Electronic Supplementary Material -Supplementing Tables and Figures

Food waste generation in Germany in the scope of European legal requirements for monitoring and reporting

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Overview Tables & Figures

Table S1. Data sources – primary production: harvested food quantities ($h_{PP,i}$), food waste coefficients ($wc_{PP,i}$), and share of bones and peels. The food waste coefficients describe the proportion of waste quantities in relation to the quantity of harvested food quantities.

Food groups	$h_{PP,i}$ Quantity in 1,000 t (Tab. in [1])		$wc_{PP,i}$ Mean ± CI$_{Min,Max}$ in mass-%		Share of peels & bones [2] Mean ± CI$_{Min,Max}$ in mass-%
Cereals	8,065	(Tab. 4021100)	2.50 ± 0.80	[3,4]	N/A
Potatoes	4,670	(Tab. 4022700)	5.20 ± 1.82 [i]	[4]	28.4 ± 4.1
Sugar (sugar beets)	2,797	(Tab. 4030200)	5.00 ± 3.00	[5]	N/A
Oilseeds	179	(Tab. 4080100)	1.00 ± 0.35 [i]	[6]	48.0 ± 11.9 [ii]
Pulses	89	(Tab. 4022600)	0.10 ± 0.04 [i]	[3]	17.0 ± 5.3
Fruit	1,325	(Tab. 4040600)	8.50 ± 2.50	[3,4]	10.9 ± 3.2
Vegetables	3,459	(Tab. 4040200)	5.10 ± 0.90	[3,4]	24.9 ± 9.9
Meat	8,994	(Tab. 4050700)	2.05 ± 0.95	[7,8]	18.7 ± 3.1
Fish	1,108	(Tab. 4060900)	4.70 ± 1.70	[9]	48.0 ± 8.5
Milk (Dairy prod.)	32,685	(Tab. 3110410)	0.60 ± 0.21 [i]	[3]	N/A
Eggs	801	(Tab. 3110610)	4.45 ± 1.05	[10]	12.0 ± 3.0
∑ Harvested food	64,173				

[i] Assumption: Interval width corresponds to the average interval of ≈ 35.0%. [ii] Approximate content of oil in the sunflower and rape seeds.

Table S2. Data sources – processing and manufacturing sector: produced food quantities ($p_{PM,i}$), food waste coefficients ($wc_{PM,i}$). The waste coefficients are based on survey data (n = 100) and describe the proportion of waste quantities in relation to the quantity of processed and manufactured food.

NACE	Segment	$p_{PM,i}$ Quantity in 1,000 t [11]	$wc_{PM,i}$ Mean ± CI$_{\alpha=0.05}$ in mass-% [12]
10.1	Processing and preserving of meat and production of meat products	14,708	0.22 ± 0.20
10.2	Processing and preserving of fish, crustaceans and molluscs	407	4.00 ± 1.64
10.3	Processing and preserving of fruit and vegetables	5,339	2.40 ± 1.11
10.4	Manufacture of vegetable and animal oils and fats	5,226	0.09 ± 0.07
10.5	Manufacture of dairy products	14,603	1.50 ± 0.78
10.6	Manufacture of grain mill products, starches and starch products	9,320	0.09 ± 0.07
10.7	Manufacture of bakery and farinaceous products	6,343	10.82 ± 2.12
10.8	Manufacture of other food products	11,770	1.74 ± 0.68
11.0	Manufacture of beverages	37,462	2.31 ± 0.84
	∑ Food production	105,178	

Table S3. Food waste in German retail: survey data (n = 77).

Store number	Sales area in m²	Food waste in kg/m²	Store number	Sales area in m²	Food waste in kg/m²
1	3,981	11.34	40	1,532	7.78
2	3,838	7.61	41	1,528	1.14
3	3,507	9.98	42	1,519	3.08
4	3,251	8.55	43	1,492	2.25
5	2,973	2.82	44	1,476	5.99
6	2,970	1.08	45	1,461	8.70
7	2,915	9.45	46	1,403	14.48
8	2,895	2.47	47	1,325	13.09
9	2,895	1.00	48	1,283	4.29
10	2,851	2.60	49	1,246	2.64
11	2,825	1.29	50	1,157	4.74
12	2,772	2.63	51	1,112	1.64
13	2,695	4.33	52	1,095	20.63
14	2,621	4.09	53	1,054	3.06
15	2,581	7.75	54	1,044	3.49
16	2,550	1.98	55	1,000	1.82
17	2,541	10.10	56	980	9.84
18	2,530	16.19	57	970	8.00
19	2,522	21.01	58	913	10.78
20	2,388	6.11	59	911	4.56
21	2,333	5.94	60	911	4.00
22	2,304	14.49	61	901	0.08
23	2,295	0.91	62	896	4.06
24	2,259	8.01	63	887	2.05
25	2,224	6.00	64	886	11.41
26	2,190	14.14	65	882	1.59
27	2,117	55.88	66	879	1.04
28	2,087	1.01	67	853	27.40
29	2,014	0.99	68	804	9.05
30	2,004	1.98	69	799	7.87
31	1,976	14.25	70	794	4.41
32	1,943	0.94	71	789	3.30
33	1,823	0.41	72	783	4.65
34	1,723	31.86	73	767	6.62
35	1,697	5.21	74	707	21.71
36	1,639	0.73	75	666	42.45
37	1,616	7.14	76	657	7.63
38	1,601	1.46	77	634	18.17
39	1,579	1.55			

Table S4. Data sources – retail: food waste coefficients (wc_R). The waste coefficients describe the food waste in kg per square meter of sales area and year.

Food waste coefficients	wc_R Mean ± CI$_{\alpha=0.05}$ in kg/(m²·a)
based on survey data from Table S.7	7.98 ± 2.13
based on data from [13]	16.40 ± 4.37 [i]
Mean value	12.19 ± 3.25

[i] Assumption: The Confidence Interval (CI (α=0.05) = ± 26.7%) based on data from Table S.7 can also be applied to data of REWE Group (2016).

Table S5. Data sources – restaurants and food services: structural data ($s_{RFS,i}$) for different facilities.

Facility	Description	$s_{RFS,i}$	Unit	References
Catering services	Visits to full service restaurants	2.03	≈ billion portions/a	[14]
	Visits to event- gastronomy	1.38	≈ billion portions/a	[14]
	Visits to fast-food restaurants	5.18	≈ billion guests/a	[14]
Hospitality and accommodation	Overnight stay	436,215,153	overnights/a	[15]
	Portions served	436,215,153	portions/a	Assumption
Hospitals	Number of beds	499,351	number	[16]
	Average bed occupancy rate	77,5	percent	[16]
	Portions served in hospitals	423,761,742	portions/a	Assumption
Schools	Primary education	2,891,926	students/a	[17]
	Secondary education	7,764,982	Students/a	[18]
	Not assigned to an area	175,107	students/a	[17]
	Share of students eating in dining hall	16.5	percentage	[19,20]
	School days per year	225	number	
	Portions served in schools	402,138,557	portions/a	Assumption
Educational institutions	Day care facilities	3,341,786	children & employees	[21]
	Child day care	148,806	children & employees	[22]
	Number of children with lunch	2,487,672	lunches/d	[21]
	Educational days per year	225	days	
	Portions served	559,726,200	portions/a	Assumption
Colleges and universities	Students 2015/2016	2,757,799	students/a	[23]
	Share of students eating in dining hall	59.9	percent	[19,20]
	Number of lecture days	160	days	
	Portions served	264,307,456	portions/a	Assumption
Care institutions & nursing homes	Available nursing places	928,939	nursing places/d	[24]
	Number of patients (stationary)	783,416	patients/d	[25]
	Portions served for (stationary)	857,840,520	portions/a	Assumption
	Number of patients (semi-stationary)	73,886	patients/d	[25]
	Portions served (semi-stationary)	26,968,390	portions/a	Assumption
Business canteens	Share of employees eating in canteens	21	percent	[1]
	Working days per year	250	days	
	Portions served	2,261,122,500	portions/a	Assumption
German Armed Forces		40,736,920	portions/a	[26]
Prisons	Prisoners in closed prison	63,482	prisoners/a	[27]
	Prisoners in open prison	11,043	prisoners/a	[27]
	Portions served (closed prison)	3	portions/(prisoner·d)	[26]
	Portions served (open prison)	2	portions/(prisoner·d)	[26]
	Portions served in prisons	77,574,180	portions/a	Assumption
Population & employment	Number of employees in Germany	43,069	1,000 employees	[28]
	German population (31.12.2015)	82,176	1,000 cap.	[29]

Table S6. Data sources – restaurants and food services: food waste coefficients ($wc_{RFS,i}$) and avoidable parts.

Facility	Food waste	Avoidable parts	unit	n	Reference
Full-service restaurants	204 ± 33 [i]	105 ± 21 [ii]	g/portion	13	[30]
Event gastronomy	204 ± 33 [i]	105 ± 21 [ii]	g/portion	13	[30]
Fast-food restaurants	28 ± 5 [i]	19 ± 4 [ii]	g/guest	1,490	[31]
Hospitality and accommodation	184 ± 48	134 ± 25	g/portion	13 & 24	[30,32]
Hospitals	152 ± 25 [i]	122 ± 25 [ii]	g/(bed·d)	64	[32]
Schools	122 ± 15	95 ± 22	g/portion	11	[32,33]
Childcare facilities	122 ± 15	95 ± 22	g/portion	11	[32,33]
Colleges and Universities	280 ± 46 [i]	193 ± 39 [iii]	g/portion	1	[34]
Care institutions (nursing homes)	152 ± 25 [i]	122 ± 25 [iii]	g/portion	64	[32]
Business canteens	132 ± 24	107 ± 29	g/portion	23 & 269	[30,32]
German Armed Forces	186 ± 26	95 ± 13	g/portion	N/A	[35,36]
Prisons	226 ± 37 [i]	116 ± 24 [iii]	g/portion	N/A	[26]

[i] Assumption: Interval width ($CI_{Min,Max}$) corresponds to the average interval of ≈16%; [ii] Assumption: Interval width ($CI_{Min,Max}$) corresponds to the average interval of ≈20%.

Table S7. Data sources – households: share of food waste ($wc_{HH,i}$) in the municipal waste collection system of residual and bio waste bins in German households, based on data from waste compositional analyses [12].

	Residual waste bin	Bio waste bin
Waste quantity in kg/(cap·year)	128.0	56.0
$wc_{HH,i}$ – share of food waste in mass-% (Mean ± $CI_{Min,Max}$)	31.7 ± 2.9	37.8 ± 3.4

Table S8. Data sources – households: distribution of food waste through different disposal paths [12,37,38].

Disposal paths	Food waste distribution in mass-% (Mean ± $CI_{Min,Max}$)
Residual waste	35.0 ± 2.0
Bio waste bin	38.0 ± 4.0
Home composting	9.0 ± 0.8
Pet feeding	5.0 ± 1.0
Sewer	11.0 ± 3.0
Others	1.5 ± 0.2 [i]
∑ in the municipal waste collection system (pr_{FW})	73.0 ± 6.0
∑ in other disposal channels	27.0 ± 6.0

[i] Assumption: Interval width corresponds to the average interval of ≈ 15.0%.
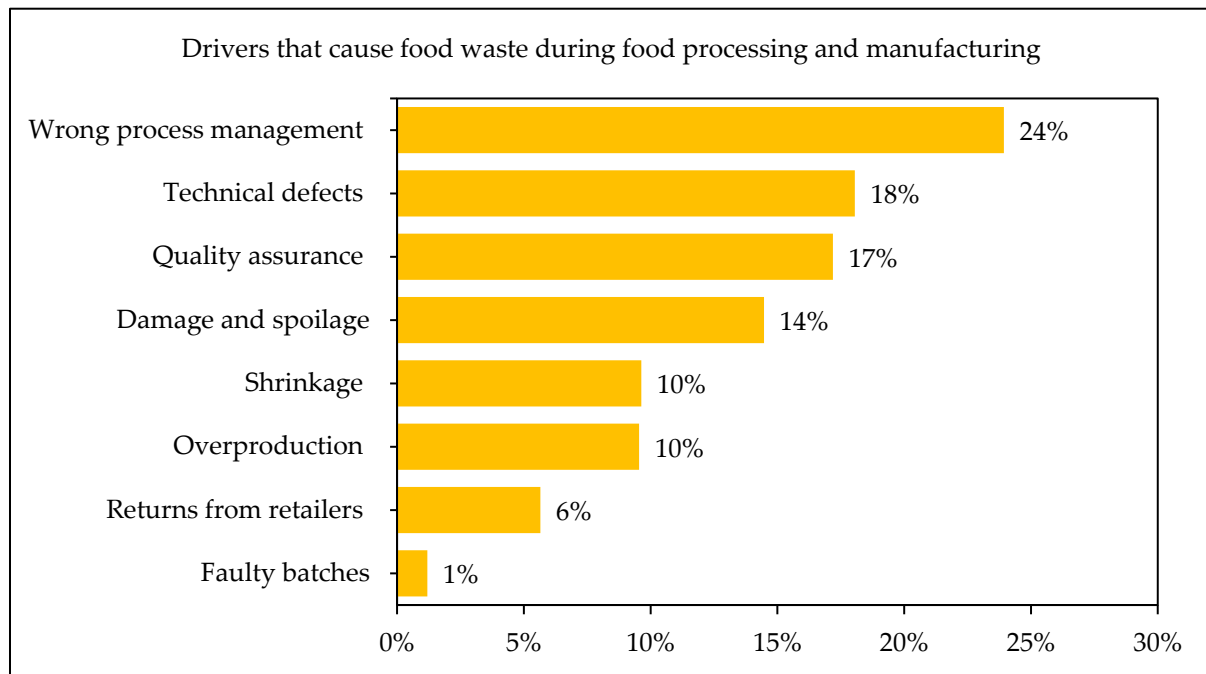
Figure S1. Drivers that cause food waste in the German food processing and manufacturing sector, based on survey data (n=100) from [12]. Avoidable potential (≈55%): wrong process management (24%), damage and spoilage (14%), overproduction (10%), returns from retailers (6%), and faulty batches (1%).

References

1. United Nations. *Transforming our world: the 2030 agenda for sustainable development*. A/RES/70/1. New York, NY, 2015. Available online: http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E (accessed on 2 February 2021).
2. *Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste (Text with EEA relevance). (OJ L 150, 14.6.2018, p. 109–140)*: Directive (EU) 2018/851, 2018.
3. COM. *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A new Circular Economy Action Plan For a cleaner and more competitive Europe. COM/2020/98 final*, 2020. Available online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2020:98:FIN (accessed on 2 February 2021).
4. Fabi, C.; English, A. *SDG 12.3.1: Global Food Loss Index. Methodology for monitoring SDG traget 12.3. The Global Food Loss Index design, data collection methods and challenges*. Food and Agriculture Organization (FAO), 2018. Available online: http://www.fao.org/3/CA2640EN/ca2640en.pdf (accessed on 2 February 2021).
5. FAO. *The state of food and agriculture. Moving forward on food loss and waste reduction*. Rome, Italy: Food and Agriculture Organization of the United Nations (State of the world). ISBN 978-92-5-131789-1, 2019. Available online: http://www.fao.or g/3/ca6030en/ca6030en.pdf (accessed on 2 February 2021).
6. *Commission Delegated Decision (EU) 2019/1597 of 3 May 2019 supplementing Directive 2008/98/EC of the European Parliament and of the council as regards a common methodology and minimum quality requirements for the uniform measurement of levels of food waste (text with EEA relevance). (OJ L 248, 27.9.2019, p. 77–85)*: Delegated Decision (EU) 2019/1597, 2019.
7. *Regulation (EC) No 178/2002 of the European Parliament and Council of January 28, 2002, setting forth the general principles and requirements of food law, establishing the European Food Safety Authority, and proposing food safety procedures*: Regulation (EC) No 178/2002, 2002.
8. European Commission. *EU platform on food losses and food waste. Terms of reference (ToR)*, 2019. Available online: https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-actions_flw-platform_tor.pdf (accessed on 2 February 2021).
9. European Commission. *Recommendations for action in food waste prevention. Developed by the EU platform on food losses and food waste*, 2019. Available online: https://ec.europa.eu/food/sites/food/files/safety/docs/fs_eu-actions_action_implementati on_platform_key_recommendations.pdf (accessed on 2 February 2021).
10. *Commission Implementing Decision (EU) 2019/2000 of 28 November 2019 laying down a format for reporting of data on food waste and for submission of the quality check report in accordance with Directive 2008/98/EC of the European Parliament and of the Council (notified under document C(2019) 8577) (Text with EEA relevance). (OJ L 310, 2.12.2019, p. 39–45)*: Implementing Decision (EU) 2019/2000, 2019.
11. Gustavsson, J.; Cederberg, C.; Sonesson, U. *Global food losses and food waste*. Extent, causes and prevention; study conducted for the International Congress Save Food! at Interpack 2011, 16–17 May, Düsseldorf, Germany. Rome: Food and Agriculture Organization of the United Nations, 2011. Available online: http://www.fao.org/3/a-i2697e.pdf (accessed on 2 February 2021).
12. Gustavsson, J.; Cederberg, C.; Sonesson, U.; Emanuelsson, A. *The methodology of the FAO study: "Global food losses and food waste*. Extent, causes and prevention" – FAO, 2011. SIK report No. 857, 2013. Available online: http://www.diva-portal.org/smas h/get/diva2:944159/FULLTEXT01.pdf (accessed on 2 February 2021).
13. Stenmarck, Å.; Jensen, C.; Quested, T.; Moates, G. *Estimates of European food waste levels*, 2016. Available online: https://www.eu-fusions.org/phocadownload/Publications/Estimates%20of%20European%20food%20waste%20levels.pdf (accessed on 2 February 2021).
14. EUROSTAT. *Guidance on reporting of data on food waste and food waste prevention according to Commission Implementing Decision (EU) 2019/2000*. Version of June 2020. European Commission. EUROSTAT, 2020. Available online: https://ec.europa.eu/eurostat/documents/342366/351811/Guidance+on+food+waste+reporting/5581b0a2-b09e-adc0-4e0a-b20062dfe564 (accessed on 2 February 2021).
15. Hartikainen, H.; Mogensen, L.; Svanes, E.; Franke, U. Food waste quantification in primary production - The Nordic countries as a case study. *Waste Manag.* **2018**, *71*, 502–511, doi:10.1016/j.wasman.2017.10.026.
16. Schmidt, T.; Schneider, F.; Leverenz, D.; Hafner, G. *Lebensmittelabfälle in Deutschland (Food Waste in Germany) – Baseline 2015 (with English summary)*. Thünen Report 71. https://doi.org/10.3220/REP1563519883000, 2019. Available online: https://www.bmel.de/SharedDocs/Downloads/DE/_Ernaehrung/Lebensmittelverschwendung/TI-Studie2019_Lebensmittelabfaelle_Deutschland-Kurzfassung.pdf?__blob=publicationFile&v=3 (accessed on 2 February 2021).
17. Gray, S. *Down the Drain: Quantification and Exploration of Food and Drink Waste Disposed of to the Sewer by Households in the UK*. Waste and Resources Action Programme, Banbury, 2009. Available online:

https://www.wrap.org.uk/sites/files/wrap/Down%20the%20drain%20-%20report.pdf (accessed on 2 February 2021).

18. Jensen, C.; Stenmarck, A.; Sörme, L.; Dunsö, O. *Matavfall 2010 från jord till bord (Food waste 2010 from soil to table)*. Norrköping. Svenska MiljöEmissionsData (SMED). SMED Rapport, ISSN 1653-8102. SMED Rapport Nr 2011-99, 2011. Available online: http://naturvardsverket.diva-portal.org/smash/get/diva2:1159518/FULLTEXT01.pdf (accessed on 2 February 2021).

19. Mosberger, L.; Gröbly, D.; Buchli, J.; Müller, C.; Baier, U. *Schlussbericht Organische Verluste aus der Lebensmittelindustrie in der Schweiz (Final Report Organic Losses from the Food Industry in Switzerland)*. Massenflussanalyse nach Branchen und Beurteilung von Vermeidung und Verwertung, 2016. Available online: https://www.bafu.admin.ch/dam/bafu/de/dokumente/abfall/externe-studien-berichte/organische-verlusteausderlebensmittelindustrie.pdf.download.pdf/organische-verlusteausderlebensmittelindustrie.pdf (accessed on 2 February 2021).

20. Schranzhofer, A.; Rockenbauer, R.; Tragner, F.; Hala, V.; Hrad, M.; Ottner, R.; Obersteiner, G.; Schneider, F.; Lebersorger, S.; Manhart, A.; et al. *Vermeidung von Lebensmittelabfall in Gastronomie, Beherbergung und Großküchen (Prevention of food waste in catering, accommodation and commercial kitchens)*. United Against Waste (UAW), 2015. Available online: https://united-against-waste.at/wp-content/uploads/2015/05/Endbericht_UAW_ABF_tatwort_final_ARA.pdf?eb6772 (accessed on 2 February 2021).

21. Kranert, M.; Hafner, G.; Barabosz, J.; Schuller, H.; Leverenz, D.; Kölbig, A.; Schneider, F.; Lebersorger, S.; Scherhaufer, S. *Ermittlung der weggeworfenen Lebensmittelmengen und Vorschläge zur Verminderung der Wegwerfrate bei Lebensmitteln in Deutschland (Determination of discarded food and proposals for minimizing food waste in Germany)*, 2012. Available online: https://www.bmel.de/SharedDocs/Downloads/DE/_Ernaehrung/Lebensmittelverschwendung/Studie_Lebensmittelabfaelle_Langfassung.pdf?__blob=publicationFile&v=3 (accessed on 2 February 2021).

22. Caldeira, C.; Laurentiis, V. de; Ghose, A.; Corrado, S.; Sala, S. Grown and thrown: Exploring approaches to estimate food waste in EU countries. *Resources, Conservation and Recycling* **2021**, *168*, 105426, doi:10.1016/j.resconrec.2021.105426.

23. Hafner, G.; Barabosz, J.; Leverenz, D.; Maurer, C.; Kranert, M.; Göbel, C.; Friedrich, S.; Ritter, G.; Teitscheid, P.; Wetter, C. Analyse, Bewertung und Optimierung von Systemen zur Lebensmittelbewirtschaftung – Teil I. *Müll und Abfall* **2013**, doi:10.37307/j.1863-9763.2013.11.08.

24. Hafner, G.; Leverenz, D.; Pilsl, P. Analyse, Bewertung und Optimierung von Systemen zur Lebensmittelbewirtschaftung ? Teil II. *Müll und Abfall* **2016**, doi:10.37307/j.1863-9763.2016.08.03.

25. Leverenz, D.; Hafner, G.; Owusu-Sekyere, K.; Rehle, F.; Schmidt, S.; Härtl, T.; Fuchs, P.; Kranert, M. *Stoffstrombilanzierung der Lebensmittelabfälle (Material flow balancing of food waste)*. In Schmidt et al. (2019): Wege zur Reduzierung von Lebensmittelabfällen - Pathways to REduce FOod WASte (REFOWAS). Maßnahmen, Bewertungsrahmen und Analysewerkzeuge sowie zukunftsfähige Ansätze für einen nachhaltigen Umgang mit Lebensmitteln unter Einbindung sozio-ökologischer Innovationen. Thünen Report 73, vol. 1, pp. 5–40, 2019. Available online: https://www.thuenen.de/media/publikationen/thuenen-report/ Thuenen-Report_73_Vol1.pdf (accessed on 2 February 2021).

26. DESTATIS. *Waste balance sheets. Waste generation, waste intensity, waste generation by economic sector*. Database of the Federal Statistical Office of Germany, 2016. Available online: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/Abfallwirtschaft/Publikationen/Downloads-Abfallwirtschaft/abfallbilanz-pdf-5321001.pdf?__blob=publicationFile&v=4 (accessed on 2 February 2021).

27. REWE Group. *REWE Group Sustainability Report 2015/2016*, 2016. Available online: https://rewe-group-nachhaltigkeitsbericht.de/2016/gri-bericht/eku/gri-306-abfall (accessed on 2 February 2021).

28. Bulwiengesa AG. *Marktstudie: Lebensmitteleinzelhandel in Deutschland - Marktstrukturdaten 2016 (Market study: food retailing in Germany - market structure data 2016)*. TLG IMMOBILIEN AG, 2017. Available online: https://www.tlg.de/fileadmin/user_upload/Publikationen-de/pdf/2017_06_23_Marktstudie_Lebensmitteleinzelhandel_in_Deutschland_-_Marktstrukturdaten_2016_DE.pdf (accessed on 8 February 2021).

29. GFI. *Guide Frischemärkte Deutschland (GFI, German Fresh Food Markets)*, 2015. Available online: https://docplayer.org/24123573-Gfi-guide-frischemaerkte-deutschland.html (accessed on 2 February 2021).

30. Lebersorger, S.; Schneider, F. Food loss rates at the food retail, influencing factors and reasons as a basis for waste prevention measures. *Waste Manag.* **2014**, *34*, 1911–1919, doi:10.1016/j.wasman.2014.06.013.

31. DESTATIS. *Generation of household waste: Germany, years, waste types. Tab. 2004-2016*. Database of the Federal Statistical Office of Germany, 2015. Available online: https://www-genesis.destatis.de/genesis/online (accessed on 2 February 2021).

32. Hübsch, H.; Adlwarth, W. *Systematische Erfassung von Lebensmittelabfällen der privaten Haushalte in Deutschland (Systematic recording of food waste from private households in Germany)*. Tagebuch Zeitraum: Juli 2016 bis Juni 2017 (Diary Period: July 2016 to June 2017). GfK SE. Nürnberg, 2017. Available online:

https://www.bmel.de/SharedDocs/Downloads/DE/_Ernaehrung/Lebensmittelverschwendung/Studie_GfK.pdf?__blob=publicationFile&v=3 (accessed on 2 February 2021).

33. Tafel Deutschland e.V. *Lebensmittel retten (Save food)*. Food Banks Germany, 2015. Available online: https://www.tafel.de/themen/nachhaltigkeit/lebensmittel-retten/ (accessed on 2 February 2021).

34. Göbel, C.; Teitscheid, P.; Ritter, G.; Blumenthal, A.; Friedrich, S.; Frick, T.; Grotstollen, L.; Möllenbeck, C.; Rottstegge, L.; Pfeiffer, C.; et al. *Verringerung von Lebensmittelabfällen – Identifikation von Ursachen und Handlungsoptionen in Nordrhein-Westfalen (Reduction of Food Waste - Identification of Causes and Options for Action in North Rhine-Westphalia)*. Studie für den Runden Tisch „Neue Wertschätzung von Lebensmitteln" des Ministeriums für Klimaschutz, Umwelt, Landwirtschaft, Natur- und Verbraucherschutz des Landes Nordrhein-Westfalen. ISBN: 978 -3-938137-27-7, 2012. Available online: https://www.fh-muenster.de/isun/downloads/Studie_Verringerung_von_Lebensmittelabfaellen.pdf (accessed on 2 February 2021).

35. Hebrok, M.; Boks, C. Household food waste: Drivers and potential intervention points for design – An extensive review. *Journal of Cleaner Production* **2017**, *151*, 380–392, doi:10.1016/j.jclepro.2017.03.069.

36. Waskow, F.; Blumenthal, A.; Wieschollek, S.; Polit, G. *Fallstudie: Vermeidung von Lebensmittelabfällen in der Verpflegung von Ganztagsschulen (Case study: food waste prevention in school catering)*. Working Paper I: Erhebung, Relevanz und Ursachen von Lebensmittelabfällen in der Mittagsverpflegung von Ganztagsschulen. Federal Ministry of Education and Research, Germany, 2016. Available online: https://refowas.de/images/WPVZ12.pdf (accessed on 2 February 2021).

37. Borstel, T. von; Prenzel, G.K.; Waskow, F. *Ein Drittel landet in der Tonne. Zwischenbilanz 2017: Fakten und Messergebnisse zum deutschlandweiten Lebensmittelabfall in der Außer-Haus-Verpflegung (One third ends up in the garbage bin. Interim balance 2017: Facts and measurement results on food waste in out-of-home catering throughout Germany)*. United Against Waste (UAW), 2017. Available online: https://www. united-against-waste.de/downloads/united-against-waste-zwischenbilanz-2017.pdf (accessed on 2 February 2021).

38. Leverenz, D.; Moussawel, S.; Maurer, C.; Hafner, G.; Schneider, F.; Schmidt, T.; Kranert, M. Quantifying the prevention potential of avoidable food waste in households using a self-reporting approach. *Resources, Conservation and Recycling* **2019**, *150*, 104417, doi:10.1016/j.resconrec.2019.104417.

39. Leverenz, D.; Hafner, G.; Moussawel, S.; Kranert, M.; Goossens, Y.; Schmidt, T. Reducing food waste in hotel kitchens based on self-reported data. *Industrial Marketing Management* **2020**, doi:10.1016/j.indmarman.2020.08.008.

40. Leverenz, D.; Moussawel, S.; Hafner, G.; Kranert, M. What influences buffet leftovers at event caterings? A German case study. *Waste Manag.* **2020**, *116*, 100–111, doi:10.1016/j.wasman.2020.07.029.

41. Schmidt, T.; Schneider, F.; Claupein, E. *Food waste in private households in Germany. Analysis of the results of a representative survey 2016/2017 by GfK SE*. Thünen Working Paper 92, 2018. Available online: https://literatur.thuenen.de/digbib_extern/dn061022.pdf (accessed on 2 February 2021).

42. DESTATIS. *Production value, production volume, production weight and enterprises of the quarterly production survey: Germany, years, goods index (9-digit). Tab. 42131-0003*. Database of the Federal Statistical Office of Germany, 2015. Available online: https://www-genesis.destatis.de/genesis/online (accessed on 2 February 2021).

43. BMEL. *Agreement in principle on the reduction of food waste between the German Federal Ministry of Food and Agriculture (BMEL) and associations representing German agriculture, the food and nutrition industry, and the catering and hotel sectors*. Federal Ministry of Food and Agriculture. Germany, 2020. Available online: https://www.lebensmittelwertschaetzen.de/fileadmin/Thuenen_Baseline/Nationale_Strategie/Grundsatzvereinbarung-final_web.pdf (accessed on 2 February 2021).

44. BMEL. *National strategy for food waste reduction*. Federal Ministry of Food and Agriculture. Germany, 2019. Available online: https://www.bmel.de/SharedDocs/Downloads/EN/_Food-and-Nutrition/Strategy_FoodWasteReduction.pdf?__blob=publicationFile&v=3 (accessed on 2 February 2021).

45. Richter, B.; Bokelmann, W. The significance of avoiding household food waste - A means-end-chain approach. *Waste Manag.* **2018**, *74*, 34–42, doi:10.1016/j.wasman.2017.12.012.

46. Quested, T.; Johnson, H. *Household food and drink waste in the UK*. Final report. ISBN: 1-84405-430-6. Banbury: Wastes & Resources Action Programme (WRAP), 2009. Available online: http://www.wrap.org.uk/sites/files/wrap/Household_food_and_drink_waste_in_the_UK_-_report.pdf (accessed on 2 February 2021).

47. Delley, M.; Brunner, T.A. Household food waste quantification: comparison of two methods. *BFJ* **2018**, *120*, 1504–1515, doi:10.1108/BFJ-09-2017-0486.

48. Quested, T.E.; Palmer, G.; Moreno, L.C.; McDermott, C.; Schumacher, K. Comparing diaries and waste compositional analysis for measuring food waste in the home. *Journal of Cleaner Production* **2020**, *262*, 121263, doi:10.1016/j.jclepro.2020.121263.

49. Herzberg, R.; Schmidt, T.G.; Schneider, F. Characteristics and Determinants of Domestic Food Waste: A Representative Diary Study across Germany. *Sustainability* **2020**, *12*, 4702, doi:10.3390/su12114702.

50. Dornbusch, H.J.; Hannes, L.; Santjer, M.; Böhm, C.; Wüst, S.; Zwisele, B.; Kern, M.; Siepenkothen, H.-J.; Kanthak, M. *Vergleichende Analyse von Siedlungsrestabfällen aus repräsentativen Regionen in Deutschland zur Bestimmung des Anteils an Problemstoffen und verwertbaren Materialien (Comparative analysis of municipal residual waste from representative regions in Germany to determine the proportion of problematic and recyclable materials)*. TEXTE 113/2020. Ressortforschungsplan des Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit. Forschungskennzahl 3717 35 344 0. FB000328. ISSN 1862-4804, 2020. Available online: https://www.umweltbundesamt.de/sites/default/files/medien/479/publikationen/texte_113-2020_analyse_von_siedlungsrestabfaellen_abschlussbericht.pdf (accessed on 8 February 2021).
51. Parry, A.; Harris, B.; Fisher, K.; Forbes, H. *UK progress against Courtauld 2025 targets and UN Sustainable Development Goal 12.3*. Project code: BCV011-005, 2020. Available online: https://wrap.org.uk/sites/files/wrap/Progress_against_Courtauld_2025_targets_and_UN_SDG_123.pdf (accessed on 2 February 2021).
52. Falcon, J.; Gray, S.; Virtue, N. *Love food champions*. Love food champions report by WRAP and women's institute. In WRAP (Ed.), 2008. Available online: http://www.wrap.org.uk/sites/files/wrap/LFC%20draft%20FINAL%20report%20201071008-FINAL.pdf (accessed on 2 February 2021).
53. WRAP. *History of Courtauld. Tackling waste in the food supply chain since 2005*, 2020. Available online: https://wrap.org.uk/food-drink/business-food-waste/history-courtauld (accessed on 2 February 2021).
54. WRAP. *Courtauld commitment 2025 milestone progress report. Building a sustainable future for UK food and drink*, 2020. Available online: https://www.wrap.org.uk/sites/files/wrap/Courtauld_Commitment_2025_Milestone_Progress_Report.pdf (accessed on 2 February 2021).
55. SFK.Online. *Souci Fachmann Kraut Database*, 2019.
56. Wagner, J.; Baumann, J.; Müller, R. *Bericht zur Ergänzung der Sächsischen Sortierrichtlinie 2014 zur Identifikation von Lebensmittelabfällen (Report amending the guideline on uniform waste analysis in Saxony, Germany)*, 2016. Available online: https://publikationen.sachsen.de/bdb/artikel/%2023865/documents/39942 (accessed on 2 February 2021).
57. Jepsen, D.; Vollmer, A.; Eberle, U.; Fels, J.; Schomerus, T. *Entwicklung von Instrumenten zur Vermeidung von Lebensmittelabfällen*. Forschungskennzahl 3712 32 311. UBA-FB 002412. ISSN 1862-4804, 2016. Available online: https://www.umwelt bundesamt.de/sites/default/files/medien/377/publikationen/2016-12-14_vermeidung-lebens_mittelabfalle_dt_lang_fin.pdf (accessed on 2 February 2021).
58. Kummu, M.; Moel, H. de; Porkka, M.; Siebert, S.; Varis, O.; Ward, P.J. Lost food, wasted resources: global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. *Sci. Total Environ.* **2012**, *438*, 477–489, doi:10.1016/j.scitotenv.2012.08.092.
59. Scherhaufer, S.; Moates, G.; Hartikainen, H.; Waldron, K.; Obersteiner, G. Environmental impacts of food waste in Europe. *Waste Manag.* **2018**, *77*, 98–113, doi:10.1016/j.wasman.2018.04.038.
60. EC-JRC. *Framework for the assessment of food waste prevention actions: meeting of the subgroup on action and implementation*. EU Platform on Food Losses and Food Waste, 2018. Available online: https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-platform_20181001_sub-ai_pres-05.pdf (accessed on 2 February 2021).
61. EC-JRC. *Collection and assessment of food waste prevention actions: meeting of the subgroup on action and implementation*. EU Platform on Food Losses and Food Waste, 2018. Available online: https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-platform_20180319_sub-ai_pres-04.pdf (accessed on 2 February 2021).
62. EC-JRC. *Collection and evaluation of food waste prevention actions: meeting of the subgroup on action and implementation*. Platform on Food Losses and Food Waste, 2019. Available online: https://ec.europa.eu/food/sites/food/files/safety/docs/fw_eu-platform_20190318_sub-ai_pres-01.pdf (accessed on 2 February 2021).
63. Goossens, Y.; Wegner, A.; Schmidt, T. Sustainability Assessment of Food Waste Prevention Measures: Review of Existing Evaluation Practices. *Front. Sustain. Food Syst.* **2019**, *3*, doi:10.3389/fsufs.2019.00090.
64. Campoy-Muñoz, P.; Cardenete, M.A.; Delgado, M.C. Economic impact assessment of food waste reduction on European countries through social accounting matrices. *Resources, Conservation and Recycling* **2017**, *122*, 202–209, doi:10.1016/j.resconrec.2017.02.010.
65. Huppes, G.; Ishikawa, M. A Framework for Quantified Eco-efficiency Analysis. *Journal of Industrial Ecology* **2005**, *9*, 25–41, doi:10.1162/108819805775247882.
66. Gabriel, R.; Braune, A. Eco-efficiency Analysis: Applications and User Contacts. *Journal of Industrial Ecology* **2005**, *9*, 19–21, doi:10.1162/108819805775247873.
67. Cristóbal, J.; Castellani, V.; Manfredi, S.; Sala, S. Prioritizing and optimizing sustainable measures for food waste prevention and management. *Waste Manag.* **2018**, *72*, 3–16, doi:10.1016/j.wasman.2017.11.007.
68. Parry, A.; James, K.; LeRoux, S. *Strategies to achieve economic and environmental gains by reducing food waste*, 2015. Available online: https://newclimateeconomy.report/ workingpapers/wp-

content/uploads/sites/5/2016/04/WRAP-NCE_Economic-environ mental-gains-food-waste.pdf (accessed on 2 February 2021).

69. HLPE. *Food losses and waste in the context of sustainable food systems*. A report by The High Level Panel of Experts on Food Security and Nutrition, 2014. Available online: http://www.fao.org/3/a-i3901e.pdf (accessed on 2 February 2021).

70. ReFED. *Roadmap to 2030: Reducing U.S. Food Waste by 50% and the ReFED Insights Engine At-A-Glance.*, 2021.

71. Priefer, C.; Jörissen, J.; Bräutigam, K.-R. Food waste prevention in Europe – A cause-driven approach to identify the most relevant leverage points for action. *Resources, Conservation and Recycling* **2016**, *109*, 155–165, doi:10.1016/j.resconrec.2016.03.004.

72. Stöckli, S.; Niklaus, E.; Dorn, M. Call for testing interventions to prevent consumer food waste. *Resources, Conservation and Recycling* **2018**, *136*, 445–462, doi:10.1016/j.resconrec.2018.03.029.

73. Smith, M.M.; Shaw, P.J.; Williams, I.D. *The potential for reducing avoidable food waste arisings from domestic households*. Proceedings SUM 2014, Second Symposium on Urban Mining. Bergamo, Italy, 19 – 21 May. CISA Publisher. ISBN: 9788862650311, 2014. Available online: http://eprints.soton.ac.uk/id/eprint/365224 (accessed on 2 February 2021).

74. Shaw, P.; Smith, M.; Williams, I. On the Prevention of Avoidable Food Waste from Domestic Households. *Recycling* **2018**, *3*, 24, doi:10.3390/recycling3020024.

75. Schmidt, K. Explaining and promoting household food waste-prevention by an environmental psychological based intervention study. *Resources, Conservation and Recycling* **2016**, *111*, 53–66, doi:10.1016/j.resconrec.2016.04.006.

76. Young, W.; Russell, S.V.; Robinson, C.A.; Barkemeyer, R. Can social media be a tool for reducing consumers' food waste? A behaviour change experiment by a UK retailer. *Resources, Conservation and Recycling* **2017**, *117*, 195–203, doi:10.1016/j.resconrec.2016.10.016.

77. Reynolds, C.; Goucher, L.; Quested, T.; Bromley, S.; Gillick, S.; Wells, V.K.; Evans, D.; Koh, L.; Carlsson Kanyama, A.; Katzeff, C.; et al. Review: Consumption-stage food waste reduction interventions – What works and how to design better interventions. *Food Policy* **2019**, *83*, 7–27, doi:10.1016/j.foodpol.2019.01.009.

78. Schmidt, T.; Schneider, F.; Leverenz, D.; Hafner, G. *Lebensmittelabfälle in Deutschland (Food Waste in Germany) – Baseline 2015*. Thünen Report 71. https://doi.org/10.3220/REP1563519883000, 2019. Available online: https://www.bmel.de/SharedDocs/Downloads/DE/_Ernaehrung/Lebensmittelverschwendung/TI-Studie2019_Lebensmittelabfaelle_Deutschland-Kurzfassung.pdf?__blob=publicationFile&v=3 (accessed on 2 February 2021).

79. Gusia, D. *Lebensmittelabfälle in Musterhaushalten im Landkreis Ludwigsburg. Ursachen – Einfluss- faktoren – Vermeidungsstrategien (Food waste in sample households in the district of Ludwigsburg. Causes – Influencing factors – avoidance strategies)*. Master thesis. University of Stuttgart, 2012. Available online: Available online: https://docplayer.org/25046049-Lebensmittelabfaelle-in-musterhaushalten-im-landkreis-ludwigsburg-ursachen-einflussfaktoren-vermeidungsstrategien.html (accessed on 2 February 2021).

80. Hübsch, H.; Adlwarth, W. *Systematische Erfassung von Lebensmittelabfällen der privaten Haushalte in Deutschland (Systematic recording of food waste from private households in Germany)*. Tagebuch Zeitraum: Juli 2016 bis Juni 2017 (Diary Period: July 2016 to June 2017). GfK SE. Nürnberg, 2017. Available online: Available online: https://www.bmel.de/SharedDocs/Downloads/DE/_Ernaehrung/Lebensmittelverschwendung/Studie_GfK.pdf (accessed on 2 February 2021).