# A Comprehensive MFA, LCA, and MFCA study of Natural Rubber Production Industry in Sri Lanka

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## 1. Introduction

Rubber industry can be recognized as one of the main foreign exchange earners for Sri Lanka which occupies an important place in Sri Lankan economy [2]. Moreover, Rubber stands for second most important plantation crop after the tea while providing various employment opportunities to a large population who are especially from rural areas in Sri Lanka. The four major types of primary rubber products produced in Sri Lanka can be stated as Ribbed smoked sheets (RSS), centrifuge latex, TSR and Crepe rubber. Despite the various benefits that are generated due to the Natural rubber production, it also causes various environmental impacts, material losses, and energy losses at the same time. Hence, this study is primarily focused on evaluating material losses and energy losses occurred during the production process of aforementioned four natural rubber products( RSS, centrifuge latex, TSR and crepe rubber) respectively, thereby recognizing the hotspots of the system utilizing tools such as MFA and MFCA. Secondarily, overall environmental impact would be calculated using a tool such as LCA.

## 2. Methodology

### *2.1 Material flow analysis (MFA)*

According to Brunner and Rechberger MFA is a systematic assessment of the flows and stocks of material within a system defined in a space and time [1].

1st Objective:

A comprehensive MFA analysis on natural rubber production process may allow relevant individuals to recognize unnecessary flows and to design environmentally-beneficial goods, processes, and systems.

### *2.2 Material flow cost analysis (MFCA)*

MFCA can be introduced as a tool of having both environmental management accounting and cost reduction abilities, which surpasses traditional management accounting.

2nd Objective:

By applying this methodology to natural rubber processing will uncover various losses incurred within the rubber manufacturing facility while revealing the certain costs related to those losses. So that, it would help relevant authorities to recognize the hot spots as well as to get ideal steps toward cost improvement of its overall manufacturing system for natural rubber.

### *2.3 Life cycle assessment (LCA)*

LCA can be called as a tool which analyzes the overall environmental burden of products at all stages in their life-cycle from the extraction of resources up to the final disposal or recycle phase.

3rd Objective:

By conducting an LCA analysis on natural rubber manufacturing process may direct factory owners to optimize their manufacturing process in an eco-friendly manner by mitigating potential environmental impacts that are to be mentioned in this study.

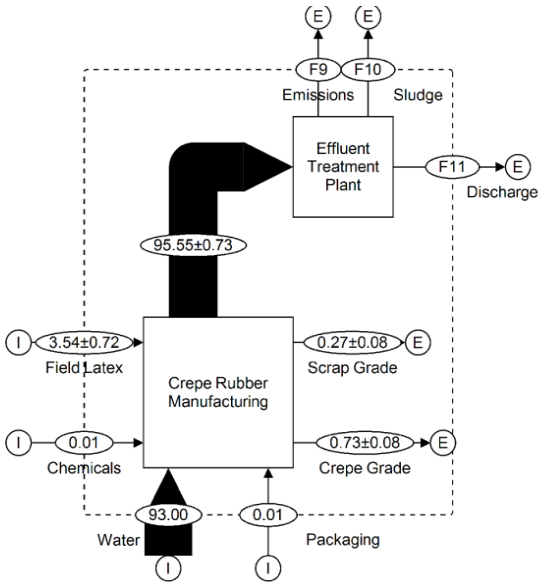


**Fig.1** MFA model for crepe rubber manufacturing
(Functional unit: kg per 1kg of dry rubber)

## 4. Results and Discussions

Subsequently to a one month field visit to a Sri Lankan crepe rubber factory in September 2014, following Material flow could be delineated despite some data deficiencies. Please note that this is not a 100% complete version of a material flow diagram, since it lacks data corresponding to some unit processes. During the field visit, the data accumulation procedure was decelerated by the fact that there is no any written data available regarding the manufacturing process, where the on-site measurements had to be taken instead. Eventually, the data related to 4 samples could be obtained within a timeline of 2 weeks. With regard to Fig.1, it is visible that there is a huge waste-flow of materials running in to the effluent treatment plant, data of which is unavailable. The greater part of the waste flow is represented by the waste water containing rubber serum. In this factory, approximately **93 liters** of water is being used merely to pack 1 kg of dry rubber. The same value was reported as **40~50 liters** within the book called “HANDBOOK OF RUBBER” published by Rubber Research institute of Sri Lanka[3].

In terms of the energy usage, the factory mainly depends on the electricity energy, where it consumes roughly 0.967MJ to produce 1 kg of dry rubber within the manufacturing facility itself. As this factory is consisted of obsolete machinery, electricity losses are reportedly being occurred mainly due to the low power factors of 3 –phase motors fitted to the machinery.

## 5. Conclusions

Given the foregoing discussions, it can roughly be concluded that massive material losses and energy losses are being occurred within the foregoing manufacturing facility. It also shows a higher water footprint which is not recognized by the responsible officials at the factory.

## 6. Future Plan and Tendencies

Since the data plays a huge role in this particular study, the efforts to extract more data are to be performed relying on long-term field visits. Therefore, 2 month field visit has already been planned to fill remaining data gaps, as well as to gain rest of the data. In this context, at least 3 factories producing crepe rubber, TSR, centrifuge latex and RSS are to be investigated whilst extracting pertinent data, subsequently followed by sketching corresponding MFA models. Afterwards, the sensitivities and uncertainties within the respective model would be tested and verified. Eventually, the MFA models are to be created utilizing the software packages of Gabi and STAN 2.5.

## 7. References

[1] Brunner, PH and Rechberger, H 2004, Practical handbook of MATERIAL FLOW ANALYSIS, Lewis, Florida.

[2] Pieris,S n.d., “Experiences of cleaner production implementation on rubber industry and potential for future in Sri Lanka”, cleaner production professionals association of Sri Lanka.

[3] Rubber Research Institute of Sri Lanka (2003) HANDBOOK OF RUBBER Processing Technology, Volume 2 edn., Moratuwa: United Printers