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DETERMINING THE BREAKAGE RATE OF SINGLE-USE AND REUSABLE CRATES IN THE FRUIT AND VEGETABLE RANGE

Results report

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Initiative Mehrweg

Table of contents

1
Introduction and objectives of the study

The debate about single-use and reusable packaging has reached a new level, at the latest since the publication of the European Commission's proposal for an EU-wide Packaging and Packaging Waste Regulation (PPWR). Since then, arguments for and against one or the other type of packaging have been put forward from a wide range of perspectives. These arguments are often supported by life cycle assessments and other types of studies. The carbon-footprint of food is on average 16-30 times higher than the carbon-footprint of the packaging[1]. Food losses along the supply chain are therefore to be avoided. This also applies to fresh fruit and vegetables. Of particular interest here is whether and to what extent the type of packaging used (single-use or reusable) influences product loss.

Meanwhile, there are no current figures available for statements on the breakage rate of single-use and reusable fruit and vegetable crates at the various distribution levels of the retail trade. The last study on this topic was conducted by the Fraunhofer IML, also on behalf of the Stiftung Initiative Mehrweg (SIM), and dates to 2012. As part of this study, a new data collection on the breakage and damage rate of single-use and reusable packaging for fruit and vegetables was carried out and evaluated.

The study focused on the following questions: Transport packaging is exposed to static and dynamic loads along the logistics chain to the point of sale (POS). Project experience shows that packaging breakage can cause damage to the products. But to what extent do breakage and damage rates occur depending on the type of packaging? At which point in the supply chain (central warehouse vs. POS) are which loss rates recorded?

The aim of the study was to quantify the influence of the type of packaging on breakage of fresh fruit and vegetable packaging.

[1] GVM, denkstatt (2020): Lebensmittelschutz ist Klimaschutz - Lebensmittelschutz durch Verpackungen: Auswirkungen auf den CO_2-Fußabdruck

2
Definition of packaging terms

The study focused on reusable and single-use crates used to distribute fruit and vegetables from the producer to the point of sale. In this report, the terms crate and packaging are used synonymously.

2.1 Reusable and single-use packaging

Reusable packaging are exclusively sales, grouped or transport packages that are designed to be re-used multiple times for the containment, protection, handling, delivery or presentation of goods[1]. Single-use packaging fulfills this purpose only once and is then recycled or disposed of.

2.2 Crates

A crate is a type of packaging made of wood, plastic or cardboard that does not completely enclose the product[2]. Crates are used primarily for transporting fruit and vegetables. Crates are available for both types of packaging, single-use and reusable.

[1] VDI 4407
[2] DIN 55405

3
Empirical determination of breakage of single-use and reusable packaging

Packaging breakage was recorded both in the incoming goods department of central warehouses and in the incoming goods department of wholesale and retail stores.

3.1 Procedure and data basis

Fresh fruit and vegetables are packed in crates after being harvested. Several transport packages of the same type of fruit or vegetable are usually combined on a pallet to form a homogeneous loading unit. This means that there is only one type of product and one type of packaging on a loading unit. The loading unit is then usually transported to a central warehouse. After unloading the delivered loading units, they are brought to a buffer area in the central warehouse's incoming goods department, where the loading units remain for a short time before being made available in the picking zone.

Data collection took place immediately after unloading in the goods-in buffer area. Fraunhofer IML employees inspected the loading units set up there from every side and documented damage to transport packages. The following data was collected:

- Data on the product and the loading unit
    - Type of fruit/ vegetable
    - Country of origin
    - Type of packaging (single-use/ reusable) and packaging material
    - Packaging dimensions
    - Number of loading units and transport packaging
    - Photographic documentation

- Data for damage documentation
    - Number of damaged transport packagings
    - Cause of breakage
    - Product damage
    - Photographic documentation

The data were collected between June and August 2020. The data were recorded in three central warehouses of large retail and wholesale companies in Germany.

The central warehouse bundles all deliveries from producers and distributes them to retail stores. In the picking process, loading units are put together for each individual store based on their needs. Consequently, a picking loading unit usually contains different types of fruit and vegetables as well as different types of packaging (see Figure 1). The mixed loading units are then transported to the store.

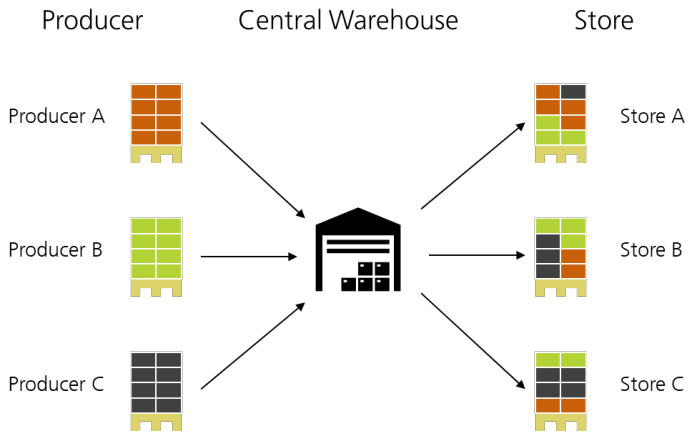

Figure 1: Example of a retail company's supply chain

Data recording at the stores took place after the loading units had been unloaded and handed over to the store's staff. Analogous to the procedure at the central warehouse, Fraunhofer IML employees inspected the loading units from every side and documented damage to individual transport packages (TP). The same data was collected as for data recording at the central warehouses (see above). The data was collected between June and August 2024. Data was collected in eight stores of large retail and wholesale companies in Germany.

In the central warehouses, TPs of 28 different types of fruit and 40 types of vegetables from 32 different countries of origin from all regions of the world were recorded during the data collection. In the stores, 32 types of fruit and 40 types of vegetables from 41 countries were recorded.

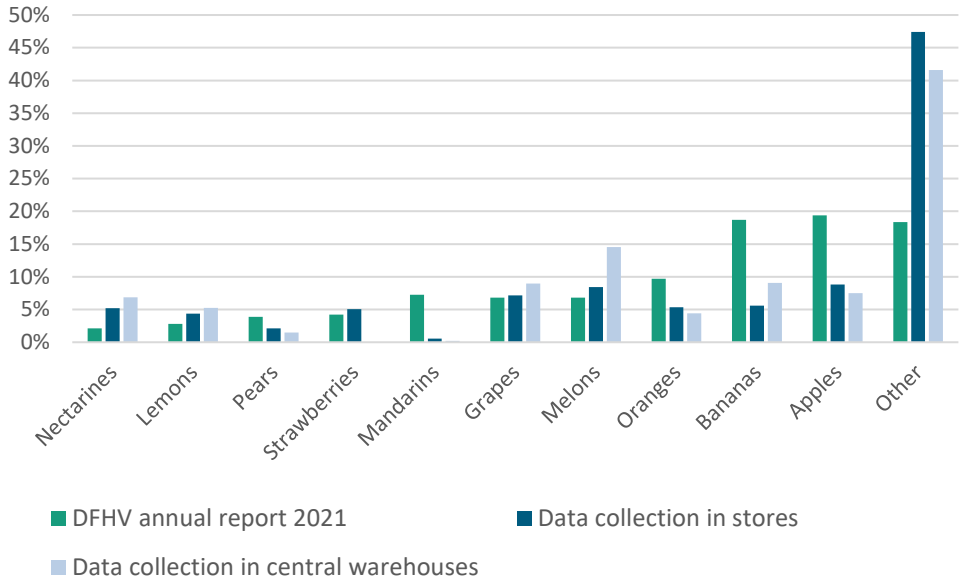

Figure 2: Top 10 purchase quantities (fruit) in 2021 compared to data recording

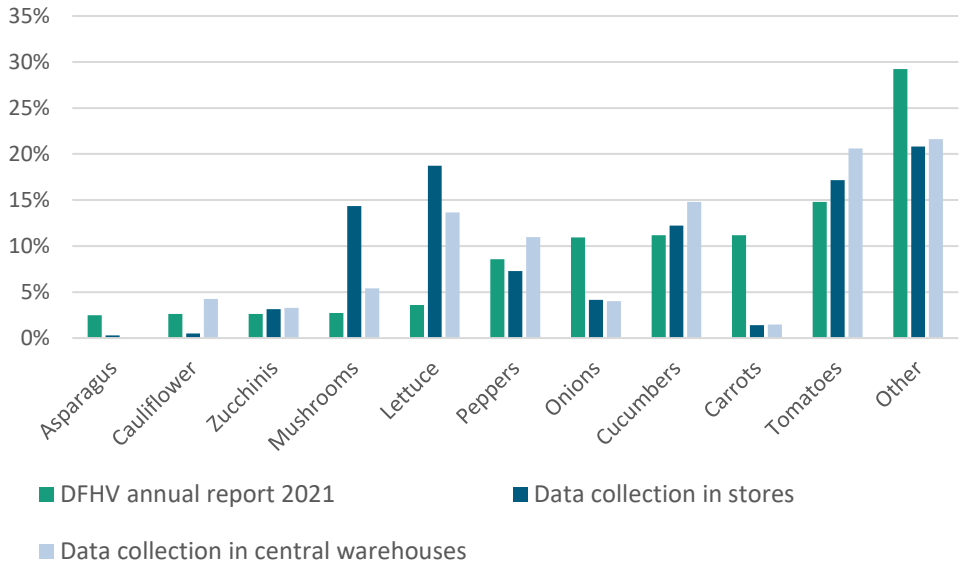

Figure 3: Top 10 purchase quantities (vegetables) in 2021 compared to data collection

Figure 2 and Figure 3 show the extent to which the collected data matches the top 10 fruit and vegetable varieties in German private households1. Over 70 percent of the top 10 fruit and vegetable varieties according to the DFHV report

[1] DFHV annual report 2021

were also among the top 10 varieties recorded in the data collection1. Figure 4 (store) and Figure 5 (central warehouse) show the top 10 countries of origin based on the collected data. The main suppliers are located in Germany, the Netherlands, Spain and Italy. Together, they account for about 75 percent of the recorded quantity.

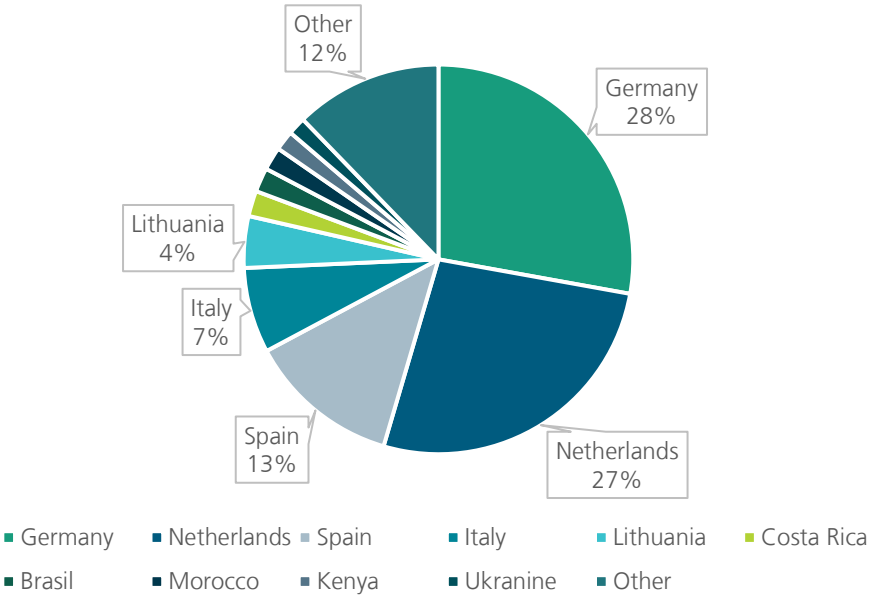

Figure 4: Distribution of inspected TPs in the stores by country of origin

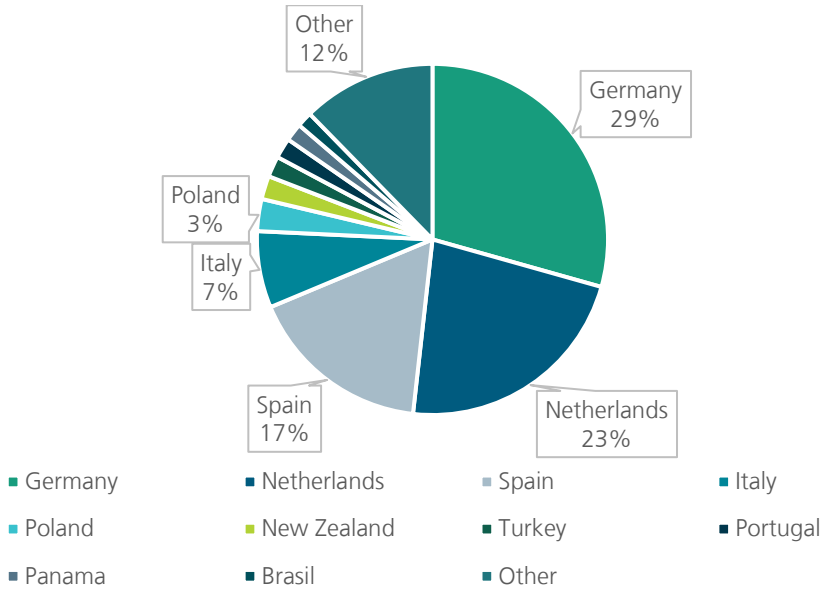

Figure 5: Distribution of evaluated TPs in central warehouses by country of origin

[1] Note: Fruit and vegetables are foods whose availability is subject to strong seasonality in some cases. It was therefore not possible to record all varieties in the top 10 during the data collection period (June to August).

3.2 Central warehouse results

A total of 60,555 transport packages were inspected in the central warehouses. Of these, 44 percent were single-use packaging and 56 percent were reusable packaging. 60 of the 26,891 single-use crates inspected were damaged. This corresponds to a breakage rate of 0.22 percent. Three damaged reusable crates were recorded during the data collection period. This corresponds to a breakage rate of 0.01 percent. Accordingly, the breakage rate for single-use crates in the central warehouses was 20 times higher than the breakage rate for reusable crates (see Figure 6).

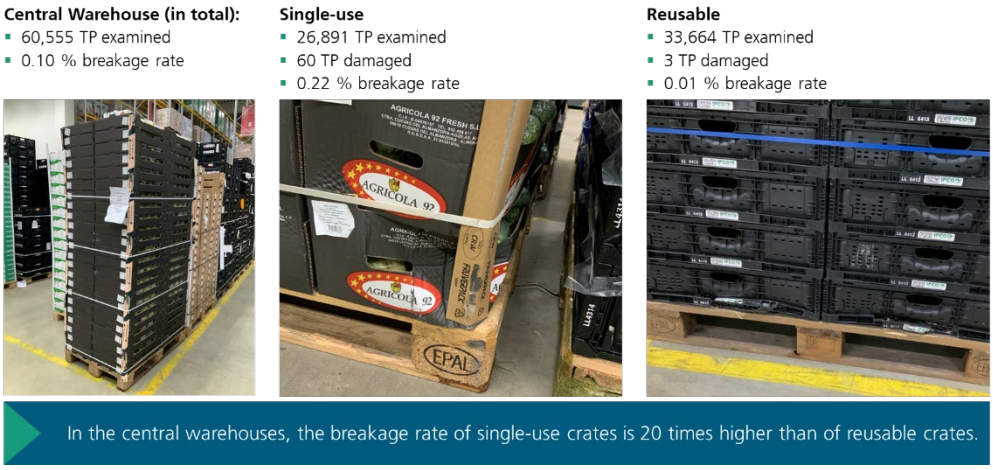

Figure 6: Overview of data recording in the central warehouses

The following causes of breakage were determined and distinguished in the central warehouse:

- Lack of stability/ stack breakage
- Inadequate securing of the loading unit
- External influences

Lack of stability/ stack breakage refers to the packaging's inability to bear the load (stack of overlying packaging). Securing the loading unit includes damage caused by insufficient or incorrect securing of the loading unit, e. g. with stretch film or strapping. External influences are always present when the packaging is damaged due to incorrect or improper handling or carelessness. Examples of this are:

- Damage during unloading from the truck, including damage caused by the forks of forklifts
- Errors in the formation of the loading unit (including overhangs)
- Incorrect loading unit securing in the truck

Figure 7 shows examples of the causes of breakage mentioned above:

Figure 7: Examples of damage: external influences (left), lack of stability (center), inadequate loading unit securing (right)

Figure 8 shows that the most common causes of damage to single-use packaging are due to the instability of the packaging and external influences. By contrast, the main cause of damage to reusable packaging (three out of three cases of damage) was incorrect and improper handling. Either the producer secured the loading unit incorrectly, the carrier did not secure the load sufficiently on the truck, or the damage was caused by carelessness on the part of the staff during loading or unloading.

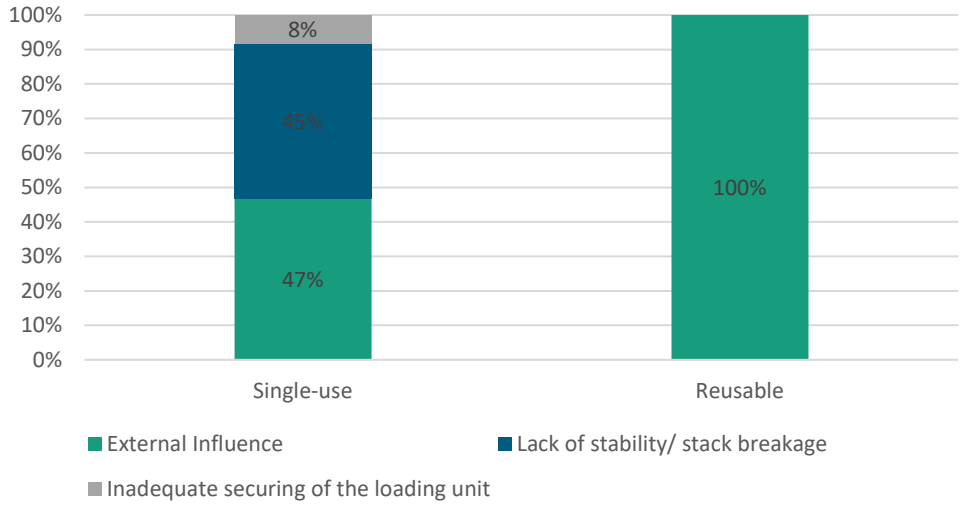

Figure 8: Comparison of causes of damage in the central warehouses

During data collection at the central warehouse, the product loss due to packaging breakage was estimated at approx. 10-20 percent for single-use crates. The fruit and vegetables were often squashed from above when being stacked due to the lower stability of the single-use crates. Due to the higher stability, the product loss was estimated to be 5-10 percent with reusable crates. The amount of product loss depends on the type of packaging and the sensitivity of the products.

3.3 Results from the stores

A total of 2,497 transport packages were inspected in stores. Of these, 39 percent were reusable and 61 percent were single-use packaging. 26 of the 1,533 single-use crates inspected were damaged. This corresponds to a breakage rate of 1.69 percent. During the data collection period, only one case of damage was recorded for reusable crates. This corresponds to a breakage rate of 0.1 percent. Accordingly, the breakage rate for single-use crates in the stores was 26 times higher than the breakage rate for reusable crates (see Figure 9).

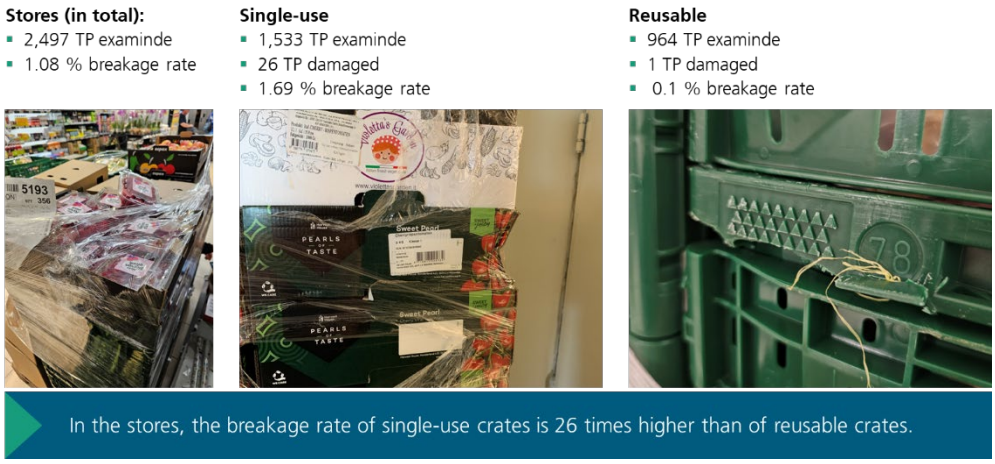

Figure 9: Overview of data collection in the stores

The following causes of breakage were identified in the stores[1]:

- Lack of stability/ stack breakage
- Inadequate securing of the loading unit
- External influences
- Lack of modular tuning
- Lack of compatibility

Since mixed picking units are formed during picking in the central warehouses, two further causes of breakage (lack of modular tuning and lack of compatibility) are added, which provide an expression of the suitability of a packaging for forming heterogeneous picking loading units. A lack of modular tuning always occurs when packaging with dimensions that do not follow from the 600 x 400 mm base module of a euro pallet causes damage. This is usually the case when the packaging has special dimensions in its base area and is therefore only partially stackable. As a result, parts of the packaging often come into direct contact with products. A lack of compatibility always occurs when the dimensions of the packaging causing the damage are modularly tuned but it

[1] The differentiation of the first three causes of breakage is analogous to the description in 3.2

cannot be integrated into a stack in a form-fitting manner (e. g. by stacking lugs on the front side walls). Frequently, incompatible packages slip into one another and rest on the product of the packaging below.

The following figures show examples of the causes of breakage mentioned:

Figure 10: Examples of damage caused by a lack of stability (left) and a lack of modular tuning (right)

Figure 11: Examples of damage caused by external influences (left) and inadequate loading unit securing (right)

Figure 12 shows that, in line with the observations in the central warehouses, the majority of the damage to single-use crates was due to a lack of stability. About a quarter of the damage could be attributed to a lack of modular tuning. In this case, crates were used whose base dimensions did not match the modular dimensions of a euro pallet. The only case of damage to reusable crates was caused by external influences.

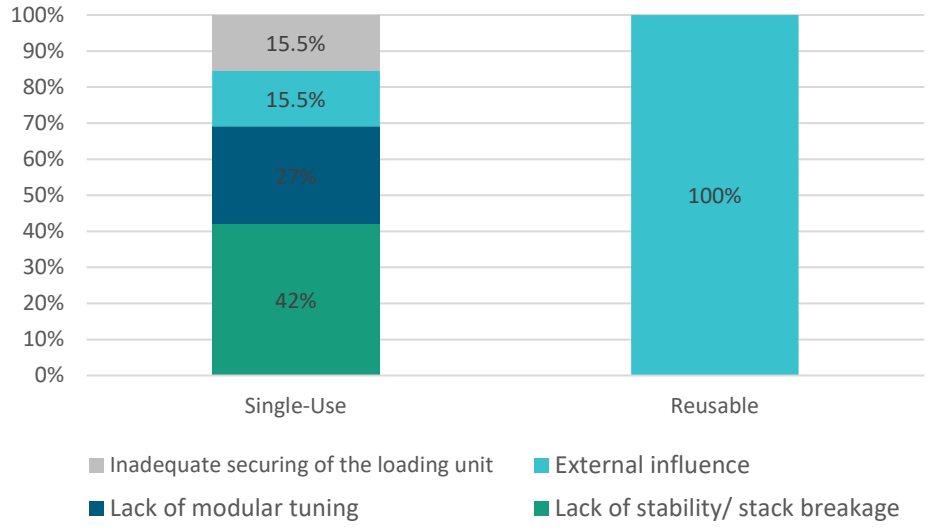

Figure 12: Comparison of causes of damage in the stores

The formation of heterogeneous loading units during store delivery and the frequent lack of modular tuning that goes with it – especially in the case of single-use crates – leads to a higher product loss rate than in the central warehouses. The estimated product loss due to packaging damage of single-use crates in the store was therefore estimated at 20-30 percent during the data collection. The product loss rate for packaging damage to a reusable crate was estimated at 5-10 percent due to its higher stability. As mentioned above, the amount of product loss depends on the type of packaging and the sensitivity of the products.

3.4 Packaging damage along the entire supply chain

Figure 13 shows the cumulated breakage rates of single-use and reusable packaging along the entire supply chain, from the producer to the central warehouse and to the store.

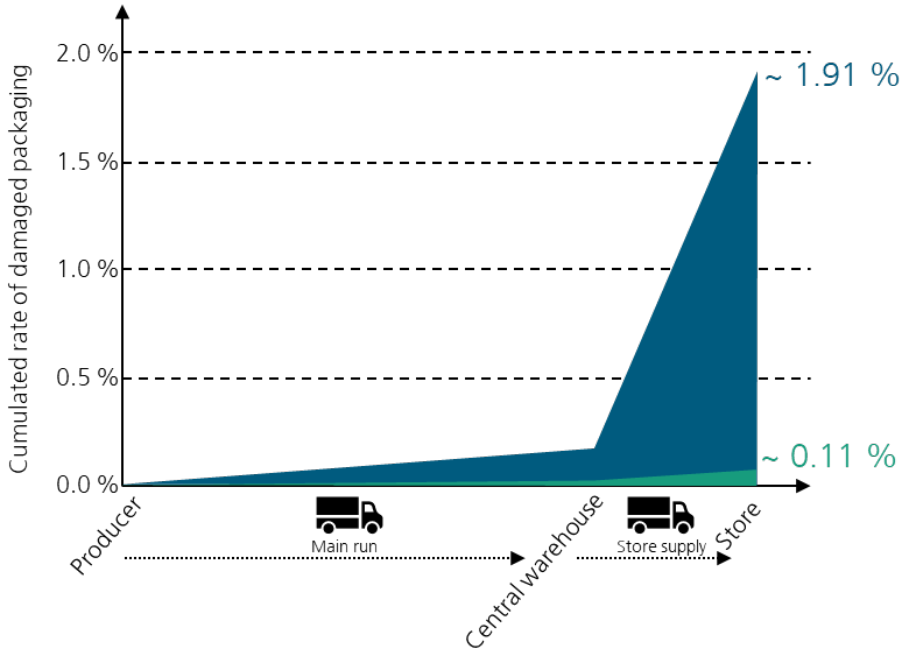

Figure 13: Cumulative breakage ratio along the entire supply chain

In the case of single-use packaging, a total of approx. 1.91 percent of all packaging is damaged on its way to the consumer. For reusable packaging, the figure is approx. 0.11 percent.

3.5 Transfer of the results to the current market situation

In the following, the calculated breakage rates are used to extrapolate the effect on the entire German market for fresh fruit and vegetables. Two scenarios are distinguished. The first scenario assumes that only single-use packaging is used along the entire supply chain, while the second scenario assumes that only reusable packaging is used. The calculation is based on the annual per capita consumption of fresh fruit and vegetables in Germany. The annual per capita consumption is approx. 64.9 kg for fruit and approx. 102.6 kg for vegetables1. This corresponds to a total consumption of approx. 14 billion kg of fruit and vegetables per year2. This corresponds to approximately 1.75 billion crates per year3 that are used for distribution.

Scenario 1 (single-use packaging): At the end of the supply chain, approx. 33.3 million packages are damaged each year. This means that approx. 64,000 tons

[1] Supply balance (Federal Ministry of Food and Agriculture 2022)
[2] Based on a population of 83.4 million people (German Federal Statistical Office 2024)
[3] An average crate contains approx. 8 kg of fruit or vegetables.

of fruit and vegetables are damaged each year1. This corresponds to a monetary value of 95.45 million euros2.

Scenario 2 (reusable packaging): At the end of the supply chain, approx. 1.92 million packages are damaged each year. This means that 1,200 tons of fruit and vegetables are damaged each year1. This corresponds to a monetary value of 1.73 million euros2.

The following figure illustrates the scenario analysis:

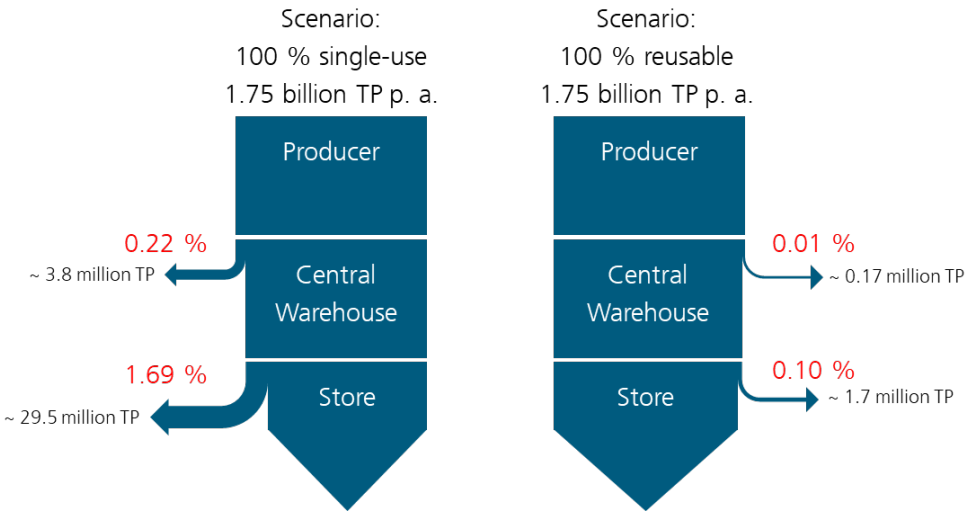

Figure 14: Illustration of the scenarios

[1] approx. 5-10 percent of the contents of a broken reusable crate and approx. 10-30 percent of a broken single-use crate are damaged on average.
[2] The average value of goods on a fruit and vegetable crate is 12 euros.

4
Summary

The aim of the study was to determine the rate of packaging and product damage depending on the type of packaging along the distribution chain of fresh fruit and vegetables. To this end, packaging damage was recorded both after the first distribution stage (producer to central warehouse) and after the second distribution stage (central warehouse to store).

The results of the recordings show that the type of packaging (single-use/ reusable) has a significant influence on the breakage rate of packaging. Reusable packaging has a significantly lower breakage rate than single-use packaging. It should be emphasized that not a single case of damage due to a lack of packaging stability was observed in reusable packaging. Rather, incorrect handling is the main cause of packaging damage to reusable packaging. In the case of single-use packaging, the most common causes of damage are external influences, packaging instability and a lack of modular tuning with other packaging.

The distribution stage has a further influence on the breakage rate of packaging. The breakage rates increase many times over for both packaging types in the second distribution stage (store delivery). The cause of this can be found – especially in the case of single-use packaging – in the lack of modular tuning of the different packaging types, which is an essential factor in the formation of picking units or heterogeneous loading units. This problem is observed not only between the two packaging types, single-use and returnable, but also among the different types of single-use packaging.

Damage to the creates can also affect the quality of the transported goods. This was observed for 10-20 percent of the fruit and vegetables transported in damaged single-use packaging at the central warehouse, but only for 5-10 percent in the case of returnable packaging. While the proportion of products loss in damaged reusable packaging in the second distribution stage was estimated to be the same, product loss in stores due to damaged single-use packaging was estimated at 20-30 percent.

The value of damaged products assuming that only single-use crates are used (single-use packaging scenario) is approximately 95.45 million euros per year, and approximately 1.73 million euros per year for a corresponding returnable packaging scenario.

In summary, the study highlights the significant differences in the breakage rate between single-use and reusable packaging, as well as the increasing frequency of damage along the distribution chain. While reusable packaging exhibits

greater stability and less packaging and product damage, handling, stability and modular tuning are critical factors for single-use packaging. The scenario analysis underscores the need to optimize packaging concepts for the distribution of fresh fruit and vegetables in order to both reduce costs and ensure the quality of the transported goods.