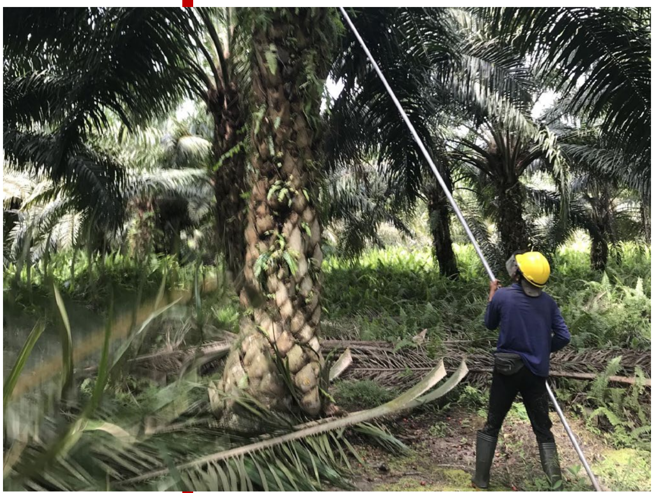
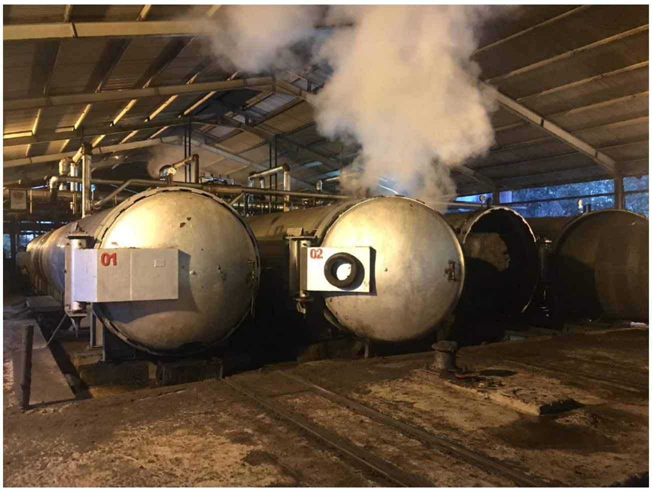
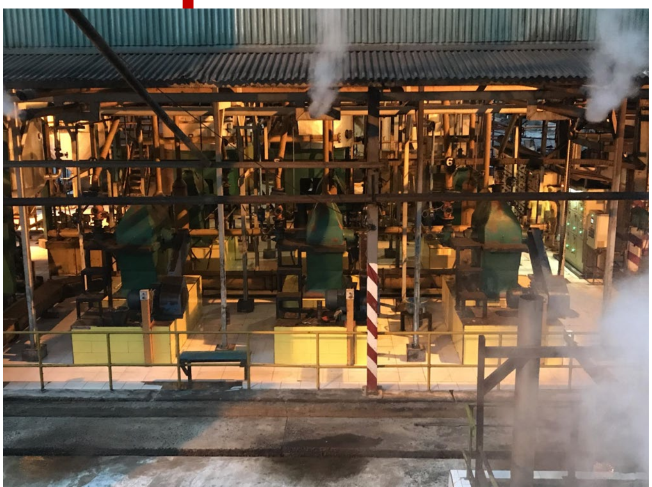
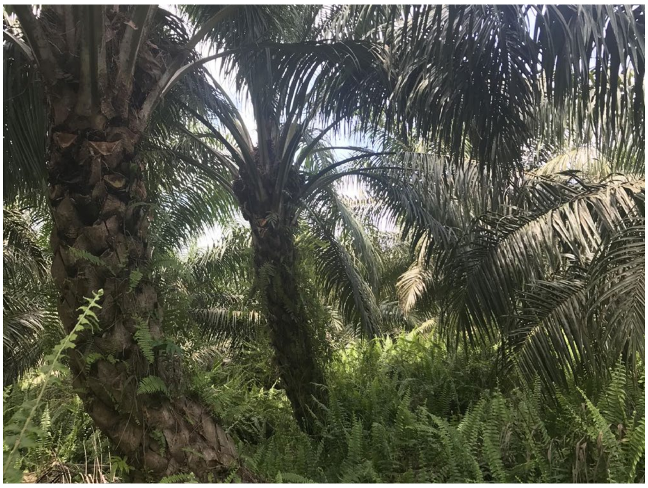
Comparative Life Cycle Assessment of RSPO-certified and Non-certified Palm Oil









Executive Summary

LCA consultants

Preface

This LCA-report is an outcome of the crowdfunded project: Life Cycle Assessment of RSPO-certified Palm Oil (https://lca-net.com/clubs/palm-oil/). The project is funded by:

- Beiersdorf
- DuPont
- ERASM
- Ferrero
- Novozymes
- PT Smart
- Unilever

Further, RSPO and the Emission Reductions Working Group (ERWG) under RSPO have supported the project in terms of facilitating data collection, expert judgements and commenting on the scope and methods of the project.

- Roundtable on Sustainable Palm Oil (RSPO)

The report is authored by Jannick Schmidt and Michele De Rosa, 2.-0 LCA consultants, Denmark, and with contributions from the members of the project listed above. The project has been carried out during May 2017 to May 2019. Appendices are available in a separate Appendix report.

Frontpage: Pictures by Jannick Schmidt at Golden Agri-Resources, Central Kalimantan 2018.

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Jannick Schmidt and Michele De Rosa 2019

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Executive Summary

Background and objectives

This report presents the first detailed life cycle assessment (LCA) study of palm oil production comparing the environmental impact of RSPO (Roundtable on Sustainable Palm Oil) certified sustainable palm oil with non-certified palm oil. The study is carried out in accordance with the ISO 14040/44 standards on LCA – including a critical panel review. LCA is a widely used framework to assess environmental impacts associated with all the life cycle stages of a product or service from 'cradle to grave'. The current LCA is a so-called cradle-to-gate study, which means that it includes the activities related to delivery of refined palm oil at refinery gate.

Many companies have committed to include only certified palm oil in their supply chain. But what does the certification of palm oil mean from a life cycle perspective? Information on the consequences of demanding certified is crucial for companies to gain awareness of their actual contribution to potential environmental impacts when buying certified palm oil, to include the quantitative potential savings in their environmental accounting and to monitor improvements. Therefore, the primary purpose of this LCA is to answer the question: What are the environmental impacts of RSPO-certified palm oil compared to non-certified? This includes the following questions: what are the GHG emissions from certified compared to non-certified? What is the impact on biodiversity from the two alternative production routes, and how much nature is conserved when choosing certified? And what are the differences for other impacts, such as respiratory impacts (from particulates, ammonia etc.), eutrophication etc.? Secondly, the purpose of the study is to identify hotspots and potential improvement options for production of palm oil.

The intended uses of the LCA are manifold. First of all, the LCA provides knowledge on the impacts of certified and non-certified palm oil. This information can be used by palm oil consumers to obtain quantitative knowledge about the effects of buying certified palm oil and, for business users, to define further requirements to their suppliers on their environmental performance. Further, the information in the LCA can help business users to prioritise improvement options in the palm oil product system.

The study complies with the International Organization for Standardization (ISO) standards 14040 and 14044 on LCA, and has undergone a critical panel review.

Functional unit

The functional unit is central for an LCA. The functional unit is a quantified performance of the product under study for use as a reference unit, i.e. it is what all the results relate to. The functional unit is defined as 1 kg of refined, bleached and deodorized (RBD) vegetable oil at refinery gate. The reference year is 2016.

Scope of the study

The model includes the following life cycle stages: cultivation of Fresh Fruit Bunches (FFB), palm oil mill, palm kernel crusher plant, and refinery. It represents RSPO-certified and non-certified palm oil production in Indonesia and Malaysia in 2016. The downstream life cycle stages are not included.

The results are calculated using two different modelling assumptions: consequential and attributional modelling. The consequential model follows as close as possible a causal modelling, where unit of analysis is a change in demand for the functional unit. By-product allocation is avoided by substitution and the impacts from indirect land use changes and offsets from nature conservation are modelled using state of art scientific knowledge in the field. The attributional model largely follows the methods of the PalmGHG calculator. Major by-products are modelled applying mass allocation (crude palm oil, kernels, crude palm kernel oil, palm kernel meal, refined oil, and palm fatty acid distillate). Land use changes are modelled using a direct land use change model (same approach as in the PAS2050 specification).

Data sources and data collection

The study is based on a detailed data collection, supported by more than 15 years of expert knowledge of the main author in assessing the sustainability of palm oil production in Indonesia and Malaysia using life cycle assessment.

For certified production, primary data are collected for 634 estates (of which 111 are smallholders), covering around 73% of the total certified oil palm planted area in Indonesia (381 estates) and Malaysia (253 estates). For palm oil mills, data have been collected for 165 mills in Indonesia (101 mills) and Malaysia (64 mills) producing 58% of the certified palm oil in Indonesia and Malaysia.

The data collection for the total industry (certified and non-certified) is carried out using best available statistics, and relying on representative coefficients to provide a sound estimate of data types not covered by statistics. Examples of such technical coefficients are literature data on Empty Fruit Bunches (EFB) and fibre outputs in the oil mill per tonne of FFB and Chemical Oxygen Demand (COD) of palm oil mill effluent (POME).

Two different background databases are used: Exiobase (version 3.3.13) for the consequential model and ecoinvent (version 3.4) for the attributional model. Exiobase is a a global hybrid multi-regional environmentally extended input output database which can be used for national level footprints and it is extensively used as a background LCI database for detailed product LCAs and corporate footprints. The advantages of this hybrid database over traditional process-based databases are that 1) it operates with no cut-off criteria and thus it is significantly more complete in terms of product flows and industries, 2) it is a truly globally trade-linked database have a complete global geographical scope, and it is based on economic, mass and energy balances both at the industry level and at the product level. The used version of Exiobase includes indirect land use changes and the electricity mixes are following consequential modelling. The applied system model of ecoinvent 3.4 in the attributional model is the allocation at point of substitution (APOS). This complies with the attributional model.

Emission models

In the FFB cultivation stage, the field emissions are calculated based on detailed nitrogen and phosphate balances. The emissions are modelled using the IPCC (2006, 2014b) approach. Emissions from cultivation in drained peat soils are using state of art data on emission factors, which depends on drainage depth.

In the oil mill stage, a state of art emission model is used to determine methane emissions from POME treatment with and without biogas capture. The emission model is based on a relationship between COD reduction under anaerobic conditions and considers the effect of different technologies.

In the consequential model, all fuel combustion emissions throughout the entire product system is based on consistent emission factors from the Exiobase database. These emission factors are country and industry specific. In the attributional model, the embedded emission factors in the ecoinvent database have been used for the background system.

Land use changes and nature conservation

According to IPCC, 11% of global GHG emissions are related to land use changes. Therefore, this source of emissions is important in LCA for activities that are associated with land use, which is the cause of land use changes.

The consequential model includes a detailed accounting of indirect land-use change (iLUC) emissions. The iLUC model has been extensively used in previous LCA studies and it has been periodically updated and improved over the last 10 years. The model follows a cause-effect principle in accordance to the LCA framework; it is applicable to any land use type and location in the world and it avoids allocation of land transformation impacts over an arbitrary period such as the PAS2050 or PalmGHG calculator approach. The iLUC model is embedded in the Exiobase database, which is used as background database in the consequential model.

The consequential model also includes the life cycle effects of nature conservation. In fact, a large share of RPSO certified oil palm growers reserve a part of the concession area to nature conservation. Nature conservation impacts are modelled accounting for direct, on-site, effects of the avoided land transformation (i.e. the conserved area) and for the induced, indirect, effects of directing land transformation to somewhere else. This approach is consistent with the used iLUC model.

The attributional model uses the same approach to land use modelling as in the PalmGHG calculator.

Results

Three impact categories have been identified as key impacts for palm oil production: global warming, nature occupation and respiratory inorganics. Nature occupation refers to biodiversity impacts from land use and respiratory inorganics refer to respiratory health effects, mostly caused by emissions of particulates, ammonia, NO_x and SO_2. The identification of these impact categories is based on the weighting and ranking of the results by using three different impact assessments methods: Stepwise, ReCiPe and Impact 2002+. Moreover, GHG emissions and biodiversity are also the impacts gaining most of the attention in the public debate on palm oil production and its environmental impacts. These three impact categories are also significantly addressed in the RSPO Principles and Criteria (P&C).

The consequential model shows a global warming impact of 3.41 (2.61- 4.48) and 5.34 (3.34 – 8.16) kg CO_2-eq./kg RBD oil for RSPO-certified and non-certified production respectively. The uncertainty ranges refer to the values within the 2.5% and 97.5% percentile. The attributional model shows a global warming impact of 3.42 and 5.32 kg CO_2 eq. for RSPO-certified and non-certified production respectively. In both the consequential and attributional model, the difference between certified and non-certified corresponds to around 35% lower impact for RSPO-certified palm. The differences for GHG emissions are mainly driven by the share of oil palm on peat, the average drainage depth of peat, yields, and share of POME treated with biogas capture.

The consequential model shows a nature occupation impact of 1.63 (1.30 - 2.05) and 2.04 (1.12 - 3.34) PDF*m^2 year/kg RBD oil for RSPO-certified and non-certified production respectively. The values in brackets refer to uncertainty ranges for 2.5% and 97.5% percentiles. The attributional model shows a nature occupation impact of 1.64 and 2.03 PDF*m^2 year/kg RBD oil for RSPO-certified and non-certified production respectively. In both the consequential and attributional model, this corresponds to an impact for RSPO-certified palm oil that is around 20% lower than for non-certified palm oil. The difference between RSPO-certified and non-certified palm oil is related to differences in yield.

The consequential model shows that results per kg RBD oil for respiratory inorganics are slightly lower for non-certified production compared to RSPO-certified. Non-certified production shows an impact of 2.33 (1.36 – 3.95) while RSPO-certified shows an impact of 2.58 (1.93 – 4.17) g $PM_{2.5}$-eq./kg RBD oil. This corresponds to 3% lower impact for non-certified production. The attributional results are inconclusive with respect to this impact category due to a likely error in the background database ecoinvent concerning particulate matter emissions factor lignite-based electricity generation. The higher impacts for RSPO-certified palm oil are mainly related to the fact that certified production is based on more intensive agricultural practices, i.e. higher fertiliser inputs, resulting in a higher nitrogen loss per unit of product.

For other impact categories, certified palm oil performs better for respiratory organics and photochemical ozone impacts, while higher impacts are found for eutrophication and acidification.

No conclusions can be drawn for the remaining impact categories: human toxicity (carcinogenic and non-carcinogenic), ecotoxicity (aquatic and terrestrial), eutrophication, acidification, non-renewable energy, mineral extraction, ionizing radiation and ozone layer depletion. Toxicity impacts are not reliable due to low representability of data coverage for certified production and missing data for non-certified production. Further, the used life cycle impact assessment method does not include characterisation factors for all active ingredients in pesticides.

Uncertainties and sensitivity analysis

An uncertainty analysis has been performed based on uncertainty information for the inventory data in the foreground system. The foreground system accounts for 85-99% of GHG emissions and 65-100% of the contribution to nature occupation and respiratory inorganics. Therefore, uncertainties in the background system (i.e. life cycle inventory databases) are regarded as having minor influence on the overall uncertainties of the results. The uncertainty analysis shows that the results are associated to relatively large uncertainties – see the indicated uncertain ranges of the results in the previous section. Uncertainties for RSPO-certified production are largely caused by data gaps in RPSO assessment reports. Nevertheless, the uncertainty analysis also shows that the uncertainties do not affect the ranking od RSPO-certified and non-certified palm oil and therefore the conclusions of this study with regards to GHG emissions, nature occupation and respiratory inorganics. In fact, the certified production performed better than the non-certified in 97% of the Monte Carlo simulations with regard to GHG emissions.

The largest sources of uncertainties related to GHG emissions are associated to peat (CO_2 emission factor, share of peat and drainage depth) and emissions from land use changes. Uncertainties also originate from data on other significant contributors such as emission level of CH_4 from the anaerobic ponds and N_2O from field emissions.

The uncertainties related to nature occupation are caused by uncertainties in yields and in the iLUC model. The uncertainties in data on yields are relatively small, while there are high uncertainties in the iLUC model and in the underlying data on biodiversity contained in transformed land. This has a major effect on the absolute value of the results for certified and non-certified, but minor effect on the relative difference between the two.

The main uncertainties related to respiratory inorganics are related to the NH_3 model for field emissions and particulate emission data in the palm oil mill boilers. For the data on particulate emissions from oil mills, no data on the size of the particulates are available, hence the difference in impact depending on the particulate size have not been addressed.

A number of sensitivity analyses have been performed to test the sensitivity of the results to key parameters and modelling choices identified throughout the study. Key parameters are the carbon stock in land set-aside as nature conservation, the share of nature conservation found on water logged peat, peat soil CO_2 emission factor and peat drainage depth. Key modelling choices are the allocation method in the attributional model and the influence on the results of the background database. The sensitivity analyses show that the ranking of RSPO-certified and non-certified palm oil is not influenced by the analysed parameters and modelling assumptions.

Conclusions

It is concluded that the three most significant environmental impacts associated with the production of both certified and non-certified palm oil are global warming, nature occupation and respiratory inorganics.

RSPO-certified palm oil performs better than non-certified for global warming and nature occupation with around 35% and 20% lower impacts respectively. On the contrary, certified palm oil has a slightly higher contribution to respiratory inorganics than non-certified.

For other impact categories, certified palm oil performs better for respiratory organics and photochemical ozone impacts, while higher impacts are found for eutrophication and acidification.

No conclusions can be drawn for the following impact categories: human toxicity (carcinogenic and non-carcinogenic), ecotoxicity (aquatic and terrestrial), non-renewable energy, mineral extraction, ionizing radiation and ozone layer depletion.

Hence, for two important impact categories, global warming and nature occupation, this study demonstrates that considerable environmental gains are achieved by RSPO-certified palm oil production over non-certified production.

Two significant improvement potentials are identified: Increasing the share of POME treated with biogas capture, and convert cultivated drained peat soils to water logged nature conservation. The reductions with biogas capture are highest when the biogas is utilised for energy generation.

Results are associated to large uncertainties, although these do not affect the comparative assertion. To reduce the uncertainty, thus increasing precision of the results and extending them to further impact categories, it is recommended to increase the reliability of the data collection in RSPO-certified annual assessment reports. This can be done by introducing a more standardised data collection, defining e.g. the units of data, the data type to collect and by introducing systematic procedures for data sanity checks (e.g. identifying outliers, mass balance checks, cross checks etc.).