SUMMARY REPORT
FOR
LIFE CYCLE ASSESSMENT OF WOVENSACKS

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Executive Summary

1.0 Introduction

The life cycle assessment study presented below illustrates the impacts of PP-HDPE woven sacks during its life cycle and compares the same with those of its alternatives. This study has been commissioned by the Indian Centre for Plastics in the Environment (ICPE). The study has been conducted following the ISO 14040 standards guidelines for Life Cycle Assessment.

2.0 Goal of the study:

The overall goal of the Life Cycle Assessment (LCA) study is to evaluate the impacts of PP-HDPE woven sacks during its life cycle vis-à-vis the competing materials, jute and paper.

3.0 Target Audience

The target audience is the policy makers who are involved in issuing policies related to plastic use and management.

4.0 Scope of the study:

The applications considered for the purpose of the study, the alternative materials considered, the functional unit and the processes/stages excluded from the scope of the study are discussed in the following sections

4.1 Applications considered:

The following applications have been studied:

- Packaging of Cement
- Packaging of Fertilizer
- Packaging of Foodgrains

4.2 Alternatives

The alternative materials considered for comparison with PP-HDPE woven sacks include

- Jute
- Paper

4.3 Life cycle stages

The life cycle stages considered for the study include

- Raw material production
- Sack manufacture
- Sack transportation
- Sack use.
- Used sack management (Reuse/Recycle and Disposal)

Deleted: production

The modes of disposal studied include incineration and landfill.

4.4 Functional unit of the study

"The production, use and disposal of 50kg woven sacks required for packing 1,00,000 Metric ton of material".

4.5 Exclusions

The stages/ processes/data excluded in the study are:

- Infrastructural requirement
- Production of the material to be packed
- Processes related to printing of information on the sacks
- Manufacturing of chemicals not forming a part of the final product.
- Transportation of materials by modes other than road.
- Material inputs less than 1% of the total input.
- Economic and socioeconomic parameters.

5.0 Life Cycle Impact assessment

The Life Cycle Impact Assessment (LCIA) phase involves the evaluation of potential human health and environmental impacts due to the environmental releases and depletion of resources. LCIA involves the use of science based conversion factors for calculating the impacts that each environmental release has on issues such as smog or global warming. There are various methodologies available for carrying out an LCIA The criteria for the selection of the impact assessment methodology and a brief discussion on the selected methodology is presented below in the following section.

5.1 Selection of the assessment method:

Keeping in view the nature of the study, the following parameters have been decided upon for selection of the impact assessment method:

1. Completeness with respect to impact categories
2. Modeling techniques used
3. Worldwide acceptance
4. Time perspective

Keeping in line with the ISO 14040 standards guidelines, emphasis has been given on methodologies that consider higher number of impact categories. Since the study is related to comparison of the products for public assertion, assessment methods using state of the art scientific models have been preferred over methods using simpler techniques. Worldwide acceptance and time perspectives have been given a comparatively lower emphasis. Also, an impact assessment method with a balanced time perspective has been preferred for the purpose of the study.

The impact assessment methods were weighted using the above criteria and the results of the same are presented below:

Table 1.1: Decision criteria for selection of LCIA method

Impact Assessment Method	Completeness	Modeling	Acceptance	Time Perspective
Eco Indicator 99 (E)	H	H	L	L
Eco Indicator 99 (H)	H	H	L	M
Eco Indicator 99 (I)	H	H	L	L
EPS	H	H	L	L
CML 2000	N	M	L	L
EDIP	M	H	M	L

(Suitability criteria: H: High, M: Medium, L: Low, N: Not suitable)

It is observed from **Table 1.1** that the Ecoindicator 99 methodology with a heirarchist time perspective, based on the defined criteria, stands out to be the better option.

5.2 Eco indicator 99

The damage categories across which the impacts can be evaluated using Eco Indicator 99 methodology are:

Human health:

The damage category, Human health, indicates the adverse impact on human health due to the release of pollutants into the environment.. The impact categories included within this damage category are:

- Carcinogens
- Respirable organics
- Respirable inorganics
- Climate change
- Radiation
- Ozone layer

Ecosystem quality

Ecosystem quality indicates the adverse impact on ecosystem quality due to the release of pollutants into the environment . The impact categories included within Ecosystem quality are:

- Ecotoxicity
- Acidification / Eutrophication
- Land use

Resources:

Resources indicate the adverse impact of consumption of material during the life cycle of the product that lead to depletion of resources. The impact categories included within Resources are:

- Minerals
- Fossil fuels

5.3 Life cycle impact assessment results

The life cycle impact assessment results for woven sacks are presented in the **Tables 1.2 and Table 1.3.**. **Table 1.2** presents the scores in terms of absolute scores while **Table 1.3** presents the scores for the alternatives relative to PP-HDPE. **Figure 1.1** presents the impact category score while **Figure 1.2** presents the damage category score. Lower the score, superior is the environmental performance of the product.

Keeping in line with the ISO 14040 standards guidelines, weighting sets have not been used and no single scores have been provided.

Table 1.2: Life Cycle Analysis scores for woven sacks (Points)

Damage category	PP-HDPE	Jute	Paper
Human Health	7.57	106.35	37.73
Ecosystem Quality	4.19	58.28	1.86
Resources	63.47	107.85	84.92

Table 1.3: Life Cycle Analysis scores for woven sacks (%)

Damage category	PP-HDPE	Jute	Paper
Human Health	1	14	4.98
Ecosystem Quality	1	11.47	0.44
Resources	1	1.7	1.33

Figure 1.1: Life Cycle Analysis scores for Woven sacks (Impact category)

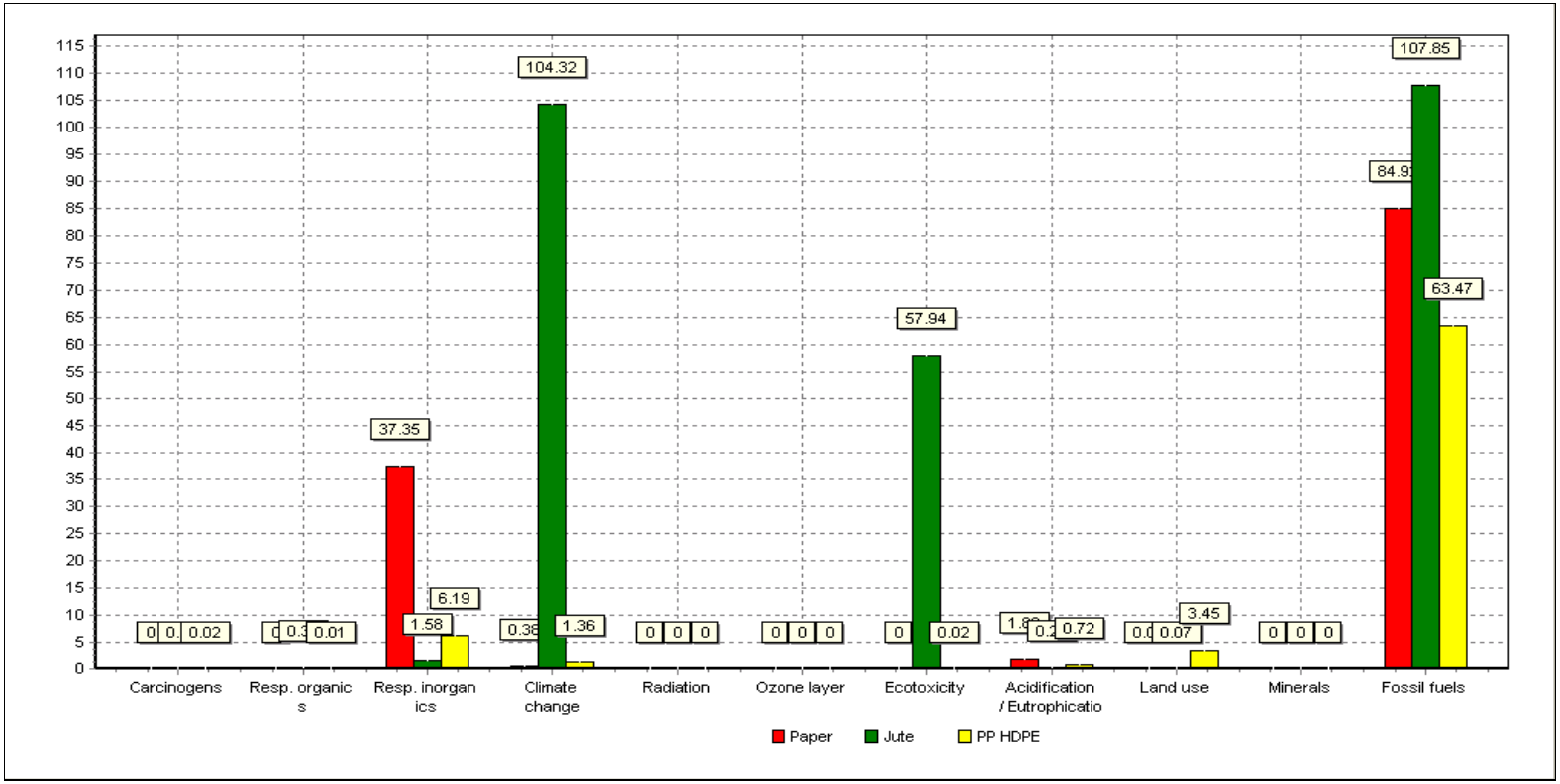
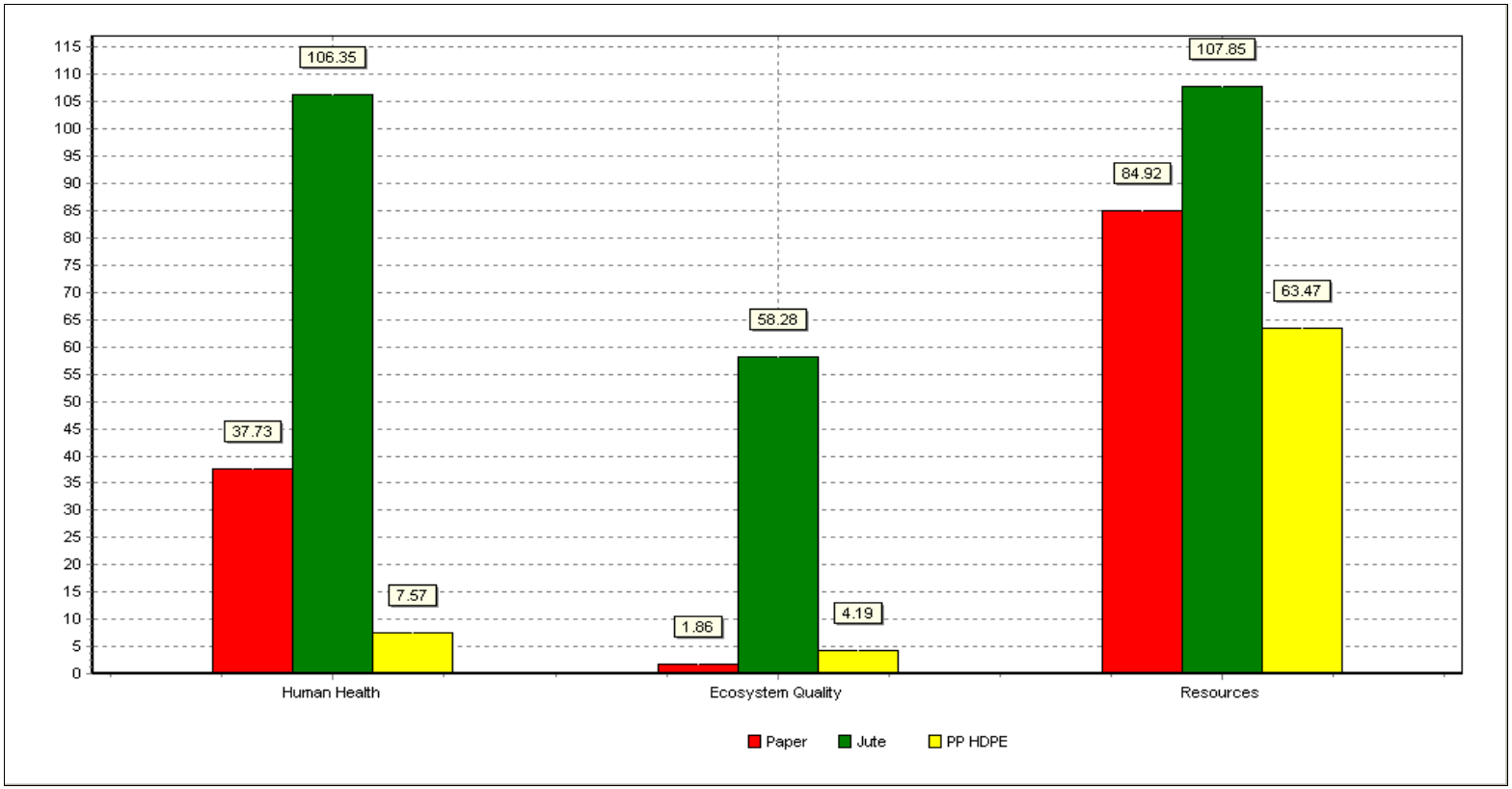


Figure 1.2: Life Cycle Analysis scores for woven sacks (Damage category)



6.0 Life Cycle Interpretation

Jute sacks:

Jute sacks, during their life cycle have an impact on the categories of Respirable organics, Climate Change, Fossil Fuels and Ecotoxicity. The impact on Land use and Acidification/Eutrophication is relatively minor.

As compared to PP-HDPE woven sacks, jute sacks have a higher score across all the three damage categories.

The parameters having a major impact on the final scores for jute are the release of methane during the cultivation process, metallic emissions, use of jute batching oil and energy consumption during the use and transportation stages. Non-recyclability is another factor that contributes to higher scores for the jute sacks.

Paper sacks:

Paper sacks during their life cycle have an impact on the categories of Respirable organics, Respirable inorganics, Climate change, Fossil fuels and Land use. The impact on the categories of Respirable organics and Fossil fuels is relatively high.

As compared to PP-HDPE woven sacks, paper sacks have a higher score for Resources and Human health but a lower score for Ecosystem quality.

Some of the key parameters which have a high influence on the final results for paper include energy consumption, particulates, NOx and SOx emissions. The use of elemental chlorine for bleaching is still prevalent in many of the Indian pulp and paper industry. Dioxin, a carcinogenic material, is released during the manufacturing process and is awarded a high negative factor in the impact assessment methodology. None of the large scale paper mills in India monitor the release of dioxins and furans and no data with regards to the release of dioxin for the Indian paper mills is available. Hence the effect of the same has not been included in the above assessment.

During the evaluation of the recycling process for paper, an increase in the scores for human health and ecosystem quality has been observed. The use of the best case scenario for the manufacturing stage has resulted in a lower score for the manufacturing stage as compared to the recycling stage.

PP-HDPE Woven sacks

PP-HDPE sacks during its life cycle have an impact on the categories, Carcinogens, Respirable organics, Respirable inorganics, Climate change, Fossil fuel and Land use. The impact on Fossil fuels, Respirable inorganics and Land use is relatively higher.

The major contributors to the scores of PP-HDPE sacks are the consumption of crude oil during the manufacturing process, air emissions during the manufacturing process and land use. Land use as an important parameter arises in case majority of the waste ends up being landfilled.

As compared to the damage categories, human health and resources, PP-HDPE sacks have a relatively higher impact on resources However, the impact on resources category is primarily due to the use of oil (about 90%) as a raw material in the manufacturing process rather than the use of energy during the entire life cycle of PP HDPE. The actual energy consumption during the life cycle of the PP-HDPE, as compared with the alternatives, is lower. PP-HDPE

thus has an advantage over jute and paper because the use of lighter materials will result in high energy savings.

Another advantage of PP-HDPE woven sacks are its recyclability. Higher is the percentage of materials recycled, lower is the impacts across all the three damage categories. But with the increase in the distance across which the sacks need to be transported, the energy consumption would increase. Hence proximity of the recycling plants to the places from where plastics are procured is also of paramount importance.

7.0 Limitations:

The study is intended to be a comparative study for PP – HDPE sacks versus the alternatives studied. Hence, a completeness check has been done for the PP – HDPE sacks The scores are to be considered in a relative sense and are meant to indicate higher or lower impact.