We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,900
Open access books available

186,000
International authors and editors

200M
Downloads

154
Countries delivered to

Our authors are among the

TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

CLARIVATE ANALYTICS
BOOK CITATION INDEX
INDEXED

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Chapter

Environmental Impact Evaluation of Rubber Cultivation and Industry in Malaysia

Sumiani Yusoff, Zameri Mohamed
and Aireen Zuriani Ahmad

Abstract

Over the last 10 years, contribution of Malaysian rubber industry to Malaysia export earnings has increased significantly from RM 15.5 billion in 2003 to RM 33.7 billion in 2013. The main objectives of this study are to provide a comprehensive inventory and detailed quantification of the environmental impact and greenhouse gases emission (GHGs) for the major part of Malaysian rubber industry comprising the cultivation of rubber tree from cradle to grave as well as Standard Malaysian Rubber (SMR) production from cradle to gate. This study was conducted through questionnaire surveys in order to create a very comprehensive life cycle inventories tables representing the actual activities in the Malaysian rubber industry. The results from the questionnaire survey indicated that the GHGs emission from the average annual activities in the cultivation of rubber trees from cradle to grave in Malaysia is 315.54 $GgCO_2eq$ and it represents 0.11% from the 2011 Malaysia GHGs emission. The average annual GHGs emission from the production of SMR in Malaysia in this study is 229.41 $GgCO_2eq$ and it represents 72.7% from the average annual GHGs emission from the cultivation of rubber trees from cradle to grave in Malaysia.

Keywords: life cycle assessment (LCA), greenhouse gases emission, Malaysian rubber industry, Standard Malaysian Rubber (SMR)

1. Introduction

The history of rubber cultivation in Malaya started in the late 1877 when nine seedlings from a batch of about 2700 germinated seeds at Kew Botanic Gardens near London were dispatched and planted in Kuala Kangsar, Perak [1]. Since the first rubber plantation in Malaya was established in 1896, the rubber industry has grown tremendously into the present Malaysia. There were 218,900 hectares of rubber planted area in Malaya in 1910 [1] as compared to 1.066 million hectares of rubber planted area in Malaysia in 2014 [2].

Over the last 10 years, contribution of Malaysian rubber industry to Malaysia export earnings has increased significantly from RM 15.5 billion in 2003 to RM 33.7 billion in 2013 [3]. Malaysia has become the world fifth largest producer of natural rubber with the production of 0.67 million tons in 2014 [2]. Due to its importance, Malaysian rubber industry is included in Malaysia National Key

1

Economic Area (NKEA) [4]. Malaysia National Key Economic Area (NKEA) is an important driver of economic activities that has a potential to directly contribute to Malaysian Economic Growth measurable by Gross National Income (GNI) indicator and will assist Malaysia in achieving a high income status by 2020 [4].

2. Literature review

Malaysian rubber industry has always been regarded as an environmentally sustainable industry. Rubber trees play an important role as a carbon dioxide sequester from the atmosphere at a rate comparable to if not better than the natural forest [5]. After the process of falling down, rubber trees are converted into renewable rubber wood for furniture based industry. The term renewable or environmentally friendly associated with the rubber wood arises from the fact that the rubber wood represents a relatively sustainable alternative as compared to the tropical woods extracted from natural forest [6].

2.1 Environmental management in Malaysian rubber industry

As one of the Malaysian industries that contribute significantly to the economic development of the country, the Malaysian rubber industry also generated a significant amount of waste [7]. These wastes are subjected to various regulations under the Malaysian Environmental Quality Act 1974. The open burning of rubber plantation wastes in the form of rubber tree stumps after land clearing are governed under the Environmental Quality (clean air) Regulations 1978 Part III (burning of wastes). The practice of open burning is only allowed for specific cases after obtaining special permission from Department of Environment Malaysia (DOE) [8].

The Malaysian government also gazettes the Environmental Quality (prescribed premises) of Raw Natural Rubber Regulations (1978) in making sure that all the raw effluents from the raw rubber processing activities in Malaysia are treated and meet the legal discharge standard before they are allowed to be discharged into the watercourse. The rubber products manufacturing factories in Malaysia are subjected to Environmental Quality (sewage and industrial wastes) Regulations (1979) and Environmental Quality (scheduled waste) Regulations (1989) [9].

2.2 Climate change and Malaysia greenhouse gases emission

Climate is an integral part of environment and climate change in more ways than one is a measure of abuse and mismanagement of this environment through time [10]. According to [11], human influence on the climate change is clear and the more we disrupt our climate, the more we risk severe, pervasive and irreversible impacts on human and natural system.

Malaysia has developed two policies which are The National Policy on Climate Change and the National Green Technology Policy to collectively guide the nation towards addressing climate change holistically, ensuring climate-resilient development, developing a low carbon economy and promoting green technologies [12]. Moreover, low carbon economy is one of the key initiatives proposed by the Malaysian government in the fight against the issue of global warming and climate change [13].

On 13 July 1994, Malaysia has ratified the United Nation Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol on 4 September 2002 [14]. As part of the obligations under Article 4 of the UNFCCC, the Government of Malaysia submitted its Initial National Communication in July 2000 and the Second

National Communication was submitted in January 2011 [15, 10]. Malaysia greenhouse gases (GHGs) emission for the year 2011 was 290.230 million tons CO_2eq and the removal was 262.946 million tons CO_2eq with a net sink of 27.284 million tons CO_2eq (**Table 1**).

Malaysia emissions per gross domestic product (GDP) for the year 2000 were 0.62 t CO_2eq/thousand RM [12]. Malaysia's commitment to address the GHGs emission in the context of sustainable development was announced by the Prime Minister during the 15th Conference of the Parties (COP 15) to the UNFCCC on 17th December 2009 [15, 16]. At the COP 15, the Prime Minister had announced Malaysia's voluntary reduction which was up to 40% in terms of carbon emission intensity of GDP by the year 2020 compared to year 2005 conditional on receiving the transfer of technology and finance support from developed countries [15].

2.3 Life cycle analysis (LCA) study for Malaysian rubber industry

Life cycle analysis (LCA) methodology is relatively a new approach in Malaysia. Majority of the LCA studies in Malaysia at present are conducted to highlight the environmental sustainability of the oil palm industry. The LCA studies on the oil palm industry in Malaysia covered all the sectors within the industry starting from the planting material production up to the biodiesel and other oil palm based products.

All the LCA studies from the oil palm industry in Malaysia have one common objective which is to dispel the misinterpretation of the oil palm industry as a very unsustainable industry by international non-governmental organization.

Life cycle analysis (LCA) methodology is the most relevant environmental management tool to measure the environmental impact and quantify the greenhouse gas emission from the Malaysian rubber industry. The LCA study conducted for the Malaysian rubber industry will definitely be a very useful source to identify the environmental hotspots in the Malaysian rubber industry and help in solving solutions to diminish these hotspots for the betterment of the Malaysian rubber industry.

Based on the findings of the LCA study from the Malaysian rubber industry, certain recommendations, policy or standard operating procedures may be introduced by Malaysian Rubber Board (MRB). The findings from the LCA study for Malaysian rubber industry will also be very beneficial for decision makers across the whole chain of the Malaysian rubber industry.

Sector	Emissions (million tons CO_2eq)	Sink (million tons CO_2eq)
Energy	218.914	
Industrial processes	18.166	
Agriculture	15.775	
Land use, land-use change and forestry (LULUCF)	2.490	−262.946
Waste	34.885	
Total	290.230	−262.946
Net total (after subtracting sink)	−27.284	

Source: [16].

Table 1.
Malaysia GHGs inventory for 2011.

According to [17], there was an earlier LCA study for the production of natural rubber latex concentrate and skim block rubber in North Sumatera, Indonesia involving two latex concentrate factories. The objectives of the study by [17] is not only confined to produce life cycle inventories and environmental impact data from the life cycle impact assessment stage, but the objective was further expanded to include the assessment on the level of eco-efficiency for the production of natural rubber latex concentrate and skim block rubber by utilizing the values obtain from the life cycle impact assessment analysis based on Eco-Indicator 99 methodology [17]. However, this LCA study for the Malaysian rubber industry is the first study of its kind carried out in Malaysia.

2.4 Lack of data on the rubber cultivation in Malaysia from cradle to grave perspective

Conducting LCA study for the natural rubber cup lump production and SMR block rubber production is the right step towards providing support to the Malaysian SMR block rubber industry. This may contribute more details and transparent information regarding the environmental impacts and the GHGs emission in the production of Standard Malaysian Rubber (SMR) block rubber from cradle to gate approach. The information from this study on LCA for the production of SMR block rubber will be very valuable for the international tires manufacturers especially in Europe to incorporate it as the verified background data in their LCA study for the tire production from cradle to grave approach.

The detailed information on the GHGs emissions from the LCA study for the production of SMR block rubber will also be very useful in assisting the Malaysian based rubber products to get certified by the newly launched Standard and Industrial Research Institute of Malaysia (SIRIM) Environmental Declaration Carbon Footprint Type III. The SIRIM Environmental Declaration Carbon Footprint Type III is part of the MyHIJAU Mark and is eligible for Malaysian Government Green Procurement Program.

2.5 Lack of detailed information on GHGs emission and the possibility of setting up voluntary carbon trading for Malaysian rubber industry

In short, it is timely that the GHGs emission related to the Malaysian rubber industry is properly studied and documented extensively for the benefits of the Malaysian rubber industry and Malaysia as whole. The results from the quantification of GHGs emission work for the Malaysian rubber industry using LCA approach will notably help in filling the information gap as described above. The results from this LCA study on the GHGs emission for the Malaysian rubber industry can also be used to project the environmental sustainability of the rubber planting activities in Malaysia as compared to other two major crops in Malaysia which are planting of oil palm and paddy cultivation.

2.6 Climate change and sustainable development

Climate change is summarized by [18] as the extraordinary warming of the earth from increased concentrations of greenhouse gases (GHGs). The current anthropogenic emission of GHGs is the highest in history and is driven largely by human activities through infrastructure development, industries, agriculture and motor vehicles [10, 11]. The atmospheric concentrations of carbon dioxide, methane and nitrous oxide at present are unprecedented at least for the last 800,000 years [11]. According

to Van der et al. in [19], it is estimated that 12–15% of the global anthropogenic carbon dioxide emissions is originated from the deforestation and forest degradation.

Climate change is more than just a warming trend as the increasing temperature through continued emission of GHGs will cause further warming and long lasting changes in all components of the climate system [10, 11]. The consequences of the climate change are likely to be harmful to humans and natural environment in the form of changes in major wind patterns, amount and intensity of precipitation and increased frequency of severe storms and weather extremes [18, 10].

Agriculture industry would be the most affected sectors of climate changes as compared to other economic sectors since it has a strong linkage and dependence on the climate and the environmental factors as suggested in [20]. Rise of temperature, changes in sowing and harvesting dates, water availability and rainfall patterns are among climatic factors that can influence the agricultural productivity [21]. Baharuddin stated in [20] that an increase in rainfall is prejudicial for rubber plantations which suffer losses in the form of loss of tapping days and crop washouts.

3. Methodology

The main goal of the study is to provide comprehensive inventories, detailed quantification of the environmental impact and GHGs emission for the cultivation of rubber tree from cradle to grave in Malaysia. Therefore, this study is required to quantify the GHGs emission and recommended strategies for improvement based on the individual Life cycle inventory (LCI) for the cultivation of rubber trees from cradle to grave. The environmental impacts and hotspots identification for the study was carried out using SimaPro software version 7.3.3 developed by Pre Consultants B.V. Eco-indicator 99 was selected as the impact assessment methodology.

For this study, the survey only represents the rubber smallholders under the supervision of rubber related agencies in Malaysia. Individual rubber smallholders are excluded from this survey as there are great difficulties in getting verified information from this group of rubber smallholders on their agronomic practices as these smallholders normally did not have any proper written record on their agronomic practices and few of them are even illiterate. Amongst the main three government agencies in Malaysia which are responsible in supervising and managing the small plot of rubber planted area owned by the rubber smallholders, only The Federal Land and Development Authority (FELDA) and Federal Land Consolidation and Rehabilitation Authority (FELCRA) agreed to take part in this study while Rubber Industry Smallholders' Development Authority (RISDA) did not allow this study to be conducted in the rubber planting areas owned by the rubber smallholders under their supervision. Based on the discussion with FELDA and FELCRA management and supported by [22, 23] data, there are 21 FELDA schemes and 274 FELCRA projects that are currently in the mature rubber stage in Peninsular Malaysia.

3.1 Life cycle assessment (LCA)

Life cycle assessment (LCA) is an environmental management tool that enables quantification of environmental burdens and their potential impacts over the whole life cycle of a product, process or activity [24]. Primarily, LCA has been introduced in product manufacturing for the purpose of tracing direct impacts and impacts associated with a product throughout the entire life cycle from cradle to grave for the purpose of getting a holistic overview of the environmental burden associated with the products [25].
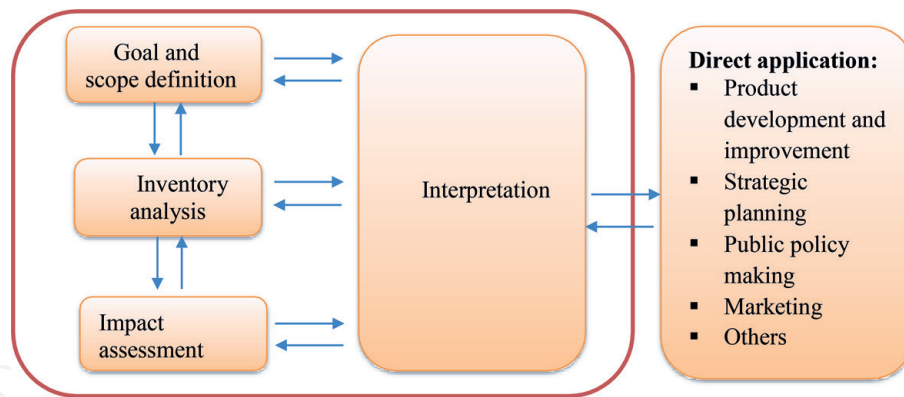
Figure 1.
Stages of LCA.

There are four phases in LCA studies namely goal and scope definition, inventory analysis, impact assessment and interpretation. The relationship between the phases is illustrated in **Figure 1**.

3.2 Goal and scope definition

This is the first phase of any LCA study and according to [26], the goal must clearly mention the intended application, the reasons for carrying out the study and the intended audience. The scope of any LCA study should be sufficiently well defined to ensure that the breadth, depth and the details in which the study is conducted are both compatible and sufficient to address the stated goals [26]. The functional unit, system boundary, allocation procedures, assumptions and limitation are parts of the scope.

3.3 Inventory analysis

The Life cycle inventory (LCI) phase is the second phase of any LCA study. Inventory analysis involves data collection and calculation procedures within the system boundary for inclusion in the inventory as relevant inputs and outputs of a product system [26, 27]. According to [28], LCI can be defined as an objective, data-based process of quantifying energy and raw materials requirements, air emissions, waterborne effluents, solid waste, and other environmental releases incurred throughout the life cycle of a product, process, or activity.

All calculation procedures in the inventory analysis for any LCA study must be transparently documented and the assumptions used must be clearly stated and explain [27]. Generally, there are two types of inventory data, i.e., the foreground data that have to be collected independently according to the purpose of carrying out LCA analysis and the background data which are usually collected from literatures and software [29]. Data validity check must be conducted during the process of data collection for inventory analysis to make sure that the data quality requirements have been fulfilled [27]. For the data collected from public sources, the sources must be referenced [27].

3.4 Impact assessment

The Life cycle impact assessment (LCIA) phase is the third phase of LCA and its purpose is to evaluate the significance of potential environmental impacts based on the LCI results [26]. The LCIA phase is important in providing the information for the life cycle interpretation phase [26].

4. Results and discussion

4.1 Life cycle impact assessment (LCIA) on GHGs emission in the production of mature rubber tree from immature rubber stage

The total GHGs emission value in maintaining the healthy growth of one immature rubber tree for a year for this study is 1.08 kgCO$_2$eq as shown in **Figure 2** and **Table 3**. The highest contributor which represented 51.6% from the total GHGs emission value in maintaining the healthy growth of one immature rubber tree for a year is the emission of nitrous oxide from the usage of ammonium sulfate at 5.60E−01 kgCO$_2$eq (**Figure 2**).

While the second highest contributor to the total GHGs emission value in maintaining the healthy growth of one immature rubber tree for a year is ammonium production with the percentage of 22.4%. Meanwhile, glyphosate production was recorded as the third highest contribution at 17.7% (**Figure 2**). The remaining three processes are considered as insignificant contributors towards the total value of GHGs emission to maintain the healthy growth of one immature rubber tree for a year (**Figure 2**).

Figure 2 obviously showed that the reduction in the usage of ammonium sulfate and glyphosate will definitely reduce the total GHGs emission value in maintaining the healthy growth of one immature rubber tree for a year. This can be achieved through the reduction in the immaturity rubber stage period and through incorporating the manual weeding method in weed management.

The GHGs emission value in maintaining the healthy growth of one immature rubber tree for 6 years duration during the immature rubber stage is 6.51 kgCO$_2$eq and this represent 14.6% from the total value of GHGs emission for the cultivation of one rubber tree from cradle to gate of 44.68 kgCO$_2$eq.

The GHGs emission in maintaining the healthy growth of immature rubber trees in Malaysia per year which based on 0.379 million hectares of immature rubber area in Malaysia at the average stand of 410 rubber trees per hectare and with 51.8% of this area is fertilized at the recommended dosage is summarized in **Table 2**.

Based on **Table 2**, as compared to the Malaysian 2011 GHGs emission of 290,230 GgCO$_2$eq in [30], the GHGs emission value from the perspective to maintain the healthy growth of immature rubber trees in Malaysia for 6 years, immature rubber stage and 1 year average for immature rubber stage is considered as insignificant.

The GHGs emission value of 524.69 GgCO$_2$eq with duration of 6 years for immature rubber stage in maintaining the healthy growth of immature rubber trees in Malaysia is very low and represent only 3.3% from the 2011 Malaysian agricultural sector GHGs emission of 15775.3 GgCO$_2$eq (**Table 2**). The GHGs emission value of 87.45 GgCO$_2$eq based on the average 1 year for immature rubber stage is considered
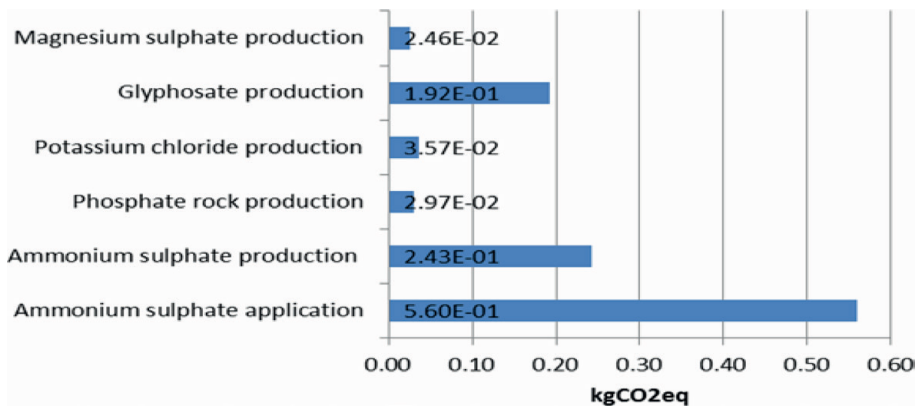

Figure 2.
GHGs emissions in maintaining the healthy growth of one immature rubber tree for a year.

as insignificant as compared to the GHGs emissions value from Malaysian agricultural sector in 2011 (**Table 2**).

Table 3 shows the list of GHGs emission and its corresponding values in contributing to the total GHGs emission value in maintaining the healthy growth of one immature rubber tree for a year.

4.2 Life cycle impact assessment (LCIA) on GHGs emission for natural rubber cup lump production from cradle to gate

The total GHGs emission value for the production of 1 kg natural rubber cup lump (56% DRC) is 4.89E−02 kgCO$_2$eq and its represent 0.11% from the total GHGs emission value for the cultivation of one rubber tree from cradle to grave (**Figure 3**).

	Immature rubber stage (6 years)	Average 1 year for immature rubber stage
GHGs emission (GgCO$_2$eq)	524.69	87.45
Percentage from Malaysia 2011 GHGs emission (%)[*]	0.18	0.03
Percentage from agriculture sector in Malaysia 2011 GHGs emission (%)[*]	3.33	0.55

[*]*Source: [16].*

Table 2.
GHGs emission to maintain the healthy growth of immature rubber trees in Malaysia.

GHGs	Weight in kgCO$_2$eq
Nitrous oxide	5.63E-01
Carbon dioxide	4.91E-01
Methane	2.87E-02
Methane, tetrafluoro-, CFC-14	6.34E-04
Sulfur hexafluoride	5.38E-04
Ethane, hexafluoro-, HFC-116	1.34E-04
Methane, tetrachloro-, CFC-10	7.70E-05
Ethane, 1,1,1,2-tetrafluoro-, HFC-134a	4.05E-05
Methane, chlorodifluoro-, HCFC-22	3.82E-05
Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	1.92E-05
Methane, bromochlorodifluoro-, Halon 1211	1.06E-05
Methane, bromotrifluoro-, Halon 1301	9.76E-06
Methane, dichlorodifluoro-, CFC-12	8.30E-07
Methane, trifluoro-, HFC-23	6.64E-07
Ethane, 1,1,2-trichloro-1,2,2-trifluoro-, CFC-113	1.31E-07
Ethane, 1,1-difluoro-, HFC-152a	1.74E-08
Chloroform	1.48E-08
Methane, trichlorofluoro-, CFC-11	1.09E-09
Methane, dichloro-, HCC-30	2.21E-10
Methane, monochloro-, R-40	2.00E-10
Ethane, 1,1,1-trichloro-, HCFC-140	7.90E-11
Methane, dichlorofluoro-, HCFC-21	2.13E-11
Methane, bromo-, Halon 1001	2.86E-17
Total GHGs Emission	1.08

Table 3.
GHGs emission profile to maintain the healthy growth of one immature rubber tree for a year.

Figure 3 has clearly described that the trend from the GHGs emission for the production of 1 kg natural rubber cup lump (56% DRC) is basically identical to the GHGs emission for the cultivation of one rubber tree from cradle to grave.

The application and production of ammonium sulfate are the two main processes responsible for 77.9% from the total GHGs emission value for the production of 1 kg natural rubber cup lump (56% DRC) (**Figure 3**). Potassium chloride production and glyphosate production recorded the contribution of 8.1 and 7.5% respectively while the remaining 13 processes are considered as minor contributors towards the total GHGs emission value for the production of 1 kg natural rubber cup lump (56% DRC) (**Figure 3**).

It is found that in Malaysia, the GHGs emission from the production of 1,193,946 tons of natural rubber cup lump (56% DRC) is 58.4 3 $GgCO_2eq$ and this only represent 0.02% from the Malaysian 2011 GHGs emission of 290,230 $GgCO_2eq$ [30]. Based on this value, the contribution of the GHGs emission from the production of 1,193,946 tons of natural rubber cup lump (56% DRC) in Malaysia is considered as insignificant as compared to the Malaysian 2011 GHGs emission.

4.3 Life cycle impact assessment (LCIA) on GHGs emission for the production of SMR block rubber from cradle to gate

Figure 4 indicates that the total GHGs emission value for the production of 1 kg Standard Malaysian Rubber (SMR) block rubber from this study is 0.407 $kgCO_2eq$.

Electricity generation, methane emission from the effluent treatment system, production of natural rubber cup lump from cradle to gate and transportation of raw material from the source to the Standard Malaysian Rubber (SMR) block rubber factories are the four key process contributors representing 95.9% from the total GHGs emission value in the production of 1 kg SMR block rubber from cradle to gate (**Figure 4**).

From **Figure 4**, it is noticeably reported that the reduction in the electricity consumption during the production of SMR block rubber, elimination in the methane mission from the effluent treatment system, reduction in the total GHGs
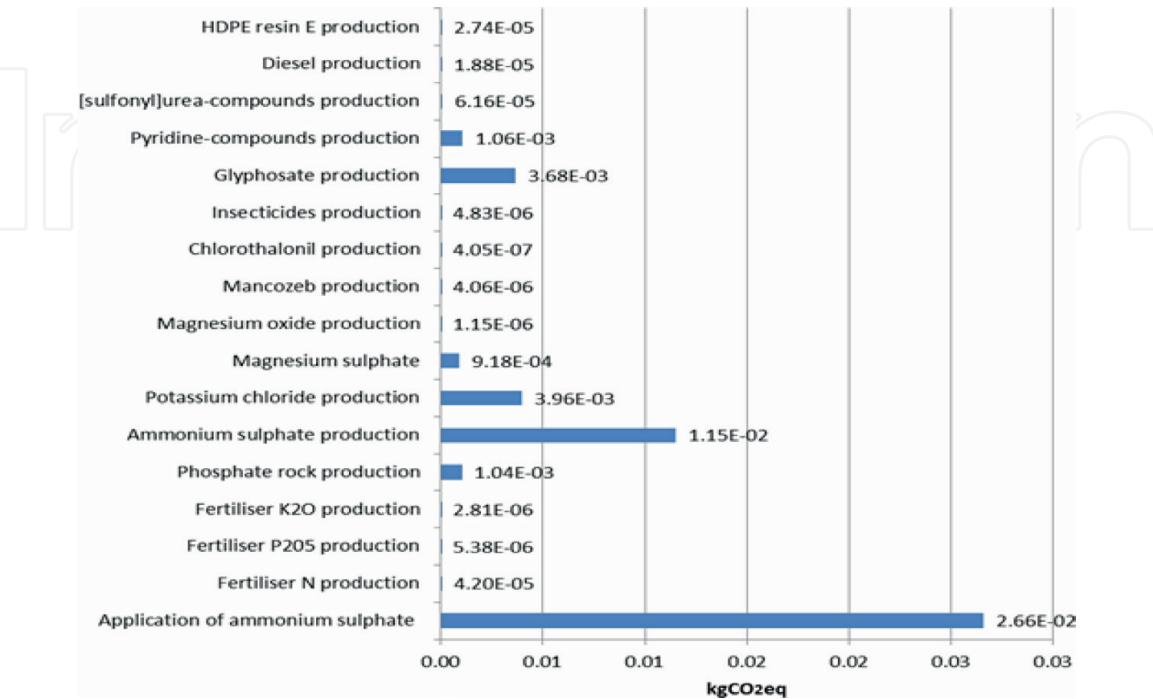

Figure 3.
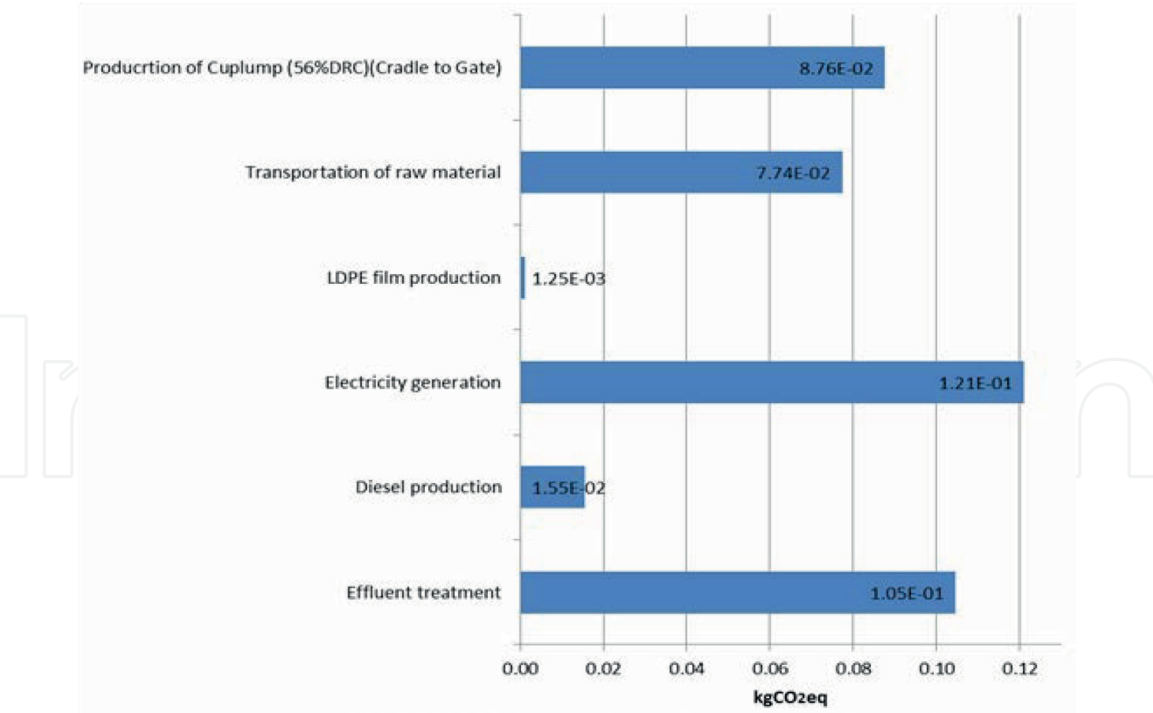*GHGs emission values for the production of 1 kg natural rubber cup lump (56% DRC).*

Figure 4.
GHGs emission values for the production of 1 kg Standard Malaysian Rubber (SMR) block rubber from cradle to gate.

GHGs	Weight in kgCO$_2$eq
Carbon dioxide	2.40E−01
Methane	1.18E−01
Nitrous oxide	4.90E−02
Methane, tetrafluoro-, CFC-14	6.16E−05
Sulfur hexafluoride	4.18E−05
Methane, chlorodifluoro-, HCFC-22	2.25E−05
Ethane, hexafluoro-, HFC-116	1.30E−05
Methane, bromotrifluoro-, Halon 1301	9.13E−06
Methane, bromochlorodifluoro-, Halon 1211	6.92E−06
Ethane, 1,1,1,2-tetrafluoro-, HFC-134a	4.39E−06
Methane, tetrachloro-, CFC-10	3.75E−06
Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	2.24E−06
Methane, dichlorodifluoro-, CFC-12	7.84E−07
Methane, trichlorofluoro-, CFC-11	3.39E−07
Methane, chlorotrifluoro-, CFC-13	1.39E−07
Methane, trifluoro-, HFC-23	6.21E−08
Ethane, 1,1,2-trichloro-1,2,2-trifluoro-, CFC-113	1.23E−08
Methane, dichloro-, HCC-30	1.09E−08
Ethane, 1,1-difluoro-, HFC-152a	1.37E−09
Chloroform	1.31E−09
Methane, monochloro-, R-40	1.68E−11
Ethane, 1,1,1-trichloro-, HCFC-140	6.50E−12

GHGs	Weight in kgCO$_2$eq
Methane, dichlorofluoro-, HCFC-21	1.99E−12
Methane, bromo-, Halon 1001	2.84E−18
Total GHGs emission	0.407

Table 4.
GHGs emission profile for the production of 1 kg SMR block rubber from cradle to gate.

emission from the production of natural rubber cup lump (56% DRC) from cradle to gate and the reduction of fossil fuels based usage in the transporting of raw material from the source to SMR block rubber factory will definitely scale down the total GHGs emission from the production of 1 kg SMR block rubber from cradle to gate.

The GHGs emission from the production of SMR block rubber from cradle to gate had the potential to be reduced through the elimination of methane release from the effluent treatment system. The methane release from the treatment of SMR block rubber factory effluent can be eradicated through changing the current effluent treatment system of facultative/anaerobic ponding system to a fully aerobic system. At present, the methane emission from the effluent treatment plant in the block rubber factories are not subjected to any environmental regulations.

The GHGs emission from the production of 562,967 tons of natural rubber cup lump based SMR block rubber in Malaysia is 229.41 GgCO$_2$eq and this only represent 0.08% from the Malaysian total GHGs emission of 290,230 GgCO$_2$eq in 2011 [30].

The list of GHGs emission and its corresponding values in contributing to the total GHGs emission value for the production of 1 kg SMR block rubber from cradle to gate is shown in **Table 4**. Carbon dioxide, methane and nitrous oxide are the three major GHGs that contribute 99.96% from the total GHGs emission value in the production of 1 kg SMR block rubber from cradle to gate (**Table 4**).

The GHGs emission from the production of natural rubber cup lump (56% DRC) in Malaysia for the average period of 1 year for cradle to gate is 58.43 GgCO$_2$eq and it represents 18.5% from the total GHGs emission for the cultivation of rubber trees from cradle to grave based on average 1 year perspective.

5. Conclusions

In summary, with the implement of Life cycle analysis (LCA) methodology for the Malaysian rubber industry in this study, it can be concluded that the reduction in the utilization of ammonium sulfate fertilizer to its optimum level has the potential to reduce the GHGs emission for the cultivation of rubber trees in Malaysia from cradle to grave perspective. Meanwhile, the reduction in the immaturity rubber stage period and incorporating of manual weeding method in the weed management have the potential to reduce the GHGs emission for the production of mature rubber trees for gate to gate boundary in Malaysia.

The GHGs emission from the production of SMR block rubber in Malaysia for the average period of 1 year for cradle to gate boundary have the potential to be reduce through increasing the supply of local natural rubber and making sure the natural rubbers are free or have a very minimum amount of contaminants. The GHGs emission from the production SMR block rubber in Malaysia for the average period of 1 year for cradle to gate boundary also has the potential to be reduce through replacing the current effluent treatment system to a fully aerobic system.

This study is hoped to be a part of the continuous effort in meeting sustainability goal in the Malaysian rubber industry and stringent environmental market regulations worldwide.

Acknowledgements

Author details

Sumiani Yusoff[1*], Zameri Mohamed[2] and Aireen Zuriani Ahmad[3]

1 Institute of Ocean and Earth Sciences, University of Malaya, Kuala Lumpur, Malaysia

2 Malaysian Rubber Board, Sungai Buloh, Selangor, Malaysia

3 University of Malaya Eco-Campus Secretariat Office, Kuala Lumpur, Malaysia

*Address all correspondence to: sumiani@um.edu.my

IntechOpen

References

[1] Chan H, Yeang HY, Lim CL, Rahman FA, Ishak S, editors. Milestones in Rubber Research. Kuala Lumpur: Malaysian Rubber Board; 2000

[2] Malaysian Rubber Board. Rubber Pocket Book. Kuala Lumpur: Malaysian Rubber Board; 2016

[3] Malaysian Rubber Board. One Nation Rubber Strategy. Kuala Lumpur: Malaysian Rubber Board; 2014

[4] Sumormo S. National key economic area (NKEA): Shaping the Malaysian rubber industry for 2020. Rubber Technology Developments. 2012;**12**(2):3-8

[5] Malaysian Rubber Board. The Malaysian Natural Rubber Industry [Internet]. 2017. Available from: http://www.lgm.gov.my/GreenMaterial/TheMalaysianNRIndustry.pdf [Accessed: 7 July 2017]

[6] Usubharatana P, Phungrussami H, Sukhodomchot N. Is parawood envrionmental firendly material? What should be known before answer? Research Journal of Applied Sciences. 2013;**8**(4):252-261

[7] Verasamy D, Isa Z, Karim MZA. Overview of waste management and recycling activities of Malaysian rubber industry. In: Proceedings of 17th Symposium of Malaysian Chemical Engineers (SOMChe2003); 29-30 December 2003; Penang, Malaysia: School of Chemical Engineering, Universiti Sains Malaysia; 2003. pp. 698-702

[8] Yew FK. Zero burning in rubber cultivation. Planters Bulletin. 1998;**1**:29-34

[9] Isa Z. Management of effluent and control of malodour from natural rubber industries. In: Short Course on Environmental Management for Rubber Industry. Selangor: Akademi Hevea Malaysia; 2004

[10] Sani S. The politics of climate change: International responses and Malaysia. Bangi, Selangor: Institut Alam Sekitar dan Pembangunan (LESTARI), UKM; 2009

[11] IPCC. In: Core Writing Team, Pachauri RK, Meyer LA, editors. Climate Change 2014: Synthesis Report. Contibution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovermental Panel on Climate Change. Geneva, Switzerland: IPPC; 2014. pp. 151

[12] Ministry of natural resources and environment Malaysia. Second national communication to the UNFCCC; Putrajaya, Malaysia; 2011

[13] Amin AQ, Filho WL. An overview of prospects and challenges in the field of climate change in Malaysia. International Journal of Global Warming. 2011;**3**(4):396. doi:10.1504/ijgw.2011.044402

[14] UNDP. Third National Communications (TNC) to the UNFCCC and Biennial Update Reporting (BUR) for Malaysia [Internet]. 2015. Available from: http://www.my.undp.org/content/malaysia/en/home/operations/projects/environment_and_energy/third-national-communications--tnc--to-the-unfccc-and-biennial-u.html [Accessed: 29 July 2015]

[15] Ministry of natural resources and environment Malaysia. Malaysia Biennial update report to the UNFCCC. Putrajaya; 2015

[16] Theseira GW. Roadmap to achieving the 40% carbon intensity emissions reduction. In: REDD+ Stakeholder

Consultation Workshop; Kuala Lumpur: Sunway Putra Hotel; 2013

[17] Maulina S. Enhancement of eco-efficiency through life cycle assessment in natural rubber latex concentrate processing [Doctor of Philosophy]. Universiti of Malaya; 2014

[18] Harris PG. Climate change and American foreign policy: An introduction. In: Harris PG, editor. Climate Change and American Foreign Policy. New York: Palgrave Macmillan US; 2000. pp. 3-25

[19] de Blécourt M, Brumme R, Xu J, Corre MD, Veldkamp E. Soil carbon stocks decrease following conversion of secondary forests to rubber (*Hevea brasiliensis*) plantations. PLOS ONE. 2013;**8**(7):e69357

[20] Al-Amin A, Filho W, Maria De la Trinxeria J, Hamid Jaafar A, Abdul Ghani Z. Assessing the impacts of climate change in the Malaysian agriculture sector and its influences in investment decision. Middle-East Journal of Scientific Research. 2011;**7**(2):225-234

[21] Ahmed A, Masud MM, Al-Amin AQ, Yahaya SRB, Rahman M, Akhtar R. Exploring factors influencing farmers' willingness to pay (WTP) for a planned adaptation programme to address climatic issues in agricultural sectors. Environmental Science and Pollution Research. 2015;**22**(12):9494-9504. DOI: 10.1007/s11356-015-4110-x

[22] FELCRA. Maklumat Asas Projek Felcra Berhad Sehingga Disember 2011. 2015. Available from: http://www.felcra.com.my/ms/pejabat-wilayah [Accessed: 6 January 2015]

[23] Ghani MNA. Maklumat Keluasan Sawit dan Getah Felda. 2015

[24] Azapagic A. Life cycle assessment and its application to process selection, design and optimisation. Chemical Engineering Journal. 1999;**73**(1):1-21. DOI: 10.1016/S1385-8947(99)00042-X

[25] Yusoff S. Feasibility of life cycle management for improving environmental management-case study on Malaysian palm oil industry [Doctor of Philosophy]. University Malaya; 2006

[26] ISO 14040. Environmental management-life cycle assessment-principles and framework: ISO. 2006

[27] ISO 14044. Environmental management-life cycle assessment-requirements and guidelines: ISO. 2006

[28] Svoboda S. Note on Life Cycle Analysis [Internet]. 1995. Available from: http://www.umich.edu/~nppcpub/resources/compendia/CORPpdfs/CORPlca.pdf

[29] Narita N. LCA data in inventory analysis. In: Workshop on the Development of LCI for Crude Palm Oil; Shah Alam: SIRIM; 2005

[30] Ministry of Natural Resources and Environment Malaysia. Environmental Facts [Internet]. 2015. Available from: http://www.nre.gov.my/en-my/Environment/Pages/Environment-Fact.aspx [Accessed: 4 August 2015]