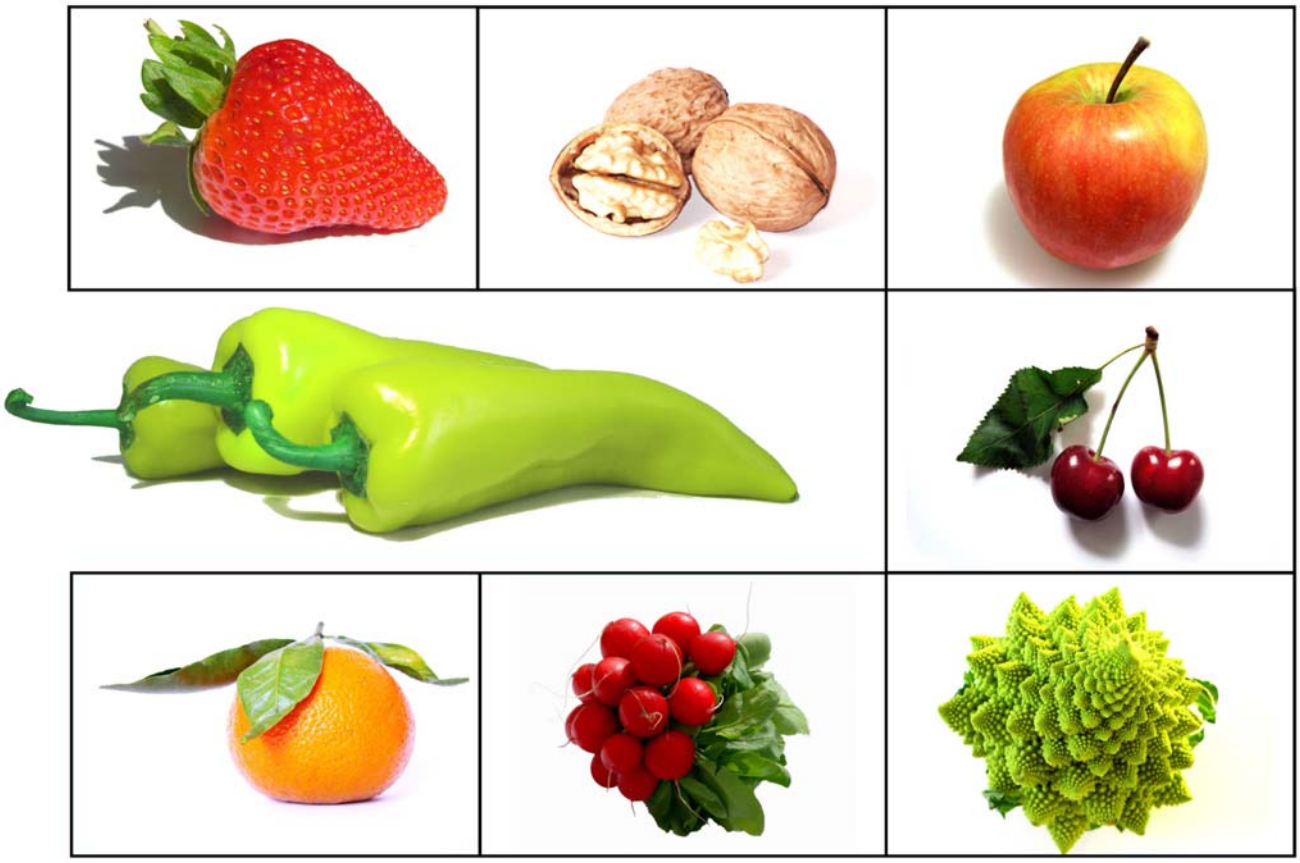


Executive Summary

The Sustainability of Packaging Systems for Fruit and Vegetable Transport in Europe based on Life-Cycle-Analysis – Update 2009

On behalf of
Stiftung Initiative Mehrweg

Fraunhofer IBP Institut Bauphysik

University of Stuttgart
Chair of Building Physics (LBP)
Life Cycle Engineering (GaBi)

PE INTERNATIONAL

Executive Summary of the Study: **The Sustainability of Packaging Systems for Fruit and Vegetable Transport in Europe based on Life-Cycle-Analysis – Update 2009**

Client: **Stiftung Initiative Mehrweg**

Geschäftsstelle

Ansprechpartner:
Staatssekretär a. D. Clemens Stroetmann
Geschäftsführer

Eichenweg 11
D-14552 Michendorf
Germany

Phone: +49 33205-24037
Fax: +49 33205-24038
E-mail: choch4@t-online.de

Date: **March 2009**

Authors

Department Life Cycle Engineering (GaBi)

Fraunhofer Institute for Building Physics (IBP)

and

Chair of Building Physics
University of Stuttgart

Dipl.-Ing. Stefan Albrecht
Dipl.-Geooecol. Tabea Beck
Dipl.-Ing. Leif Barthel
Dipl-Ing. Matthias Fischer

Hauptstraße 113
D – 70771 Leinfelden – Echterdingen

Telefon	+49 (0) 711 48 99 99 – 0
Fax	+49 (0) 711 48 99 99 – 11
E-mail	gabi@LBP.uni-stuttgart.de
Internet	www.lbpgabi.uni-stuttgart.de

In cooperation with

PE International

Dr. Sabine Deimling
Dr. Martin Baitz

Hauptstraße 111 – 113
D – 70771 Leinfelden – Echterdingen

Telefon	+49 (0) 711 34 18 17 – 0
Fax	+49 (0) 711 34 18 17 – 25
E-mail	info@pe-international.com
Internet	www.pe-international.com

Picture source:

From top left to bottom right
© Karin Miersch / PIXELIO
© S. Hainz / PIXELIO
© Knipselinse / PIXELIO
© A. Dreher / PIXELIO
© Christopher Kahnt / PIXELIO
© S. Hainz / PIXELIO
© Stephanie Hofschlaeger / PIXELIO
© Joujou / PIXELIO
© Johannes Kreißig
http://www.pixelio.de

Executive Summary

Introduction and background

It is difficult to imagine life in Europe today without fresh fruit and vegetables in our supermarkets and retail shops. Their year-round supply requires a complex logistical system. Plastic crates, cardboard boxes and wooden boxes are all used as transport packaging. While plastic crates are employed as returnable (or multi-way) packaging, wooden boxes and cardboard boxes are one-way solutions.

Task and goal of the study

In August 2008, the “Stiftung Initiative Mehrweg” (“Foundation for Reusable Systems”, a foundation under German Civil Law) ordered an update of the study “The Sustainability of Packaging Systems for Fruit and Vegetable Transport in Europe based on Life-Cycle-Analysis”, a Life Cycle Assessment (LCA) study to analyse and compare the common packaging systems for fruit and vegetables in Europe with respect to their environmental, economic and social impacts, using current data on the production and use of fruit and vegetable transport boxes. The study has primarily been authorized and conducted in 2006 and aims at comparing multi-way plastic crates, one-way cardboard boxes and one-way wooden boxes in terms of environmental impacts, costs and selected social aspects.

In order to evaluate the environmental-technical, economic and social potentials of the packaging options correctly, their specific characteristics over the whole life cycle (e.g. technical situation and boundary conditions, relevant environment effects, economic and social aspects) must be included. This study attaches great importance to reproducing a situation of fruit and vegetable transport that is representative for whole Europe and is not aimed at mapping any specific situations.

It is assumed that each of the analysed packaging systems has advantages and disadvantages, depending on the type of factors considered, the definition of the transportation task and the distribution distance.

The study provides a basis for the packaging industry, the logistical service providers and the industrial customers to reach a decision on the packaging option that offers the most environmental benefits and that best considers sustainability aspects according to the conditions in each case.

The study was carried out by the Department Life Cycle Engineering (GaBi) at the University of Stuttgart and PE International by order of the Stiftung Initiative Mehrweg (SIM).

The environmental impact assessment is a DIN EN ISO 14040ff comparative Life Cycle Assessment. The study has had its conformity with the DIN EN ISO 14040ff checked by external, independent experts. The conclusions of the Critical Review Panel were that the study was conducted in accordance with ISO 14040 and 14044.

Scope of the study

In the first instance, transportation of 1000 tons of fruits and vegetables is assumed, which are distributed either in plastic crates (multi-way-system) or in wooden boxes or cardboard boxes (both one-way-systems).

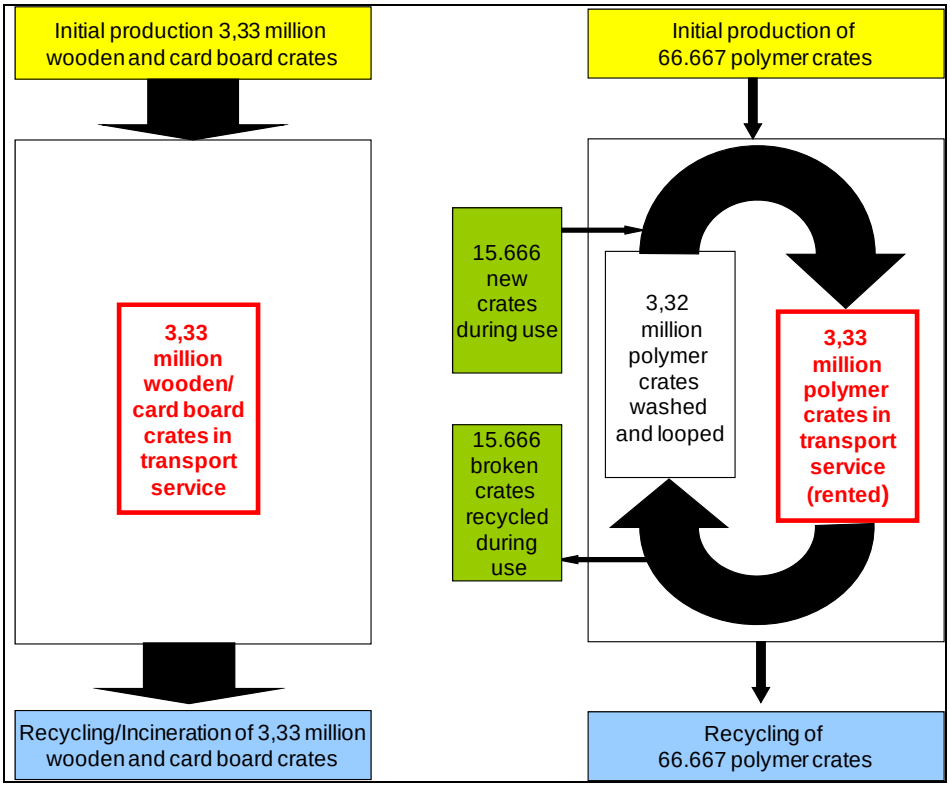
Packaging of the same size (600mm x 400mm x 240mm) and comparable capacity (15 kg fruits or vegetables per box) form the basis of the comparison. To transport this amount, 66.667 boxes in each of the analysed packaging types are necessary. As the plastic crates can be multi-used, their average lifetime and the number of fillings during the life-time have to be considered. For the plastic crates two scenarios are considered:

- A **conservative scenario**: A lifetime of 10 years and 50 fillings
- A **technical scenario**: A lifetime of 20 years and 100 fillings

Applying this to the non-returnable packaging systems, 3,333,350 (conservative scenario) and 6,666,700 (technical scenario) wooden or cardboard boxes are required to transport the same amount. The conservative scenario allows for 15,666 plastic crates to be replaced over the 10 year lifetime due to damage.

If the actual lifetime of the plastic crates is determined by the ratio of the number of crates irreparably damaged per year to the total number remaining, it may exceed the 20 year lifetime that has been assumed for the technical scenario.

Thus the conservative scenario includes substantial safety factors in reserve. The technical scenario satisfies the circumstances of typical fruit and vegetable traffic today.



Overview of the mass flows (number of boxes/crates) during the life-cycle of the systems (conservative scenario)

The study covers the whole life cycle of the three packaging systems in a Europe-wide dimension. It considers the five most significant fruit and vegetable producing-countries (Spain, Italy, France, The Netherlands and Germany) and four of the biggest consumer markets (France, The Netherlands, Great Britain and Germany).

The three systems are examined and compared with regard to:

Environmental Effects:

- The Primary Energy Demand
- The Global Warming Potential – “greenhouse effect“
- The Ozone Depletion Potential – “impact on the ozone layer”
- The Acidification Potential – contribution to “acid rain”
- The Eutrophication Potential – contribution to “over-fertilisation”
- The Photochemical Ozone Creation Potential – contribution to “summer smog”

Economic Indicators:

- The Life Cycle Costs

Social Indicators:

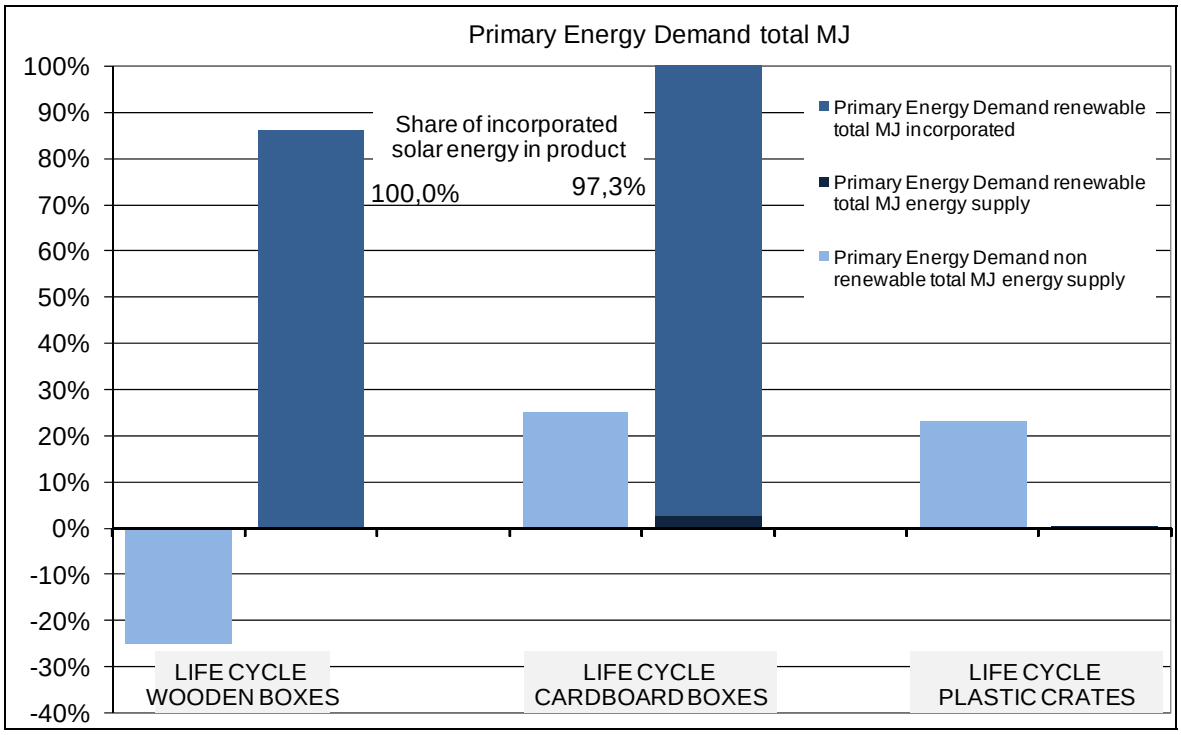
- The total time of work
- The total time of women work
- The differentiation of the working time into qualification levels
- The number of lethal and non-lethal accidents

Economic and social indicators were regarded for assessing the sustainability.

Selected results

The Environmental Effects

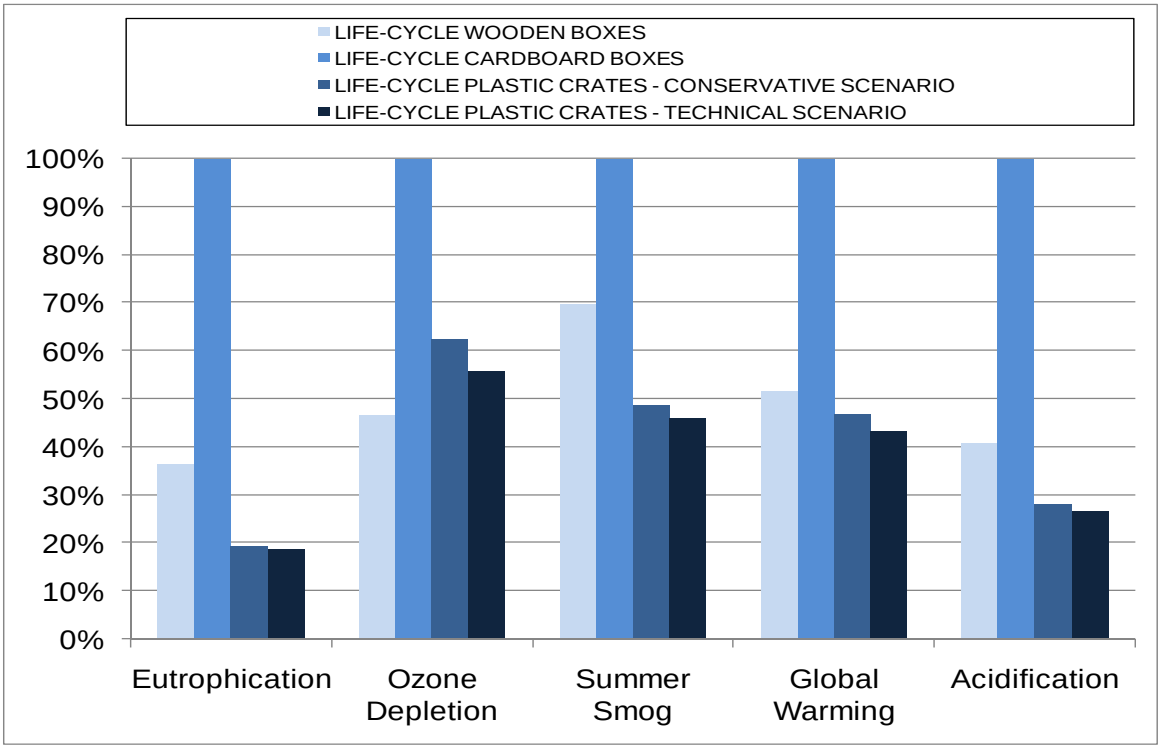
The plastic crates and the cardboard boxes have almost the same **Primary Energy Demand** from non-renewable resources. The cardboard and the wooden boxes have an additional, high requirement of primary energy from renewable resources. Non-renewable resources are saved as a result of the energy produced from burning the wooden and cardboard boxes after use. This results in a reduction in the net non-renewable primary energy used for the cardboard boxes. In case of the wooden boxes, more non-renewable primary energy is generated than is necessary for production, resulting in a negative contribution.



Relative primary energy consumption of the three systems with regard to the maximum single value for the conservative scenario (100% is the renewable primary energy demand for cardboard boxes)

Considering the other **environmental indicators**, the plastic crates and wooden boxes are approximately on the same level regarding the Global Warming Potential. The differences between them are negligible. The plastic crates perform best in the “Eutrophication”, in the “Summer Smog” and in the “Acidification” category and the wooden boxes in the “Ozone Depletion” category.

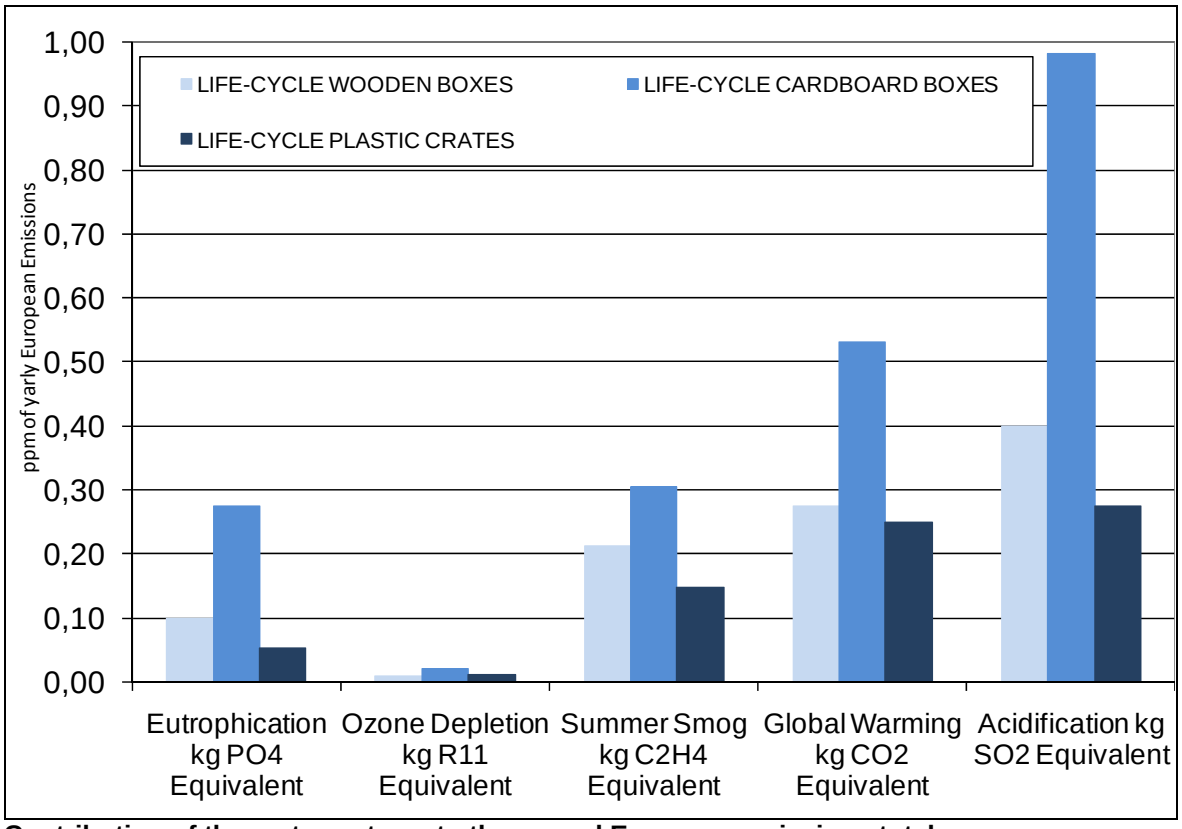
These results do not change significantly when considering the technical scenario. The relative values for the cardboard and wooden boxes are the same for the technical and conservative scenario because the impacts are proportional to the amount of fruit and vegetable transported. The plastic crates system performs better in the technical scenario due to the higher-estimated lifetime of the crates.



Environmental impacts of the plastic crates within the conservative and the technical scenario in relation to wooden and cardboard boxes, taking into account the same transport task

Comparing the emissions of the three box systems to annual Europe-wide emissions, the different performances are put into perspective as follows:

The contribution to ozone layer depletion of all three systems is very small compared to the total annual Europe-wide emissions. In other words, all three systems together produce a negligible share of the emissions of all substances in Europe that damage the ozone layer. In all impact categories the contribution of the regarded systems to the total European emissions are not exceeding one part per million. The biggest contributions of the regarded systems are taking place in the “Acidification” Category.



Contribution of the crate systems to the annual European emissions total

For the plastic crates, the assumed lifetime leaves some room for improving the performance. Furthermore, i.e. employing higher shares of secondary granulate for the production of the same type of crate could also improve the results. This approach is however limited by the fact that secondary granulate doesn`t meet the same quality standards as primary granulate.

Considering the breakage rate of 0.47% per year that was determined in the study and assuming that this remains constant, a lifetime of more than 20 years for the plastic crates is possible. With increasing lifetime, the multi-way transport system performs even better than the one-way options.

The poor performance of the cardboard can be attributed to the fact that the fruit and vegetable transport boxes regarded only consist of kraftliner and semi-chemical fluting. These materials are required to provide the cardboard with the necessary stability and protection against moisture. The complex production processes for kraftliner and semi-chemical fluting are responsible for the higher environmental impacts compared to other materials such as testliner and wellenstoff. These materials are used in other types of cardboard in higher shares, but this is not possible for fruit and vegetable transport boxes. These presented results are true for the considered application; cardboard can have advantages in other applications.

Optimisation potentials for the cardboard packaging include altering the dimensioning of the cardboard boxes to reduce the amount of cardboard actually needed as well as ensuring a more efficient energy recovery from their disposal.

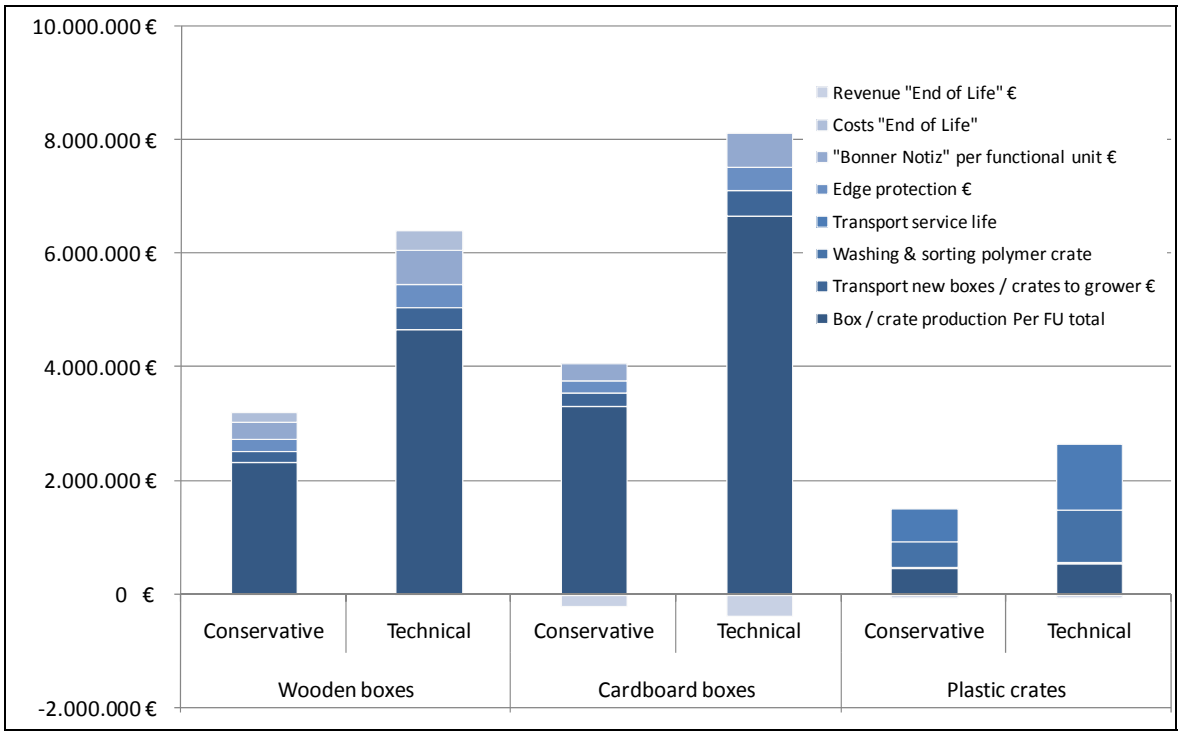
The result of the wooden boxes can be improved by ensuring that the distance the raw

material (wood) has to be transported is kept as short as possible. In addition, one could select a type of wood that is easier to process during production (e.g. poplar) as well as ensure a more efficient energy recovery during thermal recycling.

The concluding evaluation of the study shows that the ecological advantages of the plastic crates multi-way system further increases with a higher number of fillings and a longer lifetime of the crates.

Costs of the Systems

An analysis of the costs shows that the multi-way system is the most cost-effective over its whole life cycle, in both the conservative and the technical scenarios.



Costs of the three systems compared over the entire life cycle (production of boxes/crates, transportation task (+ if so cleaning) and End-of-life) considering the two scenarios

Again here, when the plastic crates have a higher lifetime (and thereby more fillings), the benefits of the multi-way system over the one-way systems are even more pronounced.

Social Indicators

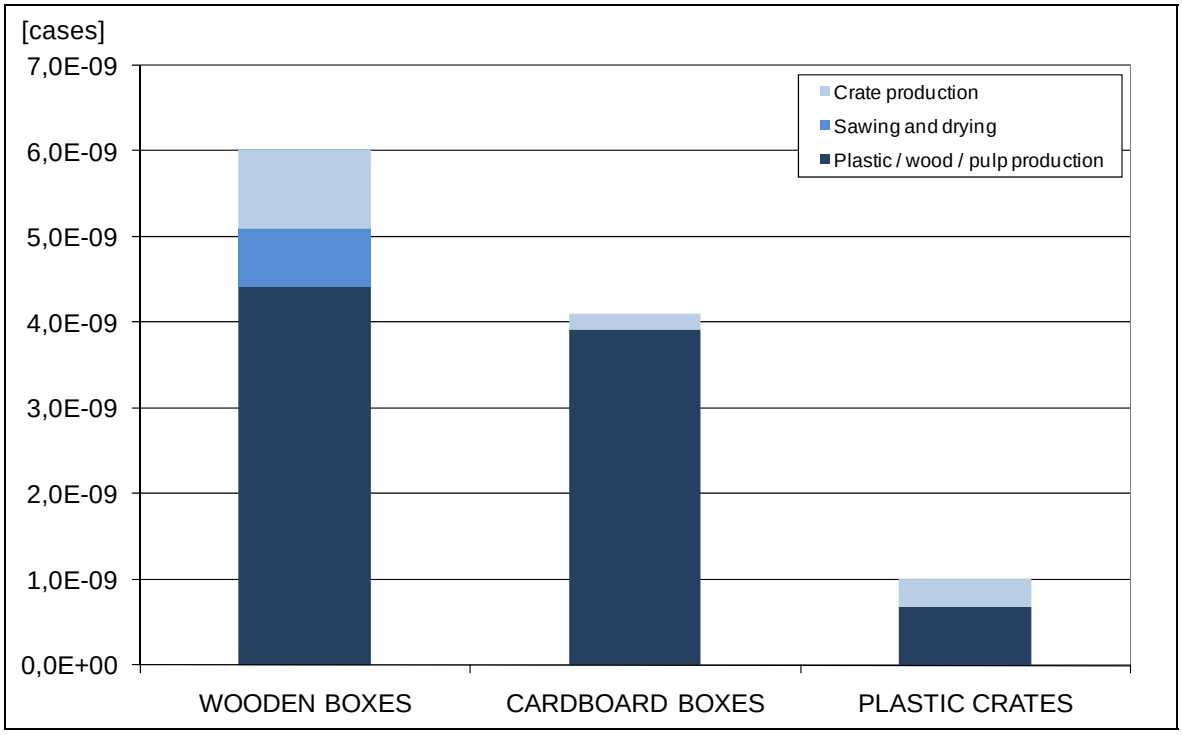
Inventory data on social indicators has not been updated in the scope of this study; therefore results may have changed to a certain extent. Anyhow, the major trends shown here to outline all aspects of the study are very unlikely to have changed.

The production of the cardboard boxes has the highest working-time, followed by the plastic crates and wooden boxes. The share of employment for women is highest for plastic crates with approx. 28 %, followed by wooden boxes with approx. 18 % and cardboard boxes with approx. 5 %.

When considering production and operation, all three systems require a relatively large

share of only low-qualified employees. For the multi-way system, these are mostly employed for washing and sorting; for wooden and cardboard crates they are employed for the production step. As a result, long-term, low-qualification jobs are ensured.

The multi-way plastic crate system shows a very low lethal accident rate. For the wooden boxes, the high lethal accident rate is caused by the logging of wood.



Lethal accidents per produced crate

Conclusions

The goal of this study was to analyse and compare the environmental impacts and the economic and social aspects of the three dominant transport systems of fruit and vegetables in Europe.

Overall, the plastic crates and wooden boxes show almost similar results in the “Global Warming” Category. The wooden boxes perform best in “Ozone Depletion”. For all other impact categories, (“Eutrophication”, “Summer Smog” and “Acidification”), the plastic boxes show the lowest impacts whereas cardboard boxes have the highest impacts for all impact categories. The multi-way system has advantages over the one-way systems in terms of the rate of lethal accidents and its economic efficiency (low costs).

Furthermore, the environmental assessment indicates that the multi-way plastic crates system becomes even more environmentally advantageous with an increasing lifetime, since the expenditure for production of the crates is distributed over a longer service life and thereby over a higher transportation capacity.