Chapter 3.

Tackling food loss and waste: An overview of policy actions

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Abstract

There are multiple and varied food loss and waste (FLW) policy actions that can take place over a variety of time periods in order to meet or make progress towards Sustainable Development Goal 12.3. However, existing peer-reviewed documents illustrate the lack of evidence-base that many of the policy actions currently have. This chapter gives a wider review of these 100+ policy actions and interventions that are available for tackling FWL, highlighting 36 policy actions and interventions classifying these as interventions into a framework of Public policy and regulation, Taxes and fees, Voluntary agreements, Information provision, Nudging, Changes to Standards, Hospitality policy, Surplus and Donation policy, Valorisation and animal feed policy, as well as Technical and innovative policy actions. This chapter also provides an introduction to wider FLW policy concepts including the food waste hierarchy; the need for multiple policy aims in a food systems context; as well the concept of policy coherence to enhance FLW policy implementation. The overall intention of this chapter is to provide the reader with the wider 'menu' of policy actions that are available to address FLW and allow comparison with the actions that were chosen in real-world FLW policy settings.

Introduction

Since the early 2000s policy issues relating to food loss and waste (FLW) have risen up the social and political agenda (Smith 2020). Major drivers of this rise have been climate change and resource use. Estimates suggest that globally one third of food never reaches a human stomach (IMechE 2013), this represents a massive waste of resources with 4 trillion megajoules of energy and 82 billion cubic meters of water are lost yearly from consumer Food Loss and Waste (FLW) alone (Coudard et al. 2021). Likewise, global FLW is associated with 8-10% of global greenhouse gas emissions (Mbow et al. 2019). Indeed, the case for reducing FLW has been successfully made in terms of nutrition, environment, society and economic development (World Bank 2020) leading to wide and diverse stakeholder engagement. This rise of FLW up the policy agenda, has meant that policies with the aim of reduction/prevention, diversion, valorisation, and redistribution of FLW have begun to be developed at multiple levels of government, and across and within multiple geographies (for examples see International programmes (Chapters 4 to 6), National programmes (Chapters 7 to 12), and local programmes (Chapters 13 to 15). One of the most prominent policy goals adopted by many government (and non-government) actors is Sustainable Development Goal 12.3 - the ambition to halve edible food waste by 2030 (Lipinski et al. 2017).

Reports have now been published that propose multiple and varied FLW policy actions over a variety of time periods to meet or make progress towards Sustainable Development Goal 12.3. The most recent reports include estimates of the tonnages reduced or diverted, and the environmental and economic impacts of each policy action (ReFED 2020; Sustainability Victoria 2020; FIAL 2021). Likewise, academic publications reviewing and establishing a peer-reviewed evidence base for the interventions available have been published (Stöckli, Niklaus, and Dorn 2018; De Laurentiis, Caldeira, and Sala 2020; Reynolds et al. 2019). However peer-reviewed documents illustrate the lack of evidence-base that many of the policy actions currently have. Finally, curated policy databases have arisen concerning food banks (Harvard Law School Food Law and Policy Clinic and The Global FoodBanking Network. 2021) and local government policy actions (Reeve et al. 2020; University of Sydney 2020).

The previous two Chapters have provided an introduction to how we currently define and measure FLW (Chapter 1), as well as the causes and consequences of FLW across the food chain (Chapter 2). This Chapter provides an introduction to wider FLW policy concepts including the food waste hierarchy; the need for

multiple policy aims in a food systems context; as well the concept of policy coherence to enhance FLW policy implementation. This Chapter then gives a wider review of policy actions and interventions that are available for tackling FLW. The overall intention of this Chapter is to provide the reader with the wider 'menu' of policy actions that are available to address FLW and allow comparison with the actions that were chosen.

The FLW hierarchy – the key to understanding FLW policy development

Waste disposal hierarchies have been a key framework that has shaped the evolution of FLW policy (Smith 2020). Waste disposal hierarchies were introduced in 1970s to shift resource-use and waste management policy from selecting linear discard based and land-fill solutions towards circular reuse/recycling based solutions. Table 1 shows how different geographies and legal frameworks have slightly different versions of the FLW hierarchy – for a wider discussion see (Papargyropoulou et al. 2014). Overall, the majority of FLW hierarchies stipulates that actors should prioritise efforts (in order of most to least preferable) to reduce (or prevent) FLW, redistribute it (e.g., to the homeless or recycle it as animal feed), valorise[i], compost, recover energy, and (finally) landfill the remainder. As discussed in Chapter 1, there are various definitions for FLW (e.g. edible vs inedible), and the measurement definition used, along with the version of the FLW hierarchy used influences the policies that governments (and other actors) implement.

Giordano et al. (Giordano et al. 2020) provides analysis of how differing FLW hierarchies has led to different outcomes, illustrating how French and Italian laws and responses are different due understandings of their FLW hierarchies.

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The policy actions reviewed in this chapter have developed out of the FLW hierarchy aims. However, there are other policy issues that are interlinked with FLW and resource use beyond the FLW hierarchy. One such issue is the interpretation of over-consumption of food as a type of waste; e.g. over-consumption of food can be thought of as a misallocation of resources (food) that could be used to feed others, and (like FLW) this has negative health, environmental, economic and social impacts (Schmidt and Matthies 2018; Parker, Umashankar, and Schleicher 2019; Clapp 2002; Horton et al. 2019; Toti, Di Mattia, and Serafini 2019; Smetana et al. 2021; Chalmers et al. 2019; Sundin et al. 2021). For now, this re-interpretation of FLW to include overconsumption of food is beyond this Chapter's scope.

The need for a diverse, evidence based FLW policy mix

Many FLW strategies are focused solely on the reduction/prevention of FLW. This is due to the use of the FLW hierarchy to develop policy actions, the definitions/scope of the FLW problem, and the drivers of FLW being (in-part) consumption based. However, as highlighted by the Waste and Resource Action Programme (WRAP, a UK charity that works globally on FLW issues), a policy mix focused only on reduction/prevention does not have a long term impact upon FLW generation (Parry et al. 2014). This is due to 1) population growth - meaning per capita reductions reduce effectiveness over time, and 2) the effectiveness of current reduction/prevention interventions vary and decrease over time. Instead, policy mixes need to be developed and implemented that are linked all stages of the FLW hierarchy and food system.

This need for diverse policy mix has been modelled in strategy documents (ReFED 2020; FIAL 2021), each having policy actions to divert, valorise, and redistribute FLW alongside reduction/prevention policy actions. Indeed, these other destinations on the FLW hierarchy have (in both referenced documents) a capacity to divert a much larger tonnage of FLW than reduction/prevention policy actions – even though reduction/prevention is preferred according to the FLW hierarchy.

The need for accurate measurement of FLW is also a priority in order to develop a comprehensive FLW policy mix. This is because accurate measurement of FLW enables targeting and refinement of policy actions to respond to the specifics of the situation and geography (Reynolds et al. 2020). There is no doubt that FLW measurement had increased in detail and scope over the last decade (World Resources Institute 2016; CEC 2019), and this has enabled the development of appropriate policy for each geographic situation. Indeed, there are now specific policies in many countries that mandate FLW measurement methodologies to quantify FLW at each stage of the food supply chain (for instance (EUROPEAN COMMISSION 2019)).

The need for a food systems approach to FLW.

Due to the complexity of causes and drivers of FLW (as outlined in Chapter 2), FLW solutions and policy need to be developed and implemented not only in a "silo" by governments (be they municipal, local, and regional, national, international), but also by wider food system actors at each stage of the food chain. Within the food chain actors who need to develop FLW policies include production (farmers), handling and storage (packinghouses, storage, transportation, and logistics), processing and packaging (processors, manufacturers, slaughterhouses, and packaging), distribution and market (wholesalers, retailers (formal and informal), consumption (households, restaurants) and waste management and valorisation. Policy also needs to be developed by and in-partnership with financiers, innovators, the research community, and civil society (both grassroots community-led initiatives and wider special interest groups) Likewise, FLW needs policies that lead to action at all geographic levels, from municipal through to global (Flanagan et al. 2019).

To enable food system wide actions, FLW policy has begun to be co-developed using public-private partnerships and voluntary agreements (Boulding and Devine 2019). Even though there is evidence of an average 14 to 1 return on investment for FLW reduction (Champions 12.3 2017), the deployment of FLW policy actions without government assistance is slow and lacking focus without the use of voluntary agreements mechanisms.

This food system approach to FLW policy development is needed as different amounts of waste are generated at different stages in the food chain, depending on the types of foods, the production and consumption processes, and the geography in question. These differences in waste generation tonnage and location in the food system will also influence the types of policy actions deployed.

Policy coherence and wider FLW policy strategy.

The use of a wider food systems approach also leads to a greater awareness of synergies and trade-offs between policy actions that can be taken. Both Roadmap to 2030 (ReFED 2020) and Australian National Food Waste Strategy (FIAL 2021) feature FLW policy actions that have potential synergies (e.g. when deployed simultaneously can lead to further enhanced FLW reduction in the wider food system, as well as wider positive social benefits). This can be seen in the selection of the final 23 interdependent actions within the "Recommended scenario" published in the Australian National Food Waste Strategy (FIAL 2021).

One type of trade-off is the amount of FLW generated. Due to different policy actions the amount of FLW generated can change in the intended sector, and across the wider system (World Bank 2020). E.g. a policy reducing on-farm FLW leads to increasing farm sales; some of these sales may then be wasted further down the supply chain, leading to increased household FLW. Alternatively, a policy focused on decreased household FLW may lead to reduced purchases, and so less food is sold by farmers. This may mean less is produced, and less wasted; or that the same amount of food is produced, and is exported to other customers/countries. The exact trade-offs differ based on food type, geographic context etc. De Gorter et al. (de Gorter et al. 2020) termed these wider FLW generation effects as indirect "cascading effects". In short, the cascading effects up and down the supply chain mean that in some cases, policy actions to reduce FLW will be reinforced while in other cases partially offset. These cascading effects can be thought of as "short term" effects that occur as the food system adjusts to the policy, but are still important to consider.

FLW policy actions can also have wider unintentional positive and negative spill-over effects in different parts of the food system beyond tonnages of FLW generated. For example, in the case of the French Food Waste law (LOI n° 2016-138) though increasing donations from supermarkets, the law may have initially flooded an under-resourced food aid sector with too much food, leading to unintended disposal issues for the food aid sector - rather than the supermarkets (see Chapter 7, and (Gore-Langton 2017; Mourad and Finn 2019)).

This complexity of multiple policies interacting in the food system is linked to the term *policy coherence*. The concept of policy coherence is used to highlight and identify mutually reinforcing policies that create synergies towards achieving agreed objectives and to avoid (or minimize) negative outcomes in other policy areas (OECD 2016; Parsons and Hawkes 2019; OECD 2021; Thow et al. 2018). There are many food system policy areas that have direct and indirect impacts on FLW, and so policy actions in these areas also need consideration with regards to policy coherence. For instance, food system policies regarding nutrition, school food, public procurement, food safety, trading practices, waste management and bio-economy, animal welfare, transport, trade, and taxes have all been identified as linked FLW at the EU/nation-state level (FBR Supply Chain & Information Management et al. 2020). Likewise, at the local or municipal government level, the Australian Local Food System Policy Database (Reeve et al. 2020; University of Sydney 2020) places FLW alongside 33 other policy areas that are within a local/municipal domain. Each of these other policy areas could link with synergies and trade-offs to FLW policy actions. As policy makers and researchers, we need to think about FLW from a policy coherence perspective to ensure that FLW policies can be designed to improve one or multiple food system outcomes and does not undermine others.

Examples of where FLW policy actions intersect with wider policy coherence issues are 1) healthy sustainable diets (WRAP 2019a), and 2) green + digital technologies (UNEP DTU Partnership and United Nations Environment Programme 2021). In the case of healthy sustainable diets, policy could enable greater amounts of FLW to be generated (e.g. shifting diets to healthy but high waste foods (e.g. salad greens). However, if FLW is considered during policy development we could find policies that further reduce FLW (e.g. changing diets towards healthy, longer shelf life, low waste foods (frozen and canned vegetables).

Review of FLW Policy Actions

There have now been multiple FLW strategy documents that provide a review of available FLW policy actions. In the USA, “A roadmap to reduce U.S. food waste by 20 percent” (ReFED 2016) provided 27 “solutions” (e.g. policy actions) while “Roadmap to 2030” (ReFED 2020) provided 40 solutions. In Australia, “The Path to Half” (Sustainability Victoria 2020) identified 25 solutions, while the Australian National Food Waste Strategy (FIAL 2021), identified a long list of 47 different interventions. In the EU, “Halving food loss and waste in the EU by 2030” (Reynolds et al. 2020) highlighted 3 approaches to FLW reduction (measurement ; valorisation; and voluntary agreements); “Changing the rules of the game” (FBR Supply Chain & Information Management et al. 2020) identified 32 policy actions, “Assessment of Food Waste Prevention Actions” (Caldeira, De Laurentiis, and Sala 2019) collated evidence from 91 actions, and “Recommendations for Action in Food Waste Prevention”(EU Platform on Food Losses and Food Waste 2019) recommended 47 actions and suggested 12 possible additional actions. At a global level “Reducing Food Loss and Waste: Setting a Global Action Agenda” (Flanagan et al. 2019), provided a priority to-do list of 107 actions and identified 10 specific interventions to scale and accelerate FLW reduction. This wide array of policy actions highlights the range, depth, detail, scope and complexity that is possible in current FLW policy. The remainder of this section introduces some specific policy actions with these based upon the interventions as listed in the Australian National Food Waste Strategy (FIAL 2021).

Public policy and regulation

Infrastructure investment

Governments can invest in capital infrastructure – such as roads or ports. This can have a benefit of reducing transit times. There are multiple studies discussing this though limited quantification of impacts (Villarreal, Garcia, and Rosas 2009; Ishangulyyev, Kim, and Lee 2019; Jedermann et al. 2014; Stroecken 2017; Lipińska, Tomaszewska, and Kołożyn-Krajewska 2019).

Research funding and innovation grants

FLW can be identified as a strategic priority for public-funded research and innovation. In addition, the governments can set up additional funding scheme to reduce FLW. However, there is limited quantification of the return on investment for FLW research.

FLW measurement policy (as well as developing data infrastructure, analytics & waste audits)

Implementing technologies and systems to better understand and measure the streams of waste produced in the food system is an important policy action (World Resources Institute 2016; CEC 2019).

Invest in cold storage and cold chain improvements

Effective storage, refrigeration and stock management is critical for ensuring shelf life is maximised and potential losses are avoided in the supply chain (Brodribb and McCann 2020). Food within the cold chain is likely to be of higher economic value, embodied environmental impact, and perishability (James and James 2010).

Encourage gleaning

Gleaning is the act of collecting leftover crops from farms after they have been commercially harvested. The gleaning of time-sensitive surplus unpicked crops from fields by local charities and organisations can prevent FLW but is constrained by labour/time factors. Academic modelling (Lee et al. 2017) estimated 0.08 tonne to 0.11 tonne per gleaner. Reports on USA gleaning effectiveness (County Health Rankings. 2019; USDA 2019) estimate ~0.25 tonne per gleaner (23,286 gleaners rescuing 5908 tonnes in 2019), while a Spanish gleaning organisation (Espigoladors 2018) gleaned at a rate of 0.17 tonnes per gleaner (~200 tonnes of food per year with ~1,148 gleaners).

Enable harvesting and sorting of all grades of crop at economic cost

A proportion of some crops is not picked as the economic value of second grade product is not sufficient to cover the additional labour requirements. There is potential for this to be tackled through the development and use of technologies e.g. picking and sorting machines. An additional system wide solution would be processors and/or retailers agreeing to purchase the 'whole crop' and then having the responsibility for finding markets for all grades of produce.

Implement date labelling best practice

The development of uniform and understandable date labelling will allow for better communication of information to consumers and wider food systems actors (Wilson et al. 2017; Newsome et al. 2014; Turvey et al. 2021; Thompson et al. 2018). This will contribute to a reduction of FLW based on shelf life and storage. Additional sub-actions include removing best before dates from items that do not require it by law; removing 'sell by and display by' dates, etc.

Improve manufacturing processes and technologies

There are many practices that reduce FLW in food and drink manufacturing: the introduction of new equipment and technology, changes to processes, and the adoption of continuous improvement initiatives.

Restricted residual waste capacity

The restriction of residual waste collection has been shown to encourage increased participation in recycling. For example, local authorities can impose a limited amount of waste which can be collected every

year through different mechanisms: special, authority-distributed residual waste bags; restricting the physical size of bins issued to households; collecting residual waste less frequently. This may encourage food system actors who would not voluntarily participate in recycling to engage (due to not being able to fit plastics, glass and food into their residual waste collection).

Separate food waste collection

The ability for all food system actors to separate out FLW is a fundamental criterion for many other FLW reduction practices. Rolling out specific FLW recycling and collection services is a crucial part of this provision.

Tackle unfair trading practices

Unfair Trading Practices (UTPs) have been identified by a number of reports (Piras et al. 2018; European Bank for Reconstruction and Development 2019; Sinclair Taylor, Parfitt, and Jarosz 2019; Messner, Johnson, and Richards 2021) as playing a significant role in increasing FLW at food manufacturing and agricultural stages – for example when suppliers are penalised for not delivering an agreed amount of product there are significant incentives to over-produce food. UTPs can occur in food systems where market power is concentrated within a few large retailers interacting with a large number of suppliers. Perishable products (chilled foods, and fresh fruits and vegetables) supplied direct from primary producers to retailers are particularly at risk due to the time constraints (short shelf life) preventing the producer from finding alternate markets.

Taxes and fees

Low-interest financing

Low interest finance and loans enable food system actors to invest in wider FLW policy actions. This is needed to allow a FLW policy ecosystem to develop. However, there is little data on impact and ROI of finance beyond the Champions 12.3 (Champions 12.3 2017) average 14-fold return on investment for investing in actions that reduce FLW.

Pay-as-you-throw (PAYT) taxes

Setting taxes for solid waste management can encourage reductions in order to avoid higher fees. In South Korea, there was a 2% recycling rate for FLW in 1995, however the introduction of a PAYT tax led to a 95% recycling rate by 2019, as well as waste tonnage reductions (Sheldon 2020; Bloom 2019).

Tax credit schemes, VAT exemptions

Modification can be made to tax law to enabled value added tax (VAT) deductions for companies who made food donations to food banks. Other options may include tax reductions or credits for organisations to engage in FLW reduction, or invest in technology aiming at FLW reduction.

Ensuring energy policy does not promote FLW

Fiscal measures (such as subsidies and taxes) to increase renewable sources of energy through the use of technologies such anaerobic digestion can incentivise the 'recycling' of FLW as energy ahead of the prevention or diversion of FLW (e.g. through re-distribution). Energy policy and fiscal measures must be designed to work in coherence with the FLW hierarchy to ensure this outcome does not occur.

Voluntary agreements

Schemes in which public and private sector organisations make commitments to improve their environmental performance, without the need for legislation or sanctions. These agreements include an element of public reporting and target-setting as well as a forum for sharing best practice. Numerous voluntary agreements have been set up to tackle FLW, either covering a wide variety of sectors and stakeholders across the food chain (e.g. the Courtauld Commitment in the UK (WRAP 2019b; WRAP 2020a), ForMat Project in Norway (Hanssen and Møller 2013) and Taskforce Circular Economy in Food in the

Netherlands(Samen Tegen Voedselverspilling 2020)) or focusing on specific sectors (e.g. Dairy Roadmap (Dairy UK 2018) and the Hospitality and Food Service Agreement in the UK (WRAP 2020b)). Wider discussion of these can be found in Reynolds et al (Reynolds et al. 2020) and Boulding and Devine (Boulding and Devine 2019).

Information provision

Employee and citizen engagement & behaviour change

Widespread adoption of best practice across the food system can reduce waste by informing and engaging staff and the wider citizenry in mitigation opportunities across supply and storage, preparation, serving and disposal, and in building confidence to make decisions. There is limited evidence of this intervention in the field. A REFRESH project pilot on employee engagement & behaviour change with the supermarket Penny (REFRESH 2020) found no evidence of effect at scale, but informal evidence that the piloted training and information provision was effective.

Consumer behaviour change campaigns

A large-scale consumer advocacy campaign (based on behavioural change theory) has been used in multiple contexts. These have been shown to reduce waste by between 5 to 15% (ReFED 2016; Reynolds et al. 2019).

Improved storage instructions

Providing better on-pack information to consumers on how to store and use products can lead to reduced consumer waste. However, this intervention only applies to part of household waste, ReFED (ReFED, 2016) estimated that 20% consumer waste due to package size or design, with 5-10% of US consumers reacting to label changes and modify behaviours.

Nudging

Portioning nudges

There are a range of 'nudges' that can be applied to reduce FLW at home and in hospitality: providing smaller plates to influence portion size; Providing the option for customers to select different size meals (e.g. regular or half portion); encourage doggy bags etc.(Just and Swigert 2016; Milford, Øvrum, and Helgesen 2015; Jagau and Vyrastekova 2017)

Changes to Standards

Changes to public procurement standards

Public procurement can be used as a lever to change the waste-related practices of schools, hospitals, prisons, the military, and other public sector canteens. The Champions 12.3 (Champions 12.3 2020) case studies provide evidence to show that FLW reduction is possible using procurement contracts that link and incentivise supply chain FLW reductions and effective ordering.

Relax product standards and specifications

Accepting food products that are cosmetically imperfect or which do not fit typical retail specifications is a method of reducing FLW. In the US it is estimated that 2.6% of US on-farm waste could be avoided through relaxing specific rules at the retail stage (ReFED 2016).

Increase residue tolerances in safety standards.

In the majority of countries there is a zero-tolerance approach to finding chemical residues in food product: if residues are detected the food must be disposed of for food safety reasons. However, advances in detection technologies can find traces of substances that may not be a risk to human health, and so this food could still be eaten if the residue tolerances in the standards were increased.

Extend allowable use-by dates

By extending use-by dates, product has more chance to be sold and consumed. Møller et al (Møller et al. 2016) ran experiments for meat products, finding longer dates (increased durability) led to FLW reduction (8% to 2%, 11% to 3%, and 6% to 3%). WRAP's household simulation model (WRAP 2020d; Kandemir et al. 2020) shows 19% to 30% improvement for people who follow the guidance (e.g. ~30% of UK population) on milk waste, if date increased 1-3 days. This could be considered a change to food risk and public health standards.

Other policy actions

Hospitality policy

Menu planning

Designing menus with FLW prevention in mind e.g. reducing the number of ingredients and repurposing food preparation trim and overproduction has been suggested as an industry led intervention by WRAP (WRAP 2020e; WRAP 2016) and the Nordic Council of Ministers (Nordic Council of Ministers et al. 2012).

Centralised and 'dark' commercial kitchens

Dark kitchens are virtual restaurants supplying food through web portals or mobile apps. Centralised and dark kitchens can reduce hospitality FLW through economies of scale in food preparation and storage.

Surplus and Donation policy

Increase resale or donation of surplus food

Surplus food can be sold or donated to food aid organisation as a method to redistribute FLW. New information technology infrastructure can play a crucial part in operationalising this policy action (UNEP DTU Partnership and United Nations Environment Programme 2021). There are multiple financial and legal methods of increasing donation (KPMG 2020). Donation standardisation, and Donation Tax Incentives as two such methods (ReFED 2016). Likewise, educating potential food donors on donation liability laws has been shown to increase the uptake of food rescue and donation.

Ensure product liability laws do not limit food donations

Companies who would like to donate surplus food may have concerns about the legal and reputational consequences from illness resulting from improper onward distribution of products. In the USA a 'Good Samaritans Act' reduces the public liability risks to retailers and food companies that donate food to local communities and food redistribution charities (KPMG 2020; Harvard Law School Food Law and Policy Clinic and The Global FoodBanking Network. 2021).

Improve re-distribution sector storage capacity and practices

One of the barriers to greater donation of surplus foods is the lack of capacity in local charitable sector to take surplus food in sufficient volumes safely. Improving and investing in capacity as well practices helps with FLW diversion to food aid organisations.

Valorisation and animal feed policy

Increase diversion of FLW to animal feed

In many FLW hierarchies, food used for animal feed are not considered to be 'waste' and therefore feeding food to animals can be an attractive policy action. The REFRESH project had a work package on this intervention (Luyckx 2018; REFRESH 2019a; REFRESH 2019b). Japan is a world leader in animal feed where 52% of waste from the food industry is now used as livestock feed, thanks to adequate policies and a certification system (Luyckx 2018).

Nutrient extraction from processing wastes

Bio-refining FLW to extract additional products is a common form of valorisation. There is limited quantification of scale in literature, but many use-cases (Gedi et al. 2020).

Value-Added processing and stabilisation of surplus food

Maximising the use of by-products and surplus production by creating new food products and brands from surplus raw ingredients (e.g. 'ugly fruit', soups, etc.). This new food is then stabilised through freezing, drying, or packaging technology to create longer shelf life value added items with less waste. Multiple programmes have scaled and used this intervention (REFRESH 2018; REFRESH 2019c; Lafon and Montoux 2015).

Fibre products from FLW

Using fibre in the manufacture of non-food products is another form of valorisation. A range of start-up, manufacturing textile products from fruit and vegetable waste are emerging globally.

Technical and innovative policy actions

Improving operational efficiency

This industry focused policy action covers discounting; stock management; ordering process & replenishment sizes; maintenance of cold chain; on shelf availability targets; etc. Forecasting food demand is a challenge, to understand how much food needs to be produced, and how to address FLW due to product life issues within the food chain. Inaccurate forecasting can lead to overproduction and oversupply. AI forecasting products are currently being developed and deployed (Fowkes, 2020). One specific time series model claims to improve forecast accuracy by ~5 percentage points across multiple foods (Arunraj et al., 2014). A European Commission research project (Grant agreement ID: 867163) found that restaurants can reduce FLW by up to 50% by accurately predicting food demand (European Commission, 2019). Other types of operational efficiency may include valorising in-store through production of foods on-site e.g. bakery products, soups, pies, salads using surplus/waste.

Processing technologies to extend shelf life

Implementing technological solutions to extend shelf life is another industry led policy action found in multiple reports and for multiple food types. WRAP's household simulation model (WRAP 2020d; Kandemir et al. 2020) has found consistent household FLW reductions based on shelf life extensions.

Optimise product and packaging to enable better portioning

Better combinations of packaging and portion size can lead to reductions in FLW. Specific interventions include offering additional size options and packaging design improvements, e.g. through smaller containers, pre-portioned serving.

Use anti-spoilage technologies in packaging

Better designed packaging and new technologies can prolong product freshness and slow down spoilage of perishable products.

Conclusions

This Chapter has introduced a variety of policy actions that a government or other food system actor can deploy to reduce/prevent, divert, valorise, and redistribute of FLW. However, innovation is constantly occurring and new technology based policy actions are emerging (UNEP DTU Partnership and United Nations Environment Programme 2021). Likewise, as FLW is linked to many other food system areas, policy actions focused at diet, agriculture, safety, etc. may have impacts on FLW. No single policy action on its own will be sufficient to solve FLW (or even bring about a 50% reduction to meet SDG12.3), and so all policy actions need to be implemented in a wider food systems context and in a coherent manner for the best outcomes for FLW and wider food system.

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Table 1 Examples of previous FLW hierarchies in EU, UK, and USA

FLW hierarchies	Waste framework directive EU (EC 2008)	WRAP food and material hierarchy UK (Downing, Priestley, and Carr 2015)	Food waste pyramid UK (ReFood 2013)	Food recovery hierarchy USA (USEPA 2015)
Highest priority	Prevention	Prevention	Reduce	Source reduction
	Preparation for reuse	Optimisation	Feed people in need	Feed people in need
	Recycling	Recycling	Feed livestock	Feed livestock
	Recovery	Recovery	Compost and renewable energy via AD	Industrial use compost
Lowest priority	Disposal	Disposal	Incineration or landfill	Incineration or landfill