

March 2009

**»The Sustainability of Packaging  
Systems for Fruit and  
Vegetable Transport in Europe  
based on Life-Cycle-Analysis«**

**Critical Review according to ISO 14040–44**

**Prepared for:**

**SIM Stiftung Initiative Mehrweg**

**Clemens Stroetmann**

**Prepared by:**

**DEKRA Umwelt GmbH**

**Sustainability Management**

## EXECUTIVE SUMMARY

In 2006–2007, *SIM – Stiftung Initiative Mehrweg* – had commissioned a previous LCA study on packaging systems for fruit and vegetable transport. This study had been critically reviewed. Due to recent changes in fruit and vegetable transport systems, the study was updated and needed to undergo a critical review again. The critical review resulted in the following conclusions:

- The study is a direct update of the previous report in terms of goal and scope, models and data. As such, the critical review report of the previous study is still applicable to a large extent. In particular, the study raises no concerns from a formal and methodological point of view. This critical review therefore focused upon the technical merits, as follows –
- Updated life cycle data include, in particular, production of cardboard boxes, production of wooden boxes, and service life of plastic crates.
- Aside from the above updates, the practitioners addressed the recommendations of the previous critical review.
- The study was conducted in accordance with ISO 14040 and 14044.
- The purpose and intended use of the study as well as the life cycle model and the data categories are transparently documented. The data, models and methods employed are appropriate, given the goal and scope of the study. The modelling, calculations and aggregation into indicator results were supported by a professional life cycle assessment software (GaBi 4, [www.gabi-software.com](http://www.gabi-software.com)).
- The unit process data were derived from surveys in industry and expert organisations or from the GaBi life cycle assessment database. Data quality was demonstrated in terms of consistency, geographic and temporal scope.
- Some assumptions remain contentious between experts. These issues are noted and commented upon below. Since they are transparently documented, this circumstance was not deemed to affect the overall outcome of the critical review.
- While the study was conducted in such a way as to also support a comparative assertion of the examined packaging systems, this critical review does not imply an endorsement of any such comparative assertion based on this LCA study.

## CRITICAL REVIEW REPORT

### Introduction

Where Life Cycle Assessment (LCA) studies are conducted to derive a comparative assertion to be disclosed to the public, this affects the interests of competitors and other interested parties. In such cases, the ISO 14040–44 standards require that a critical review be conducted by a panel of independent external experts able to represent these interests.

In 2006–2007, *SIM – Stiftung Initiative Mehrweg* – had commissioned a previous LCA study on packaging systems for fruit and vegetable transport. This study had been critically reviewed. Due to recent changes in fruit and vegetable transport systems, the study was updated and needed to undergo a critical review again.

The **objectives** of this critical review were –

- Ascertain whether the LCA meets the ISO 14040–44 standards in terms of formal procedures and methods, and specifically, whether the LCA report is written in accordance with the formal requirements of the standard for a comparative assertion to be disclosed to the public. Hints on improvement options may be given to the LCA practitioner.
- Conduct a peer review of the subject matter and data used, providing an appraisal of data sources, life cycle models, assumptions, and calculations in terms of transparency and appropriateness. Specific questions or improvement options may be given to the LCA practitioner and/or the data collection group.

The overarching aim of any critical review is to contribute to quality assurance of LCA studies, and to protect interested parties on the marketplace from unsubstantiated claims.

The critical review consisted of an analysis of the report with regard to methodological and technical aspects. The review panel held phone conferences and a face-to-face meeting with the practitioners in order to conduct a database audit, spot checks on models and calculations, and a discussion of open questions.

The review panel consisted of:

- Chairman, expertise on plastics: Dr.-Ing. Ivo Mersiowsky — DEKRA Umwelt GmbH, Division Sustainability Management.
- Expertise on wood: Dipl.-Ing.(FH) Stefan Diederichs — University of Hamburg, Department of Wood Science.
- Expertise on pulp, paper & cardboard: Tiina Pajula, MSc — KCL Science and Consulting, Espoo, Finland.
- Project management: Dipl.-Geogr. Christina Bocher — DEKRA Umwelt GmbH, Division Sustainability Management.

### Goal & Scope

Chapter 2 of the study sets out the goal and scope in an unambiguous way. The functional unit is the distribution of 1,000 tons of fruit/vegetables in one-way wooden boxes, one-way cardboard boxes or in multi-way plastic crates. Different lifespans of the plastic crates were considered as scenarios. The system boundaries comprise the whole life cycle from raw material extraction, production, distribution and utilisation to end-of-life management (recycling, disposal).

## Intended Use

The review panel appreciates that the primary goal and intended use of the study is the identification of optimisation potentials of the three different packaging systems. A secondary goal is the comparison between the systems. Therefore the discussion of the results as well as the conclusions had to address this dual purpose: while the emphasis remained on pointing out optimisation potentials for each material, the comparative assertion based on life cycle indicators needed to be appropriately reflected as well. The practitioner implemented the respective comments of the review panel.

## Economic and Social Aspects

The review panel noted that the study addresses economic and social aspects as well: it was emphasised that only the environmental aspects as examined with the Life Cycle Assessment methodology were subject to the critical review according to ISO 14040 and 14044.

## Life Cycle Inventory

---

System expansion was used to address the treatment of by-products and recycling products. Where allocation could not be avoided, the allocation procedures were explained. In the light of the goal and scope definition, the overall data quality was judged to be appropriate. Assumptions, estimates, and cut-offs were transparently recorded.

## Cardboard

Compared to the previous study, the production data of cardboard boxes has been updated using data by industry association *FEFCO*. As suggested by the review panel, the practitioners appended a section (Supplement G) summarising the changes due to updated process information for cardboard, but also for wood and plastics. In case of cardboard, the higher shares of semichemical fluting and kraftliner led to higher environmental impacts for the production of cardboard boxes.

Concerning the end-of-life modelling of cardboard boxes, the review panel brought the approach set out in Technical Report ISO/TR 14049 to the practitioners' attention. This approach would treat secondary products from recycled cardboard in a different way. The practitioners addressed the implications of this approach and provided a rationale for retaining the previous recycling model.

## Wood

The wooden box production data has been updated using data by industry association *GROW*. The higher share of poplar resulted in slightly lower environmental impacts for the wooden box production.

The review panel scrutinised the approach of system expansion for residues arising from the peeling of poplar. The practitioner conducted a sensitivity analysis regarding this assumption: implementing a mass allocation (as recommended by the review panel) did not have a noticeable effect on results. Nevertheless, the treatment of residues seemed somehow unclear, therefore the review panel recommended to add a passage explaining the rationale behind the system expansion.

## Plastics

The review panel noted that life cycle inventory (LCI) data for plastics were derived from studies of the German Environmental Agency (*UBA*) rather than from industry federation *PlasticsEurope*: while the *UBA* datasets for polyethylene (PE) and polypropylene (PP) are

from 2000 and refer to even older primary data, a sensitivity analysis showed there is an overall comparability with more recent *PlasticsEurope* datasets. The results are rather conservative and do not introduce a bias in favour of plastics. On the contrary, the review panel recommends that the practitioner check trace emissions relevant for ozone depletion (ODP): to a certain extent these originate in the upstream of plastics (oil drilling, refinery, cracker) and may have been reduced in the meantime.

Updates compared with the previous study concerned service life data for plastic crates and, in particular, higher breakage rates: these, combined with the washing of crates, resulted in higher environmental impacts for the plastic crates.

## Logistics

The same logistics model (transport matrix, European weighted average) as in the previous study was used again. It was found to be conclusively explained, appropriate and representative for the study. The need for investigating distance-related optimisation potentials – identified in the previous study – was not included in the goal and scope of this study.

## Life Cycle Impact Assessment

---

### Selection of Life Cycle Impact Indicators

The review panel acknowledged the choice of life cycle impact indicators, in particular the omission of toxicity indicators. In view of scientific debates around the development of appropriate toxicity indicators and the expected relevance for the investigated packaging systems, the rationale for not addressing these impact categories has been made more transparent.

### Primary Energy and Global Warming Potential

The review panel and the practitioners discussed the presentation of results concerning primary energy demand: it was emphasised that primary energy as a technical input indicator is a total of gross energy requirements, irrespective of source. Hence it includes renewable energy resources. By contrast, renewable energy resources will not be counted in the ecological impact assessment of resource depletion.

Similarly, the review panel recommended adding a new section in the report on how carbon dioxide (CO<sub>2</sub>) intake is treated in the LCA study: accordingly, the practitioner implemented a new section on how CO<sub>2</sub> is embodied in wood and paper (net reduction of atmospheric CO<sub>2</sub> during growth) and how emissions of such biogenic CO<sub>2</sub> upon combustion are counted against this negative offset to close the balance.

## Interpretation

---

The review panel suggested a more detailed discussion of best-case vs. worst-case scenarios of the different materials based on combinations of the parameter variations. The practitioner conducted this assessment and came to the conclusion that this does not affect the results in a substantial way: for instance, an increase of the material recycling rate of cardboard boxes would diminish the share of energy recovery, i.e. withhold credits otherwise awarded for steam. Similar scenarios for wood boxes and for plastic crates indicate that the conceivable results are appropriately represented by the existing base case and parameter variations. In other words, recombining the parameters into different scenarios (as far as viable) is not expected to render a qualitatively different outcome.


## Conclusions


---


The following conclusions are drawn:

- The study is a direct update of the previous report in terms of goal and scope, models and data. As such, the critical review report of the previous study is still applicable to a large extent. In particular, the study raises no concerns from a formal and methodological point of view. This critical review therefore focused upon the technical merits, as follows –
- Updated life cycle data include, in particular, production of cardboard boxes, production of wooden boxes, and service life of plastic crates.
- Aside from the above updates, the practitioners addressed the recommendations of the previous critical review.
- The study was conducted in accordance with ISO 14040 and 14044.
- The purpose and intended use of the study as well as the life cycle model and the data categories are transparently documented. The data, models and methods employed are appropriate, given the goal and scope of the study. The modelling, calculations and aggregation into indicator results were supported by a professional life cycle assessment software (GaBi 4, [www.gabi-software.com](http://www.gabi-software.com)).
- The unit process data were derived from surveys in industry and expert organisations or from the GaBi life cycle assessment database. Data quality was demonstrated in terms of consistency, geographic and temporal scope.
- Some assumptions remain contentious between experts. These issues are noted and commented upon below. Since they are transparently documented, this circumstance was not deemed to affect the overall outcome of the critical review.
- While the study was conducted in such a way as to also support a comparative assertion of the examined packaging systems, this critical review does not imply an endorsement of any such comparative assertion based on this LCA study.

**Signatures of Review Panel**

Name	Dr. Ing. Ivo Mersiowsky
Role	Chairman, expertise on plastics
Institution	<i>DEKRA Umwelt GmbH, Division Sustainability Management</i>
Place & date of issue	<i>Stuttgart, 2 March 2009</i>
Signature	

Name	Dipl.-Ing.(FH) Stefan Diederichs
Role	Expertise on wood
Institution	<i>University of Hamburg, Department of Wood Science</i>
Place & date of issue	<i>Hamburg 2009-03-06</i>
Signature	

Name	Tiina Pajula, MSc
Role	Expertise on pulp, paper & cardboard
Institution	<i>KCL Science and Consulting, Espoo, Finland</i>
Place & date of issue	<i>ESPOO 9.3.2009</i>
Signature	

Name	Dipl.-Geogr. Christina Bocher
Role	Project management
Institution	<i>DEKRA Umwelt GmbH, Division Sustainability Management</i>
Place & date of issue	<i>Stuttgart, 2 March 2009</i>
Signature	