# A Critical Analysis in to the Sustainable Development of Natural Rubber Production Industry

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## 1. Introduction

In many developing countries natural rubber (NR) production industry plays a critical role in their economies, and has been one of the major foreign exchange earners especially for the south east and south Asian counties. Unfortunately, NR industry faces various problem due to the lack of sustainability oriented practices in the foregoing countries, and Sri Lanka is no exception. Even though Sri Lanka has been one of the leading NR manufacturing countries which supplies top quality grade of natural rubber, the future development of its NR industry has become a great challenge as it has begun to suffer from rising costs for materials, labour and other inputs, and rubber price dips. To make the situation worse, NR industry contributes to dozens of environmental issues due to its material and energy intensive nature. Water pollution due to acidic waste water, odour of rubber and chemicals, toxicity owing to heavy chemical usage, and energy related greenhouse gas emissions are some of them. For this reason, NR processing industry has been recognized as one of the major polluting industries in Sri Lanka, and its tentacles of pollution have already destroyed the living conditions of the people who live nearby in many occasions.

To address the foregoing issues, a number of studies have been carried out and several promising steps have been taken by some responsible authorities. Several studies on effluent treatment strategies, especially related to anaerobic waste water treatment has been published to discuss on possible technical improvements and its applicability. Meanwhile, Dayaratne & Gunawardana (2015) emphasize the importance of carbon footprint mitigation and giving cost effective improvements to build up a cleaner and sustainable manufacturing model in the Sri Lankan rubber industry. Similarly, international study like Jawjit, Kroeze & Rattanapan (2010) stress the importance of producing environmentally friendly NR products to face the ongoing climate change, and to be competitive in the fast developing eco- centred market. Moreover, Rubber Research Institute in Sri Lanka (RRISL) is committed to give guidance on managing environmental issues associated with waste water discharge, and to offer latest technology to the factories in order to develop their processing practices to gain more productivity.

However, to us, the aforementioned studies lack the comprehensiveness to critically address the sustainable development in this industry. For instance, they assess the sustainability of the industry either through an environmental or economic perspective. They have been unable to address what kind of economic gains that this industry can get through carbon footprint mitigation and production of environmentally friendly goods and how it affects the betterment of the industry. As a consequence, the future development of NR manufacturing industry still stays threatened. Therefore, to assure the industry`s growth, we strongly believe that looking into NR manufacturing industry thorough economic, environmental and social perspectives is extremely vital, and thus we plan this research work. Furthermore, we strongly believe that our methodology and research findings are to be directly benefitted not only by the NR industry itself but also by all industries in developing countries.

***Research steps***: During our research period we would travel on the following hierarchy;

1. Estimation of currently occurring production related losses, waste generation, and environmental burden within NR industry
2. Suggest possible or most practical approaches to reduce on-going losses to optimize the resource consumption, and pollution mitigation
3. Validation of the potentiality of the given improvements, and futuristic decision making

## 2. Method

*Step No 1: Scope Definition*: We aimed to investigate Crepe rubber, centrifuge latex and RSS (major NR products in Sri Lanka) industries in a gate-to – gate framework.

*Data accumulation*: Data collecting has already been completed via long term field visits to 4 crepe rubber mills, 3 concentrated latex mills, and 3 RSS mills.

*Tools*: we employ following tools to reach our goals; **Material Flow analysis (MFA):** To quantify and visualize all the in-flows and outflows within the production system. **Material Flow Cost Accounting (MFCA):** To Estimate underlying economic loss in terms of overall manufacturing cost that is being put into system. **Life Cycle Assessment (LCA):** To analyse the overall environmental burden associated with the forgoing production life cycles in the subjected mills.

*Step No 2:* In accordance with Goal 1 outcomes, we propose most practical and viable improvement strategies to curb material (water, rubber, etc.) and energy losses (electricity, etc.) along with the environmental impacts (GHG emissions, etc.), by using the expertise of the professionals in various fields, and literature.

*Step No 3:* In this stage, we quantitatively assess, to how much extent the given improvements are effective, through re-execution of MFA, MFCA and LCA calculations. According to the outcomes, we critically discuss on, how previously proposed improvement strategies cause the sustainable growth of the industry, and whether they are futuristic.

In this abstract, we present our current progress up to the execution of MFCA calculations where our last year`s abstract presented at Doboku conference 2012 was solely based on the outcomes of MFA related to a Crepe rubber mill (Dunuwila, Goto & Rodrigo, 2015).

## 3. Results and Discussions

With reference to step 1, Material flow diagrams for Crepe rubber (4 mills), Centrifuge latex (3 mills), and RSS (3 mills) manufacturing processes could be completed, and according to that, MFCA models for Crepe Rubber (2 mills), Centrifuge latex (3 mills), and RSS (3 mills) production cycles, could be constructed. However, the calculations were based upon 1 ton of dry rubber input for comparison. Here, we present MFA results related to Crepe rubber production (*see Table 1*). All quantities are represented by mean value ± standard error.

**Table 1**. MFA results of Crepe rubber production

| Input / Output | Quantity: kg |
|---|---|
| **Input** | |
| Field Latex | 3176 ± 196 |
| Chemicals | 10.2 ± 0.4 |
| Packaging Materials | 2.1 ± 0.4 |
| Water | 55191 ± 8107 |
| Firewood (Rubber wood) | 511 ± 105 |
| **Output** | |
| Intended Product (Crepe Rubber) | 962 ± 2 |
| Unintended Product (Loss) | 40 ± 2 |
| Waste Water | 57042 ± 7872 |
| Emissions (firewood burning) | 768±71 |

*Crepe Rubber Production:* Up to date data processing outcomes highlighted that the total material cost (MC) was 202955±112253 LKR. Total Material loss during the production was 12064±3990 LKR. Total system costs (SC) and energy costs (EC) were 16012±4474 LKR and 7942± 775 LKR whereas the corresponding losses were found to be 589±223 LKR and 499±67 LKR respectively. However, the waste management costs were solely allocated to the material loss category in MFCA, and was 2693±141 LKR. Losses were occurred due to the operational materials (Chemicals and water), and defected dry rubber portions (contaminated, cuttings etc.).Therefore, the efficient use of operating materials, strictly adopting correct practices, and adequately controlled conditions are extremely important to address these losses.

*Concentrated Latex Production*: Total material cost for the production was calculated to be 251647±2044 LKR as the total material loss cost accounted for 11261± 2650 LKR. Total SC and EC were 4658±840 LKR and 2734±884 LKR. Correspondingly, SC loss was 216±62 LKR whereas energy loss cost was estimated to be 79±20 LKR. Furthermore, effluent treatment cost was found to be 575±237 LKR. Losses were mainly occurred owing to the operational materials (Chemicals and water), and field latex which was wasted due to inefficient separation and coagulation or as tank and bowl washings. To reduce these losses, efficient consumption of operating materials, proposing a CT criterion (Cleaner Technology (CT) standard which is approved by the industrial sector committee of Thailand to regulate the loss of rubber content in concentrated latex production), and establishment of rubber recoverable facilities are very important.

*RSS Production:* Total MC, SC, and EC were found to be 2440 ± 577 LKR, 297 ± 207 LKR, and 0 ± 0 LKR respectively. However, only a material loss cost was visible running out of the system, and could be given as 26.3 ± 7.9 LKR. There were no significant system and energy losses were shown. As a result, total economic loss became very less compared to other two production lines, which was way smaller than we expected. In our view, this phenomena occurs due to the less energy and labour intensive nature of RSS production, as it was mainly carried out by smallholders.

## 4. Conclusions

We could evaluate the economic losses for Crepe rubber, Centrifuge latex, and RSS production lines under the current system. However, we further witnessed that a number of initiatives were required to reduce loss and gain more productivity in the foregoing production scenarios.

As the next step, we hope to complete the following actions in an immediate manner.

- Conduct LCA calculations: we think RSS production would be the least polluting, while the concentrated latex production stays highest polluting due to its energy and material intensive nature.
- Execution of Step 2: we try to find the viabilities of the reduction measures that we already proposed and fresh initiatives if available by gaining access to the expertise of various fields (Rubber plantation sector, electricity, etc.), and literature.

## 5. References

Dayaratne, S.P & Gunawardana, K.D. (2015). Carbon footprint reduction: a critical study of rubber production in small and medium scale enterprises in Sri Lanka. Journal of Cleaner Production, 103(3), 87-103.

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