Food loss Solutions

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Target-Measure-Act: Less Food Loss and Waste in Dutch green beans 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 green bean 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.

Green bean market

Green beans are among the top 10 consumed vegetables in the Netherlands [1]. The domestic production accounted for 60.6 kilotons in 2021 [2]. Outside the harvesting season, the Dutch market is also dependent on its import, mainly from Mediterranean- and African countries (e.g. Morocco, Senegal and Spain) [3]. A substantial amount of the produced and imported green beans is (re-) exported to Belgium, Germany and France, showing the pivotal role of the Netherlands in the distribution of fruits and vegetables to the rest of Europe. See Figure 1 for the trade profile of green beans for the Netherlands.

Figure 1 Import and export of green beans in the Netherlands (2021).[1] Source [4].

In the context of global trade, the Netherlands account for 9.9% of the total volume of imported green beans worldwide [5]. These substantial import and export volumes come with potentially significant Loss and Waste along the supply chain, underscoring the importance of addressing FLW.

1 These numbers are the most recent national statistics published.

Table 1 Sample size, and FLW percentage + standard deviation for green beans.

Supply chain stage (simplified)	**Primary production**	**Export** in-country handling	**Import** handling & distribution	**Retail**
SIFAV data	2.7% ± 0.01% N=3	4.9% ± 0.03% N=3	3.5% ± 0.7% N=3	No data
Literature	30.2% N=4	22.5% N=3	N/A	4.9% N=1

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

FLW in the international green bean supply chain

The green bean supply chain consists of multiple actors that all add value to the product, for example by producing, transporting, and topping and tailing the green beans. Every green beans supply chain link differs, as individual companies are involved who all conduct different activities at their entity. In general, actors in the international green beans 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 green beans, and post-harvest activities on-farm such as washing, sorting and packing. Activities at the export stage include all activities performed after farm gate, prior to shipment, which can include for example packing, storage and transport. The import stage includes all activities from overseas and -land 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 as collected by SIFAV members[3], and the average FLW percentages found in literature. The green beans production and export countries included in the sample of SIFAV were Senegal, Netherlands and Morocco.

The reported SIFAV data is strongly deviating from the data reported in literature. At the primary production stage, the reported percentage of 2.7% is significantly lower than the values found in literature [6, 7, 8, 9]. A potential explanation *could* be varying farm sizes, where bigger farms show higher levels of efficiency and vice versa. The same holds for the export stage [6, 7, 9]. Here, the inclusion or exclusion of topping and tailing in FLW figures could be an explaining factor. Literature data for losses incurred at the import stage were not found. At the retail stage, only one literature source was found, reporting a FLW percentage of 4.9% [10].

Destinations of FLW in the green bean supply chain

Green beans 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 these rejected green beans as reported by SIFAV. In the primary production, export and import stages, animal feed is used as destination for the green bean side streams. Additionally, during primary production, produce is ploughed back into the soil; at the exporting stage, rejected green beans are directed to composting; and at the importing stage, rejected green beans are used for anaerobic digestion.

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 or productive use. Productive use includes animal feed, industrial use, and other uses. Deviating from the FAO (2019) definition, feed is reported as being FLW in the SIFAV data.

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

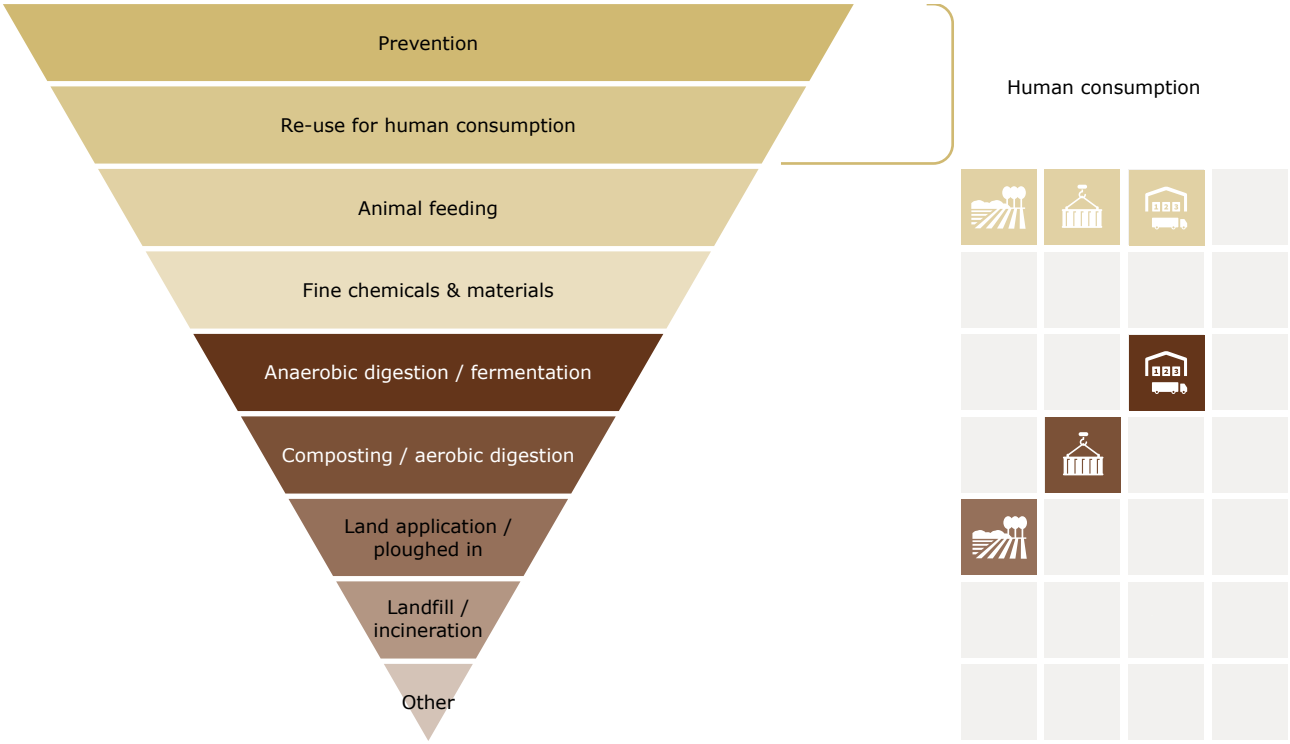

Figure 2 Destinations of discarded green beans. The visualisation is based on 'Moerman's Ladder', which ranks the value of valorisation options from high to low. The icons correspond with the supply chain stages, and the presence of an icon indicates that at least one actor mentioned this category as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

Greenhouse gas impact of green bean 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 green beans 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 green beans imports to the Netherlands. Combined with the volumes per exporting country a weighted average of the emission factors per chain link results. 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 green beans 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 green beans along the green beans 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 green beans	0.20	0.62	0.68	0.70

The SIFAV 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 export chain stage, discarded green beans in this stage of the supply chain contribute the most to the GHG emissions along the upstream chain.

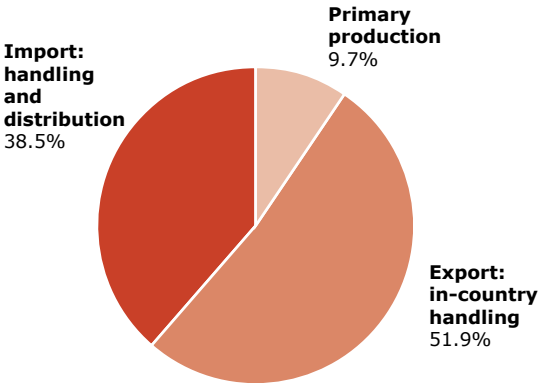

Figure 3 Division of FLW associated GHG emissions along the supply chain for the Dutch green beans import volume.

Causes of FLW in each supply chain link

Table 3 shows the causes of FLW for green beans in the international supply chain, per supply chain stage. As green beans are a perishable food item, most causes are generic and also applicable to a variety of other perishable food items. The main root causes of FLW for green beans are pest damage and disease, poor post-harvest conditions and topping and tailing.

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

Supply Chain Link	Causes of FLW
Primary production	• Insufficient availability of labour to harvest the beans (farm input) [6] • Physical damage occurs during harvesting (poor harvesting practices) [6] • Exposure to direct sunlight after harvesting causing dehydration and lack of harvesting crates (poor post-harvest practices) [6] • Russeting (pest damage or disease) [7] • Beans do not meet quality standard (weather conditions and consumer preferences) [7] • Last-minute order cancellations (unfair trading practices) [9] • Quality of irrigation water. Beans are quite salt-sensitive, already at medium salinity levels, causing yield reduction and weaker plants
Export: in-country handling	• Bruising of green beans (damage due to inadequate packaging) [6] • Dehydration and fungal infection (inadequate storage conditions) [6] • Shape deviating from cosmetic specifications and topping and tailing the green beans more than necessary (non-conformance with export standards) [9] • Last-minute order cancellations (unfair trading practices) [9] • Time between harvest and cooling too long due to lack of cooling facilities at collection centres and/or delayed supply to collection centres e.g because farmers practice a time-consuming on-farm pre-selection • Inappropriate (too low) cooling temperature (optimal 7 C) due to combined storage or transport with snow peas (optimal 0 C) because these crops are often grown for the same clients.
Import: handling and distribution	• Progressive defects; shrivelling and rotting (quality rejection at arrival)
Retail	• Brown discoloration (suboptimal storage conditions) • Overstocking (inventory management) • Oddly shaped green beans (consumer preferences)

Interventions to prevent and reduce FLW

Potential interventions for FLW reduction for green beans, 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 fruit and vegetable supply chains. Main interventions to tackle the root causes of FLW for green beans include pest-preventing measures and (pre)cooling. Root causes cannot 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, green

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 • Improved on-farm practices (e.g. wind breaks) [6]. • Improved post-harvest practices (e.g. shade to prevent dehydration) [6].	• Good Agricultural Practices (GAP) to increase the growth and quality of the product • Farm management software based on real-time data to assure optimal growth which includes the right balance between leaf growth and beans growth	• Timely supply farm input to assure optimal growth and quality • Harvest (window) planning and diversification of varieties (early/late varieties) to match supply and demand volumes • Arrangements to protect farmers against the risk of produce rejections [9]
Primary production: harvest & post-harvest 		• Post-harvest Standard Operation Procedure (SOP) maintain the quality of the product • Trained staff to maintain quality during handling • 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 • Cleanable packhouse with hygienic conditions (hand washing) to reduce risks of pests and diseases • Forced-air precooling to maintain the quality of the product. In case of outgrowers at several-hours distance from packhouse, assure availability of a collection centre with precooling plus cooled transport to packhouse • Transit settings following system to monitor and adapt settings during oversea transport • Only topping the green beans (instead of topping and tailing) [9]	• Post-harvest handling Standard Operation Procedure (SOP) to maintain the quality of the product • Training of staff to maintain quality during handling • Hygiene- and cleaning protocol to reduce risks of pests and diseases	• Timeslots for packhouse delivery to decrease waiting time at arrival
Import: handling and distribution 	• Demand and forecasting technology to match supply and demand • Automatic side-stream monitor system to understand the causes and act upon it the next time	• Efficient and quick quality checks to reduce delay and therefore quality decay after reefer delivery or air freight delivery	• First-expired-first-out warehouse management system to minimize time in the warehouse for all products • Delivery based on weekly programs with clients to match supply and demand
Retail 	• Quality-based pricing system to sell also the low-quality products • Automatic side-stream monitor system to understand the causes and act upon it the next time • Store green beans below 9 degrees Celsius to prevent brown discoloration. • Store above 5 to 6 degrees Celsius to avoid chilling injury	• 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 • Promotion of imperfect fruits and vegetables, and products made from ingredients that otherwise would be wasted to increase the demand

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 [11].

beans 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 organizations, policymakers and other interested stakeholders include:

- Fresh Knowledge https://www.freshknowledge.eu/en/knowledge-database/crops/green-bean/research-results-green-beans.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
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Take-home message

Facts and figures

- The percentage of Food Loss and Waste (FLW) in the international supply chain of green beans to the Netherlands from primary production till and including retail cannot be calculated as the FLW% of green beans in the retail supply chain stage is lacking. When using the data from literature for the retail sector, the total percentage of FLW is 15.1% in total, with the highest percentage of FLW occurring in the export- and retail supply chain stage. Estimated FLW associated greenhouse gas emissions increase from 0.20 kg CO_2-equivalents per kg green beans at primary production to 0.70 at retail for Dutch imports of green beans.
- The main root causes of FLW for green beans include pest damage and disease, poor post-harvest conditions and topping and tailing.
- The main interventions for FLW reduction for green beans include pest-preventing measures and (pre) cooling.

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 FLW volumes, 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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Contact

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

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