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Recommendation of Good Practice in the Food-Processing Industry for Preventing and Handling Food Loss and Waste

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Abstract: Food-processing companies are controlled by societal influences and economic interests, but their efforts with regard to reducing food loss and waste are very different. This qualitative study aims to identify basic recommendations of good practice for the food-processing industry in order to prevent and handle food loss and waste. For this purpose, a comprehensive literature review was conducted in the field of food waste prevention and data was collected from thirteen German companies. The findings summarize the recommendations of good practice, which cover the entire supply chain from supplier to consumer and beyond. The analysis showed that the participating companies are already partially aware of operational measures, even if they are applied or mentioned without a systematic approach. Furthermore, the analysis revealed that most activities relate to internal matters, like processing, employees and utilization. However, the responsibility of food-processing companies does not end with internal processes to reduce food waste. The results show that some companies are already aware of their responsibility to be involved along the entire supply chain. Finally, the results show that the needs of consumers and suppliers must also be considered in order to reduce food waste, in addition to direct reduction measures. This paper highlights nine important stages and 53 basic recommendations for companies to address food loss and waste in order to improve their practices.

Keywords: food waste; food loss; good practice; food-processing industry

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1. Introduction

Ninety million tons of food waste are generated every year in the European Union (EU) [1] and 12m tons of food waste are generated along the entire food supply chain in Germany alone [2]. According to the World Wide Fund for Nature (WWF) [3], more than half of this waste could be avoided. These unused foods, accompanied by an excessive exploitation of resources, lead to economic, ecological, moral, and social problems [4–9]. This use of resources does not meet the definition of sustainable development, which is to fulfil "the needs of the present without compromising the ability of future generations to meet their own needs" [10]. As a consequence, food waste reduction is an important part of establishing food security with the same relevance as energy efficiency [11,12]. The EU joined the United Nation's Sustainable Development Goals (SDG) [13] which include, inter alia, the specific goal (12.3) to halve food waste at the retail and consumer levels and to reduce food losses along supply chains by 2030 [14]. Based on the SDGs, Germany developed a national strategy for reducing food waste [15]. In particular, the food-processing industry, aside from any political considerations, has an active interest in an efficient use of resources in order to preserve their economic resources [16]. According to the Federation of German Food and Drink Industries [17], the management of operating costs is one key success factor [17] in the fight against a decline in sales, rising risks of acquisition, and the rising cost of energy and resources [18]. Product innovations and

process improvements, that also include suppliers, are a solution for this worldwide increasing challenge [18]. Therefore, dealing with food waste can also be one way to stand out from the competition in the food market [16].

1.1. Food Waste and Food-Processing Industrie

Several studies show that some food-processing companies have already taken initiatives [19]. Some have even implemented measures to reduce food waste [16,20]. Compared to other stages of the food supply chain, the reduction potential of food waste in processing is rather low [3]. However, food-processing companies are responsible for up to 18 percent [2] of the total food waste in Germany. It is assumed that 10–55 % of food loss and waste can be classified as avoidable during processing [2,3]. Companies produce different amounts of food waste for different reasons. Emerging food loss and waste are based on business decisions, inefficient management, quality assurance, or the general handling of food (storage and preparation) [20–25]. The generation of food loss and waste depends on the technology being used and on the nature of the food itself [23,26–29] (e.g., fresh products with a short shelf life [27]). Furthermore, current food manufacturing practices and food waste practices are largely influenced by culture, values, society, and the environment [30,31].

In addition, reducing food waste is a matter of business commitment. Heikkilä et al. [25] show that business concepts, management, and communication are important elements in reducing food waste. The High Level Panel of Experts on Food Security and Nutrition (HLPe) [32] implies that good practice saves food and helps to reduce waste, from the raw materials to the consumer. The implementation of good practices can be an effective starting point in reducing food waste [9]. However, the WWF [3] points out that a good practice for preventing food waste does not yet exist for food-processing companies. There are theoretic approaches, which are not based on practical experience [8]. Previous good practices were focused only on the food service or hotel sector [33–35]. Other previous studies focused on general waste management [36], analyzed ways of utilization for the food-processing industry [37], or developed a manual to minimize generating food waste [38]. These studies focused only on measures within companies' boundaries, although Oladepo et al. [39] said that "there is a need to make the individual food-processing firm responsible for the management of waste generated before and after product sale." Furthermore, Göbel et al. [27] advocated for businesses to pay attention to the earlier stages of the food supply chain. There must be a change in business behavior towards more sustainable food production [40]. Therefore, Jepsen et al. [8] described an idea of a documented good practice for food processing companies, which includes the prevention and treatment of food waste. In additional, Marthinsen et al. [19] suggested extending producer responsibility, so that producers would take responsibility for the entire food supply chain. Nevertheless, to date, there is no one good practice with unified commitments, basic recommendations, and extended producer responsibility for food-processing companies.

1.2. Aim of the Study

This study aims to fill this gap by developing recommendations for good practice in the food-processing industry in order to prevent and handle food loss and waste along the supply chain. These recommendations should then support food-processing companies to address the issue of food loss and waste, as well as providing the necessary support to improve their own practices. These recommendations are not a set of absolute guidelines supported by explicit methods. These recommendations are basic recommendations for companies to address the issues of food loss and waste. In order to elaborate on the recommendations of good practice, the ideas about good practice proposed by Jepsen et al. [8] and the extended producer responsibility outlined by Marthinsen et al. [19] were taken up and combined. In this study, we conducted a qualitative content analysis based on an exploratory survey and a comprehensive literature review in order to answer the following research questions (RQ): (i) what defines good practice within the food-processing industry

in order to prevent and handle food loss and waste? (ii) What is the scope of responsibilities for food-processing companies? (iii) What measures and recommendations do these scopes include for food-processing companies?

In conformity with FUSIONS [41], the terms "food loss" and "waste" are used synonymously to denote remaining materials which are removed from processing for utilization in this study.

2. Materials and Methods

To answer the RQs, a survey of experts from the food-processing industry was conducted. The results of the survey were structured, analyzed, and interpreted using qualitative content analysis to elaborate a category system of recommendations. Subsequently, in order to broaden the understanding of the elaborated recommendations, a context analysis was conducted to add additional material to the recommendations. For this purpose, a comprehensive literature review was also conducted to find suitable material. The information from the survey and the literature has been summarized to better explain each of the recommendations from the category system. In the following sections, the exact approach taken is explained.

2.1. Literature Research

A comprehensive literature review was conducted to obtain recommendations for the food-processing industry for preventing and handling food loss and waste. The search was conducted through search engines (Science Direct and Google Scholar) by using the following key words "food waste" and "food loss", in combination with "+ food industry", "+ practice", "+ preventing", "+ handling", "+ reducing", "+ management", "+ measure", "+ requirements", "+ recommendations", and "+ food service industry". The search was limited to documents published in English between 2007 and 2021. First, in order to identify relevant documents for this research, titles and abstracts of the documents were screened and examined for the keywords and references to the food-processing industry and food service industry. Moreover, documents were also classified as relevant if they concerned the transition between supplier and company or between company and retailers or consumers. In addition, the reference lists of these documents were analyzed following the same principles. In total, 231 documents were identified as relevant.

Secondly, the selection was further limited to studies containing recommendations for the prevention and management of food losses and waste for companies and for contact between companies and suppliers, companies and retailers, as well as companies and consumers. For this purpose, the introduction and the conclusion were read and examined to identify references to such recommendations. Subsequently, the documents with references to recommendations were read in their entirety and selected for our study.

In total, 75 documents were selected for the content analysis. In particular, 53 peer review articles, 13 scientific reports, four conference/workshop papers, and five guidelines (i.e., guides for catering sectors) were analyzed. The scientific articles were drawn from 24 different journals and more than half of all the documents were published after 2014. The documents concern a number of different subjects: the entire food supply chain (37 documents), the food service industry (17 documents), the food-processing industry (17 documents), and retail and suppliers (4 documents).

Furthermore, the selected documents were examined for relevant text passages that represent recommendations for food processing companies and food waste. These passages were marked accordingly.

Finally, 545 passages were marked and classified, using Microsoft EXCEL, into the following stages of the food supply chain: upstream supply chain (for recommendations which concern the relationship between the supplier and company), company level (for recommendations which are aimed at the company), downstream supply chain (for recommendations which concern the relationship between retailers, consumers, and the company), and beside the supply chain (for recommendations which concern other activi-

ties). Based on the classified passages, the documents were sorted into several stages of the food supply chain. Table 1 shows the stages with the selected documents.

Table 1. List of the selected documents, sorted according to the stages of the food supply chain.

Stages	Description	References	No.
Upstream supply chain	Recommendations which concern the supplier and company relationship	[9,19,20,23,25,29,31–36,42–53]	24
Company level	Recommendations which are aimed at the company	[1,3,7–9,16,19,20,22–25,27,31–40,42–88]	70
Downstream supply chain	Recommendations which concern retailers, consumers, and company relationship	[9,16,19,20,22,23,25,31,35,42,44–46,49–53,58,65,69,71,76,79,80,82,89–91]	30
Beside the supply chain	Recommendations which concern other activities	[33,35,36,39,42,46,51,55,58,65,74,88]	12

2.2. Exploratory Survey

Following the literature research, an exploratory survey was conducted to obtain recommendations for good practices regarding food loss and waste from food-processing companies. Therefore, an open qualitative questionnaire and interview guide were developed [92], addressing German food-processing companies. In order to reach as wide a variety of companies as possible, one hundred companies were randomly selected in varying proportions from the following five online lists: 25 companies from the top 100 food suppliers in Germany [93], 25 companies from the group of the Federation of German Food and Drink Industries [94], 20 companies from the group of the Food—Made in Germany e. V. [95], 15 companies from the group of the Ernährung-NRW e. V. network [96], and 15 winners of the German sustainability award between 2010 and 2016 [97]. The list of Food—Made in Germany e.V. presorted the companies into ten subsectors [95], from each of which two companies were randomly selected in order to increase the diversity of the subsections. In total, 92 companies were contacted in spring 2017 after deducting duplications. The interview request was sent to one half of the selected companies and the questionnaires were sent to the other half via e-mail. However, targeted interview requests were sent to the winners of the German Sustainability Award. The requests were addressed to people who are in contact with quality management, environment management, food waste or sustainability management. Based on the idea of Jepsen et al. [8] and Marthinsen et al. [19], the following questions were asked in order to address the RQs:

- What is your understanding of a good practice within the food-processing industry in order to prevent and handle food loss and waste?
- What would be the scope of responsibility for food-processing industry in order to prevent and handle food loss and waste?
- Which recommendations are necessary and particularly important in order to prevent and handle food loss and waste?

The first question was used as an introductory question to approach the topic. In the second question, participants were asked for their opinions on the limits of responsibility. Finally, the third question asked about individual recommendations.

The interviews were conducted via phone or face-to-face and were recorded and transcribed verbatim [98]. The average duration of the interview and the questionnaire was 30 minutes. In total, 92 companies were directly addressed via mail and phone, and 13 German food-processing companies participated (representing a response rate of 14.13%). Most of the companies did not respond or declined the questionnaire or interview, with the following justifications: too little time, no capacity, they do not give interviews, or they have not yet dealt with food waste. The data set consists of four completed questionnaires and nine conducted interviews.

2.3. Sample Description of the Survey

The characteristics of the 13 German food-processing companies who took part in the study and shared their information are shown in Table 2. The companies belonged to seven different food industry subsectors: confectionery, meat products, bakery and farinaceous products, spices and tea, various convenience products, beverage, and fish and seafood products. They were small- and medium-sized enterprises, ranging from under 100 employees to over 1000 employees. All participants were in leading positions with a direct connection to the issue of food loss and waste as the business manager, assistant to the management, corporate social responsibility director, public relations director, environmental, health and safety director, or quality assurance director. The company shortcuts from Table 2 are used to uniquely document and identify the companies in the results.

Table 2. Interview partners of the survey.

Company Shortcut	Industry Subsector	Employees	Position of Interviewee	Method [1]
C1	Confectionery	>1000	Public relations director	Q
C2	Meat products	<100	Business manager	Q
C3	Confectionery	>1000	Corporate social responsibility director	Q
C4	Meat products	501–1000	Waste management director	Q
C5	Meat products	>1000	Public relations director	I
C6	Bakery and farinaceous products	101–500	Assistant to the management	I
C7	Confectionery	101–500	Public relations director and environmental, health and safety director	I
C8	Spices and tea	101–500	Corporate social responsibility director	I
C9	Confectionery	>1000	Corporate social responsibility director	I
C10	Various convenience products	>1000	Quality assurance director	I
C11	Beverage	101–500	Environmental and energy management director	I
C12	Various convenience products	>1000	Quality assurance and product development director	I
C13	Fish and seafood products	<100	Quality assurance director	I

[1] Q = questionnaire; I = interview.

2.4. Data Analysis and Elaboration of Recommendations

In total, results from thirteen surveys and 75 documents are available for data analysis and for the development of recommendations. In order to answer the RQs, the qualitative data from the surveys and literature reviews were analyzed and interpreted using qualitative content analysis [99], MAXQDA 2020 (20.0.7.), and Microsoft Excel.

First, to determine the scope of responsibility (RQ ii), the surveys were structured on a case-by-case basis using deductive content analysis [99]. For this purpose, existing theory-based categories were selected, anchor examples were taken from the text and coding rules were established. The defined categories were based on the classification of the literature in Table 2 and were similar to the stages of the food supply chain: upstream supply chain, company level, downstream supply chain, and beside the supply chain. In addition, the minimum and the maximum units for the coding units had to be specified. The minimum unit of a coding unit were single words and the maximum units were the entire content of a survey.

Secondly, after structuring the text phrases into the stages, the content of each stage was summarized into categories using inductive categorization [99]. Therefore, the selection criterion and the degree of abstraction were set for the categorization. The selection criterion was every coding unit in which the participants described the scope of responsibility for a food-processing company. The abstraction degree of the categories was set from very high to single words in order to obtain generally relevant categories, such as company process steps.

Finally, the materials were analyzed sequentially, in the order in which they were collected, by formulating inductive coding categories. A category was formed from each text passage that matched the selection criterion. Similar elaborated categories were revised and combined into new categories. This process was carried out again to revise the categories, as half of the material was reached. Following this within-case analysis, the formulated categories were cross-case analyzed according to the same scheme. As a result, the category system was revised once more in order to reduce the number of codes even further. The results were the main codes that describe the area of responsibility of the companies.

To address RQ (iii), a second analysis was conducted by inductive content categorization. For this purpose, the selection criteria were comprised of explicit recommendations from the surveys. The degree of abstraction of the categories was set lower, in order to obtain meaningful recommendations with an appeal. The analysis followed the exact same structure as the previous one. The results were the explicit recommendations. These recommendations were further summarized into meaningful parent categories in order to provide guidance to the reader. In addition, the parent categories of the recommendations were sorted into the appropriate main codes as sub-codes.

In addition, to achieve a better understanding and implementation for the companies, the recommendations were explained using a contextual analysis [99]. For this purpose, the materials to be explained were determined, a narrow and a broad context analysis were conducted to find additional materials, and explanatory paraphrases were formulated. The materials to be explained were the recommendations from the content analysis. The material collection of the explanation consisted of the coded recommendation phrases as a narrow context and the marked text passages from the literature as a wide context. First, the marked passages were assigned to the appropriate recommendations in a Microsoft Excel sheet. Furthermore, the coded text phrases and the marked passages from the literature were paraphrased, generalized, reduced, and summarized to formulate explanatory paraphrases. These results are attached in the appendix of this paper as detailed description. The degree of abstraction was chosen so that the summarized recommendations can be used by companies.

Finally, all codes were sorted according to the stages of the food supply chain (Table 1), from farm to fork. The recommendations were labeled in the results Tables in the column "Companies and References", with the company shortcuts and explanatory literature from Tables 1 and 2. In addition, the main codes were quantified by the company shortcut.

The results from RQ (ii) and RQ (iii) are considered together as the answer to RQ (i). In total, nine main codes, 22 sub codes, and 53 recommendations with detailed descriptions were developed from the results of this exploratory study. The scope and the recommendations constitute good practice. The following sections describe each code.

3. Results

In general, the interviews and questionnaires showed that the participants had already implemented some measures in their manufacturing process or were familiar with the topic. This was evident from the given answers. The participating companies talked about their own activities which were already implemented, about plans which they are yet to implement, and about possibilities which can be devised. One company stated that it had not yet thought about good practice. However, the companies addressed different points which they considered important. Additionally, they displayed a range of different

understandings of the scope of responsibility for food-processing industry for preventing and handling food loss and waste (see Table 3). The scope of responsibility is described in detail using the main codes in the following section.

Table 3. Overview of the scope of responsibility for food-processing industry.

Stages	Main Codes	Companies (*n* = 13)	%	Company Shortcuts
	Entire food supply chain	3	23	C7,C9,C12
Upstream supply chain	Supplier level	6	46	C5,C6,C8,C9,C11,C12
	Procurement	7	54	C2,C3,C6,C8,C10,C11,C13
Company level	Internal prevention	13	100	C1–13
	Internal treatment	9	69	C1,C3,C4,C7–10,C12,C13
Downstream supply chain	Distribution	7	54	C1,C3,C5,C6,C8,C9,C11
	Consumer level	6	46	C3,C6,C8,C9,C11,C12
Beside the supply chain	Waste management providers	5	38	C1,C4,C7,C9,C10
	Other stakeholders	2	15	C9,C12

3.1. Scope of Responsibility for Food-Processing Industry

This section presents the answers from the second interview question which is in relation to RQ (ii), regarding the companies' area of responsibility. The scope of responsibility for the food-processing industry is outlined in the nine main codes: 'Entire food supply chain', 'Supplier level', 'Procurement', 'Internal prevention', 'Internal treatment', 'Distribution', 'Consumer level', 'Waste management providers', and 'Other stakeholders'. Table 3 shows the main codes and the stages of the food supply chain, with quantification and shortcuts of the companies.

In the opinion of all participating companies, the responsibility for good practice in preventing and handling food loss and waste starts with a focus on the company's own processes (*n* = 13; 100%) [7,64]. This most common response emphasizes how important it is for companies to prevent, reduce and utilize food losses and waste within their own company. However, according to Marthinsen et al. [19], the responsibility, along the entire food supply chain, should be integrated into an extended producer responsibility. According to the participants (*n* = 3; 23%), though, this should occur as a voluntary agreement. Hence, some companies expanded their scope of responsibility in order to prevent the shifting of food waste to other stages [38]. Therefore, the distribution should be highlighted [23,32,64]. In the survey, seven participants highlighted the distribution (*n* = 7; 54%) and another seven participants emphasized the importance of procurement (*n* = 7; 54%). Furthermore, this extension should also include suppliers (*n* = 6; 46%) and consumers (*n* = 6; 46%) in order to improve and learn more about the entire supply chain [7,27,36,48,65]. However, these participants described the extension of responsibility as, on the one hand, good practice and, on the other hand, as a possible additional extension by the participating companies (C7,C9,C12). No recommendations were assigned to the main code 'Entire food supply chain', due to the generality of this code.

3.2. Recommendations for a Good Food Loss and Waste Practice

In the following sections, the answers are presented from the third interview question which is related to RQ (iii), regarding recommendations for preventing and handling food loss and waste. The individual 22 sub-codes of the main codes are described in detail in the order of the stages of the food supply chain, from the suppliers to the consumers and beyond. In addition, the main code 'Internal prevention' was divided into 'Internal management' and 'Internal processes' due to its complexity and on the basis of numerous recommendations. These will be described separately from this point on. For each sub-code, the most frequently mentioned recommendations by companies, which are taken from the

most frequently named sub-codes of a main code, were described in detail. The detailed description of all 53 recommendations can be found in the Appendix A. The elaborated recommendations do not aim at a specific problem with specific methods, but they could serve as basic recommendations for companies to address food loss and waste to improve their practices. Table 4 shows all main and sub-codes with their absolute and relative quantification by companies.

Table 4. Overview of the main and sub-codes of the good practice with quantification.

Stages	Main Codes	Sub Codes	Companies (n = 13)	%
Upstream supply chain	Supplier level			
		Suppliers competence	4	31%
		Good cooperation	5	38%
	Procurement			
		Conditions of purchase	2	15%
		Raw material requirements	3	23%
Company level	Internal management [1]			
		Business strategy	2	15%
		Business goals	8	62%
		In-house transparency	5	38%
		Employees	8	62%
	Internal processes [1]			
		Raw materials	2	15%
		Process	10	77%
		Product and packaging	5	38%
	Internal treatment			
		Waste collection	4	31%
		Utilization of remaining materials	8	62%
		Analysis of remaining materials	5	38%
		Development of measures	4	31%
Downstream supply chain	Distribution			
		Good cooperation with the retail	2	15%
		Distribution planning	2	15%
	Consumer level			
		Consumer information	5	38%
		Consumer needs	2	15%
Beside the supply chain	Other stakeholders			
		Business to business exchanges	2	15%
		Joint activities	1	8%
	Waste management providers			
		Continuously inspection	2	15%

[1] Part of the main code 'Internal Prevention'.

3.2.1. Recommendations for Upstream Supply Chain

The first stage of good practice is the upstream supply chain, where the raw materials are produced and delivered by suppliers. At the supplier level, the competencies of suppliers are important in order to ensure good quality and low food waste. This is why the suppliers should also establish a good practice (C6,C8,C9), conduct quality controls (C8,C11) and ensure proper storage and transport to their customers (C8). For that, suppliers need support in order to distribute the responsibilities. Therefore, co-operations with suppliers should be established, as well as good communication (C4,C8,C9,C11), waste audits (C9), and other exchanges (C9, C12).

Furthermore, the conditions of purchase and the requirements of raw materials should be considered according to food waste. Hence, products should be ordered in appropriate quality levels (C9,C10), quantities (C2), and packaging (C13). Prior to this, raw material samples should be analyzed (C8). Table 5 shows the recommendations that refer to the supplier level and procurement.

Table 5. Recommendation for upstream supply chain.

Main Code	Sub-Code	Recommendations	Companies and References
Supplier level	Suppliers' competence	Establish a good practice	(C6,C8,C9) [9,32]
		Conduct quality controls	(C8,C11) [9]
		Ensure proper storage and transport conditions	(C8) [20,29,47,51,52]
	Good cooperation	Conduct supplier waste audits and reviews	(C9) [31,36,46,48]
		Cooperate with suppliers	(C4,C8,C9,C11) [25,31,49,51,52,58]
		Exchange best-practice with suppliers	(C9,C12) [36]
Procurement	Conditions of purchase	Order the appropriate quantities	(C2) [19,31,34,35,43–45,49,50,53,58]
		Analyze raw material samples	(C8) [51,52]
	Raw material requirements	Order a quality level appropriate to a company's own needs	(C9,C10) [23,33,42,53,58]
		Order raw material in appropriate product packaging	(C13) [58]

The most mentioned recommendation for the supplier level by companies is 'Cooperate with suppliers' (n = 4; 31%) within the sub-code 'Good cooperation' (n = 5; 38%). It points out that communication and cooperation with the supplier should be maintained and a common product development should be aimed for [25,31,49,51,52,58] (C4,C8,C9,C11). Besides, the cooperation can be expanded further by a common coordinated cultivation planning in regard to type and volume, so that no products are grown or produced to then be discarded afterwards (C8) (see Appendix A for details). The importance of cooperation with suppliers at the suppler level is also mentioned by most of the literature (six documents).

Within the research the literature mentions, it is also stated that suppliers should ensure proper storage in order to extend the shelf life of products and ensure proper transport conditions between suppliers and the own company [20,29,47,51,52] (C8). Hence, the transport chain should be improved in order to eliminate the risk of contamination (C8). In addition, the literature highlighted a need to 'Conduct supplier waste audits and

reviews' (four documents). This includes the requirement that suppliers be checked and evaluated by conducting waste audits [36,48]. Companies should check if their own raw material specifications increase the suppliers waste (C9). In such a case, the company's own quality and aesthetic standards should be revised [31,46] (C9).

'Order a quality level appropriate to a company's own needs' (n = 2, 15%) within the sub-code 'Raw material requirements' (n = 3; 23%) (five documents) is the most mentioned recommendation for the procurement. This recommendation points out that a quality level of raw materials should be used that meets the company's own needs. If it is possible and reasonable, by-products or farm surpluses should be purchased from the supplier and used as raw materials by the company [23,33,42,53,58] (C9,C10). The raw materials should be reusable, recyclable or compostable [33] (see Appendix A for details). In contrast, the appropriate quantities is most frequently mentioned within the main code 'Procurement' in the reviewed literature (11 documents).

3.2.2. Recommendations for Internal Management at the Company Level

Management is the base of a company. As such, good practice should start at the management level, so that good practice can be implemented throughout the company and values can be communicated. Therefore, the first priority for a company is the business strategy (C5,C12). A food processing-company should take food waste into account within the business strategy in accordance with the organizational culture and should derive measures for all departments (C12). In addition, company goals should be defined (C6,C12) that relate to the avoidance of food waste (C1,C5,C9,C10,C12,C13), food safety (C12) and legal requirements (C1,C4), so that the company can inspire employees by acting as a role model (C9).

In addition, in-house transparency should be extended and established as an important point for monitoring and documenting process parameters, as well as activities related to food waste. Therefore, key performance indicators should be developed, monitored (C9,C12,C13), and reported (C6,C7). A company cannot function without employees. For this reason, interdisciplinary cooperation should be established (C6,C7) and the employees should be trained (C4–10,C13) and put in charge (C5). Table 6 shows the internal management recommendations.

Table 6. Recommendations for internal management at company level.

Main Code	Sub-Code	Recommendations	Companies and References
Internal management	Business strategy	Develop a business strategy	(C5,C12) [31,34,38,43,48,49,53,57,69,74]
		Derive measures	(C12) [49,52]
	Business goals	Avoid food waste	(C1,C5,C9,C10,C12,C13) [3,8,19,33,36,42,58,76,79]
		Adjust goals	(C6,C12) [7,19,35,46,65,73]
		Ensure food safety	(C12) [31,33,45,48,58]
		Work within the legal requirements	(C1,C4) [39,48,53,55,88]
		Inspire and act as a role model	(C9) [19,35,38,73–75]
	In-house transparency	Develop and monitor key performance indicators	(C9,C12,C13) [19,20,25,31,33,35,38,47,48,55,74–76]
		Report activities	(C6,C7) [16,19,25,31,38,53]
	Employees	Train employees	(C4-10,C13) [9,16,19,20,22–25,31,33–36,38,43,44,46–48,50,51,53,58,73–75]
		Ensure interdisciplinary collaboration	(C6,C7) [55,58,73,74]
		Put persons in charge	(C5) [20,33,35,43,46,48]

Both, the sub-code 'Business goals' (n = 8; 62%) and the sub-code 'Employees' (n = 8; 62%) have received the highest number of nominations. The recommendations 'Avoid food waste' (n = 6; 46%) and 'Train employees' (n = 8; 62%) are the most mentioned by companies in the management sector.

'Avoid food waste' is the most mentioned goal within the 'Business goals'. Thereby, the avoidance and prevention of food loss and waste is considered the top priority, followed by recycling (see Table 6). As a goal, companies should try to realize zero waste in their own company [19,36] (C5,C9). For this purpose, companies should have an economic interest in reducing their food waste treatment (C5,C10,C12). Besides, they should also pay attention to the ethical aspects of food waste (C5) (see Appendix A for details).

The 'Train employees' recommendation states that a food waste reduction culture should be implemented among employees in order to internalize prevention and handling practices. Therefore, the employees should be trained in the prevention measures of food waste directly at the machines, in the collection and separation of remaining food waste, in the proper and reasonable handling and processing of raw materials and food, in the cherishing of raw materials and food, and in good hygiene practices (C4,C6,C7,C8,C13) (see Table 6). Accordingly, this training should be carried out on a regular basis (C7). In addition to the knowledge regarding handling and processing, the training should sensitize and motivate employees to increase their awareness, understanding, sense of responsibility and conscientious working practices in relation to food waste [22,34,36,38,43,48,58,75] (C5,C7,C9,C10). The employees should be empowered and encouraged to consult with superiors and to share their experiences and suggestions for improvements to reduce food waste [24,35,43] (C7,C10). Hence, a certain level of trust should be established by the management [38,74] (see Appendix A for details). The training of employees within the main code 'Internal management' is also frequently mentioned within the reviewed literature (36 documents).

3.2.3. Recommendations for Internal Processes at the Company Level

In addition to all the recommendations regarding the management level, good practice concerns the processing itself, from the raw materials through to the processing of the finished and packed product. First, the delivered raw materials should be checked with regard to quality criteria (C8,C11). In general, food should always be handled with care (C8,C11). Furthermore, good storage and transport conditions around processing should be ensured (C2,C7,C8), so that nothing will be spoilt. Before the raw materials are processed further, processes should be well-planned in order to establish a material cycle with the overall aim of processing all raw materials into finished products without any losses (C3–C5,C8,C10,C11,C12). Therefore, food loss rates, batch sizes, and prevention strategies should be developed for individual processes (C10,C11,C12). The finished product and the packaging should be of a guaranteed quality, according to the needs of customers (C3,C8,C10,C11,C12). Moreover, products and packaging should be designed in order to achieve minimal food waste. Table 7 presents recommendations for the internal processes, which range from raw materials through to processing the finished product.

Table 7. Recommendations for internal processes at the company level.

Main Code	Sub-Code	Recommendations	Companies and References
Internal processes	Raw materials	Analyze raw materials	(C8,C11) [34,43]
		Proper handling of raw materials	(C8,C11) [24,34,35,39,49,75,76]
	Process	Ensure proper storage and transport conditions	(C2,C7,C8) [16,19,20,22–24,31,33–35,43,44,49–51,53]
		Plan the processing	(C3-C5,C8,C10,C11,C12) [19,20,23,31,33,34,40,42–53,58,62,76,81,82,85]
		Establish a food loss rate and develop batch sizes	(C10,C11,C12) [42,58,76,81]
		Develop prevention strategies	(C10) [19,23,32,35,44,53,58]
	Product and packaging	Ensure product quality	(C3,C8,C10,C11) [19,20,23,25,31,33–35,44,46,49,50,58,72,75,76]
		Design packaging	(C3,C8,C11,C12) [7,16,19,20,31–35,43,44,47,49–51,53,58,76–80]

The most mentioned recommendation for the internal processes by companies and in literature is 'Plan the processing', with the sub-code 'process' (n = 7; 54%) (25 documents) Good processing planning is essential in seeking to minimize food waste. Therefore, processing should function as a standard operating procedure [33] and should ensure a stable cycle of material flows for constant further processing to avoid surpluses and unused food residues [52] (C11). Thus, the rules of responsibility should be elaborated for individual processes with the goal that raw materials are completely processed into products and by-products without food waste [40,48,53] (C3,C5). The process planning needs to ensure that processing machines function in a way that is highly efficient with short standing times so that good food can be produced [23,34,43,44,47,51,76] (C8,C11). For ensuring that a good condition is maintained, the equipment should be checked, maintained and improved on a regular basis [16,20,23,31,32,43,49,50,53] (C4,C6,C8,C10). As another prevention tool, improvement and the redesign of manufacturing processes should also be considered in order to reduce food waste right from the start [42,46,51] (C4,C10) (see Appendix A for details).

3.2.4. Recommendations for Internal Treatment at the Company Level

There is always food left over from processing. When prevention measures are no longer sufficient, and waste is produced constantly—whether unavoidable waste or avoidable losses or surpluses—the company has the responsibility to take over waste treatment. This starts with the correct collection, storage and transport of the food waste (C1,C7,C12,C13). The remaining materials should be used according to the hierarchy (C1,C2,C5,C7–11) in the best possible way (C5,C8,C10).

To improve the food waste situation and utilization of the waste, the remaining materials should be analyzed in terms of quantities (C7,C8,C12) and waste sources (C4,C7,C8). On this basis, the remaining materials should be assessed (C7,C12). In addition, a holistic analysis of products should also be considered, including the examination of possible alternative opportunities for total avoidance (C9). The company's responsibility does not end at the utilization and analysis of remaining materials. For a permanent improvement of the situation, a company should take care of developing (C6,C7,C8,C13), prioritizing (C6,C8) and evaluating measures to ensure food waste prevention (C6,C7). Table 8 gives recommendations for internal treatment, which refer to waste treatment, analysis, and measures.

Table 8. Recommendations for internal treatment at the company level.

Main Code	Sub-Code	Recommendations	Companies and References
Internal treatment	Waste collection	Collect and store remaining materials	(C1,C7,C12) [34,53]
		Separate remaining materials	(C7,C12,C13) [1,19,35,39,49,51]
		Ensure coordinated transport	(C1) [88]
	Utilization of remaining materials	Use the food waste hierarchy	(C1,C2,C5,C7–11) [16,19,23,27,32–35,37,39,40,42–47,49–51,53–55,57,59,64,67–72,83,86,87]
		Chose the best way of utilization	(C5,C8,C10) [23,42,49,61,64,66]
	Analysis of remaining materials	Analyze quantities	(C7,C8,C12) [19,25,33,35,38,43,44,46,51,53–55,61–65]
		Analyze the waste sources	(C4,C7,C8) [33,35,39,44,48,51,54,61–63]
		Assess the remaining materials	(C7,C12) [19,33,35,39,43,51,60,61]
		Analyze alternative opportunities	(C9) [61]
		Analyze holistic products	(C9) [84]
	Development of measures	Develop measures	(C6,C7,C8,C13) [7,16,19,24,32,33,35,38,54,55,57–59]
		Prioritize measures	(C6,C8) [36,39]
		Evaluate measures	(C6, C7) [38,54]

The most frequently mentioned recommendation for the internal treatment by companies is the recommendation 'Use the food waste hierarchy' (n = 8; 62%), within the sub-code 'Utilization of remaining materials' (n = 8; 62%). The aim of this recommendation is to transform the remaining materials into resources according to the food waste hierarchy [34,35,39,43,44,54,59,67–69]. In order to remain available to the food supply chain, the remaining materials should be reused, recycled or recovered, with disposal as the last option [27,33,43,44,59]. For example, materials could be used for rework or product development, resale to other companies, food or industrial by-products, food donations, animal feed, or biogas with subsequent composting or as thermal usage (see Table 8). Additionally, waste water should also be utilized [64] (C5) (see Appendix A for details). The utilization of remaining materials according to the food waste hierarchy is also most mentioned within the reviewed literature (36 documents).

3.2.5. Recommendations for Downstream Supply Chain

After the raw materials have become finished products, they leave the company. In the downstream supply chain, the company should deal with the distribution and consumers of its products. Therefore, good cooperation and exchange with retailers should be established (e.g., to coordinate packaging, sales quantities etc. (C9,C11)). Further distribution planning should be ensured by marketing measures (C11), as well as proper storage and transport (C8). At the final stage of the supply chain, the consumer should be considered as well. To increase awareness, the consumers should be informed about food waste by the companies (C6,C8,C9,C11,C12). Furthermore, the consumer needs

should be identified in order to improve products and offers (C9,C11). Table 9 shows the recommendations for the downstream supply chain that address the distribution and the consumer level.

Table 9. Recommendations for downstream supply chain.

Main Code	Sub-Code	Recommendations	Companies and References
Distribution	Good cooperation with the retail	Coordinate with the retail	(C9) [20,22,42,52,65,80,91]
		Establish exchanges with the retail	(C9,C11) [51,80,91]
	Distribution planning	Control sales with marketing measures	(C11) [9,20,23,45,46,51–53,58,71,82,90]
		Ensure proper transport conditions	(C8) [20]
Consumer level	Consumer information	Sensitize, consult and inform consumers	(C6,C8,C9,C11,C12) [16,19,20,25,31,35,42,44,49–51,53,65,69,79]
	Consumer needs	Identify the consumer needs	(C9,C11) [49,50,76,89]

'Establish exchanges with the retail' (n = 2; 15%) within the main code 'Distribution' and the sub-code 'Good cooperation with the retail' (n = 2; 15%) is the most mentioned recommendation by companies regarding the downstream of the supply chain. For more transparency, there should be an exchange with trading partners about food waste (e.g., volumes, units, and types of food waste) [51,80,91] (C9,C11). Furthermore, the exchange with retailers should be used to improve a mutual understanding about agricultural processes, circumstances, and finite resources (C9,C11) (see Appendix A for details).

'Control sales with marketing measures' are mostly mentioned by literature within the sub-code 'Distribution planning' in the main code 'Distribution' (12 documents). Companies should forecast consumer demand, consider available trading partners, and sales volumes for distribution coordination [20,45,51,53,58,71] (C11). To control sales, companies should use marketing measures (e.g., campaigns) [52]. In terms of managing surpluses, alternative distribution channels for human consumption should be identified and, if possible, used [9,20,23,46,51,58,71,82,90] (C11) (see Appendix A for details).

At the consumer level, 'Sensitize, consult and inform consumers' is the most mentioned recommendation by companies and the literature (n = 5; 38%) (15 documents). A company should promote consumers' knowledge and awareness of food and food waste (see Table 9). Therefore, consumers should be informed and consulted about the appropriate handling of food, the values of food, storage tips for a long shelf life, best-before-dates, and alternative uses for products [16] (C6,C8,C9,C12). In addition to this information about the products, consumers should be sensitized to the agricultural sector and finite nature of resources, in a similar way to retailers and employees. Furthermore, companies should listen to their consumers regarding proposals of best practice and make these proposals available to other consumers (C9,C11,C12) (see Appendix A for details).

3.2.6. Recommendations for Beside the Supply Chain

In addition to all the activities in the supply chain, which ranges from the supplier to the customer, good practice can be extended to recommendations beside the supply chain. These recommendations mainly concern other companies and networks which can take joint action against food waste. As per these recommendations, companies should conduct business to business exchanges with other food processing-companies (C9,C12), build networks and participate in them, as well as conduct joint campaigns to improve consumer awareness (C9).

Furthermore, dealing with food waste providers is also a priority beside the supply chain. Correct disposal procedures for food waste providers should be checked in an ongoing and continuous fashion, because the responsibility for dealing with food waste should not stop with the supply chain (C1,C10). Table 10 shows the recommendations for other stakeholders and waste management providers beside the supply chain.

Table 10. Recommendations for beside the supply chain.

Main Code	Sub-Code	Recommendations	Companies and References
Other stakeholders	Business to Business exchange	Conduct business to business exchanges	(C9,C12) [36]
	Joint activities	Collaborate with network partners	(C9) [33,35,36,39,42,46,55,58,65,74]
		Conduct joint campaigns	(C9) [42]
Waste management providers	Continuously inspection	Conduct continuously inspection	(C1,C10) [33]

Beside the supply chain, 'Conduct business to business exchanges' within the main-code 'Other stakeholders' is the most frequently mentioned recommendation by companies (n = 2; 15%). A regular, planned business to business exchange of best practice examples should be planned to learn from each other how to avoid food waste (C12). Furthermore, comparative analysis with other companies should be conducted and benchmarks created (e.g., volume of utilizations) (C9, C12). Common ways of dealing with food waste should be explored with other companies [36] (see Appendix A for details).

Aside from exchange with other companies, the results of the literature research highlighted the need to 'Collaborate with network partners' (10 documents). Food waste collaborations with network partners should be established (e.g., with other chain actors, food banks, round tables, and discussion forums) (see Table 10). Furthermore, in collaboration with regulatory agencies, companies should invest more into Research and Development in order to develop processing technologies [39] (see Appendix A for details).

Last but not least, the recommendation 'Conduct continuous inspections' (n = 2; 15%) (one document) aims to develop and strengthen relationships between companies and waste management providers [33]. For this purpose, the chosen providers should be continuously verified and approved. Upon regular inspections, the chosen providers should have adequate hygiene standards. It should be ensured that the disposal procedure is in accordance with the agreements and is carried out in a proper and professional way. Therefore, undercover monitoring of waste management providers could be carried out to observe whether the materials are being disposed of as agreed (C1,C10) (see Appendix A for details).

4. Discussion

This paper addresses the RQ (i): what defines a good practice within the food-processing industry in order to prevent and handle food loss and waste by identifying the scope of a good practice (RQ ii) and recommendations to prevent and handle food loss and waste (RQ iii) based on a survey and literature review.

In total, nine main codes, 22 sub-codes, and 53 recommendations of good practice along the supply chain were identified for food-processing companies. The nine main codes outlined the scope of responsibility for the food-processing industry. The results show that good practice for the preventing and handling of food loss and waste does not start and end only in the food-processing company itself. The scope begins with the supplier and ends with the customer and beyond; a finding which addressed RQ (ii). Furthermore, the survey discloses that some companies are already aware of their responsibilities regarding the food supplier chain (see Table 3).

Companies, from several different sectors, who deal with food waste mentioned measures that they have already implemented, or at least considered. To answer the RQ (iii), these measures were identified through the survey and summarized into 53 recommendations along the entire food supplier chain.

In summary, good practice can be defined by a broad scope of responsibility for companies and recommended actions for all stakeholders at each stage of the food supply chain; a finding which addressed RQ (i). However, the measures mentioned show a strong pattern: the companies are mostly concerned about internal food waste treatment (n = 9, 69%) and their internal management and processing (n = 13, 100%). Thereby, the subcode 'Process' was the most cited, by ten companies, followed by 'Employees', 'Utilization of remaining materials', and 'Business goals' cited by eight companies each.

A narrow and broad context analysis was conducted to complement and further describe the elaborated recommendations. The broad context analysis included analyzing literature that also contained recommendations for companies. As result, the literature research shows a similar pattern. The most cited recommendations within the reviewed literature were the utilization of food waste (36 documents), the process (30 documents), 'Product and packaging' (28 documents), and the training of employees (27 documents). In contrast to the survey responses from the companies, 'Analysis of remaining materials' (22 documents) was highlighted by reviewed literature. The recommendations regarding downstream and upstream of the supply chain were classified by companies during the interview as additional points on which they should focus on after improving their own business. The subordinate role of interaction with other stakeholders perhaps indicates the limited willingness of companies to extend the company boundaries.

The main priorities of the participants are related to their own internal processes and the utilization of remaining materials, possibly due to the limited influence of the companies on broader processes. Nevertheless, Strotmann et al. [38] emphasized the need to stop the shifting of food waste to other parties because combating food waste is not a matter for an individual company alone. Without an overarching concept, a permanent solution to the problem would not be realizable. "Collaboration at all stages is essential" to managing the issue, as Richter and Bokelmann [16] pointed out. The effects on food waste at the supplier level as a result of their own specifications for pre-products is often unknown [8].

4.1. Theoretical Implications

Nevertheless, some companies are engaged in improving the entire supply chain (see Table 3). However, every company implements their own food waste management measures [89] and this leads to different management systems in each case. Yet, food waste is manageable and should be a component of the company's management systems [25]. Therefore, the recommendations of good practice for preventing and handling food loss and waste are intended to assist food processing companies in combating food waste and losses. These recommendations could be used to create an individual practice and performance indicator system [48]. In addition, the recommendations could be used as a test system for the verification of one's own practice [8] and could be a part of an environmental audits certification process [57].

Due to diverse kinds of businesses and causes of food waste, the recommendations will be very different in their implementation and interpretation within individual companies. This is to be expected, especially in terms of the difference between chilled and dry products. These differences will become evident in storage, transport, and packaging. Smaller companies may not have the resources to implement all of the recommendations, or to even audit their suppliers extensively. However, due to their flexibility and responsiveness, smaller companies have the potential to implement measures faster than large companies [78,100]. Furthermore, it is probably easier for a brand company to communicate directly with customers. Nevertheless, companies are discouraged from skipping recommendations arbitrarily. Where recommendations are omitted, this should encourage

a discussion about situation in the company. The decisions and obstacles should be justified when deciding which recommendations really are unsuitable, not possible, or irrelevant for the company. Not all recommendations need to be implemented at once; they can be implemented step by step. Firstly, recommendations should be implemented within the company and then extended to the entire food supply chain.

In this respect, it is worth mentioning that the focus should be on the prevention of food waste and not on its redistribution [27,42]. Mourad [101] criticizes the tendency for companies to promote recycling as the first solution, despite recycling being at the bottom of the food waste hierarchy. However, stakeholders still generally prefer weak measures over strong sustainability measures [42]. Mourad [101] emphasizes that prevention which is based on optimization is weak. These measures are often voluntary commitments and best practices must always be economically rentable. Furthermore, prevention measures are underestimated for achieving major transformations in the food market [101]. Strotmann, et al. [38] underline that technical solutions already exist, but that the supply chain is a sociotechnical system. The results show that some companies (n = 5, 38%) do realize the urgency of communicating with consumers, which contrasts with the results of Richter and Bokelmann [16] who found that companies do not communicate with consumers. As such, raising awareness is an important and very efficient strategy [42,78]. However, the awareness of food manufacturers also needs to be increased, according to Tekler et al. [102]. Yet, raising awareness alone is not sufficient. To prevent food waste, employees should be involved in developing and implementing prevention measures [38]. The results show that many companies are already taking employee training into account (n = 8, 62%). Moreover, companies should also adopt sustainable waste management practices [102]. Nonetheless, Mourad [101] notes that companies may only use the issue of food waste to improve their image, while maintaining their daily practice and shifting the disposal to others.

As the most sustainable solution, Mourad [101] suggested focusing on strong food waste prevention measures based on holistic changes in the food system. For this purpose, the recommendations of good practice can support companies. Companies should try to achieve the ambitious goal of 100% zero waste through prevention and not simply accept food waste as unavoidable (see Appendix A, 'Avoid food waste'). Food-processing companies have to deal with waste, seeing as it is their business to deal with food in general. In addition, reducing food waste is part of their responsibility in contributing to the SDG 12.3. I retail and consumers are to save 50% of the food, then less food must be produced in the upstream food supply chain. Some recommendations of good practice aim at strong sustainability measures, such as revising companies' own quality and aesthetic standards, the purchase of by-products or farm surpluses, developing and implementing business strategies, redesigning of processes, products and packaging, choosing the best methods for utilization, and searching for opportunities for the total avoidance of waste, among others (see Appendix A). These should be focused and developed further by companies in order to design out waste in order to move away from the current "take-make-waste extractive industrial model" and towards the direction of a circular economy [103]. Policies have already taken steps towards strong sustainability measures by launching the circular economy [83]. In this context, waste disposal is a specific sector that should be considered for a circular economy, as well as the transition from food law to waste law. Therefore, further studies should examine the experiences, influences and financial interests of waste management providers in order to make these material streams more transparent.

4.2. Limitations of the Study and Recommendations for Future Work

In the context of this study, these results are limited by the small sample size of interview partners. However, the response rate of 14% is almost identical to the response rate of 12.35% from Richter and Bokelmann [16]. In addition, in the selection of the interview partners, a wide spectrum of different companies was addressed. This spectrum includes companies from different subsectors, of various sizes, different operational areas (regional and international), and sustainability-oriented companies (see Table 3). It can be

assumed that only companies who already dealt with food waste or at least developed recommendations to reduce food waste responded, because they were familiar with the measures mentioned. One company even admitted openly that they had not dealt with the issue yet. Thus, it is assumed that the gained information are reliable and valid. The findings of the literature research confirmed the statements of the companies, and most of the literature research findings were also mentioned by the companies.

However, the quality of the individual recommendations found in the literature varied widely. For example, some studies provided exact recommendations for companies, including measures like 'educate and train staff' [35], 'communication to stuff' [19] or 'use farm surpluses' [42]. While other references provided suggestions of ideas that could help companies (e.g., 'intelligent packaging' [51]). Some recommendations from the literature concurred verbatim with the categories identified (e.g., 'assess the remaining materials' [61] or 'train employees' [73]).

It turned out that, in particular, the guidelines for food-service companies contained very precise recommendations that are transferable to other companies. The reason for this may be that many peer-reviewed studies collected recommendations for an overview, made small suggestions for future research, or tested single new approaches and could not yet assess them finally. Therefore, it may be more effective for a food processing company to follow food industry recommendations than studies on individual measures, as more in-depth information is needed to establish them.

The survey may not be representative of the entire food industry. However, this study was conducted as qualitative and exploratory research and the small sample size could be counteracted by the literature. Moreover, an assumption of this study is that interviews were more effective than the questionnaires for this research, because more interviews could be conducted than the questionnaires that were completed. Due to the different foci of the interviewees, the qualitative content analysis proved to be very suitable. Therefore, the results could be easily transferred to other industry segments.

Some of these recommendations have direct and some indirect effects on the reduction of food waste (e.g., 'Train employees' and 'Collaborate with network partners'). However, indirect recommendations are the conditions for directly reducing measures and effects [8]. Thus, checking the effects of recommendations is only possibly in a long-term analysis. In addition, validation or adaptation of the non-exhaustive recommendations is suggested after some time by further research. The survey was conducted prior to COVID-19 and therefore the recommendations could not include this aspect extensively. Therefore, post-pandemic research should be conducted in order to determine what other recommendations for reducing food waste were developed by companies during the pandemic.

Due to the unprecedented pressure that the pandemic is putting on food processors, companies are forced to reduce costs or invest in preventive and corrective maintenance measures [53,104]. Both measures support the strategy for less food waste. Strotmann et al. [105] noted that, as a result of the pandemic, food service companies were taking more conscious and precise actions to address food waste than before the pandemic.

If companies only want to reduce food waste for public relations reasons and without a strategic approach, they will eventually fail, according to Strotmann et al. [38], because there is no evidence that the adherence of waste avoidance practices can be organized in an economically self-supporting way under harsh competitive conditions [8]. Thus, the avoidance of food loss and waste is becoming more and more a question of the willingness and moral position of a company. In this respect, the implementation of recommendations of good practice for preventing and handling food loss and waste could be a support and represent the chance to become a role model within the food processing-industry.

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Appendix A.

Table A1. List of all recommendations for preventing and handling food loss and waste with detailed description.

Main Code	Sub-Code	Companies in % (*n* = 13)	Recommendations	Companies and References	Detailed Description
Supplier level	Suppliers' competence	31%	Establish a good practice	(C6,C8,C9) [9,32]	Establish good practice to avoid food waste
			Conduct quality controls	(C8,C11) [9]	Check, pack and deliver products of suitable quality Control products based on risk factors, including foreign objects, residues and sensory qualities
			Ensure proper storage and transport conditions	(C8) [20,29,47,51,52]	Ensure proper storage to extend shelf life Ensure proper and intelligent transport conditions between suppliers and own company Improve the transport chain to eliminate the risk of contamination Avoid long food transports
	Good cooperation	38%	Conduct supplier waste audits and reviews	(C9) [31,36,46,48]	Check and evaluate suppliers with waste audits Check to see if own raw material specifications increase the suppliers waste Revise own quality and aesthetic standards
			Cooperate with suppliers	(C4,C8,C9,C11) [25,31,49,51,52,58]	Maintain communication and cooperation Conduct common product development Conduct common coordinated cultivation planning in regard to type and volume
			Exchange best-practice with suppliers	(C9,C12) [36]	Exchange best-practice for avoiding food waste Train suppliers to deal with post-harvest waste and efficient harvesting
Procurement	Conditions of purchase	15%	Order the appropriate quantities	(C2) [19,31,34,35,43–45,49,50,53,58]	Monitor and adjust orders Set up a need-based procurement without stock buying Order in adequate intervals

Table A1. *Cont.*

Main Code	Sub-Code	Companies in % (n = 13)	Recommendations	Companies and References	Detailed Description
	Raw material requirements	23%	Analyze raw material samples	(C8) [51,52]	Analyze samples prior to dispatch of the main delivery Ensure demanded quality, but stay flexible
			Order a quality level appropriate to a company's own needs	(C9,C10) [23,33,42,53,58]	Use a quality level of raw materials that fits own needs Buy and use by-products or farm surpluses as raw materials Chose reusable, recyclable or compostable raw materials
			Order raw material in appropriate product packaging	(C13) [58]	Buy raw materials with less packaging Buy raw materials with appropriate packaging sizes
Internal management	Business strategy	15%	Develop a business strategy	(C5,C12) [31,34,38,43,48,49,53,57,69,74]	Taking food waste into account within the business strategy in accordance with the organizational culture Integrate a general statement or commitment into the business strategy for: careful handling of food full use of raw materials sparing use of raw materials provide resources to reduce food waste Communicate the business strategy
			Derive measures	(C12) [49,52]	Derive and develop measures from the business strategy for all business departments Focus on the core business departments (sales, marketing, development, planning, and processing)
	Business goals	62%	Avoid food waste	(C1,C5,C9,C10,C12,C13) [3,8,19,33,36,42,58,76,79]	Avoiding and preventing food waste should be a top priority followed by recycling Try to realize a zero-waste policy in one's own company Have an economic interest in reducing food waste and food waste treatment Pay attention to the ethical aspects of the food waste
			Adjust goals	(C6,C12) [7,19,35,46,65,73]	Elaborate goals and instruction to avoid food waste Adjust goals continuously
			Ensure food safety	(C12) [31,33,45,48,58]	Produce safe products instead of reducing food waste at all costs Establish a quality management system or other quality assurance systems
			Work within the legal requirements	(C1,C4) [39,48,53,55,88]	Process and act within the scope of legal foundations (e.g., recycling law, food safety guidelines, compliance for human consumption, compliance with job procedures, environmental responsibility, etc.)
			Inspire and act as a role model	(C9) [19,35,38,73–75]	Inspire employees (e.g., reward facility, assign food waste prevention champion) Motivate employees toward green practices Assign food loss and waste prevention champion Act as a role model in your canteens and at events

Table A1. *Cont.*

Main Code	Sub-Code	Companies in % (*n* = 13)	Recommendations	Companies and References	Detailed Description
	In-house transparency	38%	Develop and monitor key performance indicators	(C9,C12,C13) [19,20,25,31,33,35,38,47,48,55,74–76]	Monitor and document all activities related to food waste by an adequate control system Create a system to control the internal processes based on developed individual key performance indicators Develop key performance indicators to review process parameters, e.g.,: Volumes of food loss Volumes for biogas facilities Energy yield Financial loss Hygiene Communicate improvements Check the whole management based on performance measurement Organize the monitoring, documentation and controlling of food waste
			Report activities	(C6,C7) [16,19,25,31,38,53]	Communicate results to the management level and operators on a regular basis Report findings in an environmental review
	Employees	62%	Train employees	(C4-10,C13) [9,16,19,20,22–25,31,33–36,38,43,44,46–48,50,51,53,58,73–75]	Implement a waste reduction culture among employees to internalize prevention and handling practices Train the employees in: Prevention of food waste directly at the machines Collection and separation of remaining food waste Proper and reasonable handling and processing of raw materials and food Cherishing raw materials and food Good hygienic practices Food safety policies and HACCP Train the employees on a regular basis Sensitize and motivate employees for: Awareness, understanding, sense of responsibility Conscientious working practices Empower and encourage employees to consult with superiors and share their experiences and suggestions for improvement Establish a level of trust for employees
			Ensure interdisciplinary collaboration	(C6,C7) [55,58,73,74]	Involve all employees from all business departments from management to operations in order to counteract food waste Improve the communication between departments
			Put persons in charge	(C5) [20,33,35,43,46,48]	Put a person in charge to deal with food waste Form an internal audit team to deal with food waste loss

Table A1. *Cont.*

Main Code	Sub-Code	Companies in % (*n* = 13)	Recommendations	Companies and References	Detailed Description
Internal processes	Raw materials	15%	Analyze raw materials	(C8, C11) [34,43]	Analyze delivered raw materials in regard to quality criteria at the incoming goods inspection
			Proper handling of raw materials	(C8,C11) [24,34,35,39,49,75,76]	Respect and handle raw materials and food with care according to their specifications Deal with inhomogeneous raw material qualities for production Develop measures to minimize raw material residues in the product packaging
			Ensure proper storage and transport conditions	(C2,C7,C8) [16,19,20,22–24,31,33–35,43,44,49–51,53]	Ensure proper storage conditions in accordance with the requirements of the raw materials and/or products Monitor the remaining shelf life by FIFO (first-in-first-out) or FEFO (first-expiring-first-out) approach Monitor the stock to correct deviations Ensure and constantly improve good conditions of transport within the company Ensure proper transport conditions in accordance with the requirements of raw materials and/or product Apply transport measures to protect the materials from contamination, residues, etc.
	Process	77%	Plan the processing	(C3-C5,C8,C10,C11,C12) [19,20,23,31,33,34,40,42–53,58,62,76,81,82,85]	Ensure good processing planning Establish standard operating procedures Establish a stable cycle of material flows for constant further processing to avoid surpluses and unused food residues Elaborate rules of responsibilities for individual processes Process raw materials completely into products and by-products Ensure highly efficient processing machines and short standing times Check, maintain and improve processing equipment to ensure their good condition Improve and redesign manufacturing processes Use machine learning
			Establish a food loss rate and develop batch sizes	(C10,C11,C12) [42,58,76,81]	Forecast expected food loss rates for processing at the development stage Plan batch sizes economically in order to keep the loss rate low Plan batch sizes according to loss rates of machines, storage time, stock levels, and market opportunities Ensure that employees undercut planned food loss rates
			Develop prevention strategies	(C10) [19,23,32,35,44,53,58]	Develop proactive strategies against faulty batches or surplus Develop procedures and maintenance concepts for dealing with process disturbances, defective equipment, and power failures

Table A1. *Cont.*

Main Code	Sub-Code	Companies in % (*n* = 13)	Recommendations	Companies and References	Detailed Description
Internal treatment	Product and packaging	38%	Ensure product quality	(C3,C8,C10,C11) [19,20,23,25,31,33–35,44,46,49,50,58,72,75,76]	Guarantee the quality of the finished product in accordance with the customer specifications Produce products with a long best-before date and appropriate shelf life according to the needs of customers Check the quality on a regular basis Design and adapt products for less food waste
			Design packaging	(C3,C8,C11,C12) [7,16,19,20,31,32,34,35,43,44,47,49–51,53,58,76–80]	Design packaging, packaging size and portion size according to consumer needs or customer specifications Design packaging for: safe food optimal and long storage life individually and easily to serve easy emptying Use less packaging Label a standard date label to prevent consumer confusion
	Waste collection	31%	Collect and store remaining materials	(C1,C7,C12) [34,53]	Remove the remaining materials from the process immediately Collect the remaining materials in suitable collection containers Collect and store remaining materials under hygienic conditions Treat remaining materials in the same way as food and as a part of the quality management system
			Separate remaining materials	(C7,C12,C13) [1,19,35,39,49,51]	Make sure that the mono-fraction separation of the materials is guaranteed from the beginning Follow the waste management provider's guidelines for waste separation Mark the collected material clearly
			Ensure coordinated transport	(C1) [88]	Ensure a coordinated waste transport including delivery note and vehicle marking according to the recycling law
	Utilization of remaining materials	62%	Use the food waste hierarchy	(C1,C2,C5,C7-11) [16,19,23,27,32–35,37,39,40,42–47,49–51,53–55,57,59,64,67–72,83,86,87]	Transform the remaining materials into resources according to the food waste hierarchy: Rework Product development Resale to other companies Food by-products Industrial by-products Food donations Animal feed Biogas with composting Thermal usage Reuse, recycle or recover remaining materials for the food supply chain Use disposal as the last option Recycle water

Table A1. *Cont.*

Main Code	Sub-Code	Companies in % (*n* = 13)	Recommendations	Companies and References	Detailed Description
			Chose the best way of utilization	(C5,C8,C10) [23,42,49,61,64,66]	Chose the best technological, possible, permissible, sustainable course of action Use economically feasible methods of utilization Build up network to redistribute Conclude contracts with local businesses to recycle food waste
	Analysis of remaining materials	38%	Analyze quantities	(C7,C8,C12) [19,25,33,35,38,43,44,46,51,53–55,61–65]	Conduct regular food waste audits Analyze all remaining materials Map the process as support Analyze irregularities that produce waste in larger quantities or at higher frequencies Conduct analysis on a representative day for regular measurements Quantify the volume of the remaining materials promptly on an immediate, hourly or daily basis Document results of analysis
			Analyze the waste sources	(C4,C7,C8) [33,35,39,44,48,51,54,61–63]	Analyze the kind of the remaining materials Identify the source of the remaining materials Identify the reasons for generating the remaining materials
			Assess the remaining materials	(C7,C12) [19,33,35,39,43,51,60,61]	Assess the volume of the remaining materials to: total processing volume financial losses environmental aspects social aspects Categorize the remaining materials based on the analysis results and the chosen manner of utilization
			Analyze alternative opportunities	(C9) [61]	Check the legitimacy of the remaining materials Check alternative opportunities for a total avoidance
			Analyze holistic products	(C9) [84]	Analyze the entire supply chain from supplier to consumer of a single product
	Development of measures	31%	Develop measures	(C6,C7,C8,C13) [7,16,19,24,32,33,35,38,54,55,57–59]	Eliminate, correct and optimize processes and process deviations that contribute to material losses Involve employees in the development of measures Review and reconsider current practice, measures, and decisions Define measures and their implementation in detail Use different types of measures, e.g., technological, personnel or planning
			Prioritize measures	(C6,C8) [36,39]	Implement measures first at hotspots and sources with the highest savings potential or with strong deviations
			Evaluate measures	(C6,C7) [38,54]	Evaluate the effects of the measures Adjust the measures continuously

Table A1. *Cont.*

Main Code	Sub-Code	Companies in % (*n* = 13)	Recommendations	Companies and References	Detailed Description
Distribution	Good cooperation with the retail	15%	Coordinate with the retail	(C9) [20,22,42,52,65,80,91]	Coordinate packaging changes, packaging size, sales volumes, and adequate divisions of lead time etc. with the trading partners Develop forecasts with retailers Clarify the treatment of products that could not be sold by trading partners Create incentives to avoid product returns or waste for the retail
			Establish exchanges with the retail	(C9,C11) [51,80,91]	Establish exchange with trading partners about food waste (e.g., volumes, units, types of food waste) Discuss with trading partners the content of agricultural processes and circumstances and the finite nature of resources for a better mutual understanding
	Distribution planning	15%	Control sales with marketing measures	(C11) [9,20,23,45,46,51–53,58,71,82,90]	Consider available trading partners and sales volumes Forecast the demand and coordinate the distribution Use marketing measures to control sales, e.g., by campaigns Identify alternative distribution channels for human consumption Try to manage surpluses through alternative distribution channels
			Ensure proper transport conditions	(C8) [20]	Ensure proper transport conditions for the product between company and customers Manage and design the transport chain to eliminate contamination
Consumer level	Consumer information	38%	Sensitize, consult and inform consumers	(C6,C8,C9,C11,C12) [16,19,20,25,31,35,42,44,49–51,53,65,69,79]	Promote consumer knowledge and awareness of food and food waste Inform and consult the consumers about: appropriate handling of food value of food storage tips for a long shelf life best-before-date alternative use of product Sensitize consumers to the agricultural sector and finite nature of resources Adopt proposals of best practice from consumers and make these proposals available for other consumers Use the ´right´ language of consumer Communicate about environmental conservation Appeal to social norms and consumer's self-esteem Use campaigns, social media, newsletter, etc.

Table A1. *Cont.*

Main Code	Sub-Code	Companies in % (n = 13)	Recommendations	Companies and References	Detailed Description
	Consumer needs	15%	Identify the consumer needs	(C9,C11) [49,50,76,89]	Ascertain and know consumer needs concerning product and packaging size Combine producers and consumer needs in one product Know the reasons why consumers waste food Maintain direct contact with consumers to get feedback
Other stakeholders	Business to Business exchange	15%	Conduct business to business exchanges	(C9,C12) [36]	Plan a regular B-to-B exchange of best-practices in order to avoid food waste Conduct comparative analysis with other companies Create common benchmarks, e.g., volume of utilizations Explore joint possibilities to deal with waste
	Joint activities	8%	Collaborate with network partners	(C9) [33,35,36,39,42,46,55,58,65,74]	Collaborate with network partners on food waste, e.g., with other chain actors, food banks, round tables, discussion forums or regulatory agencies
			Conduct joint campaigns	(C9) [42]	Prefer a joint consumer information campaign instead of individual company measures Support of school education for the subject nutrition Support food waste social movements
Waste management providers	Continuously inspection	15%	Conduct continuously inspection	(C1,C10) [33]	Check the waste disposal companies with regard to a license and a continuous verification Develop and strengthen a relationship with waste management providers Inspect the waste disposal companies regularly for adequate hygiene Ensure that the disposal procedure is in accordance to the agreements and carried out in a proper and professional way Monitor the waste disposers undercover to see if the materials are disposed of as agreed

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