Universität Stuttgart

Lehrstuhl für Bauphysik

LBP-Report 4

(2007) New research results in brief

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

1. 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 a one-way solution.

2. Task and goal of the study

In April 2005, the “Stiftung Initiative Mehrweg” (“Foundation for Reusable Systems”, a foundation under German Civil Law) ordered a Life-Cycle Assessment (LCA) study to analyse and compare the common packaging systems for fruit and vegetables in Europe with respect to the environmental impacts related to their use. Knowledge should also be gained on the costs and selected social aspects to address sustainability.

Multi-way plastic crates, one-way cardboard boxes, and one-way wooden boxes are compared.

3. Scope of Research

Packaging of the same size (600mm x 400mm x 240mm) and comparable capacity (15 kg fruit or vegetables per box) forms the basis of the comparison. To transport an amount, of 1000 tons of fruit and vegetable 66,667 boxes in each of the analysed packaging types are necessary. As the plastic crates can be multi-used, the average lifetime and the number of fillings during the lifetime have to be considered. For the plastic crates, two scenarios are considered:

– conservative: lifetime of 10 years; 50 fillings
– technical: lifetime of 20 years; 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 13,333 plastic crates to be replaced over the 10-year lifetime due to damage.

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).

4. Selected results

The Environmental Effects
For the five assessed environmental indicators, the plastic crates and wooden boxes are approximately on the same level in the categories greenhouse effect, acid rain and summer smog. The plastic crates perform best in the category “eutrophication” and the wooden boxes perform best in the “ozone depletion” category.

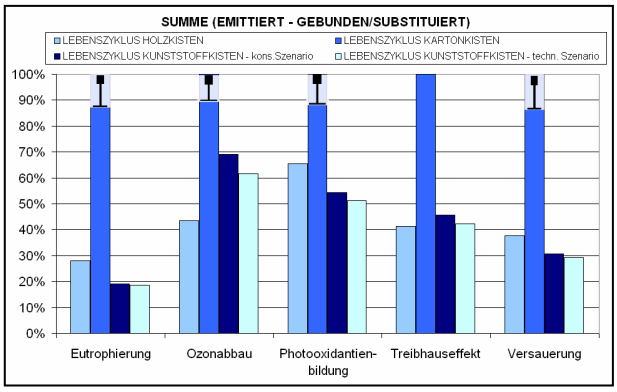

Figure 1: Environmental impacts of the plastic crates within the conservative scenario and the technical scenario in relation to wooden and cardboard boxes, taking into account the same transport task.

[1] PE International, Leinfelden - Echterdingen

For all environmental indicators, the cardboard packaging is by far the solution that is most damaging, in a relative and absolute sense.

The poor performance of the cardboard can be attributed to the high share 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 testliner and wellenstoff, which are used in other types of cardboard in higher shares, but which is not suitable for the transport of fruit and vegetable.

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 scenario.

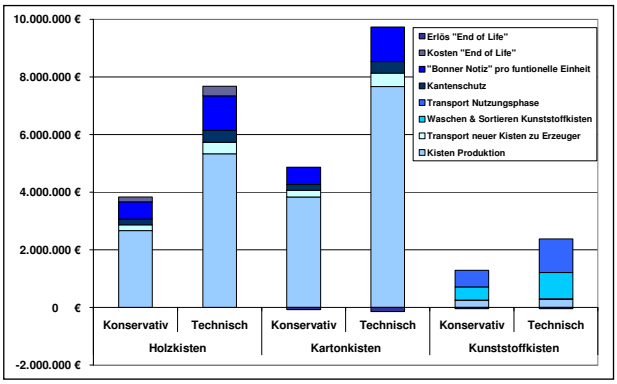

Figure 2: Costs of the three systems compared over the entire life cycle (production of boxes/crates, transportation task (+ if so cleaning) and End-of-life) considering the two scenarios.

Again here, where 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
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 lowqualified 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.

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

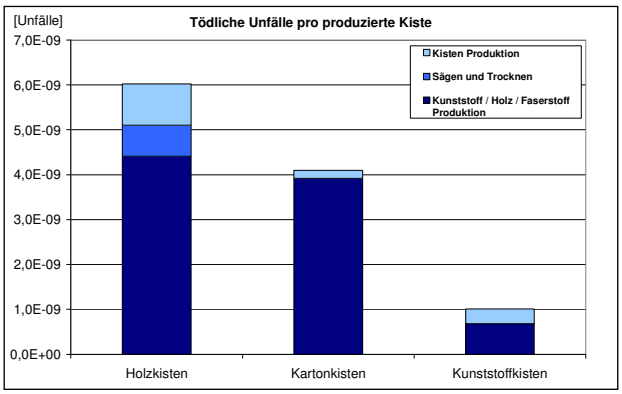

Figure 3: Lethal accidents per produced crate.

5. 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 environmental impact categories, both with significant advantages compared to cardboard boxes. 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).

The multi-way plastic crates system becomes 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.

6. References

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[2] LBP, PE: GaBi 4 Software-System and Databases for Life-Cycle Engineering. Copyright, TM.; Stuttgart, Echterdingen

[3] Makishi, C.; Barthel, L.-P.; Schuller, O.: Social Aspects of Packaging Systems for Fruit and Vegetable Transport in Europe; CILCA 2007; Conferência Internacional Ciclo de Vida; 26th-28th February, 2007; Sao Paulo; Brazil

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Herstellung und Druck: IRB Mediendienstleistungen des Fraunhofer-Informationszentrums Raum und Bau IRB, Stuttgart