm, compared with the yield of other crops for the production of vegetable oils, is a low demand on fertilizers, pesticides and water (RSPO, 2016). The biggest benefit of cultivation the palm oil is the production of bio fuel and the potential to produce side products. Apart from that it can be used in many other spheres: food and industrial oils, soaps, detergents, cosmetics, vitamins (due to the content of vitamin A and E) or polyurethane production (Escobar et al., 2006).

Palm industry is extremely demanding on the amount of workforce, the world's average is 5 workers per 1 hectare. There is a number of reasons for this the most important one being the fact that while other oil crops are harvested using heavy industrial equipment, the palm oil is harvested manually (WWF, 2015). Sayer et al. (2012) advocate the opinion that the cultivation of palm oil ensures better livelihood to the poor and in this way it has a positive impact on social and economic stability in some areas.

In 2006 the number of people working in the palm oil industry was around 1.7 - 2 mil. In 2010 it was 4.5 million and this number is still increasing (World Growth, 2015). Between the years 1986 and 2005 the unemployment rate increased from 2.7 % to 11.5 %. Since then, it started to decrease until last year it fell to the level of 6 % (Statistics of Sumatera Utara, 2016). The regular income brings better life to domestic residence, for example, they can pay school fees for children, buy luxury goods or quit planting their own crops and buy them in stores.

From the environmental perspective, the greatest advantage of oil palm cultivation is the reduction of soil erosion and retention of carbon dioxide. One hectare of palm plantation can absorb up to 100 tons of CO_2 from the atmosphere (Morel et al., 2011). The negative impacts of the cultivation can be reduced by means of better use of parts of palm tree and waste water from the production process. Biological waste from palm oil production can be used as fuel for generating electricity or as a fertilizer in the plantation. Total savings can reach up to US$ 0.03 per liter of crude palm oil. In 2008 almost 2000 villages had ensured independent electricity supplies in frames of the project called Energy Self-Sufficient Village, which involved usage of biological waste from palm oil production (Kusdiana et al., 2008).

Palm oil industry is an important source of income to the Indonesian budget, mainly due to export. Also it increases the monetary stability of state through foreign exchange and better redistribution of tax revenues. One dollar earned from production is related to three dollars earned through the supply of materials and services, labor and national incomes (Hunt, 2010).

4.4 Environmental and social costs of palm oil

The most important ecological cost is deforestation happening because of the palm plantation development, especially in places where the original land is used, that is the rainforests. The economic aspects play more important role in the process of decision making related to the new plantation development than the environmental ones. Cutting down of the rainforests is related to biodiversity reduction, disruption of ties with indigenous peoples and also the loss of forest products. It means air pollution, loss of access to land and loss of environmental benefits of the original rainforest (water,

medical plants). This soil is rich in nutrients but on the other hand palms are unable to absorb enough water (Sayer et al., 2012).

According to Fitzherbert et al. (2008) there are four main reasons for deforestation and the consequent expansion of oil palm plantation:

- development of palm plantations is the major reason for deforestation;
- palm plantations replacing original forests have been destroyed by logging or fires;
- palm plantations serve as part of a combined economic enterprise, the profit of wood and paper pulp is used directly for its foundation;
- indirect deforestation contributes to creating better road access to previously inaccessible parts of the forest. Soil can also be initially deforested due to other reasons and subsequently planted with palm trees.

Setting fixed prices for the released emissions when burning rainforests can partially help to reduce damage done to tropical forests. It is expected that the total amount collected in this way could reach US$ 30 billion per year. This money could be invested in projects, which are aimed at ensuring renewable energy sources for people who have no access to electricity (Un-redd, 2016). A lot of emissions are released in the process of oil palm transportation and the exploitation of the factory. The use of fertilizers and pesticides contaminates soil and surface or underground waters. The chemicals flowing into rivers or seas in the result of the soil erosion have impact on living ecosystems in these waters. Soil erosion is another negative effect, which influences yields of rice fields.

Another important problem is presented by the fact that the workers are not provided with adequate protective equipment which leads to accidents and injuries. The injuries are often caused by sharp thorns from palm fruits or palm branch. The accidents are mostly caused by manipulation with equipment, which is used for palm fruit picking. The absence of protective garments or equipment presents serious danger for workers who use pesticides or fertilizers. It mainly affects women who are often involved in the process of manipulation with these chemicals, but also have little physical strength and get smaller financial rewards for this kind of work. The pesticide called Paraquat is one of 25 pesticides used in the palm cultivation. It is mainly used for weed control around small palm trees. It can cause acute poisoning and other health problems. Long-term use of

Paraquat may have a negative influence on human reproduction system, or it can cause skin cancer. In the early stage of pregnancy Paraquat as well as many other chemicals can have negative effect on the fetus (Friends of the Earth et al., 2008).

The inhabitants, who live in the vicinity of palm plantation or palm factory, are threatened by pollution associated with the palm oil cultivation and processing. One of the side products of the palm fruit processing is liquid waste, which is often released into water in non-purified form. Therefore it directly affects people and communities that use this water for cooking, washing clothes or bathing. It does not only have a direct impact on their health causing skin problems but it indirectly affects those families whose livelihood depends on fishing. The waste from costal plantations or the waste brought by contaminated rivers which flow into the sea, damage the sea waters and coral reefs, as well as causes harm to marine species and negatively impacts biodiversity and ecosystems of coral reefs, significantly reducing the job opportunities for entire fishing communities (Wakker, 2005).

Apart from that numerous conflicts arise between cultivation companies and indigenous peoples in the process of plantation development. Most of such conflicts occurred in the years 1967 – 1998 in the period of second Indonesian president Suharto. The most common cause of such conflicts was in the fact that state-owned company did not take into consideration for the locals and their needs in process of the land grabbing. Because of the badly defined land laws, it was almost impossible for original landowners to claim their lands and very often they were driven off their lands. From the historical perspective this industry is associated with high level of corruption (Budidarsono et al., 2013).

In comparison of the benefits and costs of the expansion of palm plantations, the palm plantation is acceptable only for those, who prefer to economic growth and food production against the environment. It is logical to expect high rate of plantations expansion and massive deforestation related to the increasing demand for palm oil associated with the growth of the population and economic progress. Our main task therefore is not to stop the expansion of palm plantations, but to limit its negative impacts on biodiversity, reduce carbon emissions and improve the poor living situation of the indigenous people (Sayer et al., 2012).

4.4.1 Biodiversity loss

Indonesia is one of countries with the biggest biodiversity in the world and it is the third largest area covered by rainforests. About 10 % of all flowering plants of the world, 12 % of described species of mammals and 17 % of described reptiles can be found in Indonesia. The country can also boast on the highest diversity of parrots, palm trees and primates, as well as the highest level of marine biodiversity in the world (Lambertini, 2000). On the other hand it is the most vulnerable and most endangered part of the world too. In particular, it is the island of Sumatra hosting a unique ecosystem called Leuser Ecosystem covering over 6.5 million acres of land and over 460,000 acres of carbon rich peat lands (Rainforest Action Network, 2016).

The deforestation of rainforests has the biggest negative impact on orangutans, which are classified as critically endangered animals. In the past there were 315,000 individuals, now their number has reduced to only 60,000 in the world and only 6,000 individuals belong to Sumatran breed. Other endangered species are the Sumatran tiger, Sumatran rhinoceros and elephants (Orangutan.com, 2016).

- The Orangutans

  They could be called ‘people of the forest’ since their DNA is up to 97 % identical with the human DNA. The island of Sumatra is the home to Sumatran orangutan, the population of which has decreased by 80 % in the last 75 years, and nowadays the number of living orangutans is estimated at around 6,000 individuals mainly concentrated in the northern part of the island. In 2000 Sumatran orangutan was classified as a critically endangered species (Singleton et al., 2008).

  Environmental issues related to palm industry which directly affect orangutans are manifold. The primary and most important one is the loss of their natural habitat due to the expansion of the palm tree cultivation and the related to that fragmentation of their population. Amount others negative factors one can list forest fires related to the development of new plantations and conflicts with humans. The secondary impact of the palm oil industry on their life rests in ensuring the access into previously inaccessible parts of the forest and the subsequent increase of orangutan hunting (Ancrenaz et al, 2008).

Many areas now covered with oil palm plantations were originally the main area of occurrence and habitat for orangutans. Unfortunately, the natural habitat of orangutans often directly overlaps with the main growing areas, because the orangutans mainly live in fertile lowlands nearby rivers, which are most often used for the development of new plantations. Resulting enforced fragmentation of orangutan population breaking the natural ties of living ecosystems is one of the main problems for the population of this species. Once separated, some individuals cannot re-connect with their community populations and are faced with consequent genetic isolation caused by cross-breeding in a small group. As the result of this nowadays Sumatran orangutan population is split into 13 separate communities, only 3 of which have around 1,000 individuals and the remaining 7 communities have approximately 250 individuals. It makes these communities even more vulnerable (WWF, 2015).

Another serious problem directly related to the palm industry is the conflicts between humans and orangutans. Orangutans, that are dependent on increasingly smaller fragments of forest, start coming to oil palm plantations in search for food sources. They damage the young palm shoots and destroy palm trees before the trees start producing (Brown et al, 2005). In two days one orangutan can eat up to 300 young palm trees, with the cost US$ 2 per palm tree, and in this way they can cause considerable financial damage (Butler et al., 2009).

When the expansion is unavoidable people should look for the ways to protect orangutans as well as for the means of protection of the palm plantation against orangutans. As Yuwono (2007) mentioned one of the possibilities is building corridors between forest fragments, translocations of orangutans, protection of plantations using electric fence, building rescue centers and the like.

- The Sumatran Tigers

  One of the other endangered species is the Sumatran tiger with wild population around 500 individuals and less than 150 breeding pairs. Their population is threatened by the destruction of their natural habitat by the pulp plantation and paper industry (Rainforest Action Network, 2016).

Another problem Sumatran tiger is affected by is decrease of natural food supplies, which is related to the decrease of their habitat. In search for food tigers attack domestic animals, direct attack on people is also not an exception. Nevertheless, the biggest problem and threat for Sumatran tiger is their illegal hunting caused by the increasing use in traditional Chinese medicine (Alfred et al, 2011).

- Sumatran Elephants

  The Sumatran elephant is yet another animal belonging to endangered species due to habitat loss deterioration or fragmentation. These problems are caused by the oil palm development, pulp plantation growth and paper industry expansion. Because of the loss of their natural habitat the elephants come out of the rainforest in search of food which leads to division and fragmentation of their population and in the end results in higher vulnerability to illegal hunting. With the loss of natural habitat and food sources elephants have to look for alternative food supplies, and they often ravage oil palm plantations. Thus the elephants also come into direct conflict with humans and their economic interests. In one night, the elephants are able to destroy hundreds of hectares of young palm trees and in this way cause great financial losses (Alfred et al, 2011).

- Breeding Birds

  Indonesia is home for almost 1,550 bird species, more than 430 of which cannot be found anywhere else in the world. For comparison, only one-fifth of Indonesian islands host twice more species than the whole of the North America. These birds live mainly on one or two islands and 114 species are classified as endangered. That means Indonesia is considered to be the country with the biggest number of endangered bird species (Rainforest Action Network, 2016).

- Plant Diversity

  Indonesia has more than 25,000 species of flowering plants 40 % of which cannot be found anywhere else in the world. Indonesian plant diversity can be compared only with Amazonian, where the number of species is equaled (Rainforest Action Network, 2016).

5 Analysis of impacts of palm oil on Indonesian economy

This chapter is focused on the impact of palm oil on the economy and its related indicators. These relationships are expressed by econometrics model with two equations. First equation is targeted to the production of palm oil regarding the aspects, which are related with it, and second one represents GDP, which is affected by production and economic aspects.

5.1 Specifications of econometrics model

The assumption is that if the production of palm oil brings major changes in GDP, the economy should be considered as palm oil dependent.

Structure of econometric model (all variables are in logarithmical form)

$$lny_{1t} = \gamma_{11} \cdot lnx_{1t} + \gamma_{12} \cdot lnx_{2t} + \gamma_{13} \cdot lnx_{3t} + \gamma_{14} \cdot lnx_{4t} + \gamma_{15} \cdot lnx_{5t} + \gamma_{16} \cdot lnx_{6t} + u_{1t} \quad (1)$$

$$lny_{2t} = \beta_{21} \cdot lny_{1t} + \gamma_{21} \cdot lnx_{1t} + \gamma_{27} \cdot lnx_{7t} + \gamma_{28} \cdot lnx_{8t} + \gamma_{29} \cdot lnx_{9t} + \gamma_{26} \cdot lnx_{6t} + u_{2t} \quad (2)$$

Declaration of variables

y_1..... Production of palm oil fruits (in 100,000 Mt)
y_2.....GDP (in billions US$)
x_1.....Unit vector, intercept (UV)
x_2.....Harvested area of palm oil fruit (in 1,000 ha)
x_3.....Exports of palm oil (in 10,000 t)
x_4.....Price of palm outputs (in US$ per ton)
x_5.....Labor force in agriculture (in million)
x_6.....Time vector
x_7.....Gross fixed capital formation (in billions US$)
x_8.....Labor force (in million)
x_9.....Development flows to agriculture (in million US$)

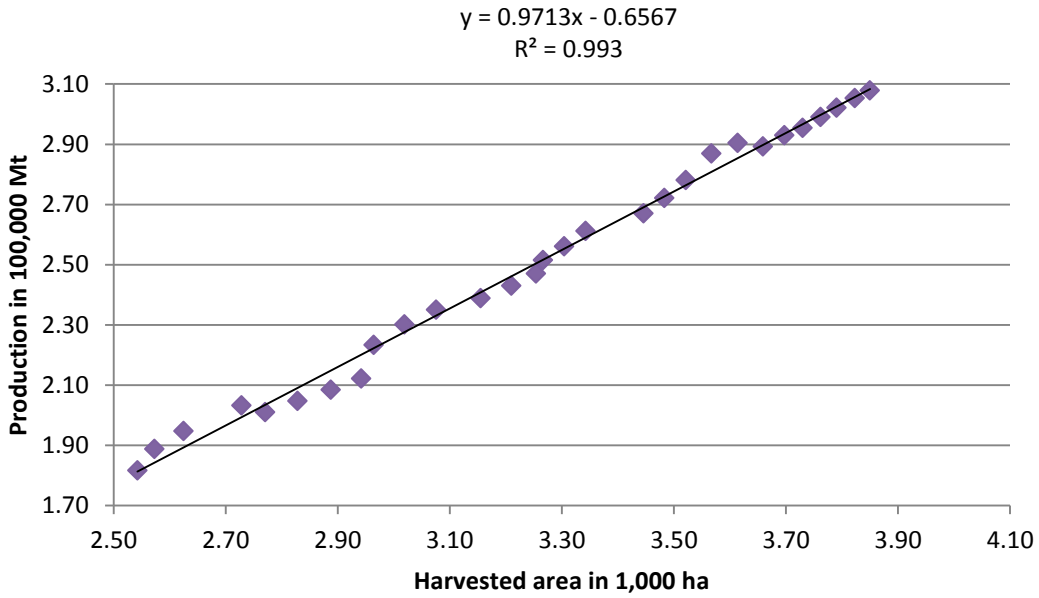
Economic assumptions

For the first equation, the economic assumption is that the endogenous variable – production of palm oil (y_1) is explained by the harvested area (x_2), export of palm oil (x_3), price of palm kernels (x_4) and employment in agriculture sector (x_5). It is expected that if one of the explanatory variables will increase, the explained variable will increase too.

Economic assumption for second equation is that the explanatory variables such as the production of palm oil (y_1), investments (x_7), labor force (x_8) and development flows to agriculture (x_9) explain the endogenous variable - GDP of Indonesia (y_2). It is expected that if one of the explanatory variables will increase, GDP should increase too. There is a positive dependency between endogenous an exogenous variables.

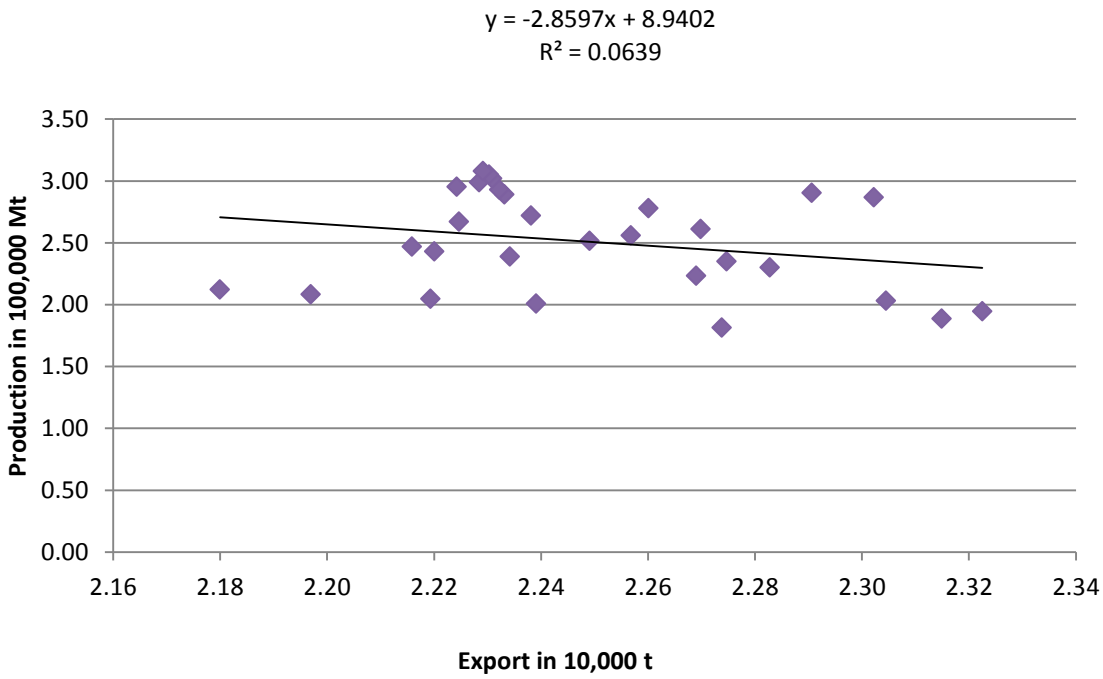
Dependences between selected variables are expressed in Figure 12, 13, 14 and 15. The used values are in logarithm form. Figure 12 describes the relationship between production (y1) and harvested area (x2). The dependence is high and all changes in explanatory variables should have impact on endogenous variable. Figure 13 shows the dependence between production (y1) and export (x4). The dependence is lower than in Figure 12, but explanatory variable should have a significant impact on endogenous variable.

Figure 12: Dependence between production of palm oil & harvested area



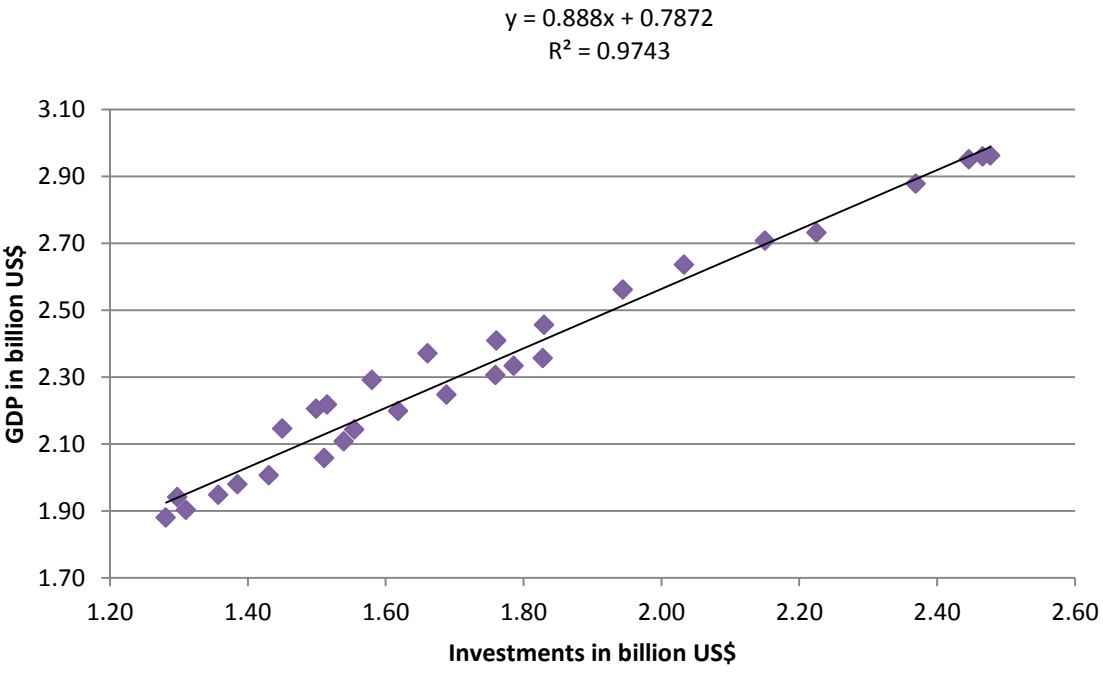
Source: Faostat, 2016

Figure 13: Dependence between production of palm oil & export of palm oil



Source: Faostat, 2016

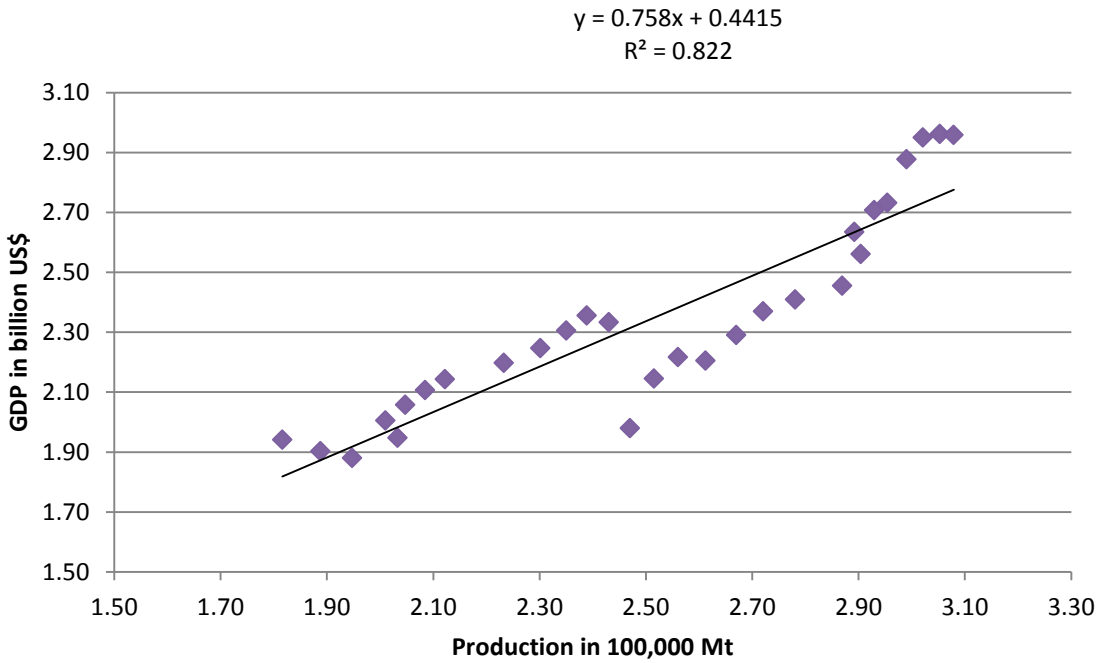
Figure 14: Dependence between GDP & investments



Source: The World Bank, 2016

The figures 14 and 15 include the dependences in second equation. Figure 14 includes the relationship between GDP (y2) and investments (x7). This relationship is huge so the endogenous variable is very impressible by this exogenous variable. The dependence between GDP (y2) and production (y1) is shown in Figure 15. It is main dependence for whole econometric model that express the relationship between first and second equation.

Figure 15: Dependence between GDP & production of palm oil



Sources: The World Bank, 2016, Faostat, 2016

It can be seen the dependence between those two variables. So it confirms the assumption for the econometric model that there is a relation between increase of GDP and increased production of palm oil. But it does not express the value of dependency.

5.2 Parameters Estimation and Statistical Verification

1st Equation – Parameters Estimation & Statistical Verification

Figure 16: Ordinary Least Squares Method – Equation 1

```
Model 1: OLS, using observations 1985-2013 (T = 29)
Dependent variable: Log_Prod
HAC standard errors, bandwidth 2 (Bartlett kernel)

             coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------
  const       -1.26632      3.11452     -0.4066   0.6881
  Log_HA       0.526253     0.182255     2.887    0.0083   ***
  Log_Expo     0.217380     0.0911136    2.386    0.0257   **
  Log_Price    0.0291821    0.0213452    1.367    0.1848
  Log_emp      0.472066     0.706960     0.6677   0.5109
  Time_v       0.0276324    0.00864422   3.197    0.0040   ***

Mean dependent var   2.506117   S.D. dependent var   0.398534
Sum squared resid    0.022698   S.E. of regression   0.031414
R-squared            0.994896   Adjusted R-squared   0.993787
F(5, 23)             1094.226   P-value(F)           1.52e-26
Log-likelihood       62.56620   Akaike criterion    -113.1324
Schwarz criterion   -104.9286   Hannan-Quinn        -110.5631
rho                  0.553075   Durbin-Watson        0.893496

Excluding the constant, p-value was highest for variable 5 (Log_emp)

LM test for autocorrelation up to order 1 -
  Null hypothesis: no autocorrelation
  Test statistic: LMF = 9.76073
  with p-value = P(F(1,22) > 9.76073) = 0.00493725
```

Source: Output from Gretl, 2016

Parameters with stars are statistically significant (S), *** = 0.1 significance level, ** = 0.05 significance level, * = 0.025 significance level.

The parameter of employment in agriculture is not statistically significant as well as the parameter for time vector. On the other hand statistically significant is harvested area, export of palm oil and average price of palm oil outputs – this result was expected.

The Coefficient of Determination R^2 determines, that endogenous variable is explained by 99.49 % of predetermined variables. The adjusted coefficient of determination is 99.38 % that expresses the well-chosen variables for this model. The test shows no autocorrelation among the residuals up to order 1.

2nd Equation – Parameters Estimation & Statistical Verification

Figure 17: Ordinary Least Squares Method – Equation 2

```
Model 2: OLS, using observations 1985-2013 (T = 29)
Dependent variable: Log_GDP
HAC standard errors, bandwidth 2 (Bartlett kernel)

             coefficient   std. error   t-ratio   p-value
  ---------------------------------------------------------
  const       6.21647      2.51226       2.474    0.0212  **
  Log_Prod    0.619828     0.249488      2.484    0.0207  **
  Log_Inv     0.0338052    0.0153869     2.197    0.0384  **
  Log_Lab     1.82944      1.28713       1.421    0.1686
  Log_Flo     0.0250130    0.0455089     0.5496   0.5879
  Time_V      0.0792933    0.0194229     4.082    0.0005  ***

Mean dependent var   2.344886   S.D. dependent var   0.338060
Sum squared resid    0.040460   S.E. of regression   0.041942
R-squared            0.987356   Adjusted R-squared   0.984607
F(5, 23)             725.5743   P-value(F)           1.67e-24
Log-likelihood       54.18437   Akaike criterion    -96.36874
Schwarz criterion   -88.16496   Hannan-Quinn        -93.79942
rho                  0.508739   Durbin-Watson        0.942696

Excluding the constant, p-value was highest for variable 5 (Log_Flo)

LM test for autocorrelation up to order 1 -
  Null hypothesis: no autocorrelation
  Test statistic: LMF = 9.8053
  with p-value = P(F(1,22) > 9.8053) = 0.00485553
```

Source: Output from Gretl, 2016

Parameters with stars are statistically significant (S), *** = 0.1 significance level, ** = 0.05 significance level, * = 0.025 significance level

The parameter of labor force and development flows to agriculture – especially in environment are not statistically significant. But parameters for variables – production of palm oil, investments and time vector are statistically significant.

The test of autocorrelation shows no autocorrelation among the residuals up to order 1. The Coefficient of Determination R^2 shows, that endogenous variable is explained by 98.74 % of predetermined variables. The adjusted coefficient of determination is 98.46 % that expresses the well-chosen variables for this model eve it is smaller than in the first equation.

Model with estimated parameters – all variables are in logarithmical form

$$y_{1t} = 0.285946 + 0.683348 \cdot x_{2t} + 0.138530 \cdot x_{3t} + 0.0406095 \cdot x_{4t} - 0.118279 \cdot x_{5t} + 0.0050978 \cdot x_{6t} + u_{1t}$$

$$y_{2t} = 6.21647 + 0.619828 \cdot y_{1t} + 0.0338052 \cdot x_{7t} + 1.82944 \cdot x_{8t} + 0.0250130 \cdot x_{9t} + 0.0792933 \cdot x_{6t} + u_{2t}$$

5.3 Economic verification and elasticity of variables

The parameters of variables are in a logarithmical form, so it is not necessary to calculate the coefficients of elasticity, because the estimated parameters are the coefficients of elasticity at the same time. So the impact of each explanatory variable on the endogenous variable could be compared without the units. All parameters above 1 % and under – 1 % are elastic, the parameter between 1 % and – 1 % are not elastic. If there is a small elasticity, the endogenous variable will slowly react to a one percentage change in the exogenous variables. Only one parameter from the model has a high elasticity – Labor force.

γ_{12} – Elasticity of palm oil w.r.t. harvested area (0.683348 %)

If the harvested are of palm oil will increases by 1 %, the production of palm oil should increase by 0.683348 %. The direction of the parameter γ_{12} confirms the economic hypothesis that if the harvested area increases, the production of palm oil increases too. Low elasticity can be explained by other variables that affect the production – for example the age of palm tree. It means if the harvested area will rise the production should be affected by it in few years, because the first fruits are small size and contain a small amount of oil.

γ_{13} – Elasticity of palm oil w.r.t. export of palm oil (0.138530 %)

The parameter is 0.138530, which means if the export of palm oil increases by 1 % the production of palm oil increases 0.138530 %. This direction of parameter confirms also the economic hypothesis that the production of palm oil is dependent on export of palm oil, which expresses the foreign demand for palm oil. The low elasticity is a result of delayed response of increased demand and export.

γ_{14} – Elasticity of palm oil production w.r.t. average price of palm oil outputs (0.0406095%)

If the price will increase by 1 %, the production of palm oil will increase by 0.0406095 %. The direction of the parameter γ_{14} confirms the economic hypothesis and it is smallest elasticity of variables in equation. The elasticity is almost 0, so the production is not affected by price of palm oil, but probably by demand. In agriculture, low elasticity of supply is typical. This is related to the length of production period – it takes time before farmers can benefit from higher prices by cultivation more palm oil (perennial crops). Second notion is a notion related to developing: it is proved that in developing countries, elasticity of supply is smaller than in richer countries, because markets do not work perfectly: there is low market response due to high share of auto consumption, disintegrated markets, low use of purchased inputs, etc.

γ_{15} – Elasticity of palm oil production w.r.t. labor force in agriculture (–0.118279 %)

The parameter of labor force in agriculture does not confirm the economic hypothesis that higher production of palm oil should affect higher employment in agriculture. In the equation if the labor force in agriculture will increase by 1 %, the production of palm oil decreases by 0.118279 %. This discrepancy is probably caused by the fact that labor force in agriculture does not include the employees like engineers in palm industries, which is also necessary for increased of palm oil production. Another explanation can be related to technological progress – if new technologies are labor saving, production of palm oil can increase with a lower amount of labor used as input.

β_{21} – Elasticity of GDP w.r.t. production of palm oil (0.619868 %)

This is the most important parameter in this econometric model because it explains to which extent the production of palm oil affects the GDP of Indonesia. It shows how important the production of palm oil is for Indonesian economy. If the production of palm oil increases by 1 %, the GDP of Indonesia increases by 0.619868 %. The dependency between these two variables is shown in Figure 15. The value shows, the parameter is inelastic but it would be too optimistic to expect a reaction over 1 % that would show that palm oil is able to trigger other industries of the Indonesian economy.

γ_{27} – Elasticity of GDP w.r.t. investments (0.0338052 %)

The parameter of investments says if the investments will increase by 1%, the GDP of Indonesia will increase by 0.0338052%. This direction confirms the economic hypothesis that the GDP of palm oil is dependent on investments and investments contributes to Indonesia economy.

γ_{28} – Elasticity of GDP w.r.t. labor force (1.82944 %)

According to the model, the labor force has a positive effect on GDP. If the labor force increases by 1 %, GDP increase by 1.82944 %. The economic theory says that the expansion in the workforce helps create rapid GDP growth. It means if the labor force will increase, the GDP should increase as well. The elasticity is the highest one and it shows the quick response of GDP on labor force.

γ_{29} – Elasticity of GDP w.r.t. development flows to agriculture (0.0250130%)

This parameter is really low and it is inelastic parameter but it still holds the assumption if the flow to agriculture increase by 1%, the GDP of Indonesia increases by 0.0250130 %. The direction of parameter γ_{29} confirms the economic hypothesis that if the capital will grow, the GDP will grow as well.

5.4 Application of econometric model

The parameters from econometric model will be used for the simulation of the possible effects on the Indonesian economy. The predictions include the production of palm oil, harvested area and export of palm oil, labor force and GDP of Indonesia.

1st simulation: The biggest production of palm oil was between years 2011 and 2012 by 7.62 %. How much will change the GDP, which is US$ 910.48 billion, if the production of palm oil will increase by same value?

$$0.619868\ \% \cdot 7.62\ \% = 4.72\ \%$$

Thanks to elasticity of parameters is possible make a prediction that if the production of palm oil will increase again by same share as in 2012 the GDP will increase up to US$ 953.45 billion. This projection shows the rising production, which is an expected

thanks to any substitute in the internal market. None of vegetable oil has a some features and so huge scale of using. It means the Indonesian economy will grow and the poverty will be decreased.

2nd simulation: How the production can be changed if the harvested area will be cut down by 42.94 %. It would be 3,040,000 ha like in 2003. Nowadays the production of palm oil is 120,000,000 Mt.

$$0.683348\ \% \cdot 42.94\% = 29.34\ \%$$

If the harvested area will decrease by 42.94%, the production could be affected by 29.34 %. Especially the value of production will decrease on 84,792,000 of the palm oil production. This simulation could represent the risk of anti-campaign and the effect by NGO´s. The government could prohibit the production or cut down the harvested area for improving the environment as results of these pressures.

3rd simulation: How much the production would decrease from 1,200 (in 100,000 Mt), if the export of palm oil will decrease by 50 % because of decreased world demand for palm oil?

$$0.138530\ \% \cdot 50\ \% = 6.93\ \%$$

If the world demand for palm oil (export of palm oil) will decrease by 50 %, it will have impact on production by 6.93%. That means the production would decrease on level 111,600,000 Mt. The average price of palm oil outputs does not include the environmental costs. But it would be, the price will probably rise by 100%. It could lead to decline of world demand because it won't be the cheapest vegetable oil any more.

4th simulation: If the production will decrease by 6.93 %, because of decreased world demand for palm oil. How much the GDP force will be affected by this decline? The GDP is US$ 910.48 billion.

$$0.619868\ \% \cdot 6.93\ \% = 4.30\ \%$$

The new level of GDP will be US$ 871.33 billion if the production would decrease because of decline of world demand and export. It can be seen the relationships between

world demand for palm oil and growth of Indonesian economy. If the environmental costs will be included into price of outputs, it will have a negative impact on GDP.

5th simulation: If the GDP will decrease by 4.30 %, because of decreased world demand for palm oil. How much the labor force will be affected by this decline? The labor force is now 124,060,000.

$$\frac{4.30\ \%}{1.82944\ \%} = 2.35$$

It is expected a decline of labor force on level 121,144,599 when the GDP will decrease by 4.30 % by any reason. Thanks to this simulation it can be seen the effect of decreased world demand on labor force.

All simulations confirm the assumption of this econometric model. These predictions show the impacts of palm oil on Indonesian economy. The predictions point to relationship between increased production and increased GDP. It shows that 50 % decline of world demand for palm oil will have an impact on labor force by 2.35 % decreasing and 4.30 % decreasing of GDP. The production is important for Indonesian economy that is expressed by GDP. It causes decline of labor force and a job losses that affects poverty in country and among the inhabitants.

6 Evaluation of results and recommendations

For evaluation of results we have chosen the SWOT analysis, which is focused on the strengths and weaknesses of palm oil industry as well as the opportunities and threats in relation to the contemporary society. Using the SWOT analysis, we can evaluate the current state of affairs in the palm oil industry and establish a strategy for the sustainable development of palm oil in Indonesia.

6.1.1 Strengths

Indonesia is the biggest world producer of fruit of oil palm tree as well as crude palm oil. It is to a large extent due to the fact that Indonesia provides good agro – climatic conditions for its cultivation, therefore its production is still on increase on Sumatra, Papua and Borneo. From geographical perspective Indonesia has an advantage in the sphere of palm oil plantations development. At the same time when compared to its main competitor, Malaysia, Indonesia has a bigger reserve of potentially available land for oil palm cultivation mainly on Sumatra, Kalimantan, Sulawesi and Papua. Indonesian export is focused on India, China, Malaysia, Singapore and the Netherlands. The world's demand has a tendency to increase and the market provides an opportunity for Indonesia to cover the needs of the world's population. As the analysis shows, the export is statistically significant part of the palm oil production process, which contributes to GDP of Indonesia.

In terms of profitability, the productivity of oil palm in comparison with other oilseed crops is much higher, for example in comparison to soybean and oil seed has a better yield per hectare. In the international market the price of palm oil is lower than other vegetable oils (Mekhilef et al., 2011).

Since palm fruits can be harvested in Indonesia without seasonal breaks, the supply of raw materials is carried on throughout the year. At the same time, palm oil has technically better properties in comparison to soybean oil, which was the most common vegetable oil at the beginning of the millennium.

From the social perspective, palm oil spurs local economic development, rural development, improves the social relation and creates new job opportunities, which leads to decrease of poverty in the country. In 2012 there were more than 65 million of

inhabitants with an income less than US$ 1.25 per day (Businessinfo, 2015). Because of the high rate of unemployment, which was 6 %, or more than 7 million people in 2014, the palm oil industry has a lot of cheap workforce available.

Our terrain research revealed that Indonesian people use the palm oil mainly for cooking but also in traditional medicine for healing, it is a part of traditional soap or they mix it with other oils. That is why the oil is so cheap in Indonesia. The survey in appendix 1 shows domestic demand for palm oil outputs on Sumatra.

Thus, the strengths of palm oil industry are:

- availability of lands and very good agro – climatic conditions
- availability of cheap workforce
- better characteristics in comparison to others vegetable oils
- rural development and improving of social relations
- export abroad
- domestic demand for palm oil

6.1.2 Weaknesses

The weaknesses are mainly unsatisfactory supply of electricity and gas, lack of technology and infrastructure in the country. Malaysia has much better facilities, and for that reason is probably even higher yields per hectare. Indonesia lacks machinery like industrial machinery, storage tanks, pipes, packaging material and so on (Obidzinski et al., 2012), which is the result of a lack of support for research and development and, consequently, slower adaptation of new industrial technologies.

From environmental perspective, cultivation of palm oil reduces the quality of soil, retains the sediments, and causes soil erosion; it leads to deterioration of water quality and quantity due to fertilizers. The loss of biodiversity and eventual extinction of some species of fauna and flora can added to the list of weakness of palm oil industry. Related to these problems there are the health issues caused by smog, dust, noise and chemicals.

In Indonesia there is a conflict of local communities and government regulations, especially in relation to the right of land ownership, which sometimes leads to rather ambiguous situations in this area. Indonesia has been facing this problem for long time.

There are several known cases, where planters defended their land rights like in the Northern Sumatra and they were accused of preventing the development of palm oil plantations.

There is an unfavorable security situation in the sphere of relationship between communities and government in Indonesia, which could lead to the change of attitude of the government landowners. Bribing and illegal fees on land are still very common. According to Friends of the Earth et al. (2008) Indonesian companies give 5% of their annual revenues for bribes.

There are other illegal practices associated with timber harvesting which involve government officials, civilian and military. These practices in the palm oil sector are the result of lax approach of government and weak efforts of government officials.

There is a limited extent of marketing - the lack of market information and market linkages. From the perspective of human resources, although palm industry provides lots of new job opportunities, the level of professional HR managers is still very limited. Despite the fact that palm industry creates new jobs, the need for workforce is largely dependent on the yield, which brings uncertainty among workers of permanent employment.

Most of the factories are concentrated only in Sumatra and Java, which leads to increased fuel prices in other areas of Indonesia. Competition in palm industry is necessary but the country lacks the integration of industry and related industries. In this regard, Indonesia is a marginal player, because it is not focused on the production of derived products with a high added value. National industrial system is dominated by the export of CPO in primary form and if this trend continues, the country will be left behind in the development of downstream industries.

To sum up, the weaknesses are:

- lack of technologies and infrastructure
- negative impact of fauna and flora
- undeveloped related industries
- lack of support for research and development

- unfavorable political situation and corruption

6.1.3 Opportunities

The global demand for oil increase with growing population, and as a result it leads to the growth of demand for products from the palm oil industry (bio-fuels and associated products). Due to increasing demand, which according to the analysis will affect the GDP, Indonesia has an opportunity to develop industries for subsequent processing of palm oil that could lead to larger supply and bigger revenue. So therefore it is necessary to focus on development and construction of processing units for associated products.

Another opportunity is presented by cooperation with competitors in processing technologies, thereby reducing investment for each company. Likewise, there are big opportunities for the involvement of universities and students in research and development and system improvement through education and innovative activities.

In Indonesia, there are strong laws, regulations and government policies to regulate the establishment and management of plantations and the process of obtaining land permits is lengthy and challenging. With increasing negative impact on environment mainly produced by deforestation, the government introduced accreditation standards for sustainable palm oil. Based on this, the association RSPO was founded in cooperation with producers, retailers, consumers, banks, investors and non-governmental organizations (NGOs). RSPO promotes the production of sustainable palm oil products by means of a set of voluntary standards. Accreditation standards of RSPO are determined by the market. The Indonesian government in cooperation with the association of growers of oil palm in Indonesia (Indonesian Oil Palm Growers Association) has introduced a new certification system for environmental protection in the palm industry. Legislation apparatus include the laws regulating the responsibility of companies with regards to the environment or a legal acts prescribing to obtain development permit for the plantation over 25 ha. It is necessary to constantly improve the recently established Indonesian organization ISPO and extend the supply of certified palm oil satisfying the world's demand for sustainability development. The organization is internationally recognized and it helps with technical support to palm oil production companies. It cooperates with nutrition consultants and

scientists around the world and it supports research in terms of nutritional and health aspects of palm oil.

Environmental impacts can be reduced by means of appropriate use of available organic methods of cultivation – for example wastewater can be used in the plantations instead of some fertilizers. The next sustainable step may be a better use of wood from felled trees or integration of palm plantations and the cultivation of livestock; thereby the income of owners of plantations could increase.

It is also needed to increase mechanical support of palm oil industry. Increase of productivity can be achieved by replacement of the manual methods of harvesting with the methods involving help of livestock.

In terms of capital resources there are a special loan programs for the development of oil palm plantations. In 2007 a new investment law came into force which also applies to palm industry. With this law enforcement the country provides a favorable environment for investment opportunities. It includes various improvements in the form of tax holidays and other incentives, also releases the restrictions on the residence and employment of foreigners or extension of territorial contracts (to 95 years from the original 25 years). The main aim of incentives is future investments in infrastructure and in underdeveloped areas, increasing employment and promoting innovative technologies (Businessinfo, 2015).

The main opportunities are as follows:

- increasing demand for CPO
- improving of the processing technology
- involvement of universities in research
- improving of ISPO
- favorable conditions for foreign investors

6.1.4 Threats

The biggest threat is the competitiveness of petroleum products and other vegetable oils for biofuels and energy. Negative campaigns on palm oil in the world market also negatively affect its competitiveness. The anti-campaigns are mainly based on environmental issues.

Palm oil is continuously labeled as unhealthy product; it is put in direct relation to the problems with carbon footprint, land use, global warming and biodiversity loss.

High degree of competition in the market of vegetable oils and the ever growing global demand for quality vegetable oils cause aggressive behavior of some suppliers of other vegetable oils as they attempt to retain their own livelihood.

Some suppliers mark their oils by labels that target at restructuring oil imports from tropical areas and subsidizing rapeseed oil from the EU. Due to this step it is difficult and expensive to obtain a market share for a new supplier. Across the world there are numerous non-governmental organizations (NGOs), which condemn the practices that do not aim to ensure sustainable development (World Growth, 2015). Among such organizations one can list the Sumatran Orangutan Society, Friends of the Earth, Greenpeace, the Center for International Forestry Research (CIMMYT), etc. Despite the fact that some NGOs are focused on reporting, others are focused on campaigns or counseling, they all have the same goals, which is to improve sustainable development practices, the introduction of certified palm oil and ensuring compliance with certain decisions.

From environmental perspective, pests and diseases present a serious threat. Therefore, it is necessary to find a long-term sustainable, cost-effective and efficient solution, which is not in sight yet. Temporary solutions which are being implemented are ongoing research, early detection of diseases and continuous monitoring of plants.

Due to higher demand and increasing prices of biodiesel production the price of vegetable oil can increase too. The price of CPO is influenced by the price of oil and the production of other vegetable oils (mainly soybean oil) and therefore it leads to price fluctuation of CPO and PKO. Export tax for CPO is between 0 and 22.5 %. It depends on the market price of palm oil. Indonesia has introduced an 'automatic mechanism', which means if price of CPO drops below US$ 750 per ton, the government reduces export taxes to zero (Investments, 2015).

Although Indonesia with Malaysia produces 85 % of world production of CPO, these countries do not have sufficient influence in determining the price of oil in the

international market. The solution could be to create strategic alliances to regulate the supply of CPO and Palm Kernel Oil on the world market.

The threats of palm oil are:

- increasing revenue in Malaysia
- anti-campaigns on palm oil
- diseases and pests of palm trees
- CPO price affected by price of oil
- competitiveness of other vegetable oils
- potential threat is presented by low costs of oil in India and Vietnam

7 Conclusion

Palm oil has been cultivated for centuries; it has a long history and a wide range of uses. At the same time, the negative effects associated with its cultivation and production has become the topic of the day relatively recently. Palm oil is the world's bestselling vegetable oil and the major share of its volume is currently produced by two countries - Indonesia and Malaysia. These two countries are responsible for approximately 87% of global production of palm oil. This oil is commonly used as a food additive or as an additive in biofuels. Palm oil usage is really widespread.

All objectives set out in this diploma thesis were fulfilled and the importance of palm oil production was evaluated by econometric model and SWOT analysis. From economic point of view the production of palm oil is a very attractive and promising industry.

The econometric model stresses the relation between production of palm oil and the growth of Indonesian GDP. It means that Indonesian economy can be classified as palm oil dependent. The application of econometric model also manifests strong ties between world's demand for this product and employment of labor force in Indonesia. In the model the global demand was represented by the export of palm oil. The decline of demand affects the production, although this reaction is postponed. With regards to direct relation between production of palm oil and the GDP development, the changes in production have an impact on each variable of the GDP equation, which in turn leads to decrease of labor force demand, that is to say, also has social repercussions.

The SWOT analysis indicates that one of the major weaknesses of the Indonesian palm oil industry is a high degree of corruption. Although, the government has taken steps to establish strong legislation in the sphere of plantation development, ubiquitous corruption makes these regulations quite often useless. Therefore, the stakeholders in the palm of industry should pay more attention to national and international issues. All of them have a negative impact on the competitiveness of a certain producer in the palm oil industry. Tin order to succeed in the competitive race, Indonesia should focus on export and downstream industries. There is still a lack of the latter in comparison with Malaysia. It is necessary to improve the quality of products as well as the added value of palm oil. It is to no surprise, that little or no investment to R&D has negative effects on palm oil industry threatening

sustainability and profitability of palm oil in the long-term perspective. Volatility of prices is another negative factor for the market, since the price of CPO varies depending on the price of the oil. Strategic alliances can provide effective co-operation in the sphere helping to eliminate this negative factor.

Indonesia is the most efficient producer of CPO in the world mainly due to the low production costs. It is possible to maintain such low costs mainly due to high yield per hectare, the possibility of all year round harvesting, cheap labor force, extensive reserves of unused land, low production costs and favorable climatic and soil conditions, which are also listed as main strengths in SWOT analysis. In particular, production technology and labor costs are some of the most influential aspects affecting output of production. Labor force is a rather controversial aspect: on the one hand, labor force is abundant and cheap in the country, which has a positive effect on the palm oil industry, on the other hand though, in comparison with other crops, cultivation of oil palm is quite labor intensive, which results in a high share of costs for cultivation and plantation care.

Taking into account the constant growth of global population we can expect a continuous increase of the palm oil cultivation areas. It is therefore necessary to focus on the research aiming at increasing the efficiency of utilization of felled palm tree trunks. Indonesia should focus on the improvement of ISPO, further development of the end products, better control of the market (equilibrium of supply and demand) and environment protection with the aim to reduce the impact of the negative campaigns on the industry.

This thesis helps to establish the basis for correct investments allocation. These investments would be necessary for sustainable development of palm oil. The inputs should be allocated in R&D, which will lead to bigger production and increase of GDP.

Expansion of palm oil plantations is called green plague and such plantations are called green desert. It is undisputable that in many cases it is really a green desert and it has extensive negative influence on the environment. On the other hand, palm oil production and related industries support the development of infrastructure, increase local employment and ensure better living conditions for domestic population. Indonesian economy grows in direct relation to the growth of palm oil production and export. Despite

of the manifold problems it presents to the local people, palm oil industry is still beneficial from perspective of the global society.

This work could be used as basis for a continuous research in this area. Its results and outputs could be of use for the purpose of qualification of the impacts on environment and quantification of the price of palm oil with regards to such impacts.

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Appendix 1

Prepared survey for 20 random inhabitants from Balige – Sumatra

1. Do you use the palm oil and where?
    - 20 people use the PO for cooking
    - 5 people use the PO for making soap
    - 1 person use the PO for traditional medicine (with onion for children with flatulence)
2. Do you know any different way how to use the palm oil?
    - 11 people know the using for traditional medicine (with onion or caro oil for broken bones and injuries)
    - 8 responders say the using as important part for soap and cosmetics
    - 7 people know that Pertymina fuel is mixed with PO for ensure a cheaper price
    - 3 people without answers
3. Do you think that the palm oil has any good effects for you?
    - 9 responders say NO, because of smog and environment
    - 8 say YES, because of better infrastructure/cheaper fuel
    - 3 say YES, because they work for palm oil industry
4. Is possible to replace the palm oil?
    - 6 say YES by olive oil
    - 14 did not answer
5. Do you think that the situation in Sumatra is better thanks to industry of palm oil? Somehow easier?
    - 13 responders say YES
    - 5 responders do not know
    - 2 responder say NO – palm oil is bad

Appendix 2

Data for 1st equation in logarithm form

Year	y_1	x_2	x_3	x_4	x_5	x_6
1985	1.82	2.54	2.29	2.19	4.53	1
1986	1.89	2.57	2.19	2.22	4.55	2
1987	1.95	2.62	2.26	2.31	4.55	3
1988	2.03	2.73	2.32	2.38	4.58	4
1989	2.01	2.77	2.39	2.32	4.58	5
1990	2.05	2.83	2.46	2.26	4.58	6
1991	2.08	2.89	2.52	2.38	4.58	7
1992	2.12	2.94	2.59	2.52	4.59	8
1993	2.23	2.96	2.63	2.60	4.59	9
1994	2.30	3.02	2.67	2.72	4.59	10
1995	2.35	3.08	2.73	2.75	4.60	11
1996	2.39	3.15	2.77	2.76	4.60	12
1997	2.43	3.21	2.78	2.77	4.60	13
1998	2.47	3.25	2.70	2.78	4.60	14
1999	2.52	3.27	2.70	2.79	4.61	15
2000	2.56	3.30	2.83	2.78	4.61	16
2001	2.61	3.34	2.80	2.76	4.61	17
2002	2.67	3.45	2.81	2.81	4.61	18
2003	2.72	3.48	2.85	2.83	4.62	19
2004	2.78	3.52	2.92	2.84	4.62	20
2005	2.87	3.57	2.99	2.84	4.63	21
2006	2.90	3.61	3.05	2.87	4.63	22
2007	2.89	3.66	3.10	2.91	4.63	23
2008	2.93	3.70	3.12	3.00	4.63	24
2009	2.95	3.73	3.18	2.00	4.63	25
2010	2.99	3.76	3.26	3.01	4.63	26
2011	3.02	3.79	3.34	3.07	4.63	27
2012	3.05	3.82	3.35	3.12	4.64	28
2013	3.08	3.85	3.37	3.12	4.64	29

Sources: Faostat (2016), The World Bank (2016)

Appendix 3

Data for 2nd equation in logarithm form

Year	y_2	y_1	x_7	x_8	x_9	x_6
1985	1.89	1.82	1.30	1.84	0.20	1
1986	1.88	1.89	1.29	1.85	0.32	2
1987	1.90	1.95	1.28	1.86	0.52	3
1988	1.95	2.03	1.36	1.87	0.99	4
1989	1.98	2.01	1.43	1.88	1.21	5
1990	2.01	2.05	1.51	1.89	1.31	6
1991	2.06	2.08	1.54	1.90	1.45	7
1992	2.11	2.12	1.55	1.91	1.49	8
1993	2.14	2.23	1.62	1.93	1.49	9
1994	2.15	2.30	1.69	1.94	1.51	10
1995	2.20	2.35	1.76	1.96	1.59	11
1996	2.22	2.39	1.83	1.96	1.66	12
1997	2.25	2.43	1.79	1.96	1.71	13
1998	2.29	2.47	1.39	1.99	1.76	14
1999	2.31	2.52	1.46	1.99	1.78	15
2000	2.31	2.56	1.52	2.00	1.79	16
2001	2.33	2.61	1.50	2.01	1.83	17
2002	2.36	2.67	1.58	2.01	1.84	18
2003	2.37	2.72	1.66	2.02	1.90	19
2004	2.41	2.78	1.76	2.03	1.96	20
2005	2.46	2.87	1.83	2.04	2.18	21
2006	2.56	2.90	1.94	2.05	2.25	22
2007	2.64	2.89	2.03	2.05	2.31	23
2008	2.71	2.93	2.15	2.06	2.32	24
2009	2.73	2.95	2.23	2.07	2.57	25
2010	2.88	2.99	2.36	2.07	2.75	26
2011	2.95	3.02	5.43	2.08	2.75	27
2012	2.96	3.05	5.46	2.09	2.86	28
2013	3.01	3.08	5.44	2.09	2.90	29

Sources: Faostat (2016), The World Bank (2016)