Food loss Solutions

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# Target-Measure-Act: Less Food Loss and Waste in Dutch tabel grape supply chains

The growing recognition of the economic, social, and environmental consequences of Food Loss and Waste (FLW) has spurred a call to action among and in cooperation between stakeholders in the food system. The United Nations (through SDG 12.3) and the EU (through the Waste Framework Directive and the CSRD reporting directive) fully support reducing FLW. However, the question remains: Where should your company begin? This factsheet serves as a steppingstone in embracing the Target-Measure-Act approach. The information and statistics presented in this factsheet aim to empower you to target FLW in your food supply chain and formulate your objectives accordingly.

This factsheet presents the table grape supply chain, the FLW percentages in the main supply chain stages, its destinations and impacts, and the causes and possible interventions to support FLW reduction through the Target-Measure-Act approach.

## Table grape market

The Netherlands produces mainly wine grapes, with a total of 173 hectares of land allocated to their production. The production of table grapes is negligible [1]. However, the Netherlands does import a large volume of table grapes every year (Figure 1). Imports of table grapes to the Netherlands come mainly from the continents of Africa (41% of total import volume), South-America (32%), Asia (15%) and Europe (13%) [2]. The main countries of origin include South Africa, India, Peru and Chile [3]. A significant portion – 99% of the total imported volume – is exported to neighbouring countries, especially within the European Union. In comparison, the Netherlands imported 1.1 kilotons of other types of grapes, such as wine grapes, with a total value of 1.8 million euros, and exported 8.4 kilotons of such grapes with a total value of 23.7 million euros [2].


**Figure 1** Import and export of table grapes in the Netherlands (2021).[1] Source [2].

Table grapes are among the top 5 fruits and vegetables in terms of their import value in the Netherlands, accounting for

1 These numbers are the most recent national statistics published.

**Table 1** Sample size, and FLW percentage + standard deviation for table grapes.

| **Supply chain stage (simplified)** | **Primary production** | **Export** in-country handling | **Import** handling & distribution | **Retail** |
|---|---|---|---|---|
| SIFAV data | 2.1% ± 5.2%<br>N = 26 | 3.3% ± 5.6%*<br>N = 24 | 5.8% ± 10.8%*<br>N = 5 | 3.9% ± 4.3%*<br>N = 4 |
| Literature | 9.5%<br>N = 4 | 7.5%<br>N = 3 | 3.0%<br>N = 3 | 3.0%<br>N = 5 |

* This number includes default data, as provided by the Sustainability Initiative Fruit and Vegetables (SIFAV).

around 9% of the total import value of fruits and vegetables [4]. In the context of global trade, the Netherlands accounts for 8% of the total volume of imported table grapes worldwide and 9% of their total value [5]. These substantial import and export volumes come with potentially significant Loss and Waste along the supply chain, underscoring the importance of addressing FLW.

## FLW in the international table grape supply chain

The table grape supply chain consists of multiple actors that all add value to the product, for example by producing the grapes, transporting, or providing storage. Every table grape supply chain link differs, as individual companies are involved, who conduct different activities at their entity. In general, actors in the international table grape supply chain include growers, exporters, importers and retailers. However, also different types of intermediaries can be active in the supply chain in the exporting countries, and actors can also perform multiple functions, such as being grower and exporter.

The FLW data collection process consisted of an inventory with quantitative templates with questions on produced or processed volumes and losses, its causes and destinations of lost products. The templates were distributed among SIFAV members (importers and retailers), who in turn shared them with their upstream partners. Partners included were growers, exporters and importers. Data collected at the primary production stage include the activities production and harvesting of table grapes, and post-harvest activities on-farm such as, sorting and packing. Activities at the export stage include all activities performed after farm gate, prior to shipment, which can include for example washing, packing, storage and transport. The import stage include all activities from overseas transport, arrival until delivery to the retail distribution centre and can include sorting, re-packing and delivering. Activities in the retail stage include the storage, transport and sales at the distribution centres and retail outlets. Table 1 shows the average FLW percentages[2] per supply chain stage collection by SIFAV members[3], and the average FLW percentages found in literature. The table grape production and export countries included in the sample of SIFAV were Spain, South Africa, and India.

The reported SIFAV data was not completely in line with the data reported in literature. Especially at the primary production stage, the reported FLW data in Table 1 (2.1%) was lower compared to literature (9.5%) [6, 7, 8, 9]. This difference can probably be explained by the difficulty of estimating FLW in the primary production stage. Validating the data provided by the export stage was challenging, as the activities conducted are not set in stone. For its literature data, we selected reported data on packing houses, external cold storage facilities and the 'between intake and export' stage. The data reported in the literature was scattered, like the SIFAV data. Given the spread in the data, the SIFAV data was in line with the average data reported in literature (7.5%) [6, 8, 9].

For import and retail, the reported data was in line with the data reported in the literature. In the import stage more reliable data is available, as these companies have data on purchasing and selling in their systems. The reported FLW data in literature was limited, as not many studies are available. Data on FLW for table grapes at the import stage could only be found in Blankenberg *et al.* (2021), who used simulations and reported 4.8% for 2017 and 1.9% for 2018 [7], and Louw (2017), who reported 2.2% FLW between import and retail depots [9]. The reported retail data for

2 This factsheet uses the FLW definition of FAO (2019). FLW refers to the decrease in quantity or quality of the edible portion of raw, semi-processed or processed food, intended for human consumption, that is redirected to other non-food uses unless diverted to productive use. Productive use includes animal feed, industrial use, and other uses such as fertiliser and ground cover. Deviating from the FAO (2019) definition, animal feed and land application/ ploughed in are reported as being FLW in the SIFAV data.

3 Please be aware that the reliability of the SIFAV dzata presented in this factsheet is constrained by the sample size at each supply chain stage.

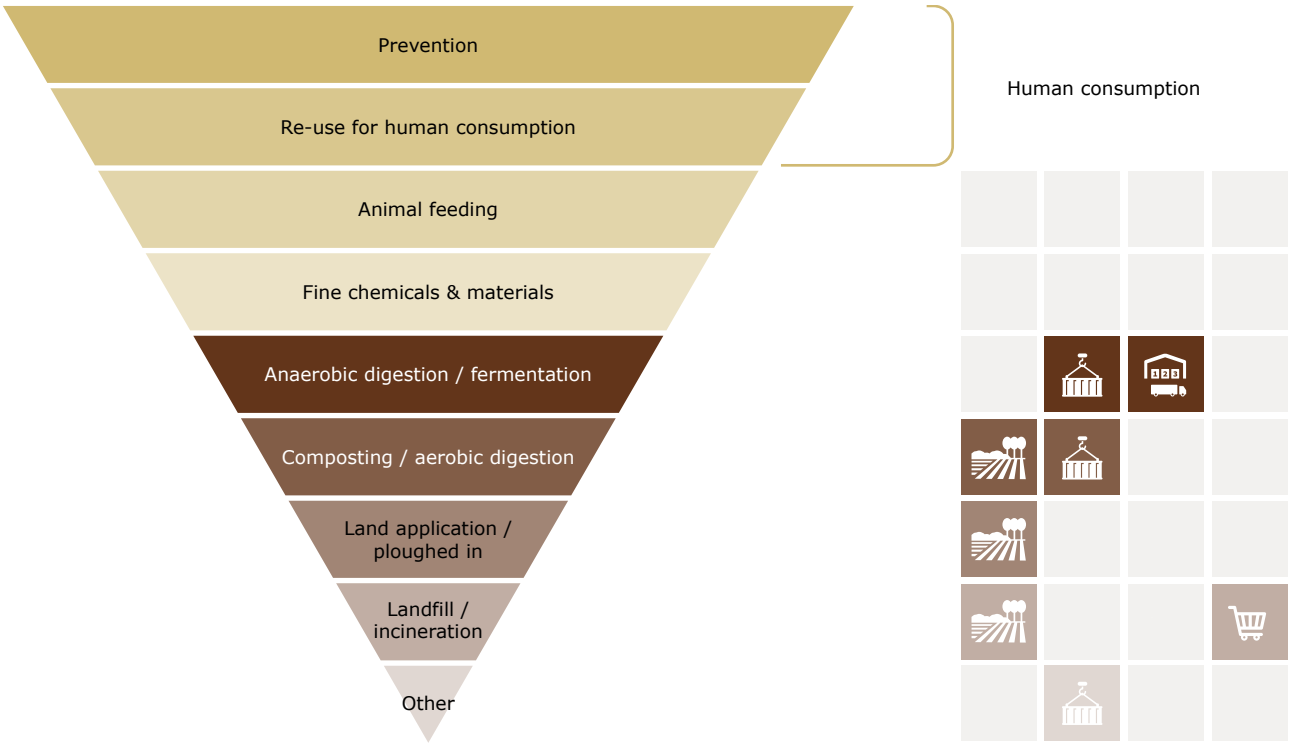


**Figure 2** Destinations of discarded table grapes. The visualisation is based on 'Moerman's Ladder', which ranks the value of valorisation options from high to low. The icons correspond with the supply chain stages, and the presence of an icon indicates that at least one actor mentioned this category as a destination of discarded table grapes. Source: SIFAV.

table grapes was compared with literature date from retail stage studies in Egypt, Sweden (2x), and the simulated data in South Africa. The average rate of FLW at the retail stage was estimated at 3.0%, in line with the reported data at the retail stage by SIFAV.

## Destinations of FLW in the table grape supply chain

Table grapes not suitable for human consumption are rejected, become part of the FLW side stream, and need a new destination other than human consumption. Figure 2 shows the destinations of rejected table grapes as reported in the SIFAV inventory. Table grapes side streams are not used as animal feed or for fine chemicals and material use, but discarded via anaerobic digestion, composting, land application, landfill or other. Although the primary production, export and import supply chain stages use the table grape side streams for anaerobic digestion and/or composting, the retail supply chain stage only discards the table grape side streams as landfill.

## Greenhouse gas impact of table grape FLW

FLW does not only have a negative effect on economic factors, but also on social and environmental factors such as food security and climate change. As an example of environmental impact, the FLW associated greenhouse gas (GHG) emissions for the Dutch table grapes import and distribution are presented here, covering the activities primary production, transportation (from the country of origin to retail), and packaging. The primary production and transportation related emission factors are origin-dependent. Therefore, the FAO detailed trade matrix was used to determine the countries of origin, including a correction for re-export among European countries, for the table grape imports to the Netherlands. From this import profile, an average emission factor for the primary production, export and import stages result. For distribution towards retail the volume for domestic consumption and the export volumes to various countries are used as input for the average emission factor for the retail chain stage. The packaging emission factors were derived from literature.

The resulting FLW attributed GHG emission factors for the table grapes imported to the Netherlands based on SIFAV data are given in Table 2. The emissions per kg product increase to the end of the supply chain. In other words, one kg product wasted at the retail sector contributes to a larger extend to GHG emissions compared to one kg product lost at primary production.

**Table 2** Impact factors in kg $CO_2$-equivalents per kg table grapes along the table grapes supply chain for the Netherlands.

| Supply chain stage (simplified) | Primary production | Export: in-country handling | Import: handling and distribution | Retail |
|---|---|---|---|---|
| FLW associated kg $CO_2$-equivalents per kg of table grapes | 0.52 | 0.89 | 1.06 | 1.24 |

The FLW percentages from Table 1 are applied to the import volume of the Netherlands. Converted to impact, the chain stage division in $CO_2$ footprint as in Figure 3 results. With the highest FLW % in the import, discarded table grapes in this stage of the supply chain contribute the most to the GHG emissions along the chain.

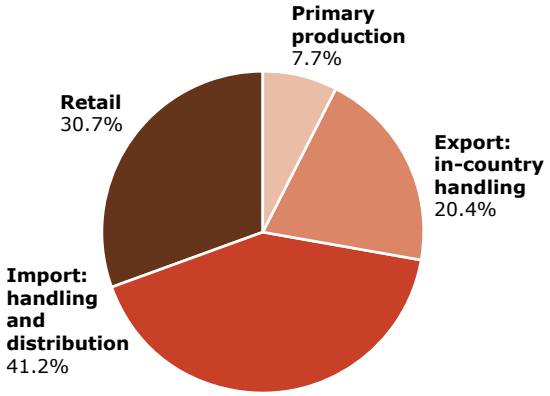


**Figure 3** Division of FLW associated GHG emissions along the supply chain for the Dutch table grapes import volume.

## Causes of FLW in each supply chain link

Table 3 shows the causes of FLW for table grapes in the international supply chain, per supply chain stage. As table grapes are a perishable food item, most causes are generic and also applicable to a variety of perishable food items. In the country of origin, the main root causes of food losses include products not meeting the specification, and uneven quality due to over maturity, type of variety and unskilled labour. The root causes of table grape discards at import and retail include low quality on arrival, progressive defects, and supply and demand planning.

**Table 3:** Causes of FLW in each supply chain link. Cause categories are provided in brackets.

| Supply Chain Link | Causes of FLW |
|---|---|
| Primary production | • Uneven quality including over-maturity, small (shot) berries, water berries, and physiological disorders (poor production practices leading to suboptimal starting quality for the product at harvest)<br>• Selection of only 1 or 2 export varieties (limited harvest windows, leading to over-supply during peaks)<br>• Selection of export varieties that are not demanded by the domestic market and lack of storage facilities (push-market agriculture leading to demand gap)<br>• Product dehydration due to unskilled labour, lack of awareness and capacity (poor harvesting and post-harvest practices [10])<br>• Shattered berries (lack of infrastructure for efficient logistics)<br>• Thrips, fruit flies or fruit worms (pest damage or disease infections [10]) |
| Export: in-country handling | • Dehydration, shattered berries, mechanical damage, bruising, inoculum diffusion and increase in pathological infections (damage due to inadequate packaging)<br>• Mixed loads with suboptimal conditions (temperature and relative humidity)<br>• Product not meeting specifications due to over-maturity, product variety, unskilled labour and climatic damage (non-conformance with export standards) |
| Import: handling and distribution | • Shattering, pathological decay, water berries and mechanical damage (quality rejection at arrival)<br>• Temperature and relative humidity setting (inadequate conditions during transit) |
| Retail | • Progressive defects, shrivelling, rot and lack of cooling areas in the shelves to display all table grapes in the refrigerator (inventory management [10])<br>• Selecting the most beautiful table grapes (consumer preferences [10]) |

## Interventions to prevent and reduce FLW

Potential interventions for FLW reduction for table grapes, per supply chain stage, are provided in Table 4. The interventions are classified into three categories: hardware, software and orgware[4]. Addressing all three categories ensures a comprehensive approach to developing strategies to decrease FLW. Most potential interventions presented can be implemented in all type of international fresh fruit supply chains. Main intervention to tackle the root causes of FLW for table grapes include implementing Good Agricultural Practices (GAP), improving communication, coordination, planning and forecasting with suppliers and clients, and using demand and forecasting technology. Root causes cannot

4 Hardware, software and orgware interventions = Hardware interventions refer to the physical assets that are needed to adequately handle and preserve the product throughout the chain. Software interventions are related to the skills, knowledge and communication that guide daily operations and decision-making. Orgware interventions relate to the organisational aspect, being about the roles and responsibilities throughout the chain [10].

**Table 4** Potential interventions for FLW reduction per supply chain link. Source: Literature and expert consultation.

| | Hardware | Software | Orgware |
|---|---|---|---|
| **Primary production: growth** | • Spray with sufficient air support to protect all crops against pests and diseases<br>• Well-designed trellis system to allow an airflow through the plants | • Good Agricultural Practices (GAP) to increase the growth and quality of the product.<br>• Farm management software based on real-time data to assure optimal growth | • Timely supply farm input to assure optimal growth and quality<br>• Harvest (window) planning and diversification of varieties (early/late varieties) to match supply and demand volumes |
| **Primary production: harvest & post-harvest** | • Crates/foam protection to reduce bumping | • Post-harvest Standard Operation Procedure (SOP) to maintain the quality of the product<br>• Trained staff to maintain quality during handling<br>• Knife- and clippers disinfection protocol to reduce risks of pests and diseases<br>• Data registration software to improve transparency in the supply chain, so other actors can act when a low-quality batch arrives | • Deploy outlets or utilization pathways for harvested products not fit for export to match supply and demand volumes |
| **Export: in-country handling** | • Trucks for transport to packhouse to minimize bumping and manage the capacity<br>• Cleanable packhouse with hygienic conditions (hand washing) to reduce risks of pests and diseases<br>• Forced-air precooling and cooling in packhouse to reduce quality decay<br>• Air humidification and liners to maintain relative humidity and therefore the quality of the product<br>• Packing line for clamshells, punnets or top-seal to maintain micro climate and reduce handling moments<br>• Transit settings following system to monitor and adapt settings during oversea transport | • Post-harvest handling Standard Operation Procedure (SOP) to maintain the quality of the product<br>• Training of staff to maintain quality during handling<br>• Hygiene- and cleaning protocol to reduce risks of pests and diseases<br>• Temperature and relative humidity measurement in cold storage and packhouse to correct settings and maintain the quality of the product | • Timeslots for packhouse delivery to decrease waiting time at arrival |
| **Import: handling and distribution** | • Demand and forecasting technology to match supply and demand<br>• Automatic side-stream monitor system to understand the causes and act upon it the next time | • Compatibility, temperature and ethylene management in the warehouse to avoid over-ripening<br>• Efficient and quick quality checks to reduce delay and therefore quality decay after reefer delivery | • First-expired-first-out warehouse management system to minimize time in the warehouse for all products<br>• Delivery based on weekly programs with clients to match supply and demand |
| **Retail** | • Quality-based pricing system to sell also the low-quality products<br>• Automatic side-stream monitor system to understand the causes and act upon it the next time | • Compatibility, temperature and ethylene management in the shelfs to avoid over-ripening<br>• Dynamically lower the price when supply exceeds demand to increase the demand | • Revision of the aesthetic standards to lower the rejection of edible food on cosmetic grounds in preceding supply chain links<br>• Promotion of imperfect fruits and vegetables, and products made from ingredients that otherwise would be wasted to increase the demand |

always be tackled by simply investing in one intervention. Often losses found in one part of the supply chain are already caused further upwards in the supply chain. For example, table grapes sorted out at arrival at the importer due to bruises received the bruises due to transport or the packaging that was used in the producing country. Therefore it is needed to collaborate with other actors in the supply chain to efficiently reduce FLW.

## Further readings

Interesting material for further readings for companies, branch organisations, policymakers and other interested stakeholders include:

- Fresh Knowledge: Become a postharvest expert. https://www.freshknowledge.eu/en.htm
- EFFICIENT protocol. Take the "Target, Measure, Act" approach to reduce food waste? Yes, but be pragmatic about it. https://www.wur.nl/en/research-results/research-

institutes/food-biobased-research/show-fbr/take-the-target-measure-act-approach-to-reduce-food-waste-yes-but-be-pragmatic-about-it.htm
- The FLW cause and intervention tool. https://the-efficient-protocol.azurewebsites.net/
- Broeze, J. (2019). Agro-chain greenhouse gas emissions (ACE) calculator. Wageningen, the Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Agro-Chain Greenhouse Gas Emissions (ACE) calculator (cgiar.org)
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2 CBS (2021). Goederensoort naar land; natuur, voeding en tabak, 2008-2021. Accessed 07-08-2023. https://opendata.cbs.nl/#/CBS/nl/dataset/81267ned/table

3 Agrimatie (2021). Handel in agrarische goederen – groenten en fruit. Groenten en Fruit: Nederland Brengt eigen en internationaal aanbod samen. Accessed 07-08-2023. https://agrimatie.nl/ThemaResultaat.aspx?subpubID=2232&themaID=2276

4 Ministerie van Landbouw, Natuur en Voedselkwaliteit (2022). In 2021 blijvend sterke rol Nederlands handel groenten en fruit. Accessed 07-08-2023. https://www.agroberichtenbuitenland.nl/actueel/nieuws/2022/01/13/in-2021-blijvend-sterke-rol-nederlandse-handel-groenten-en-fruithttps://www.agroberichtenbuitenland.nl/actueel/nieuws/2022/01/13/in-2021-blijvend-sterke-rol-nederlandse-handel-groenten-en-fruit

5 FAOSTAT (2021). Trade – Crops and livestock products. Retrieved from FAOSTAT. https://www.fao.org/faostat/en/#data/TCL

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7 Blanckenberg, A., Opara, U. L., & Fawole, O. A. (2021). Postharvest losses in quantity and quality of table grape (cv. Crimson seedless) along the supply chain and associated economic, environmental and resource impacts. *Sustainability*, 13(8), 4450. https://www.mdpi.com/2071-1050/13/8/4450

## Take-home message

**Facts and figures**

- The percentage of Food Loss and Waste (FLW) in the international supply chain of table grapes to the Netherlands from primary production till and including retail is 14.3% in total, with the highest percentage of FLW occurring in the importing country. Estimated FLW associated greenhouse gas emissions increase from 0.52 kg $CO_2$-equivalents per kg table grapes at primary production to 1.24 at retail for Dutch imports of table grapes.
- The main root causes of FLW for table grapes in the country of origin include products not conforming to export specifications, and uneven quality due to over maturity, type of variety and unskilled labour. The root causes of FLW for table grapes arriving in the Netherlands include low quality on arrival, progressive defects, and mismatch between supply and demand.
- The main interventions for FLW reduction for table grapes include implementing GAP, and using communication, coordination, planning and forecasting technology with suppliers and clients.

**Where to begin?**

- Implement the target-measure-act strategy and make use of the tools of the FLW toolbox at www.foodloss-solutions.com.
- Concrete actions and targets
- Actions: Set targets for your own organisation and monitor the side streams, discuss the causes of FLW, determine reduction strategies, allocate capacity, formulate a business case, discuss challenges with chain partners, and evaluate the results.
- Targets: Connect your targets with the SDGs. Achieving targets is feasible when tackled jointly in the supply chain with support of a wider network of stakeholders.

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9 Louw, L. (2017). *Economic aspects of losses and waste: Case study of the South African table grape supply chain* (Doctoral dissertation, University of Pretoria). https://repository.up.ac.za/bitstream/handle/2263/65496/Louw_Economic_2017.pdf?sequence=1&isAllowed=y)

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## Contact

Do you want to start with the Target-Measure-Act approach to monitor and reduce your Losses and Waste in the grape supply chain? Please do not hesitate to contact us.

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Project Website FLW Toolbox URL
www.foodloss-solutions.com

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