

POSTbrief 60

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Food Waste



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Overview

This briefing assesses interventions to prevent edible food waste. While there is some uncertainty,^a the Waste and Resources Action Programme (WRAP) estimates that in 2021 the UK wasted 10.7 million tonnes of food, worth over £22 billion. Food waste accounts for 8-10% of global GHGs. If food waste were a country, it would be the world's third largest emitter after China and the USA.

There are hundreds of potential interventions to reduce food waste. However, as most are not supported by evidence, and few legislative approaches have been implemented, policymakers seeking to tackle the issue would need to act with limited knowledge.

While efforts have focussed on reducing downstream (especially household) food waste, evidence suggests changes across the supply chain are needed. Studies note that achieving reductions in one part of the supply chain may require expenditure or profit losses elsewhere.

Measures at the farm-level will be required to reduce total food waste levels. The evidence base for short food supply chains in reducing food waste on farms is limited. Some argue that Whole Crop Purchasing is preferable to "Wonky Veg" initiatives, although more studies are needed.

Several studies demonstrate that information sharing and collaboration across the supply chain could improve forecasting accuracy, avoid overproduction, and reduce food waste. Various supply chain techniques and technologies could improve information sharing, inventory management, and forecasts. However, publicly available evidence that these measures can cost-effectively reduce food waste in practice is lacking. Academics and other commentators also argue that suppliers need incentives and support to implement measures like accurate forecasting and measuring food waste.

Most published studies test interventions downstream. Nutritional guidelines and changing portion and plate sizes and types have been shown to reduce downstream food waste. However, the evidence base is limited for many widely recommended measures, including information and awareness campaigns; social norm or nudge interventions; apps; and smart kitchen devices. Effective interventions mostly achieve reductions smaller than the 50% required to meet UN Sustainable Development Goal 12.3.^b

^a The NGO WWF estimates there could be 12.8 million tonnes of food wasted in the UK, revealing that more food is wasted in primary production than previously thought.¹

^b SDG 12.3: By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.

Evidence suggests applying date labels consistently (and only when necessary) could reduce food waste. However, improvements in consumer understanding would also be required.

Academic and other commentators note that the benefits of food packaging may have been overstated. There is a lack of evidence that intelligent and other packaging technologies prevent food waste, although zero packaging approaches can be effective.

WRAP and others have reported several successes through the voluntary approach to food waste prevention. However, academic and NGO commentators have argued that the evidence base for voluntary approaches is limited. WRAP reports that significant progress is still required in measuring and reducing food waste and that some governmental interventions are needed.

Mandatory food waste measurement and reporting is widely regarded as a pre-requisite for designing and evaluating interventions. Several studies also argue that legislative measures are necessary to address cosmetic standards and "unfair trading practices" that cause food waste, and that governmental interventions are needed for large-scale reductions in hospitality and food services waste. Experts have also recommended requiring companies to conduct food waste minimisation plans and reforming date labels and food safety.

Studies have found subsidies for anaerobic digestion (AD) have encouraged landfill diversion and disincentivised redistribution for human consumption.

Some recommend legal measures to support redistribution, such as Good Samaritan laws. However, evidence is lacking that these measures reduce food waste. Several academics have argued that redistribution should be time-limited, noting that the waste hierarchy prioritises preventing surplus over redistribution.

Separate collection may prevent food waste. Evidence suggests that providing people with feedback on how much waste they are producing is a weaker intervention and WRAP concludes that more studies are needed. Studies show that food waste taxes like Pay-As-You-Throw (PAYT) may prevent food waste in the short-term, but without new regulations they are unlawful in England.

Glossary of useful terms and abbreviations

Term	Long Form	Meaning
AD	Anaerobic digestion	A process whereby biomaterials including food waste are broken down in the absence of oxygen to produce renewable biogas and digestate or fertilizer.
EPR	Extended producer responsibility	A regulatory approach that places financial responsibility for products' lifecycle impacts on producers.
FEFO	First expired, first out	An inventory management or stock rotation technique based on food's remaining product life
FIFO	First in first out	An inventory management or stock rotation technique not based on remaining product life
GCA	Grocery Code Adjudicator	A statutory arbitrator and regulatory established to enforce and encourage compliance with the GSCOP
GSCOP	Groceries Supply Code of Practice	A series of binding legal obligations on designated retailers that apply to their interactions with direct supply suppliers
HaFS	Hospitality and Food Services	
MLOR	Minimum Life on Receipt	A stipulated remaining product life of food upon delivery to a buyer
MTO	Make-to-order	Inventory management technique based on preparing in response to a final order.
MTS	Make-to-stock	Inventory management technique based on minimum stock levels in anticipation of final orders.
PAYT	Pay-as-you-throw	An economic instrument charging producers (including households) for waste collection proportionately to the quantity

		of waste they produce. Also known as direct and variable rate charging schemes.
PDCA Cycle	Plan-Do-Check-Act Cycle	Processes through which managers use the knowledge and experience of actors within an organisation and across the value chain to identify food waste reduction measures.
SFSCs	Short food supply chains	An alternative to long globalised food chains involving few (if any) intermediaries between producers and consumers, with food generally travelling shorter distances, also known as alternative markets, direct marketing, or direct distribution systems.
WCP	Whole Crop Purchasing	Contractual mechanism whereby retailers buy an entire crop and using produce that is below sellable quality in other parts of their supply chain.
WCRP	Whole Chain Reduction Plan	A structured process to embed food waste reduction in the business culture and operations of the supply chain

1 Background

1.1 What is food waste?

Food waste and surplus

There is no universally accepted definition of food waste.^{2,3} This is partly because the food supply chain is complex.^{4,5} There are also different definitions for measuring food waste, and regulating waste.⁶ Several studies note that defining food waste is contentious, and not value-free.⁶⁻¹¹

Several experts suggest that agreeing standard definitions for food waste measurement^c is a priority in better understanding the scale of food waste, its causes, and potential solutions.^{2,12-15} The Food Loss and Waste (FLW) Protocol was developed by an international multi-stakeholder partnership with the aim of providing common terminology.¹⁶

The FLW Protocol underpins the Waste and Resources Action Programme's (WRAP) measurement and reporting guidelines (the UK Reporting Guidelines).¹⁷ Under the UK Reporting Guidelines, food is defined as any substance that is, or was at some point, intended for human consumption. This includes drinks, food that is spoiled or no longer edible, and products past their use by date.

Food should be measured as waste if its final destination indicates that it has left or been removed from the food supply chain. These final waste destinations include anaerobic and co-digestion, composting, incineration, land application, landfill, sewer disposal and food not harvested.

Under the UK Guidelines, material is surplus if it is removed from the food supply chain for redistribution as animal feed, or for bio-based^d processing for use in non-food products, such as textiles.¹⁹ However, some argue food sent to animal feed, for example, should be measured and reported separately as waste.^{16,20-23}

Food loss

Food loss is food removed from the supply chain in production, post-harvest, and processing. Food loss is sometimes used to distinguish from food wasted

^c There is a legal definition of waste. Section 75(2) of the Environmental Protection Act 1990 defines waste as "any substance or object which the holder discards or intends or is required to discard". This definition determines when regulatory obligations with respect to "waste" apply (section 7.1).

^d Bio-based value chains manage agricultural residues to produce materials and energy as part of a circular economy model.¹⁸

at the retail, restaurant, and consumer levels.⁴ However, for a variety of reasons, some studies criticise the distinction.^{20,24–26}

The Guidelines do not categorise food waste as “unavoidable” or “avoidable”. However, they do distinguish between food that is edible or once edible food, and the inedible parts of food such as shells, bones, pits, or stones.¹⁷

Following the UK’s Reporting Guidelines, this briefing does not use the term food loss. Instead, food waste covers food removed from the entire “farm-to-fork” supply chain. This briefing only covers interventions to prevent food waste intended to be consumed by humans, and does not address inedible food waste prevention.

1.2 How much food is wasted in the UK food supply chain?

This briefing discusses interventions to tackle food waste at each stage of the food supply chain (Box 1).

The food supply chain can be differentiated between upstream and downstream food waste.

- **Upstream** is the stage before food reaches consumers. It includes farming, manufacturing, and retail. It also includes Hospitality and Food Services (HaFS) before food is served to customers (pre-kitchen, in-kitchen, and buffet or serving).
- **Downstream** refers to the consumption-stage of the supply chain. This includes plate waste in HaFS, and households.

Box 1 Food waste across the food supply chain

WRAP estimates that in 2021, the UK wasted 10.7 million tonnes of food:

- **Farming** – 1.6 million tonnes.
- **Manufacturing** (using agricultural materials to produce foods, including processing, packaging, preservation, and cooking) – 1.4 million tonnes.
- **Retail** (including distribution centres and points of sale, such as supermarkets, convenience retailers and specialist shops) – 0.2 million tonnes.
- **Hospitality and food services (HaFS)** (including wholesale distribution, and various public, private, and commercial catering settings) – 1.1 million tonnes.
- **Households** – 6.4 million tonnes.²⁷

Studies note levels of food wasted upstream may be underestimated, in part due to a lack of measurement and voluntary reporting.^{28–47} For example, the

NGO WWF estimated that 3.3 million tonnes of food is wasted on UK farms annually.¹ This suggests UK food waste totals 12.8 million tonnes, more than WRAP's estimated 10.7 million.

However, WWF and WRAP use different datasets and definitions of waste.^e While there is uncertainty, the best available evidence indicates that significant quantities of food, particularly fresh produce, are wasted on farms.^{49,20,50}

Commentators note that food waste on farms has been investigated less than other stages of the FSC.⁵¹ This is partly due to the cost.⁵² However, some suggest policymakers have focussed too much on households (see [the relative importance of reducing farm-level and downstream waste](#)).^{21,53,54}

Levels of food waste in retail are relatively low.⁵⁵ Academic and other commentators note that data is rarely publicly reported because it is considered confidential or proprietary.^{38,45,56,57} Researchers note that retailers are sophisticated operations well-placed to reduce food waste.⁵⁸ However, evidence suggests retailers may cause or shift waste elsewhere in the supply chain (sections 2.1, 3.1 and 6.1).^{57,59}

Studies note that most HaFS do not routinely measure food waste,^{31,59-63} and underestimate its extent.⁶⁴ Commentators describe available HaFS food waste figures as estimates³⁰ and "rough guestimates".³¹ Several studies argue this makes designing and evaluating HaFS interventions difficult, if not impossible.^{28-31,65-74}

Evidence suggests food waste reduction opportunities in HaFS are considerable.^{60,70,75-77} Out-of-home food consumption is growing,^{29,30,70,78} and the amount of food wasted in UK HaFS is assumed to have increased since 2011.⁶² However, there is no reliable data source of sufficient quality for HaFS food waste that allows comparisons over time.^{79,80}

WRAP has reported that household food waste increased by 13.5% between 2018-2021.⁸¹

1.3

What are the impacts of food waste?

WRAP estimates that food wasted in the UK has a value of over £22 billion a year.⁸² Food wasted that could have been eaten is enough to feed the entire UK population 3 meals a day for 11 weeks.

Wasting food contributes to climate change by wasting the energy and resources involved in food production ([CBP 7552](#)). Food waste also releases greenhouse gases (GHGs) when landfilled.

^e For example, WWF includes food that goes to animal feed as waste. WRAP does not. WWF also includes pre-harvest food waste, whereas WRAP's on-farm estimate scope "starts when a food crop or animal are ready for harvest or slaughter" and includes rejections.⁴⁸

WRAP reports that the GHG emissions from food wasted annually by households is 18 million tonnes.⁸³ The United Nations Environment Programme estimated that between 8-10% of global GHGs are associated with food waste.⁸⁴ If food waste were a country, it would be the world's third largest emitter after China and the USA.⁸³ Environmental impacts, including GHG emissions, also arise from the use of land, water, and energy resources in the production, processing, packaging and transport of wasted food ([PN 702](#)).

1.4

What are the main causes of food waste?

Studies identify several causes of food waste at each stage of the supply chain (sections 2.1, 3.1, 4.1, 5.1 and 6.1). Academic studies have largely focussed on household food waste, partly because more food is wasted by households than in other parts of the supply chain.⁸⁵

However, studies show that food waste occurring in one stage (such as on farms or in households) can be caused by practices and factors in other stages and broader systemic issues.^{42,86} Researchers suggest it is important to distinguish between the location and causes of food waste.^{10,26,87}

Some studies distinguish between technological, institutional and social drivers of food waste.⁸⁶ The FLW Protocol distinguishes causes (the proximate reason for food waste) from drivers (an underlying factor that plays a role in creating the cause).¹⁶ Another approach is to outline causes of food waste at different levels.⁸⁸

- **micro-level** include stage-specific causes at each segment of the supply chain
- **meso-level** causes are factors that contribute to food waste at the micro-level including law and regulation, policy on food production and waste disposal, or factors relating to supply chains
- **macro-level** causes such as food prices (Box 2)

The macro-level relates to the entire food system, made up of complex and dynamic networks of decision-makers, natural processes and human activities ([PN 626](#), [PN 702](#)). Research is exploring the interconnected causes of food waste in the supply chain and wider food system ([PN 626](#)).^{3,89-92}

Some argue that food waste is a symptom of a "broken food system".⁹³ However, while the evidence base is growing, system-level research on food waste is currently limited.⁹⁴⁻⁹⁶

The Covid-19 pandemic temporarily reduced food waste in households (section 6.1).⁹⁷⁻⁹⁹ However, a review found the pandemic caused shocks, disruptions or ripple effects upstream, leading to calls for greater resilience in the food system.⁹⁹

Box 2 The price of food and overproduction

Several studies identify the relatively low price of food as a main cause of food waste,^{100–107} particularly in countries where food is cheap relative to incomes.^{21,100–109}

Policy choices to drive productivity, efficiency and cheap food (PN 707) are said to have resulted in a “paradox of productivity”.¹⁰¹ Studies note that more intensive farming has increased environmental degradation and fragility, while contributing to malnutrition and an “obesity pandemic”.^{14,101,110–114} High production costs, and value extraction by intermediaries (including shareholders) also mean producers’ profit margins are low.¹¹⁴ Commentators argue that cheap food can incentivise overproduction and waste if retailers do not bear the costs of this waste (see section 2.1).¹¹⁵

Researchers have suggested the price of food should reflect the social, environmental, and economic impacts of its production and consumption.^{2,14,101,103,104} Academics have argued that increasing the price of food could reduce food waste, enhance food resilience and security, and provide various environmental and health benefits.^{2,93,113,116}

This assumes that high-income countries have higher levels of food waste. However, the UNEP’s Food Waste Index has found that household food waste is likely to be lower in higher-income countries (although the evidence base, particularly for low-income countries, is limited).^{84,115}

Food prices could be adjusted by, for example, carbon pricing.^{100,117} The UK Health Alliance on Climate Change recommends a carbon tax on food producers.¹¹⁸ The Climate Change Act 2008 contains powers to introduce personal carbon trading.^{119,120}

However, raising the price of food would have regressive social welfare impacts, raising just transition issues (PN 706).^{100,121} Some commentators suggest compensation policies could help, such as increases in social security, with the costs offset by additional VAT revenues.^{2,73,101}

The NGOs WRAP and WWF suggest national food waste strategies could deliver benefits without having to raise prices.¹³ The World Bank has recommended that such strategies should include:

- legislation to prevent unfair trading practices
- mandatory food waste measurement and reporting
- reducing barriers to the sale, donation, and redistribution of food
- support for smart infrastructure, storage and insurance¹⁰⁰

Researchers note that policy problems like food waste are challenging for policymakers to act on and have to be “framed”.^{122,123} Most stakeholders will

have an interest in how food waste is framed, and there are competing narratives.^{122,123}

For example, some studies argue that consumers have been disproportionately blamed by policymakers for household food waste.^{6,24} This is said to shift responsibility for food waste away from retailers and government (section 7).^{24,103,122,124–128}

Several academic commentators note the importance of engaging retailers, given the accrued environmental impacts of food waste as it moves downstream.^{35,41,56,129} Large retailers are also a more easily accessible target for policy measures than scattered individual households.^{38,37,130,131}

Studies show that practices shaped by law and governance cause food waste across the supply chain. One example is food law, which places various obligations on businesses relating to food safety, hygiene and labelling.^{13,51,86,86,106,112,132–134} Evidence also suggests that subsidies for anaerobic digestion (AD) and only taxing landfill have encouraged food businesses to focus on landfill diversion rather than prevention and the higher stages of the waste hierarchy.^{6,59,69,73,135–140}

Evidence suggests a consensus in the UK that responsibility for addressing food waste should be “shared” or “distributed” across those involved.¹²⁷ However, implementing this is challenging.¹²² Studies have identified economic instruments applied to waste (Box 3), and mandatory food waste reduction targets and extended producer responsibility as possible options (Box 16).

Researchers have also highlighted the importance of joining-up food waste across several policy domains (and respective government departments), including:

- agricultural production, food security, diet, and health
- food safety and labelling
- public procurement
- tax^{6,14,69,101,116,122,131,141,142}

Box 3 The cost of waste

Several studies say the low cost of disposing of waste hides the true economic, environmental and social costs of food waste.^{86,109,143} Evidence suggests this is a disincentive to businesses and consumers implementing food reduction practices.^{86,144–146}

Using economic instruments to make waste more expensive is considered particularly useful in tackling food waste, given the challenges involved in using direct regulation against multiple sectors, levels and motivations.^{2,117} Examples include landfill and incineration taxes, Pay-As-You-Throw (PAYT) schemes and extended producer responsibility (EPR).¹⁴⁷

Some academics also suggest that taxes for wasting food may be preferable to the regressive impacts of increasing the food prices.⁷³ However, while fees and taxes are *expected* to impact on levels of food waste,¹⁰³ evidence reviews highlight the lack of research specifically evaluating their impact on food waste reductions.^{14,102,103,148,149}

Evidence demonstrates the effects of pricing mechanisms can also be short-lived, and making disposal more expensive can have unintended consequences.^{150,151} For example, taxes on food waste may result in multiple actors bearing the cost who may not be driving the causes (Section 7.3), reducing demand and harming producers, encouraging harmful overconsumption or leading to waste crime.¹⁴³

Taxes require well-resourced enforcement, and transparently assessing the true cost of food waste is difficult.^{109,152} Evidence suggests that waste taxes should be combined with mandatory separate collection of food waste.^{59,73}

1.5 The waste hierarchy

Waste is devolved. This briefing focuses mainly on England. For an overview of waste policy in the UK's devolved administrations, see [CBP 7552](#).

Food waste is subject to the generic frameworks of waste law, notably the waste hierarchy (see Box 4).⁶

Box 4 The waste hierarchy

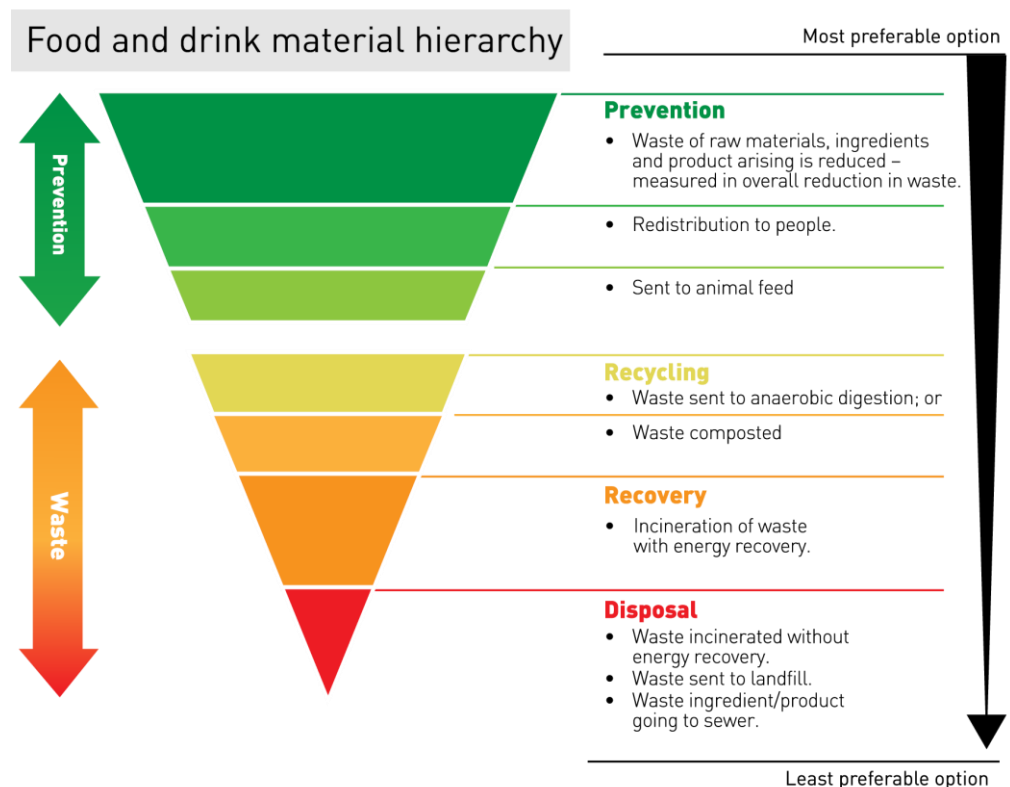
The waste hierarchy lists the priority order for tackling waste. At the top of the hierarchy is prevention, with measures to prevent materials from becoming "waste". A range of management options lower down the hierarchy are concerned with managing waste.¹⁵³ Several hierarchies exist to

describe food waste (Figure 1).¹⁵⁴ Most begin with prevention options to limit the production of surplus food.^{155–157} Prevention is preferable to options lower in the hierarchy, such as redistributing surplus food for human consumption.^{8,136,156,158–160}

Some food waste hierarchies consider sending surplus food for animal feed is an example of waste prevention (as is surplus redistribution).¹⁶¹ Others view this a form of waste management (as recycling).²² Other examples of food waste management options lower down the hierarchy include recycling food waste via AD, composting and land spreading.

All hierarchies list the last resort as food waste sent for disposal by incineration^f or landfill. The hierarchies are a guide, and departures are sometimes justified. For example, the AD of food waste can have lower GHG emissions than redistribution.¹⁵⁷

Figure 1 The food and drink material hierarchy



Source: WRAP

^f Unlike landfill, incineration is not taxed and will not count towards biogenic GHG emissions that activities regulated under the emissions trading scheme may otherwise be subject to capping and trading.¹⁶²

The waste hierarchy serves a policy-directing function for governments,^{163,164} but it also constitutes a legal obligation for businesses.⁹ There is statutory guidance for businesses on applying the waste hierarchy, which businesses must consider when discharging the duty to apply the waste hierarchy.¹⁶⁵

1.6 Self-regulation and the voluntary approach to food waste

The voluntary approach to preventing food waste has been adopted by successive governments in England for over twenty years.^{166–168} This relies on industry self-regulation and collaboration and represents the primary response to meeting the United Nations Sustainable Development Goal (SDG) 12.3 target^h.^{169,170}

The Courtauld Commitments are a series of UK voluntary agreements setting out progressive non-binding targets that now align with SDG 12.3.ⁱ The Food Waste Reduction Roadmap, centred around “Target, Measure, Act”, is another voluntary measure (Box 10).

The number and type of Courtauld signatories (or members under later fee-based iterations),¹⁷² and the scope of the commitments, have expanded over time. Earlier commitments focussed on reducing household food waste. Later this extended to reducing waste in the post-primary production supply chain. Targets for 2030 also refer to the GHG and water-related impacts of food and drink consumption ([PN 702](#)).¹⁷³

While a signatory or member who stops contributing could be excluded, this has not happened to date.¹⁶⁸ As is typical with voluntary agreements, there are no sanctions for not meeting the targets.

The voluntary approach is coordinated by WRAP, a charity and climate action NGO that receives most of its income from UK central and devolved administrations.^{174,175} WRAP publicly reports aggregated food waste reductions against the targets, including data voluntarily reported in confidence by businesses.^{169,170}

⁹ Under regulation 12(1) of the Waste (England and Wales) Regulations 2011/988, relevant businesses must take all such reasonable measures to apply the hierarchy and prioritise waste prevention.

^h The aim under UN SDG 12.3 is to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses, by 2030.

ⁱ Courtauld 2030 aims at a 50% reduction in per capita food waste in the post-farm gate supply chain by 2030 as against the UK 2007 baseline. The Courtauld target does not focus on farm waste (see section 2.2). The Government’s Environmental Improvement Plan 2023 also sets a target that, by 31 January 2028, the total mass of annual residual food waste does not exceed 64 kg per capita.¹⁷¹ This is equivalent to a 50% reduction from 2019 levels.

WRAP supports several activities within the voluntary approach. This includes:

- the large-scale public awareness campaign Love Food Hate Waste
- convening working groups to benchmark and encourage best practice on food labelling and packaging
- providing tools and resources to support reductions^{169,176}

1.7

The legislative approach

In 2018, the previous government proposed a new legislative approach to food waste in the Resources and Waste Strategy (Box 5).¹⁷⁶

Box 5 The Resources and Waste Strategy

The Resources and Waste Strategy includes the aspirational target of eliminating food waste to landfill by 2030 and meeting UN SDG 12.3. To achieve this, the previous government proposed several legislative measures to prevent food waste upstream in supply chain.

These include new powers under the Agriculture Act 2020 relating to transparency and fairness in the supply chain. The previous government also suggested the possibility of mandatory redistribution obligations, food waste prevention targets and food waste reporting.^j It has powers under the Environment Act 2021 to make waste related targets and to implement producer responsibility obligations for food waste, including targets and financing around prevention.

Other measures in the Strategy included funding for surplus redistribution organisations; appointing a Food Surplus and Waste Champion; and introducing mandatory food waste collections every week. The role of the Food Surplus and Waste Champion was subsequently dropped, and food waste reporting has yet to be implemented.¹⁶² The 2023 Waste Prevention Programme contained no additional measures to tackle food waste.¹⁷⁸

The Resources and Waste Strategy proposed to continue the voluntary approach to tackling downstream consumer food waste.¹²²

Except for new regulations to tackle unfairness in the dairy sector,^k legislative measures to prevent food waste proposed in the Resources and Waste Strategy have not yet been implemented.

^j Improved food waste reporting was also included in the Government Food Strategy of 2022.¹⁷⁷

^k The Fair Dealing Obligations (Milk) Regulations 2024/537 came into force on 10 July 2024.

1.8

Food waste interventions

This briefing assesses interventions to reduce food waste across the supply chain. A food waste intervention is any attempt to reduce waste. Interventions are categorised in different ways.^{14,179} While there is some overlap, this briefing distinguishes between:

- law, regulation, and policy
- informational interventions
- technological solutions

Designing food waste interventions

Evidence shows that interventions to reduce food waste can have interacting benefits for sustainability, health and food availability, and be a cost-effective measure to address climate change.¹⁸⁰

However, policymakers have to decide whether to specifically target food waste prevention, or to achieve that as part of broader approaches that make food supply chains sustainable.^{100,181}

Studies also note the potential for trade-offs and unintended consequences.^{100,181} Attention will need to be paid to the cost-effectiveness of interventions at scale,¹⁸⁰ effects on the environmental sustainability of diets ([PN 702](#)) and their impact on producers' livelihoods.^{143,180,182}

Evidence suggests that substantial reductions in food waste are unlikely to be achieved through a single intervention.^{14,75,181,183-185}

Evaluating food waste interventions

There are hundreds of policy and other potential interventions to reduce food waste.^{186,187} However, academic commentators note that most are not supported by any underlying evidence base, either from testing in the field, or in the specific food waste context.^{58,186,187} Owing to a lack of consistent measurement across the supply chain, evaluating interventions will be difficult, if not impossible.^{28-31,65-74}

Evaluating the effectiveness of interventions is difficult, particularly when multiple interventions are deployed simultaneously. This is because it can be difficult to disentangle the influence of isolated interventions from one another, as well from broader social and economic trends.^{13,14,150,188}

For instance, levels of food waste generated in the UK may have been affected by inflation, the price of food, earnings, population growth, and more people living alone.^{170,189,190} While lessons may be learnt from other jurisdictions, evidence suggests interventions that work in one region may not in another.¹⁴

There are also difficulties in testing interventions on food waste that demonstrate anything more than statistical correlation ([Study designs](#):

primary research).⁵⁸ The relatively few food waste interventions studies that have been carried out to date^{29,46,148,150,179,191} are therefore useful, but not entirely reliable.⁵⁸ Academic evidence reviews (Study designs: secondary research) have concluded that policymakers will have to act with limited evidence.^{179,181}

Several evidence reviews also highlight various methodological limitations of existing studies, including:

- unreliable methods of measuring food waste, sometimes without a baseline
- time-limited evaluations tested on relatively small samples
- a lack of comparability across studies because they use different definitions
- failure to account for possible rebound effects or unintended consequences, such as negative outcomes of overconsumption^{14,150,179,192–194}

Recommendations for improving the evidence base include:

- evaluating interventions using consistent methods and measurement
- more studies that explore long-term impacts and use larger sample sizes and random sampling techniques
- further exploration as to scalability and cost-effectiveness
- greater efforts to understand causal mechanisms and rebound effects^{14,124,179,195}

2 Farms

2.1 Why is food wasted on farms?

A systematic review has identified six major causes of food waste on UK farms:

- diseases
- pests and animals
- extreme weather events
- harvest and storage
- quality and cosmetic or aesthetic requirements¹
- errors in forecasting demand, changes in demand and overproduction.⁴⁶

However, that review found evidence as to which factors have the biggest impact is inadequate, with UK-specific studies on demand mismatch and overproduction particularly lacking.⁴⁶ A narrative review of farm-level food waste also found there is not enough primary data collection to give confidence in knowledge of levels of on-farm food waste.⁴⁷ Commentators such as the NFU also highlight other possible causes, such as labour shortages at harvest time or delays in the supply chain that can result in spoilage and food waste.¹⁹⁷

Diseases, pests, and animals

Many organisms cause diseases, reducing crop yield of several economically significant crops, such as potato, wheat, and rice ([PB 51](#)).⁴⁶ Some studies estimate that for some crops, food wasted worldwide due to diseases is 55 kg per person per season.⁴⁶ One study suggests crop protection could reduce food waste by up to 40%.¹⁹⁸

Pests are frequently mentioned as a cause of food waste, including moths, flies, birds, mice, and slugs.⁴⁶ A Defra study has estimated waste at levels of 5-20% for UK cereals due to pests and pathogens.¹⁹⁹ Some pests are very difficult to control and many chemical controls are banned because they are dangerous to human health and the environment ([PB 43](#)).⁴⁶

¹ These include (i) legally required marketing standards, and (ii) private cosmetic standards set by retailers and other buyers. In the UK, marketing standards apply among other things to 10 fruits and vegetables, which are classed according to colour, size, shape and defects.¹⁹⁶

Extreme weather events, harvest, and storage

Extreme cold, heat, downfalls and floods can cause food loss on farms.⁴⁶ The impact of some events is likely to increase due to climate change.⁴⁶ Farmers may sometimes overplant as insurance against poor weather, leading to waste.²⁰⁰ However, they will also be planting to meet expected volumes in contracts and overproducing may have an economic impact for growers.¹⁹⁷

A systemic review found that harvest techniques and technologies, and a lack of suitable storage contribute significantly to food waste.⁴⁶ Storing crops in facilities such as cold stores can also be costly.¹⁹⁷ However, these are largely understudied.⁴⁶ Food can also be wasted post-harvest due to damage during transport.¹

Quality and cosmetic requirements

Research identifies that some causes of farm-level food waste originate further down the supply chain, particularly the cosmetic requirements of buyers.^{105,201,53,51,107,202,73,203,13,47} These can lead to “imperfect” produce not being consumed ([PN 707](#)).

Some international studies suggest cosmetic standards are the main cause of farm-level food waste.^{2,14,106,131,202} A systemic review estimated that in the UK, between 7-65% of food wasted on farms is due to these requirements, with an average of 25%.⁴⁶

There is some evidence that retailers apply aesthetic requirements that are more stringent than legally required marketing standards (“over-specification”).^{2,53,73,86,202,204,205} Private cosmetic standards may also be used to manage supply and demand, with standards loosened when demand is high and tightened when demand is low, driving waste, but data are lacking.^{54,202,206}

Numerous studies find consumers are unwilling to purchase produce perceived as suboptimal.^{207–211} However, there is debate about whether this expectation has been created by retailers (see Section 2.2).^{54,203} A narrative review has suggested that consumer acceptance of imperfect produce could be altered through public campaigns.⁴⁷

Demand mismatch and overproduction

Forecasting demand is challenging, and is affected by the seasons, weather and special occasions.²¹² For example, consumers may cut back on traditional summer grocery purchases in poor weather.²¹³ There is no single demand forecasting technique, with various methods used.^{86,212,214–216}

Some studies call for improvements in forecasting accuracy.^{51,105} Research shows collaboration and information sharing can increase the accuracy of forecasts.^{46,51,212,217–219} However, studies find a lack of this in practice.^{42,220,221}

Studies suggest that variability in demand can be induced by retail practices, particularly around promotions.^{51,218,42,105} Seeking to maintain on-shelf availability can also lead buyers to order too much food and suppliers to overproduce.^{38,222,218,42,220,223,37,224} A Scottish study found overproduction may

be less significant than previously thought.⁵¹ However, clarifying this requires further research.^{46,106,225,m}

Several studies highlight how food waste on farms (and elsewhere) can be a side-effect of the market power of large food retailers.^{203,54,225,224,53,38,226,127,105,227,166,46,55,228,229} However, global commodities traders are also powerful actors in the global food system.^{230–232} Commentators also note that some smaller retailers are less powerful than larger retailers and manufacturers.²³³

Some research suggests retail power can drive positive outcomes, such as modernising production and driving efficiency.^{227,234–237} However, several studies and commentators argue that supermarket business models lead to unsustainable outcomes that keep prices low but pass costs, risk and waste on to suppliers (PN 707).^{238,237,226,114,239,240}

Studies suggest that various contractual and unfair trading practices mean that farmers often bear the costs and risks of overproduction and waste.^{95,10,51,53,54,42,86,105,106,166,201,203,224–226,241–243,55,244,245} Farmers invest in cycles of food production that cannot be rapidly adjusted and would require accurate forecasting information well in advance.¹⁹⁷ Studies and commentators argue that if buyers do not bear the costs of waste from overproduction, there is little incentive for them to improve forecasting accuracy.^{21,26,86,203,224–226,246,247}

Examples of these practices include:

- changes to orders at short notice, such as changing the proportion of stock bought from different suppliers to exploit cheaper offers⁵⁴
- requiring suppliers to deliver full quantities on time, with penalties for non-delivery
- over specifying aesthetic requirements
- certain minimum life on receipt (MLOR) requirements
- exclusivity terms
- being removed as a supplier for non-commercial reasons (delisting)

Evidence suggests farmers may experience some of these practices when they supply intermediaries (manufacturers or processors), although some of these practices may originate with retailers.²⁴⁸

These practices can lead suppliers to overproduce to ensure they can supply enough acceptable produce on time.^{10,42,50,51,54,105,107,166,201,241,249,250} This can lead to food not being harvested, particularly if food prices fall.^{51,203,251,252}

^m Feedback has found that of farmers who answered the question, 9 in 10 reported that “overproduction leads to greater price volatility”.⁵⁴

Food waste caused by overproduction and unfair trading practices can also increase in times of crisis,²⁵³ resulting in disruptions to supply chains and labour shortages.^{254,255,1}

The relative importance of reducing farm-level and downstream waste

Efforts to date have largely focussed on reducing downstream food waste, for many reasons. More food is wasted in households than any other sector of the supply chain. Downstream food waste has a higher environmental impact than food wasted upstream (PN 702),^{73,256} and is more likely than farm-level waste to be incinerated or landfilled.^{241,257,258} Some commentators also view food waste in primary production as more acceptable than food wasted by consumers.^{51,203}

Overproduction by about 130% above nutritional needs is also argued as necessary to guard against supply chain disturbances,^{22,116} even though this “redundancy” may cause food waste on farms and elsewhere.^{21,22,160}

However, some high-income countries have food supplies 200% above nutritional needs.^{21,22,160} One study adopting a theoretical approach suggests that relying on overproduction to provide redundancy could undermine long term food resilience^{n,116}

Commentators note that reducing household food waste could also reduce farm-level food waste, as falling demand could lead to cuts in production.²⁵⁹ However, the think tank Green Alliance argues that this will not be the case if policies encourage overproduction,²⁶⁰ and farm-level food waste reductions may be more reliably achieved.^o

Modelling studies suggest that cuts in consumer waste are not always more beneficial than cuts on farms in reducing overall food waste levels.^{100,262} This suggests that achieving farm-level food waste reductions may require both demand and supply side measures, with optimal approaches varying between countries and commodities.^{100,262,263}

ⁿ Food resilience is the ability of the food system to withstand and recover from shocks.¹¹⁶

^o The NFU has outlined five ways that farmers and growers reduce food surplus and waste: managing risk by supplying multiple customers, and working with buyers to manage crop flushes or deficits through promotions or specification changes; unspoilt crops unfit for human consumption are used or sold as animal feed; partner with food surplus redistribution charities; using food waste to aid soil nutrition and/or renewable energy production when sent to anaerobic digestion, composted or incinerated for energy recovery; and, measuring food waste using WRAP’s ‘Target, Measure, Act’ toolkit.²⁶¹

2.2

Law, regulation, and policy to prevent food waste on farms

Voluntary efforts

The Courtauld prevention targets for voluntary food waste initiatives do not cover food wasted in farming. Academic and NGO commentators have raised concerns that this excludes significant quantities of food waste from existing regulation.^{54,122,264} However, WRAP notes there is an expectation that businesses will act to reduce food wasted in primary production, and the Courtauld Commitment 2030 supports farm-level reductions through a variety of measures outlined in this briefing.^{265,p}

Relaxing private standards

Retailers have been encouraged to voluntarily relax their own private cosmetic standards.^{73,136} However, qualitative research suggests that competitive positioning in response to consumer expectations of quality and freshness remains a barrier to voluntary relaxations of cosmetic standards.^{172,218}

Wonky Veg

“Wonky Veg” lines are a relatively niche practice where retailers sell suboptimal produce at discounted prices.^{54,266,267} Evidence shows price reductions increase the likelihood of consumers purchasing suboptimal foods.^{207–209,268,269} Retailers report these lines reduce food waste on farms.⁵⁴

Price discounts for suboptimal foods may contribute to food waste by encouraging consumers to prioritise aesthetics over quality and taste, instead of normalising food of different colour, shape or size.^{136,208,223} Academic and other commentators also note that these lines reduce profit margins for farmers, as the production costs are the same as for optimal foods, while adding to the risk that food will not be harvested.^{51,54,157,197,251,270}

Some argue that Whole Crop Purchasing is preferable to Wonky Veg.^{172,251,270}

Whole Crop Purchasing (WCP)

WCP involves retailers buying an entire crop and using produce below sellable-quality in other parts of their supply chain.^{54,75,271,272} It has been adopted by several prominent retailers, including Tesco and Morrisons.

Researchers have argued that WCP could reduce the incentive to overproduce, as farmers are assured of a market for all of their crop.^{22,53,73,107,207,209} WCP places the risks or burden of finding secondary

^p Including partnerships with primary producers, which encourages collaboration with primary producers to identify and implement best practices for reducing farm-level waste. This includes working with farmers to improve forecasting, harvesting practices, and post-harvest handling. The Courtauld Commitment also involves improving data collection on food waste, which includes waste occurring on farms.¹⁹⁷

markets for surplus (such as fruit salads, juices and smoothies) on retailers and their greater economies of scale.^{172,272}

There is some evidence that WCP can reduce food waste.^{54,75,271,272} However, it is unclear to what extent it is being used successfully, and researchers say more studies are needed.^{172,272}

Short Food Supply Chains and Gleaning

WRAP has supported voluntary initiatives to reduce food waste on farms, including the online Food and Drink Surplus Network. This provides access to new marketplaces for surplus food, known as Short Food Supply Chains (Box 6).²⁷³

Box 6 Short Food Supply Chains (SFSCs)

Examples of SFSCs (also known as alternative markets and direct marketing or distribution systems) include:

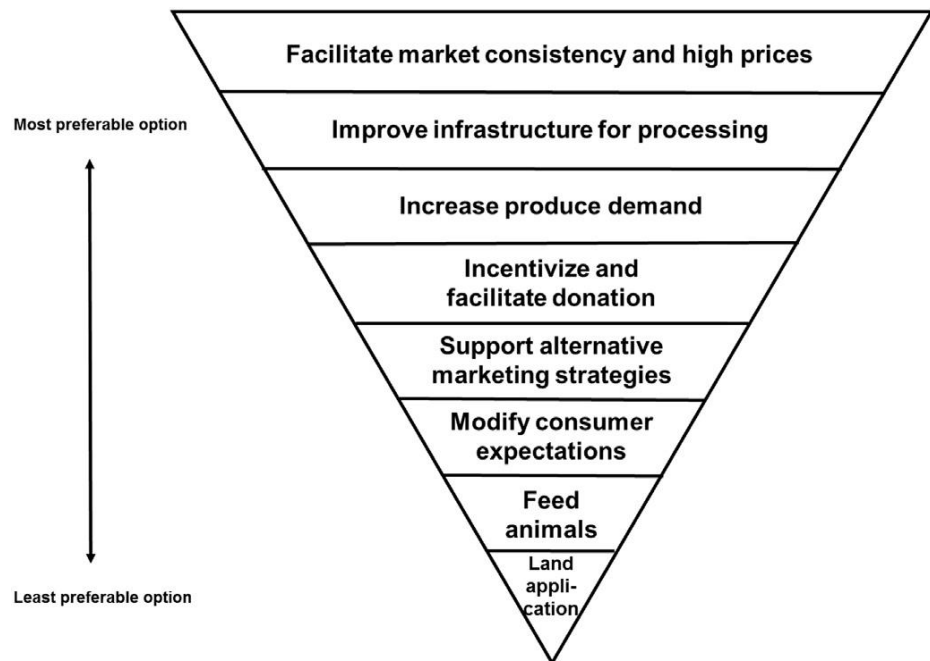
- on-farm or direct internet sales
- vegetable box subscriptions and meal kits
- farmers' markets
- producer and consumer co-operatives such as Community Supported Agriculture (CSA).^{59,73,107,114,274}

SFSCs involve few (if any) intermediaries between producers and consumers, with food generally travelling shorter distances.²⁷⁴ This increases the bargaining power of farmers,²⁰³ and allows them to keep a greater share of profits.^{73,114,275,276}

SFSCs can also reduce single-use packaging.^{59,108,274}

Other voluntary efforts include gleaning. This involves volunteers picking a donated crop, sometimes for charitable redistribution organisations. Studies suggest gleaning has the potential to reduce food waste by redistributing surplus where low prices make harvesting unviable.^{55,51,277}

However, the evidence base for the effectiveness of SFSCs and gleaning in reducing food waste is limited. Both carry the risk that food may not be consumed, and feature lower down a proposed hierarchy for food waste reduction on farms (Figure 2).^{154,241,251}

Figure 2 Proposed farm-level food waste prevention hierarchy

Source: Johnson et al 2019

Researchers suggest SFSCs have the potential to be less wasteful than retailer-led systems, by bypassing intermediaries and private cosmetic standards.^{10,73,107,202,203}

However, a literature review concluded that there is uncertainty about the impact of SFSCs on food waste.⁷³ Evidence is lacking around possible rebound effects.^{51,73,251} It is unclear whether SFSCs can move beyond niche provision,⁵⁹ although digital technologies may help (Box 8).

A small UK case study found levels of waste were much lower in a CSA scheme compared with a supermarket system.²⁷⁸ However, the findings may not be generalisable, and causation was not established.²⁷⁸ In other studies and jurisdictions there are promising results,^{54,154,279,280} but also contradictory findings.²⁸¹

Gleaning receives mixed support amongst growers, as it involves donating food that is costly to produce.²⁵¹ The NFU also raise concerns that when carried out by inexperienced volunteers crops may be damaged and next year's harvests negatively affected, such as bud damage of soft fruit crops.¹⁹⁷

A qualitative UK study found redistributors lacked incentives to glean smaller quantities of food from smaller producers.¹⁷² International modelling studies highlight gleaning can be unpredictable and lead to inefficiencies,^{277,282} such as institutionalising food surpluses (section 4.2). Studies note that gleaning could be supported by

- resources to coordinate volunteers
- expanding the pool of farms and reducing the number of gleaning trips

- tax incentives for food donations from the agricultural sector.^{50,73,277,283}

Legislative interventions

Several academic studies recommend legal interventions to address buyer practices that contribute to food waste on farms.^{284,122,203,172,46} Examples include:

- regulating unfair trading practices
- improving information sharing, and
- reforming and regulating marketing and cosmetic standards

Studies suggest such interventions could reduce food waste by spreading risk, reducing demand variability, and smoothing prices.^{2,10,50,51,53,100,116,251}

However, there is a lack of evidence to demonstrate the efficacy of these interventions.²⁵⁹ This is partly because some approaches have not yet been implemented, but there is also a lack of research as to which factors have the biggest impact on farm-level waste.^{46,259}

Regulating unfair trading practices

The Groceries Supply Code of Practice (GSCOP) was not designed with food waste prevention in mind.¹²² However, some suggest GSCOP has the potential to reduce food waste on farms (and in manufacturing).¹⁶⁶ This is because GSCOP regulates some practices that cause food waste.^{166,172,285}

However, there is limited research, with qualitative studies suggesting the impact of GSCOP on food waste is unclear.^{51,166,172} One of these studies found improvements in supplier-retailer relationships to be less significant against practices that cause food waste, although without quantification.¹⁷²

Academic researchers note that competition-driven interventions like GSCOP aim to deliver lower food prices for consumers.^{226,286} Researchers have argued that this means the causes of food waste related to competition and lower food prices cannot be addressed under GSCOP.^{172,287}

Survey and qualitative evidence suggests GSCOP has improved supplier-retailer relations.^{172,288–291} However, concerns have been raised that unfair practices continue.²⁹² Many of these are associated with food waste. For example, the NGO WWF,²⁹³ and Riverford's Fair to Farmers Charter,²⁹⁴ call on retailers to:

- Honour purchasing commitments relating to quantity and price
- Provide fair specifications, and
- Commit to a fair price that reflects the true cost of food.

The Groceries Code Adjudicator (GCA) was established to enforce GSCOP and encourage compliance with it.⁹ The GCA is both an arbitrator and a regulator.²⁹⁵

The GCA's expenses are supported by a financial levy on specified retailers, imposed with the consent of the Secretary of State.²⁹⁶ Governments have always accepted the GCA's levy business case.²⁹⁷ However, several commentators express concern that the GCA is under-resourced, particularly in its ability to carry out investigations.^{106,166,172,226}

Some academic and NGO commentators argue that the GCA should use its fining powers more, so as to deter non-compliance with the Code.^{166,240,288} However, regular statutory reviews of the GCA have not reported this as an argument made by a significant number of those consulted.²⁹⁷ Some have also noted that there is evidence to support the "compliance" rather than "deterrent" oriented approach to enforcement adopted by the GCA.^{240,297}

A former Shadow Minister for Environment, Food and Rural Affairs has called for the GCA's remit to be strengthened to include a focus on tackling unfair trading practices that cause food waste.²⁹⁸ A mixed-methods study on the Pubs Code Adjudicator that analysed interview, arbitration and appeal data found limitations with the novel "code adjudicator" model on which the GCA is based.²⁹⁹

A common concern raised about GSCOP is that it only protects direct suppliers of designated retailers.^{54,106,122,166,172,226,286,300} For example, the GCA annual survey shows the 3rd highest reported problem is "incurring significant costs because of inaccurate forecasting by retailers".³⁰¹ Inaccurate forecasting is a driver of farm-level food waste,¹⁹⁷ but in some sectors, farmers are indirect suppliers and thus not protected by GSCOP.³⁰²

Several organisations, including those in the Groceries Code Action Network, have argued GSCOP should be extended to intermediaries such as processors and packers, and that the financial threshold for designation should be reduced.^{240,303,304}

The Government has powers under the Agriculture Act to protect indirect suppliers not covered by GSCOP (Box 7).

The Agriculture Act 2020 does not oblige the Secretary of State to make regulations, and the fair dealing, data and marketing powers are currently largely unused.^{286,305} There have been consultations.^{248,306,307} The Fair Dealing Obligations (Milk) Regulations 2024/537 came into force on 10 July 2024.

Commentators have welcomed legislation like the Agriculture Act 2020 which embed food waste prevention in supply chains.^{13,14,122,286} However, concerns have been raised that the design and implementation of the Act has been a missed opportunity to do this effectively.^{122,286,305}

⁹ Under the Groceries Code Adjudicator Act 2013.

Box 7 The Agriculture Act 2020: fair dealing, data, and marketing powers

Section 29 of the Agriculture Act 2020 gives the Secretary of State broad powers to make UK-wide regulations for the purpose of promoting and enforcing fair contractual dealing between business purchasers and “qualifying sellers”^r of agricultural products.²⁸⁷

Section 23 provides powers to collect, record, and disseminate data from persons in, or closely connected with, the agri-food supply chain in England. These powers may be used to minimise waste, amongst other purposes.

Section 37 contains a power to make regulations relating to marketing standards for agricultural products marketed in England.

The NGO WWF has recommended that Defra seek to better understand what measures have the most impact in strengthening farmers’ positions and preventing food waste on farms.¹ However, one researcher has argued that the previous government did not fully consider how the fair dealing powers could be used to reduce food waste.²⁸⁷

Another concern is the coexistence of two regimes, with the new Agriculture Act regime sitting alongside GSCOP.^{122,240,286,300} Research has shown this means retailers are not explicitly required to address food waste on farms caused by unfair trading practices.^{122,308}

Information sharing

The previous government considered using the data powers could reduce food waste on farms.¹⁷⁶

A systematic review,⁴⁶ literature reviews,^{49,73} and various case, modelling and other studies^{107,309,42,91,96,43,218,202,105,310,311,219,312,212,313,217} suggest better information sharing and collaboration could improve forecasting accuracy, avoid overproduction and reduce food waste. One academic commentator has described information sharing as the “holy grail” of food waste reduction.⁵⁸ Others consider it a public good.^{314,315}

WRAP and WWF have argued that consistent food waste measurement (section 7.3) is important for information sharing, collaboration and forecasting.^{316,317} However, researchers note there are significant barriers to this, including around trust and technology (section 2.3 and Box 8).^{58,212,311,318}

^r Qualifying sellers may be based in the UK or elsewhere and are exhaustively defined as: (i) farmers and other primary producers; (ii) recognised producer organisations, (iii) recognised associations of producer organisations, and (iv) produce aggregators.

Box 8 Demand forecasting and Industry 4.0

Industry 4.0 technologies include the Internet of Things (IoT). This facilitates information exchange between items like smartphones or sensors, regardless of their location.^{319,320}

Artificial Intelligence (AI) and machine learning can use large datasets on sales, store opening times, seasonal variations, public holidays and weather to more accurately predict demand.^{59,321–323}

By not relying just on sales data, data-driven supply chains guided by these technologies have potential to better:

- predict weather, demand, and minimise supply mismatches
- monitor real-time weather, growing and ripening conditions of food in production and distribution
- facilitate real-time data sharing safely across the supply chain
- foster trust and collaboration between FSC actors^{266,318,321–327}

Digital technologies also provide opportunities for waste reduction through SFSC business models, with recipe kit providers using algorithmic automation to forecast demand.^{101,133,280,325,326}

Reforming and regulating marketing and cosmetic standards

Several studies recommend legal reform of marketing and cosmetic standards and practices.^{2,51,116,251}

Some researchers have recommended a wholesale ban on using cosmetic factors to determine food quality.^{55,73,206,328} Some commentators have suggested replacing marketing standards with requirements based on nutritional value.^{21,59} However, others have doubted the feasibility of this.⁷³ The previous government argued that marketing standards are beneficial to producers, traders and consumers.³²⁹

Some researchers and the NGO Feedback have recommended classifying the use of private cosmetic standards to manage demand as an unfair trading practice.^{2,53,59}

Farm support and subsidies

A systemic review identified what it described as genuine concerns about adherence to the food waste hierarchy on farms, citing a reliance on AD to deal with surplus and waste (section 7.1).⁴⁶ However, the NFU has disputed this, arguing that AD is not available to most farmers, despite offering several potential resource utilisation and soil health co-benefits.³⁰³

FareShare argues more surplus could be redistributed from farms.^{330,331} It has recommended surplus redistribution be treated as a public good under the Environmental Land Management Scheme (ELMS) ([PN 627](#)), and

supported under the Sustainable Farming Incentive.³³² In February 2024, the previous government announced a £15m fund to redistribute farm-level surplus, which can be used commercially.^{333–335}

However, others have raised concerns about institutionalising surplus redistribution (section 4.2).^{115,336–338} The NGO WWF has recommended incentivising food waste reporting alongside redistribution and gleaning.¹

A literature review and a modelling study suggest that the design of agricultural subsidies could reduce food waste, particularly if they do not provide farmers with unconditional support.^{49,339} However, subsidies may eventually lead to an increase in waste beyond a certain productivity threshold.^{49,339}

Reducing farm-level food waste by using more of what is produced could increase supply and meet growing demand.^{50,340} Studies suggest that encouraging the purchase of certain foods (e.g. fruit and vegetables) and reducing demand for others (e.g. meat and dairy) could prevent food waste and improve diets.^{101,260,341–343} A US study found that subsidies for Wonky Veg could reduce farm-level waste cost-effectively.³⁴⁴

2.3

Informational interventions and technological solutions

A literature review notes that only a few studies have examined the impact of agricultural education and training in reducing farm-level food waste.⁴⁹

Various technological solutions could improve forecasts and potentially prevent food waste.^{133,212,345–349} For example, Industry 4.0 could also play a role (Box 8).^{217,321,323,349} Studies also recommend using weather and satellite data to predict pest outbreaks.^{46,350} Evidence suggests a lack of trust is a barrier to information sharing and accurate forecasting.^{212,311,318} Distributed ledger technologies such as blockchain may help (Box 9).

If overproduction and surplus is reduced, research suggests redundancy could be provided by investing in better storage and stocks of long-life food.^{46,49,110,116} Investing in freezing and ventilation systems could reduce food waste by extending product life.⁴⁶

A recent literature review highlighted the role of cultivation practices, water supply, soil quality and crop protection measures to reduce food waste.⁴⁹ Interventions focusing on climate change adaptation could also reduce the likelihood of food waste on farms.⁴⁹ Waterlogging-tolerant crops and altered planting times could reduce waste from extreme precipitation events.⁴⁶

Systematic and literature reviews highlight integrated pest and crop management as a way to reduce pesticide application without incurring excessive waste.^{46,49} Using natural pest enemies, biocontrol agents, and predators are other methods.⁴⁶

Box 9 Blockchain - *The Trust Machine*

Distributed ledger technology (DLT) is a decentralised database shared across a network (PB 28). DLT deploys cryptographic techniques to secure data and prevent tampering. Blockchain is a type of DLT. It groups data in secure “blocks” before adding them to a database.

Studies argue that blockchain could potentially address trust barriers to collaboration.^{351–353} Digitising documentation can speed up real-time data sharing to improve forecasting.^{318,352,354,355} Blockchain can also be combined with IoT to remotely monitor and share product life information in production, distribution and storage.^{356,357,351,358–363}

Academic and NGO commentators consider that Industry 4.0 technologies could be used to significantly reduce food waste in the supply chain (see also [Redistribution technologies](#)).^{100,116,217,349,364–366} For example, it may help address constraints such as the average 12 phone calls needed between a charity and a farmer to arrange a food donation.³³⁵

However, systematic and literature reviews have found that the evidence for Industry 4.0 is limited, as few studies specifically address food waste.^{352,353,367,368} One academic commentator has argued that data sharing between businesses is crucial to preventing food waste, but that blockchain would not be a panacea.³⁶⁹ An academic evidence review found evidence for the cost effectiveness of various technological innovations including IoT is lacking.³⁷⁰

Systematic and other evidence reviews also identify several barriers to widespread deployment.^{3,212,222,322,325,351,352,363,366–368,371–376} These include cost; a lack of skills and infrastructure; and challenges relating to scalability, capacity, security, privacy, and regulatory uncertainty.

Studies also note that the average benefit-cost ratio for investing in various farm-level food waste reduction tends to be lower than elsewhere in the supply chain.^{49,50,116} Several academic studies have argued that incentives are required for suppliers, such as revenue sharing mechanisms.^{42,43,49,50,116,172,219,313,346}

A qualitative Spanish case study found that where there is an imbalance of power, technological innovations do not improve food waste efficiency.³⁷⁷ Instead, such innovations are said to help large retail and export companies “to monopolise the commercial margin and transfer some of their running costs to the weaker agents”.³⁷⁷

3 Manufacturing

3.1 Why is food wasted in manufacturing?

Studies have identified several causes of food waste in manufacturing, including a lack of effective reduction strategies, incentives and oversight.^{44,133} Food processing errors, inadequate storage facilities, cold-chain management and related failures to comply with hygiene rules also cause waste.^{22,42,59,86,95,105,223,378,379}

Other causes include cutting, trimming, overfilling, and automated processing methods.⁸⁶ Products that are improperly packaged or stacked can be damaged.^{88,380}

Issues with supply chain management or logistics can also generate waste. Examples include order processing and procurement, inventory management, materials handling, and packaging.⁴³ Make-to-stock (MTS) inventory relies on bulk batches of stock, but this can be wasteful.^{43,59,91,95,218,309,310,381–383}

Internal organisational barriers to preventing food waste in manufacturing are understudied.^{86,378} A Swedish study found normalisation of food waste by managers can obstruct implementing prevention policies.³⁸⁴ However, several causes of food waste are beyond the control of managers.²¹⁸

A lack of collaboration, coordination and information sharing can cause food waste.^{42,385} For example, overproduction due to demand forecasting, on-shelf availability, cosmetic standards, and minimum life on receipt (MLOR) requirements, can cause manufacturing food waste.^{42,59,73,86,95,105,172,200,218,223,224,226,252}

High MLOR requirements provide consumers with longer product life, but leave less leeway for delays.^{106,386} WRAP has found that some retailers have more stringent MLOR requirements than the industry standard.³⁸⁷ Some retailers are also said to reject deliveries that are non-compliant with MLOR requirements instead of renegotiating the price.³⁸⁷

3.2

Law, regulation, and policy to prevent food waste in manufacturing

The voluntary approach

Processes to support food waste reduction: Target-Measure-Act

An academic UK study has argued that there are not enough initiatives to prevent food waste in manufacturing.²⁰⁰

However, WRAP has developed Whole Chain Food Waste Reductions Plans (WCRPs) to help businesses, including manufacturers, identify cost-effective food waste reduction opportunities. WCRPs are part of the Food Waste Reduction Roadmap (Box 10).

Box 10 The Food Waste Reduction Roadmap and Whole Chain Food Reduction Plans

The Food Waste Reduction Roadmap encourages all food businesses (not just Courtauld members) to adopt the Target-Measure-Act approach and:

- set food waste reduction targets (ideally aligned with SDG 12.3)
- measure and publicly report on food waste, and
- take action to reduce food waste, including by supporting suppliers and consumers to reduce food waste.^{158,172,388}

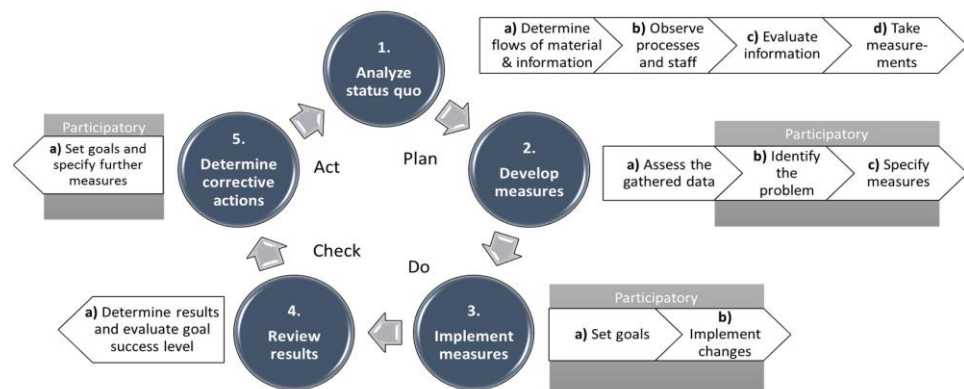
Large retailers are expected to collaborate with suppliers through WCRPs.^{172,388,389} These aim to embed food waste reduction in business culture and operations.²⁷³ There are toolkits, guidance and case studies to help businesses identify cost-effective prevention measures.^{388,390,391}

The Roadmap aims to have all large businesses participating in Target-Measure-Act by 2026, and WCRPs in place with all key suppliers by 2030.³⁸⁸ Unlike Courtauld, resources under the Roadmap are freely available.⁴⁸

In 2023, WRAP relaunched the Roadmap after it had failed to hit key targets following the pandemic and cost of living crisis.^{392,393} Some commentators suggest its ambitions have been watered down as a result.³⁹²

WRAP's most recent progress report showed improvements in businesses setting targets.³⁹³ However, WRAP has argued that significant progress is still required in encouraging large business to participate. 19% of large businesses are collaborating with supply chain partners. 48% of participating businesses saw food waste levels increase.

WCRPs apply well-known techniques to the specific challenge of food waste. Examples include Plan–Do–Check–Act (PDCA) cycles (Figure 3) and new approaches to logistics, such as integrated supply chain management and value stream mapping.

Figure 3 PDCA Cycle

Source: Strotmann et al 2017

Target-Measure-Act and PDCA techniques are related to a regulatory technique known as management-based regulation.³⁹⁴ It involves a framework that structures processes through which businesses create their own improvement plans.³⁹⁴

Management-based regulation can be voluntary or mandatory (Mandatory food waste minimisation plans). Well-known voluntary examples include the EU's Eco-Management and Audit Scheme³⁹⁵ and ISO 14001 certification.³⁹⁶ An ISO standard for food waste prevention is currently under development.³⁹⁷

These techniques help businesses identify cost-effective prevention opportunities that may have been overlooked.^{42,44} Opportunities include collaborative forecasting, alterations to inventory management, and improved cold chains.^{42,43,59,73,91,95,218,309,310,398,399}

However, systematic reviews and other studies have argued these techniques are understudied in the context of food waste.^{3,95,219,348}

Modelling-based studies demonstrate the theoretical potential of information sharing and collaborative forecasting.^{219,312,400} Case studies in the academic literature suggest the potential, but most do not quantify reductions.^{42,43,218,219,310,378}

A German study found that a reduction of up to 39% was possible by applying a PDCA cycle.³⁹⁸ A case study in the grey literature has shown that collaborating reduced a ready-meal manufacturer's food waste by 33%.⁴⁰¹ Several WRAP case studies show out how collaborative forecasting and WCRPs can reduce food waste and costs.^{316,402-404}

However, evidence reviews and studies demonstrate that challenges with integration and a lack of trust are barriers to information sharing and collaboration between buyers and suppliers.^{42,43,91,126,172,219,310,312} These approaches are also resource intensive.^{42,43}

Academic commentators have argued that incentives for adoption may be needed.^{172,313,398,405} Evidence suggests that retailers may benefit from these techniques, whereas manufacturers may pay the costs.^{219,400} A qualitative UK

study found incidences of manufacturers hiding food waste reductions from buyers to avoid a corresponding price reduction.¹⁷² The study also found limited progress in implementing WCRPs partly because a business case was lacking.¹⁷²

There is some evidence to demonstrate the effectiveness of management-based regulation outside of the food waste context.^{406,407} However, Defra has argued a lack of uptake is a common weakness of voluntary management-based regulation.⁴⁰⁸

Legislative approaches and proposals

Mandatory food waste minimisation plans

A systematic literature review has argued that policymakers “must make it compulsory” for managers to adopt Target-Measure-Act or PDCA-style approaches to food waste.³ A legal study has also made a case for mandatory food waste due diligence.²⁸⁴

The Government Office for Science has recommended mandating food waste minimisation plans.⁷⁵ The Committee appointed by the Norwegian Government tasked with designing a food waste law has recommended similar due diligence obligations.⁴⁰⁹

All of these recommendations would be similar to mandating WRAP’s WCRPs or a relevant ISO standard.

Similar mandatory waste approaches have previously been adopted in the UK in the other contexts. For example, Site Waste Management Plans were previously required in the construction sector.⁴¹⁰ These were later repealed under the Red Tape Review, not because of the underlying principles, but because the templates were considered cumbersome.⁴¹¹

Feeding surplus food to animals

Following the 2001 Food and Mouth outbreak, feeding certain types of food waste to pigs was banned.^{412,413} However, this practice remains permissible in other jurisdictions, including Japan and New Zealand.^{414–416}

An academic review published in 2023 has concluded that relevant EU regulations are too restrictive given available technology and monitoring systems.⁴¹⁷ A panel of experts,⁵ convened by the NGO Feedback, also consider it is possible to produce safe feed from surplus food in licensed plants, away from farms, supported by adequate biosecurity and monitoring.⁴¹⁸

Feedback estimates that 2.5 million tonnes of food waste could be prevented by legislation allowing unused surplus food from manufacturing, retail, and commercial catering to be used as feed for omnivorous livestock.⁴¹⁴

⁵ Comprising veterinary epidemiologists, microbiologists and pig nutritionists from the Universities of Leeds, Cambridge and Wageningen, APHA-DEFRA and the European Food Standards Agency.

However, Feedback contends such legislation should be within a context where a 50% reduction in UK meat and dairy consumption is prioritised.^{115,419}

Insect bioconversion into fertiliser or protein for animal feed may be perceived by stakeholders as a lower risk alternative for utilising surplus foods,^{420–425} although insects can be a vector for disease.^{115,426} However, the UNEP Food Waste Index 2024 states insect-based processing for livestock feed or pet food is categorised as “feeding animals” and hence the material taken out of the supply chain as surplus.⁴²⁷

Unfair trading practices and GSCOP

GSCOP could potentially reduce food waste in manufacturing caused by unfair trading practices. However, the evidence base is limited (section 2.2).

3.3

Informational interventions and technological solutions

Inventory management

Improved inventory management could potentially reduce food waste in manufacturing. For example, Make-to-order (MTO) involves mixing identical ingredients (e.g. a tomato sauce base) for different brands, but delaying final differentiation until an order is confirmed.^{21,59,91,95,219,309,310,381} Studies argue that MTO, or MTO combined with MTS, can reduce waste and costs, albeit without quantification.^{21,59,91,219}

However, some inventory management techniques may make manufacturers worse off.³¹³ A modelling study found MTS could reduce waste to the benefit of retailers and suppliers, but only if retailers reduced MLOR requirements.⁴²⁸

Industry 4.0

Several studies argue that ICT and Industry 4.0 (Box 8) innovations that support information sharing and collaboration could reduce manufacturing food waste.^{133,219,325,348,349,364,429,430} The independent Made Smarter review commissioned by the previous government in 2017 estimated manufacturers could cost-effectively prevent 17.6 million tonnes of food waste by adopting digital and automation technologies.³⁴⁹

However, researchers note these solutions have capital costs.²¹⁹ There is also a lack of evidence for the cost-effectiveness of IoT in reducing food waste across the supply chain (section 2.3).³⁷⁰

Upcycled food

Research highlights how techniques to use food by-products or upcycled food could reduce food waste in food product manufacturing.^{223,431} Examples include whey used in protein powders; carrot peel in powdered soup; and grain from beer brewing in granola bars.^{223,432,433}

A challenge is that by-products must be immediately processed to avoid microbial growth.²²³ Studies demonstrate methods for the safe extraction of

valuable components.^{187,434} However, commentators note it can take decades to make them feasible at scale, and incentives may be needed.^{223,435,436}

Evidence suggests the commercial success of these products depends on public acceptance.⁴³⁷ A US survey study found this could be addressed through a carefully designed label.⁴³³

4 Retail

4.1 Why is food wasted in retail?

Evidence suggests a common cause of food waste in retail is products reaching their expiration date.^{41,86,219,252,415,438} Some organisations do not donate or redistribute food beyond a best before date, even though this can be lawful^t and prevent food waste.¹⁴¹

Getting food on shelves with sufficient remaining product life is logistically difficult.^{42,91,94,202,203,219,225,441} Breaks in the cold chain can lead to food waste.^{32,37,42,94,220,442,443} Evidence shows that packaging formats, faults, and breakages also cause food waste.^{33,34,37,40–42,73,86,94,220,415,441,444}

Maintaining safety stock provides a buffer against uncertain demand. However, evidence suggests this can be wasteful, especially for perishables.^{311,445} Studies note that demand forecasting, inventory management, promotions, and on-shelf availability lead to overordering and waste in retail.^{40,42,219,441,34,218,223,220,41,38,43,382,73,129}

Studies suggest offering more choice of products increases waste.^{32,40,42,94,107,446,447} Discount retailers tend to offer a smaller variety of products and waste less food in store.³⁸ Food waste may differ across types of retailers.⁹⁴ However, the evidence is inconclusive as to the effect of outlet size.³⁸

Studies find a lack of staff training, resources and incentives cause food waste in retail.^{32,37,39,41,42,73,94,220,398,415,415,448} Internal corporate policies can also cause waste.^{32,40,41,441}

4.2 Law, regulation, and policy to prevent food waste in retail

The voluntary approach

Price reductions (“yellow sticker” shopping)

Evidence suggests that consumers are less willing to pay for imperfect food, or food approaching its expiry date.^{268,268,449} Offering consumers an economic incentive to purchase this food can reduce in-store waste.⁴⁵⁰ This measure is

^t If the food is fit for human consumption, not injurious to health, and complies with reasonable expectations of quality.^{439,440}

widely deployed to sell over-ordered, overstocked, and suboptimal food products.^{38–41,59,104,208,445,446,451,452}

Studies suggest price reductions are especially effective for bread,^{268,268,449} but less so for meat products.^{42,441} Where in a store offers are placed can also help leverage sales and reduce waste.⁴⁵³

There is a lack of evidence showing that price reductions lead to household food waste (section 6.1). However, a systematic review found that price reductions fail to address supply chain waste caused by overproduction.⁹⁴

Surplus food redistribution

Surplus food that is still edible is produced at every stage of the supply chain.^{59,160,252} Redistributing this surplus prevents waste by diverting it for people to eat (see also [redistribution technologies](#)). Surplus redistribution is distinct from food banks, which tend not to distribute surplus or prevent waste.¹⁵⁹

However, some academics argue that the main brokerage model of redistribution is associated with addressing food insecurity^u and institutionalised in England.^{159,454} This involves industry donating surplus food, or offering it at a reduced cost, to a broker who redistributes surplus to other charitable groups or end users.^{159,455} Examples include the charitable surplus redistribution organisation FareShare, and social supermarkets selling surplus at a reduced cost, such as the for-profit distributor Company Shop.^{159,172,456}

A smaller model involves food sharing practices that take a universalist approach, seeing no necessary connection between food surplus and food insecurity.^{2,159,457–461} Examples include:

- sharing home-grown produce, meals, and leftovers
- serving meals made from surplus (such as FoodCycle and the Real Junk Food Project)
- community fridges (such as Hubbub's network)
- "pay-as-you-feel" stores known as sharehouses

WRAP provides support for surplus redistribution within the voluntary frameworks of Courtauld (section 1.6) and the Roadmap (Box 10), including:

- The Redistribution Working Group, bringing together stakeholders to identify barriers, share best practice, and monitor progress¹⁵⁸

^u Food insecurity can be defined as a "lack of regular access to enough safe and healthy nutritious food for normal growth and development and an active and healthy life" (United Nations). In the UK, food insecurity is mostly due to households' inability to afford nutritious food. Food insecurity increases mental and physical health risks (including dental decay and obesity) and affects educational and lifetime attainment ([PN 704](#)).

- Best practice guidance on, for instance, redistributing own-label products or food beyond a best before date^{440,462–464}
- Template or framework agreements to support redistribution partnerships^{465,466}
- Statutory guidance outlining the legal obligation to apply the waste hierarchy¹⁶¹
- Distributing grant funding from government to support surplus redistribution initiatives^{156,467}

Levels of redistribution have more than trebled since 2015.⁴⁶⁷ However, studies note that a small proportion of surplus food is currently redistributed, with most sent for recycling or recovery.^{55,468} Evidence suggests there are significant opportunities to increase redistribution in the UK.^{455,467}

Retailers account for 38% of all the UK's redistributed surplus.⁴⁶⁷ WRAP reports retailers have increased redistribution by 105% in recent years.⁴⁶⁷ However, WRAP estimates that retailers could redistribute an additional 65,000 tonnes of surplus.⁴⁶⁷ FareShare has argued that there is more potential to redistribute surplus from farms and HaFS.³³⁰

Expanding redistribution to feed food insecure people was described in 2000 by the NGO Sustain as “unwelcome”,⁴⁶⁹ with concerns raised about using surplus to support food insecurity.⁴⁷⁰

Several more recent academic studies argue redistribution should be a time-limited intervention, because it fails to address the causes of surplus food and waste or inequality.^{471,157,472,137,473–475,469,454,172,476,160,122} However, NGOs highlight the community food sector provides other benefits, highlighted below.

The waste hierarchy provides that redistribution is less desirable than reducing surplus.¹⁵⁶ A qualitative UK study has found redistribution poses a significant barrier to reducing surplus, as it allows retailers to maintain on-shelf availability.¹⁷²

However, studies also note that some redistribution may be necessary, as prevention measures alone may not have long term impacts.^{65,187,477,478} This is because of population growth and the variable effectiveness of interventions over time.

Academic and other studies describe UK surplus redistribution as fragmented, and in its infancy compared to France, Spain and the USA.^{137,160,252,479} Challenges include:

- unpredictable supply^{137,160}
- logistical constraints around transport, storage, and refrigeration^{8,73,454,455,480–482}
- the limited capacity of the charitable sector^{55,483}

- competition between redistribution organisations that undermines the sector's effectiveness and long-term sustainability^{137,160,172,456,484}

Surplus redistribution is said by some to be an environmental, social and economic "win-win".⁴⁸⁵ However, academic commentators note that these gains are unclear.^{8,8,283,412,472,486-491} A recent study found the UK is heading toward a "lose-lose" future of food insecurity and high levels of surplus.⁴⁵⁴

Most studies do not measure waste prevention,^{487,492} only food redistributed.^{137,283,473,474,487,492} Two studies suggest 22-40% of redistributed food may be wasted.^{8,487} However, only one of these is from the UK, and was published in 2008. The other investigated one charity in Sweden. Early research findings indicate no necessary relationship between food sharing and waste reduction.^{283,461,493} There are few studies quantifying the environmental effects of donated food (see section 7.1).⁴⁸⁷

Evidence suggests redistribution organisations can promote healthy eating and provide healthy food.^{137,473,475} However, academic and other commentators note that more research is needed on the health outcomes of surplus redistribution.^{252,330,494}

For example, a UK study highlights concerns as to the ability of food surplus redistribution initiatives to guarantee a well-balanced diet.²⁵² Studies from other countries have raised concerns about the nutritional inadequacy of redistributed food,⁴⁷⁵ and the potential to unintentionally reinforce poor diets.⁴⁹⁴ However, FareShare argues these may be exacerbated in post-farmgate redistribution models.³³⁰

Studies suggests food redistribution organisations can strengthen communities, and reduce isolation and loneliness.^{495,491,473,475,471} However, academic and other commentators, in the UK and abroad, have raised concerns that the indignity, shame and stigma of relying on food donations can also be harmful.^{159,496-498} Charitable organisations also do not have the resources to provide universal coverage, with academics suggesting "a right to food" approach is a more effective alternative.^{336,499,500}

The Scottish Government and the All-Party Parliamentary Group on Ending the Need for Foodbanks argue that policies should reduce reliance on emergency or crisis food aid through "cash-first" approaches, but acknowledge several wellbeing benefits from community food provision.^{498,501}

Legislative proposals

Some studies recommend legal measures to support redistribution, including from retail.^{187,477,502} However, for the reasons given above, concerns have been raised about further support for surplus redistribution.^{503,504}

Economic incentives

Studies suggest that tax incentives could offset the costs involved in food donation.¹⁵⁸ For example, Italy's 2016 Gadda law allows municipalities to reduce waste tax paid by retailers proportionally to surplus food donated.⁵⁰⁵ Commentators in the academic¹⁶⁰ and grey⁵⁰⁶ literature have recommended that the UK offer tax incentives and credits.¹⁶⁰

There is some tax relief for companies in respect of trading stock.^{136,507} The House of Commons Environment, Food and Rural Affairs Committee recommended in 2017 that the then Government better communicate this.¹³⁶ However, some studies have queried whether this provides adequate incentives.^{160,455,506}

Commentators have suggested that the UK's zero-rated VAT on food provides incentives for donation.^{158,455,508} However, its effectiveness has not been monitored.¹⁵⁸

One study has questioned the desirability of tax incentives for food donation.⁵⁰⁴ This is because tax incentives use public resources to allow private companies to avoid costs of doing business. The study concludes that waste taxes would better implement the waste hierarchy.

Good Samaritan laws

Concerns have been raised that the fear of criminal and/or civil liability acts a barrier to food redistribution (should recipients become ill after consuming donated food).^{252,32,441,73,283,508,86,69,509–512,249,141}

These studies suggest fear of liability is partly about confusion and uncertainty about the relevant law. A pre-print^v legal study has found this to be somewhat justified in England.^{503,513} For example, there is a publicly available legal guide to donating food in the UK.⁴⁵⁵ However, it is said to contain errors and omissions.^{503,513} Some academic and NGO commentators have called for government to clarify the laws surrounding surplus food redistribution.^{513,514}

Another concern is that liability is too expansive in light of the need to reduce food waste.⁴⁵⁵ This is said to cause businesses to be overcautious in donating food, resulting in overdeterrence.⁴⁵⁵ Some suggest liability protections, such as Good Samaritan laws, are a potential solution.^{40,73,252} Some commentators have recommend the UK adopt a Good Samaritan law.^{158,252,506}

However, one study has argued a Good Samaritan law may be unnecessary and potentially undesirable in England.⁵¹³ This is because liability is not as expansive as often assumed. Good Samaritan laws may thus be a "solution in search of a problem".^{5,513,515,516} UK academics have argued it is necessary to better communicate existing rules, rather than alter them to address potentially false perceptions of liability.^{513,517}

Several studies conclude there is no evidence that similar laws in other jurisdictions have reduced food waste.^{503,516,518–521} One US study found tentative evidence that liability protections are correlated with increased donation, but also higher levels of waste.⁵²²

Some commentators argue the social benefits of donating food outweigh allowing people to sue for injury.⁵¹⁵ However, some studies argue that Good Samaritan laws will reduce donors' incentives to take care.^{160,473,515} One US

^v A pre-print is an article that has not been subject to double blind peer review. However, this pre-print was reviewed by a lawyer with relevant expertise.

study found weak evidence to suggest that states with strong Good Samaritan laws had higher levels of foodborne illness.⁵²² These laws could thus leave recipients open to harm and limit access to justice.^{503,510,515,518,523}

Some Good Samaritan laws protect donors by removing strict liability for donating food, leaving in place liability for negligence.^w Others require evidence that a donor acted with gross negligence and/or intentional misconduct to be liable.⁵¹⁵

Italy's Good Samaritan law only protects non-profit redistribution organisations, and is regarded by some as an example of best practice.^{158,524,525} The United States' Good Samaritan Food Donation Act 1996 (the Bill Emerson Act, as amended) applies to farmers, gleaners, manufacturers, restaurants, retailers, and food banks.^{73,515,518,526}

Some legal commentators have argued that strict liability may be more appropriate for large commercial organisations like supermarkets.^{503,527} However, strict liability for farmers is said by some to be unfair, excessive, and of little practical impact.^{528–530}

Mandatory redistribution obligations and agreements

Studies have found that formalising relationships between donors and redistribution organisations may increase redistribution.^{139,531} WRAP's framework agreements are a voluntary approach.^{465,466}

A legislative approach could require donors to enter into such agreements.¹³⁷ The Resources and Waste Strategy considered the possibility of a mandatory food redistribution obligation (Box 5).

This is similar to France's 2016 Garot Law, which promotes (rather requires or mandates) food donation.⁵³² Amendments to the Garot Law now require certain supermarkets, mass caterers, wholesalers and other food businesses to enter into agreements with charitable food redistribution organisations to donate surplus food.^{13,55,533–537} The law does not require any minimum quantities of food be donated, but it requires donation quality management plans.^{13,245}

The Law also prohibits the deliberate destruction of edible food and requires large food waste generators to follow the waste hierarchy.^{245,532,538} Fines of up to 0.1% of annual turnover apply for non-compliance with the Garot Law.^{55,533,539–542} However, no sanctions to date have been levied.⁵³²

The House of Common Environment, Food and Rural Affairs Committee found little support for mandatory redistribution in England.¹³⁶ Commentators suggest that the Garot law has improved the quality of donated food and been helpful in rural areas.^{157,537,543} However, commentators argue that the law has not encouraged waste prevention, and may have caused more food waste upstream.^{13,55,69,532,544–546}

^w Unlike liability in negligence, strict liability provides that a claimant does not need to prove a defendant was at fault (failed to take reasonable care). This means a defendant may still be held liable even if they have taken all reasonable precautions. Strict liability is governed by the Consumer Protection Act 1987.

4.3 Informational interventions

Several studies propose staff training on food waste.^{33,39,40,220,441,547–549} However, an academic study found limited evidence to demonstrate this achieves reductions.¹⁸⁷ A pilot project found no evidence of effectiveness at scale.^{187,550} Some interventions, such as fewer best before dates or less packaging (sections 7.4 and 7.5) may require staff training to implement.⁴⁸ In certain circumstances, therefore, training may be necessary, but not sufficient.⁴⁸

Based on evidence from focus groups, interviews and modelling, some studies have argued that parent companies need to take a strategic lead on food waste prevention.^{32,37,40,41} This could involve, for example, communicating clear lines of responsibility for food waste, and giving employees time and incentives.⁴¹ A study based on primary data from three Swedish stores found investing in more time for employees to prevent fresh products from being wasted would be cost-effective for retailers.⁵⁵¹

Some suggest consumer awareness campaigns could reduce in-store food waste.^{37,41,548,552} For example, retailers could inform consumers that imperfect but nutritional food would be wasted if not purchased.^{267,415,449,481,553–556} One retailer is using eye-tracking to understand consumer choices around loose produce and how this relates to awareness campaigns.⁵⁵⁷ However, several studies highlight the lack of evidence that these measures are effective.^{267,415,449,481,553–556}

4.4 Technological solutions

Supply chain management

Various supply chain and logistics strategies, as in manufacturing, have the potential to reduce food waste in-store.^{41,220,548,558} For example, modelling and case studies suggest decreasing distribution and storage times, increasing product life, and stock-age inventory management such as “first expired, first out” (FEFO) can reduce retail-level food waste.^{559,445,560,441,561,442,385,313,383} Analysing data from large supermarkets, one study found unpacking food in distribution centres could reduce food waste by 35%.⁵⁶⁰

Academic commentators have highlighted the potential of integrating expiry dates in inventory management.^{59,311} FEFO strategies could also be enhanced through “dynamic” expiry dates and pricing (Box 11), and intelligent packaging and container systems which remotely monitor and communicate product life in real time (see also [packaging](#)).^{562–564,73,442,363,565,561,379,566–568} Simulations suggest that dynamic expiry dates or pricing have the potential to cost-effectively reduce retail food waste by up to 80%.^{442,569,570}

Studies also note that food waste reductions estimated under simulations and models may not be replicated in the real world or in practice, at scale, and across all product lines.^{442,560,563} Academics have noted that reductions achieved in practice by one company may be considered commercially

sensitive and so not publicly shared.^{58,186} However, reductions also depend on the accuracy of predicted product life and demand, as well as supply chain practices.⁴⁴²

Box 11 Dynamic expiry dates and pricing

It is possible to estimate remaining product life using shelf-life modelling and temperature data.^{59,379,442,563} Dynamic expiry dates could improve FEFO approaches by accounting for these temperature abuses.^{442,569} If integrated within barcodes, this could also enable automatic price reductions (dynamic pricing).^{59,571,572} This could allow for price reductions to increase gradually as an expiry date approaches, reducing the labour costs and stigma associated with yellow sticker markdowns.^{40,59,442}

WRAP has found that retailers could significantly improve their inventory practices.³⁸⁷ However, information sharing and collaboration also remains challenging.^{43,91,218–220,512,561,573} Studies also identify technological barriers to barcode integration,^{40,311,312,387,445} which may be more expensive than training and incentivising employees in inventory management.^{220,311,573}

Reducing a store's product range could be more effective than adopting expensive technologies.^{32,40,447} A study based on interviews with store managers and experts found retailers could reduce product choice without harming competitive advantage.⁴⁰

Packaging

Studies outline several packaging-optimising strategies that could help reduce food waste in retail.^{574–576} These include:

- ensuring product protection, ventilation, and temperature control
- redesigning packaging to reduce damage in transport and handling
- retail-ready packaging that minimises handling and improves stock rotation

Evidence shows that packaging innovations can significantly extend product life.^{577–579} However, a systematic review found some studies rely on inaccurate product life estimates.⁴⁴² Studies also highlight that extending product life does not directly translate into food waste reductions.^{218,443,580,581} WRAP and others have also suggested that in some circumstances, packaging may cause food waste in supply chains and that removing packaging can reduce waste in various fresh produce types (see further section 7.5).^{582,583}

Some have argued that extending and communicating product life through packaging innovations will be insufficient to address food waste's systematic causes.^{10,108}

Intelligent packaging that can communicate real-time product life may have rebound effects, including causing more food waste in retail.⁵⁶⁵ Several studies, including systematic reviews, highlight the lack of evidence that packaging (especially intelligent) technologies reduce food waste across the supply chain, including in households (section 6.4).^{59,73,103,106,148,584–589}

Several studies highlight potential side-effects of supply chain technologies like intelligent packaging and containers.^{73,237,589–591} These include increased food prices, and concerns that powerful companies will gain more control of the supply chain. Innovations could also increase the overall environmental burden of packaging.⁵⁷⁸

There are also several barriers to deployment, and evidence reviews note that actors paying for packing innovations will not always benefit financially from the waste reductions achieved.^{223,319,320,363,379,442,564,577,585,592,593}

Redistribution technologies

Studies show that redistribution websites, social media platforms and apps are effective in connecting people and organisations directly (Box 12),^{32,326,594–596} and scaling operations up and out.^{32,159,252,457,459,597–602}

However, several academic studies, including systematic and other evidence reviews, find a lack of evidence demonstrating the effectiveness of redistribution technologies in reducing food waste across the supply chain (not just in retail).^{67,148,150,179,597,598,600,603–605}

Few studies have assessed whether the relatively small quantities^{493,600} of redistributed surplus is eventually consumed.⁶⁰⁶ In 2018, researchers stated claims as to social, economic, and environmental benefits are said to rely on limited data.⁵⁹⁸ There may also be rebound effects.^{607,x} However, FareShare dispute this and state that their data is increasingly comprehensive.³³⁵

Studies also identify concerns and challenges around:

- trust, food safety and the proliferation of platforms^{136,148,595,604}
- the financial sustainability of underpinning business models^{459,608}
- the coordination of volunteers and retaining user-engagement.^{609–611}

Box 12 Redistribution websites, platforms, and apps

Various websites, social media platforms and apps support surplus food redistribution by connecting different users:

^x Such as where the cost savings and convenience of using digital sharing platforms stimulate additional demand for products and services, offsetting the expected environmental benefits of food sharing.

- **Business to consumer** apps and platforms connect farmers, supermarkets, and restaurants with consumers. Examples include Too Good To Go and Karma.^{612,344,252,38}
- **Consumer to consumer** apps, such as OLIO, allow consumers to share surplus and leftovers with one another.⁶¹²⁻⁶¹⁵
- **Consumer and business to charity** apps support donating food to non-profit redistribution organisations. Examples include FoodCloud and FareShare Go.^{252,612,616}

Platforms have different modes of offering surplus, including through donations, discounts and bartering.^{459,602,617,618}

5 Hospitality

5.1 Why is food wasted in HaFS?

Systematic reviews have identified a lack of research on HaFS food waste, including causes.^{29,30,67,191} However, studies note that the diversity of the sector^y makes it difficult to research and generalise findings.^{12,29,31,60,67,68,70,77,150,256,619–623}

Stages, size, cuisine and serving styles

Studies reach different conclusions as to which stages of HaFS (such as pre-kitchen, in-kitchen, or plate waste)^z are most wasteful.^{30,59,60,67,68,624} Studies have found high levels of plate waste in UK restaurants.^{31,60,70}

Some studies have suggested a correlation between restaurant or outlet size and the amount of food wasted.^{62,625} Chain-affiliated restaurants are said to be less wasteful, owing partly to greater resources.^{60,72} However, one study found smaller independent coffee shops wasted less food than larger outlets.⁷²

Menu and service design (including offering more choice) can cause in-kitchen and plate waste.^{28,31,60,63,68,86,605,626,627} Evidence suggests levels and causes of food waste differ across cuisine, country, dining context (such as fine, casual or canteen) and serving style (buffet or *à la carte*).^{28–31,60,62,63,68,70,381,619,625,628–630}

Three systematic reviews conclude self-serve buffets generate more waste than *à la carte*.^{29,30,191} While buffets allow customers to control portion size,^{59,67} they provide little incentive to avoid plate waste.^{30,625,68,31,28,60,29,62,381,631,632} *À la carte* may produce more in-kitchen food waste, but there are contrary findings.⁵⁹ Some studies suggest that pressure from UK operators leads hotels abroad to adopt buffets as part of all-inclusive packages.^{624,633}

^y Including schools, universities, prisons, hospitals, residential homes, company or workplace catering, cafes, restaurants, pubs, takeaways, fast food, street vendors, hotels and events.

^z Studies also define stages differently.^{31,60}

Pre and in-kitchen food waste

Studies show that the causes of pre and in-kitchen HaFS food waste include packaging damage; logistical and transportation constraints; poor inventory or stock management; and trimming, cooking or plating practices and errors (preparation).^{28,29,31,59,60,62,70,73,86,634,635}

Evidence suggests accurate forecasting can be challenging.^{31,59,68,636} Reservations where possible enable some estimate of demand,⁵⁹ but online bookings can result in no shows.⁶⁰

However, studies show that HaFS often deliberately overproduce or over-cater to avoid underproviding.^{62,637–640} These studies suggest staff lack incentives and training to implement accurate forecasts and reduce food waste.^{29,60–62,70,71,628,641–645}

Evidence shows the importance of collaboration with suppliers in forecasting.^{31,62,63,221} However, this is difficult for smaller organisations, as suppliers often have greater market control and can dictate the volume and frequency of deliveries.^{31,62,67,72}

Plate waste

Studies show a significant cause of plate waste is portions or plates that are too big.^{191,646,59,623,647,30,648,28,625,71,86,252,649} Evidence suggests low quality food and confined budgets can also cause plate waste, particularly in schools, hospitals^{aa} and cafeterias, but data is limited.^{59,86,631,650}

Some studies suggest consumer's lack awareness and concern about plate waste.^{30,31,60,64,67,68,70–72,622,624,646,651,652} However, some commentators highlight the sector's responsibility for practices, business models and portion sizes that cause plate waste.^{31,72,646} Patron-type may also be a factor. For example, certain ages, genders or nationalities may waste more food than others.^{29,630,653–655}

Studies suggest some diners and restaurateurs are reluctant to ask for or offer takeaway boxes and doggy bags, and that there are reputational consequences if eating leftovers make patrons unwell.^{653,656–661} WRAP has found that 40% of customers are embarrassed to ask for doggy bags, but 74% support being offered one.^{646,656}

Government support and incentives

Some studies argue that a lack of governmental support causes HaFS waste, especially regarding redistribution.^{60,68,72}

Relatively low levels of surplus are redistributed from HaFS, although the sector is more fragmented than retail.^{31,72,156} Some studies argue tax incentives for redistribution from HaFS are insufficient.^{31,67,72}

^{aa} A Welsh case study found a strong and direct correlation between the general quality of hospital meals and levels of food waste.⁶³¹

Some studies highlight a fear of liability and overly stringent food safety laws prevent redistribution from HaFS (see [Good Samaritan laws](#)).^{28,29,31,59,67,72,512,622} However, evidence suggests that corporate policies, including in the UK, are often stricter than legal requirements.^{31,62,67,68,72,662} A Swiss study argues that food safety concerns in HaFS are more likely about reputation than real liability risks.⁶⁰⁵

5.2 Law, regulation, and policy to prevent food waste in HaFS

The voluntary approach

WRAP has reported that the HaFS Agreement's food waste prevention target was exceeded and acted as a catalyst for change (Box 13).⁶⁶³ A similar Dutch multi-stakeholder partnership achieved an average 21% reduction in self-reported food waste amongst participating restaurants.⁶⁶⁴

However, a UK study argues voluntary measures have had a limited effect, noting assumed increases in levels of HaFS food waste.^{66,70} A lack of reliable data does not allow comparisons over time.⁸⁰ Some studies argue implementation of HaFS recommendations are dispersed and have been poorly communicated.^{28,67} However, these studies may pre-date the Guardians of Grub campaign.

Evidence suggests that some HaFS actors use several strategies to reduce food waste.^{29,31,60,62,70,622,625} However, these strategies are not widely deployed.^{31,191,661,665} Studies have found many in HaFS do not consider food waste prevention a priority.^{31,67,70,72}

Studies demonstrate a robust business case for food waste prevention in HaFS, with cost and benefits often realised by the same organisation.^{28,60,62,67,72,512,666–668} HaFS actors may be beginning to recognise this.^{31,605}

Evidence suggests [food waste measurement](#) is necessary to achieve cost-effective reductions.^{12,28,180,669} WRAP has a food waste tracking sheet, although one study claims it has not been evaluated and uptake is limited.⁷⁰

Box 13 The voluntary approach to food waste in HaFS

WRAP has coordinated several voluntary initiatives to prevent HaFS food waste, including the 2012-15 HaFS Agreement. The Agreement aimed to reduce the CO₂ emissions of food (and packaging) waste by 5%.^{252,663}

HaFS is now covered by Courtauld and the Roadmap.²⁵² There is a HaFS Working Group, and efforts are being made to include food waste in health and food safety inspections.^{266,663}

The Guardians of Grub campaign provides tools to measure the benefits of food waste prevention, including staff training and consumer education on portion control.^{670,663,67}

Quantification can be laborious and expensive for HaFS actors.⁶² Studies suggest that most lack resources and relevant expertise.^{70,622}

Participants in one study argued the government should do more to raise consumer awareness.^{70,72} However, there is a limited evidence base for the effectiveness of consumer awareness campaigns in reducing HaFS food waste.

Legislative approaches

Several studies, including systematic reviews, argue that government interventions are necessary to support large-scale reductions in HaFS food waste.^{29–31,60,67,70,73,77,671–673}

Procurement, training, and nutritional requirements and guidelines

The EU REFRESH project has recommended public procurement rules for hospitals, schools, and prisons.¹⁰² Some studies also recommend formal food waste reduction training as part of food safety and hygiene certification.^{29,126,221,674} The ISO standard for food waste prevention under development will also apply to HaFS,⁴⁸ whereas the Government Office for Science has suggested mandating waste minimisation plans.⁷⁵

The UK's Government Buying Standards for Food and Catering Services apply to public sector organisations and contain mandatory and best practice standards relating to food waste (CBP 7552).¹ The best practice standards include that suppliers provide staff training on food waste prevention. There is case study evidence in the grey literature suggesting procurement contracts can prevent food waste.¹⁸⁷ Defra have undertaken an evidence review on sustainable food procurement that has yet to be published, which considers food waste reduction in combination with other strategies.⁴⁸

A rapid evidence review found that changing nutritional guidelines in schools can be part of food waste reduction strategies.¹⁷⁹ A recent US field experiment study found that nudges to increase vegetable consumption increased plate waste.⁶⁷⁵ However, other US studies found nutritional requirements reduced plate waste by between 14–28%.^{179,676,677}

Mandatory doggy bags

Studies note that takeaway boxes and doggy bags^{bb} can be used to reduce plate waste,^{29,60,656,660,660,661,678} and evidence suggests they reduce food waste in HaFS.^{679–681}

^{bb} Takeaway boxes should not be used for pre-cooked food that would be re-heated a third time if taken home.⁶⁵⁶

Concerns have been raised that takeaway boxes shift food waste to homes.^{605,657,682} Zero Waste Scotland's pilot study estimated that 92% of food taken home was consumed.⁶⁸³ Similarly, a New Zealand study analysing survey data found 8.2% of respondents threw away leftovers.⁶⁵⁶

Some jurisdictions have sought to encourage takeaway box and doggy bag uptake through legislative interventions.⁶⁶¹ France requires restaurants to provide takeaway boxes when customers request them.⁶⁵⁶ However, some commentators have identified a cultural backlash to the law.⁶⁸⁴ Studies have also explored social norm interventions to increase uptake of doggy bags, albeit with mixed results.

Economic instruments

Some commentators have suggested charging customers for wasting food, or providing discounts or incentives for customers that do not.¹⁵⁰ For example, a quasi-experimental field study in a Slovenian hotel achieved a 34% reduction in plate waste through an incentive (combined with other interventions).⁶¹⁹

However, evidence reviews conclude more research is needed.^{14,150} The effects of these interventions may be short lived,¹⁵⁰ but could be more effective than informational interventions ([PN 714](#)).¹⁵⁰ The potential negative effects on customer loyalty and health also requires testing.⁶⁸⁵

Some academics argue charges or penalties, such as Pay-As-You-Throw (PAYT) schemes, could reduce HaFS waste.^{58,70,109} Businesses in the UK already pay charges for waste collection. However, an environmental consultant has argued that because many commercial waste collectors charge by volume rather than weight, PAYT for commercial food waste (which tends to be heavier) is not widely applied.⁶⁸⁶ An alternative approach would be to apply tax incentives to HaFS business to reduce waste.³³⁵

China's 2021 Anti-Food Waste Law imposes additional penalties on restaurants that consistently waste large quantities of food and allows them to charge customers for excessive plate waste.^{687,cc} However, the impact has not yet been evaluated.⁶⁸⁹⁻⁶⁹¹

5.3

Informational interventions

HaFS organisations, management, and employees

Several studies highlight the potential of staff training to reduce HaFS food waste, albeit without specific testing or measurement.^{62,692,221,31,635,693,624} A HaFS Agreement participant has claimed a 7% reduction in waste after a training programme, but it is challenging to disentangle training from other

^{cc} The law also contains provisions relating to restaurants offering a variety of portion sizes to meet different needs, improving back-of-house-management and providing information to customers.^{48,688}

activities to reduce waste.⁶⁶³ Food waste minimisation plans could also raise awareness and improve employee commitment.^{67,398}

However, a Danish hospital study found training had no impact on food wasted (although the training was limited and poorly attended).⁶⁹⁴ Evidence also suggests that the fastmoving nature of kitchens generate several barriers to implementing standards and training.⁶⁴⁴ A systematic review recommends future research focus on strategies that target managerial knowledge and kitchen practices.³⁰

Consumer awareness campaigns

Research published by online marketplace company Groupon found that 35% of frequent UK restaurant guests regularly do not finish their meals.^{60,695} Studies also suggest a lack of consumer awareness about the negative impact of HaFS food waste, with one study highlighting that consumers perceived excessively large meals as value-for-money.^{70,72,632,696}

Studies show that improving food waste knowledge reinforces personal attitudes towards not wasting food out-of-the-home.⁶⁵¹ However, the relationship between attitudes, norms, intentions, and behaviour change is understudied.^{665,665,697-699}

A systematic review has concluded it is difficult to draw conclusions about the effectiveness informational interventions (PN 714).¹⁹¹ Studies have achieved measured reductions of between 14-35% in University or school canteens and hotels through consumer awareness or educational techniques.^{30,77,619,699-703} However, some studies also find information to be more limited.^{77,619,632,704} Combining interventions may be more effective.^{14,150,151,188,671,705,706}

Informational interventions can also have unintended consequences. Informing restaurant diners in an experimental US study that wasted food was recycled significantly increased plate waste.⁷⁰⁷ Interventions that reduce plate waste can also cause serving waste.⁷⁷

Feedback

Evidence reviews show the effectiveness of providing feedback on performance is unclear.¹⁵⁰ Some studies appear to achieve reductions through tracking and reporting levels of plate waste.^{77,700,708} However, others found feedback failed to reduce food wasted by students;^{700,709} maintained (but did not improve) reductions achieved by other interventions;⁷¹⁰ or achieved relatively small reductions but only when combined with interventions.⁶³²

Social norm interventions

Informational interventions can use social influences to change individual behaviour. For example, social norm interventions seek to change behaviour by providing information about other people's attitudes or behaviour.^{14,151}

Evidence reviews and other studies argue further research is needed on the long-term effectiveness of social norm interventions like prompts and moral

persuasion.^{14,150,179,711,712} Evidence reviews show prompts to be a relatively effective intervention to achieve large-scale behaviour.^{150,705} Evidence suggests they work best when messages are: tailored to a specific audience; polite; instruct easy-to-perform behaviours; and located where targeted behaviour occurs.^{14,150,151,195,713}

Some intervention studies have achieved waste reductions in buffet settings through social norm interventions.^{619,620,665,710,711,714,715} One study found a prompt combined with a financial incentive (a 20% discount for not wasting food) was more effective than the prompt alone.⁷¹¹

Doggy bags and social norms

Social norm interventions have also been used to increase doggy bag uptake.^{150,195,653,656,660,661,716,717} A pilot study by Zero Waste Scotland found promotional materials and reheating information normalised leftover boxes.^{681,683} However, scaling this up would need financial support, for instance via subsidies or tax incentives.^{681,683} An experimental Dutch study found a default “opt-out” approach was more effective than a prompt.⁷¹⁶

Social normal interventions can also be counter-productive.^{685,711} A UK study found HaFS managers had limited success with offering leftover boxes because guests felt embarrassed and refused.³¹ A New Zealand study found an appeal to saving money likely to be the most effective motivator for encouraging doggy bags.⁴⁷⁵

5.4 Technological solutions

Evidence suggests a lack of resources prevents many (especially small or medium-sized) HaFS from using expensive technological innovations.^{60,67} Some studies have found service managers more resistant to technological solutions than incremental operational innovations.⁶⁰⁵

Measurement technologies

Digital measurement methods, such as smart meters, apps and automated quantification or tracker tools, could help reduce HaFS food waste.^{29,12,67,718,669,719} For example, trials show smart meters (like Winnow and Leanpath) can help reduce food waste by 31-62% (by weight).^{67,720,721}

However, studies evaluating these methods in HaFS are said by academics to be rare.^{605,718} These tools may be also be unaffordable and less cost-effective for smaller HaFS contexts.^{70,180} An academic study found that, in the absence of incentives, there is no direct connection between measuring food waste and food waste prevention.¹²

Demand forecasting

Evidence suggests accurate forecasting could reduce over-ordering and catering waste.^{31,60,221,640} Various study-types including some recent intervention studies show that affordable and relatively simple techniques (such as a rolling-day average) could reduce food waste in HaFS by as much

as 50%.^{32,58,60,77,637,640,650,722-729} A Swedish study found accurate forecasting in a school was possible even when demand was uncertain during the Covid-19 pandemic.⁶³⁷

However, studies and academics argue that HaFS require support to incentivise trust and to implement forecasts.^{31,58,58,605,636,640} Some academics recommend economic instruments such as waste taxes (section 7.3).^{31,58}

Changing default options

Portion and plate size and type

Exploratory, correlational, and causal research studies demonstrate reducing portion and plate sizes significantly reduces food waste (by 19-57%) across several serving styles.^{29,73,86,179,191} Changing plate shape⁷³⁰ and type,^{179,731} and removing side plates,²⁹ can also reduce food waste. Three systematic reviews conclude that plate waste could be avoided if buffet patrons choose dish sizes.^{29,30,191}

When combined with other interventions, tray-less approaches have demonstrated food waste reductions in buffets of 25-54%.^{73,701} A rapid review concluded that only the plate-change and size-reduction studies could be assessed with any certainty.¹⁷⁹

Academic commentators note the cost of changing plates may be negligible.¹⁷⁹ There is potential for customer loyalty to be negatively impacted by smaller portions.^{31,67} However, there is some evidence consumers view portion control positively,^{67,620,648,655,711} although price reductions may be needed.⁶⁵⁵

WRAP argues that consumers should be encouraged to ask for smaller portions.⁶⁴⁶ However, a systematic review highlighted the importance of interventions that shift a focus from individuals to broader social practices.³⁰

Menu design

Several commentators recommend careful menu design to reduce HaFS food waste.^{31,67,73,187,191,191,632,732} This could involve reducing the number of ingredients, repurposing food, limiting choice or removing garnishes unlikely to be consumed.

However, only a few studies have explored limiting choice. Some show this can reduce food waste,^{86,733,734} but there are inconsistent findings.¹⁹¹ A systematic review of hospital food services found offering more choice was most effective in reducing waste.⁶⁷²

6 Households

6.1 Why is food wasted in households?

Consumer behaviour

According to WRAP, food not being used in time (because it smelled or looked off or was past the date label) accounts for 40% of edible household food waste in the UK.⁸² 25% of this is associated with too much being prepared or served. Studies show that buying too much food, inadequate storage practices, and shopping infrequently can cause food household food waste.^{103,735,736,151,94,737,142,738–741,148,512,104}

Evidence suggests food waste behaviour is complex.⁷⁴² Studies show that household food waste is embedded within practices and habits around planning, shopping, storing, preparing and consuming food.^{14,103,148,743–746}

The EU REFRESH project developed a framework of factors that affect household food waste.^{14,193} These are motivation, socio-demographics (sometimes called segments), opportunity, and ability or control.^{dd}

There are conflicting studies on how income affects food waste.^{21,103,105,747–749} WRAP has found that food waste is on average higher in households struggling with the cost of living.⁷⁵⁰ However, WRAP also found that most household food waste is generated by those with less of an economic motivation to reduce it.⁷⁵⁰

Evidence suggests smaller households produce relatively less waste than larger ones, particularly those with children.¹⁴⁸ Some studies find that age, gender, education level and employment status are correlated with food waste.^{14,685,742,751} However, a systematic review found no consensus about the role of age and education.¹⁴⁸

Some studies find a correlation between consumers with good food skills and those who self-report wasting less food.^{14,151,193,751,752} However, some find no clear correlation between planning and waste.¹⁴⁸

Upstream factors

Studies show that household food waste is affected by factors determined upstream, including shopping infrastructure, retail practices, packaging, and date labelling.^{24,104,151} WRAP has recently found that people do not feel

^{dd} Motivation includes attitude, awareness, and social norms. Opportunity includes time and access to technologies. Ability includes skill and knowledge around food. Control relates to the ability to change behaviour.

empowered to act on food waste.⁷⁵⁰ Another review has called for multi-level understandings of the causes and solutions to household food waste.⁷⁵³

Price reductions and multi-buy promotions

Some commentators are concerned that price reductions and multi-buy promotions incentivise overbuying and cause household food waste.^{5,14,32,94,193,446,573,754} Examples include “buy one get one free” (BOGOF) and 3-for-2 offers.

However, only a few studies have assessed this.^{268,553,755–757} Several studies, including systematic and literature reviews, conclude there is a lack of evidence that price promotions cause household food waste.^{94,209,756,758–761}

Some commentators have argued that store layouts can contribute to overbuying and household waste.^{38,57,762}

A systematic review found that households that shop exclusively in supermarkets waste more than food those who also use small shops and markets.¹⁴⁸

Date labels

Date labels provides cues to consumers when buying, eating, and disposing of food, and this can cause waste.^{14,440,754,763–765}

However, studies show that consumers misunderstand date labels,^{86,766} particularly the difference between use by and best before dates.^{14,73,85,132,223,742,754,767–771}

There is some uncertainty as to the prevalence of this misunderstanding.^{223,772,773} WRAP has found that some people use best before dates correctly.⁷⁷³ However, age and level of education influence understanding.⁷⁶⁴ Evidence suggests consumers lack confidence in their ability to estimate food safety.^{151,752}

Evidence suggests that food businesses misapply date labels in ways that cause avoidable food waste.^{14,106,774–778} Examples include using:

- use by dates instead of best before dates
- best before dates when no date label is required
- display until or sell by dates that are not legally required but which consumers find confusing.

Packaging

Studies demonstrate packaging formats can lead to over-purchasing and are a significant cause of household food waste.^{103,107,581,743,779–783,783,784} Examples include multipacks and fixed portion sizes.

Evidence suggests that consumers do not always use packaging and storage techniques effectively to fully extend product life.^{14,103,104,581,584,743,781,783–788}

One example is removing packaging and storing food in another container.

However, several studies argue that research into packaging-related food waste is lacking.^{576,581,782,789} A Swedish study has estimated that packaging could account for 20-25% of household food waste, with an additional 21% “potentially related” to packaging.^{781,789}

Covid-19

Systematic reviews have found that the Covid-19 pandemic resulted in changes to food-related practices that reduced household food waste.^{98,99} However, another review found that few studies had statistically significant results.⁹⁷

WRAP administered a survey that found UK citizens generated less self-reported food waste during lockdown.^{790,791} However, these levels of food waste rebounded as pandemic-related restrictions eased.^{750,792}

6.2

Law, regulation, and policy to prevent food waste in households

The voluntary approach

Some studies argue that retailers should voluntarily adopt marketing and various nudge-related strategies to reduce household food waste.^{32,102,268}

However, concerns have been raised that retailer-led solutions may serve purposes other than the reduction of food waste.^{10,793} Academic commentators have highlighted the limits of voluntary efforts by retailers to reduce household food waste (section 7.2).⁷⁴⁵

Date labels

One study has argued that there are relatively few ways to reduce downstream food waste through law and regulation.¹⁰² However, evidence suggests applying date labels consistently and only when necessary could reduce food waste in households (and upstream).^{106,754,794,795}

WRAP has found switching from a use by to a best before date could, in certain contexts, safely reduce household food waste.⁷⁷¹ This could be achieved voluntarily or legislatively (section 7.4). However, evidence suggests this would be insufficient without efforts to also improve consumer understanding, which may rely on retail staff understanding (sections 4.3 6.3).^{48,180,771,795-798}

Prohibiting promotions and supporting healthy diets

Evidence suggests that supporting healthy diets can be part of food waste reduction strategies.^{179,193} One example is prohibiting multi-buy and BOGOF offers.^{102,118} In June 2023, the previous government announced that it would delay banning multibuys on less healthy foods and drinks until October 2025 ([PN 686](#), [PN 707](#)).^{799,800}

One study found the Scottish ban on multibuy alcohol discounts increased rather than reduced sales.⁸⁰¹ The researchers concluded that bans can backfire if retailers adopt other promotions that encourage consuming unhealthy foods and drinks.⁸⁰¹ Zoning law in the USA has required retailers to include space for fresh produce, albeit with mixed results.^{14,802}

A literature review has suggested alternatives to eliminating promotions altogether.⁷⁵⁸ Suggestions included retailers combining multibuys with information about how to reduce waste; “buy one, get one later” (BOGOL) and dynamic pricing.^{32,38,446}

A survey found BOGOL popular amongst US consumers.⁸⁰³ However, interviews with Danish consumers found abolishing promotions conflicted with people’s sense of personal responsibility.⁸⁰⁴

Separate food waste collection and prevention

Concerns have been raised that separately collecting food waste creates an “out-of-sight, out-of-mind” mentality that undermines prevention at the top of the food waste hierarchy, and makes it more likely that food will be sent to anaerobic digestion or incineration lower down the hierarchy ([PN 387](#), Section 1.5).^{182,803}

However, there is some evidence that separate collection can increase awareness and reduce waste, at least in the short-term.^{14,805,806} A Brazilian experimental study found that simply measuring household food waste led to measured reductions during the 166-day study.⁸⁰⁷ The authors suggest separately collecting food waste could support household measurement and prevention.

WRAP’s recent study suggests there is potential to reduce food waste through separate collection, but concludes that further studies of long-term effects are needed.⁸⁰⁸ That study found separate food waste collections were significantly associated with less food waste over the short-term.⁸⁰⁸ However, the size of the effect was uncertain, and the study did not show a direct causal relationship.⁸⁰⁸

WRAP had previously concluded that there was little evidence to support suggestions that seeing quantities of food waste influences behaviour.^{806,103} Systematic reviews conclude that feedback is among the weaker performing interventions (section 6.3).^{150,151}

Pay-As-You-Throw (PAYT) schemes

South Korea’s PAYT scheme^{ee} for food waste is combined with a landfill ban. Evidence suggests the scheme has reduced food waste generation by 20%.^{809,810} However, it is unclear how much of this was a result of increased costs instead of social norms.⁸⁰⁹ The OECD suggests that the scheme’s preventative effects may also be wearing off.⁸¹⁰

^{ee} Unlike flat fees like council tax, PAYT charges producers for waste collection proportionately to the quantity they produce.

A 2011 meta-analysis found that of all the economic instruments evaluated (taxes, fees, trading schemes, deposit-turn systems, subsidies and procurement), PAYT schemes were the most effective in preventing waste.⁸¹¹

Several jurisdictions have PAYT schemes, but without new regulations they are unlawful in England for most types of household waste, including food.^{686,ff} A Swiss study found public objections to PAYT are not insurmountable and recommends policymakers conduct trials.⁸¹²

There is a debate about whether the cost of food waste should be borne just by consumers under PAYT or shared across the chain.¹⁰⁹ Some academic and other commentators have argued that food waste taxes should instead be levied against companies,¹⁶⁰ particularly retailers (Box 16).²¹

School and university curricular

Some countries, including Italy and France, have required schools and universities to include food waste prevention within their curricula.^{14,179}

The Government Office for Science has recommended schools and universities should be encouraged to include materials to help students prevent food waste.⁷⁵ The National Food Strategy included a similar recommendation.⁸¹³ The previous government reported that it had strengthened requirements on schools to teach children about food.¹⁷⁶

Studies including evidence reviews conclude that the long-term effectiveness of educational interventions is unclear.^{103,179,814} Studies in the academic and grey literature have achieved short-term measured food waste reductions of between 33-50% through educating school children.^{179,815-818} Others find that macro-level school-and university-based interventions could be a promising part of multi-level strategies to reduce household food waste.⁸¹⁹⁻⁸²¹

Time

Some studies have suggested that increasing people's free time has the potential to support sustainable consumption practices like reducing household food waste.^{14,25,822,823} Examples include reduced working hours; increased part-time work and parental leave; and universal basic income. However, their impact on food waste has not been evaluated.¹⁴

6.3

Informational interventions

Information interventions are the most widely used and researched intervention to reduce food waste.¹⁵⁰ They can seek to reduce household

^{ff} Section 45(3) of the Environmental Protection Act 1990 provides that no charge shall be made for the collection of household waste except in cases prescribed in regulations made by the Secretary of State. Current exceptions to this do not include food waste. Concerns have been raised that PAYT also requires overhauling waste collection systems.⁴⁸ For example, Korea's PAYT scheme uses radio frequency identification (RFID) technology amongst other approaches to accurately track and charge for waste.

food waste and change individual behaviour by providing knowledge (awareness raising, instruction and feedback) or using social pressure (pledges, norms and modelling).

However, several evidence reviews demonstrate a lack of evidence as to their effectiveness, with information rarely being sufficient to change behaviour (PN 714).^{103,150,179} Various channels or formats can be used to disseminate information (including social media, household apps and smart kitchen devices). However, academic researchers say they have not been fully evaluated.^{150,824}

Studies show it can be difficult for single interventions to address the complex practices, habits and broader structures related to household food waste.^{103,124,743,768} To be effective, information should be combined with other interventions, including system-wide changes (Box 14).^{14,150,151,180,188,705,706,745,814,825,826}

Box 14 HomeLabs

HomeLabs was a five-week experiment in five Irish households.⁸²⁷ It combined multiple interventions to achieve a 28% reduction in food waste (measured by weight). These included:

- information about the consequences of food waste
- improved food storage and a fridge triage box
- food waste audits
- a visit from a chef.

HomeLabs is not considered scalable. However, it demonstrated that household food waste could be reduced through combined interventions targeting habits and practices around food acquisition, storage, and preparation.

Awareness raising, instruction and feedback

Awareness raising

Evidence suggests consumers lack awareness about the consequences of food waste.^{14,103,828} Some academic commentators argue that raising awareness about this is necessary but not sufficient for behaviour change,^{103,151,742,829,830} but others question this.⁸⁰⁷

One evidence review found it is unclear which motivations (e.g. economic, moral or environmental) to reduce food waste are strongest.⁸²⁶ However, two other reviews suggest saving money is the strongest motivation.^{103,148} Targeting an environmental conscience with information about the consequences of food waste may thus have limited effect.¹⁰³

Systematic and other evidence reviews find that few studies evaluate the effectiveness of awareness raising.^{14,150} Another review found that little can

be gleaned about the effectiveness of information campaigns because the tone of many is unknown.¹⁷⁹

Studies in the grey literature have used public awareness campaigns to achieve quantified food waste reductions.^{831–834} For example, WRAP's Love Food Hate Waste campaign is reported to have contributed to reducing edible food waste in the UK by 20% between 2007–12.^{14,116,189}

However, levels of food waste generated in the UK may have been affected by inflation, the price of food, earnings, population growth, and more people living alone.^{170,189,190} One academic study has argued the effect of Love Food Hate Waste is largely unknown.³² Another found the cost-effectiveness of consumer education campaigns is potentially high, but effectiveness ultimately uncertain.¹⁸⁰

A systematic review found no evidence that films and TV programmes highlighting the problem of food waste have reduced food waste.¹⁵⁰ Evidence suggests raising awareness should avoid normalising high levels of household food waste, as this may make wasting food appear acceptable.¹⁴

Education and Instruction

Survey evidence suggests that providing instruction significantly increases intentions to reduce food waste.⁸¹⁴ Evidence also suggests people like receiving instructions about food handling, using leftovers, and how to reduce fruit and vegetable waste.^{151,835,836}

Studies that have measured the effects of instruction have reduced food waste by 10–31%.^{179,744,745,824,837,838} The largest reductions were achieved when combining instruction with feedback about the cost of food wasted locally.⁸³⁷ However, one study has argued that these one-off interventions may not be effective over the long term.⁷⁴⁵

The food-waste-reduction app Too Good To Go is running a "Look, Smell, Taste, Don't Waste" awareness campaign on best before dates.^{455,839} A US survey study found some potential for education to improve understanding of date labels.⁸⁴⁰

Feedback

Feedback on someone's own food waste can be provided in various ways, such as [separate food waste collection](#) and [smart kitchen devices](#).

However, evidence from the broader research suggests feedback is among the weaker performing interventions.^{150,151} Studies suggest that feedback can also foster feelings of resignation that can backfire on prevention efforts.^{14,151,841–845}

Pledges, norms, and modelling

Pledges

Pledges involve committing to perform a target behaviour, sometimes by signing promise cards.^{14,150} Evidence suggests pledges have moderate

effectiveness in securing environmental behaviour change, but they are expensive to test and implement.

However, there is a lack of research on using pledges to reduce household food waste.^{150,846} One study combined instruction with a pledge to achieve a self-reported 12% increase in perceived ability to prevent household food waste.^{150,179,847} However, it was not possible to identify the impact of the pledge.

Social norms

Academic reviews argue there is some evidence that social norms exert social pressures that shape food waste behaviour.^{150,151,848} However, they conclude that using social norm interventions to reduce household food waste has not been properly evaluated.

Evidence from the broader environmental behaviour change research suggests social norm interventions are relatively effective.^{195,705,849} However, they exert more influence in public.^{195,653,850} They may thus be less effective in reducing household food waste than preventing HaFS plate waste.^{150,195,712}

Modelling

Interventions based on modelling behaviour can provide instruction while exploiting the social tendency to conform.^{14,150} For example, cooking classes can include waste prevention tips while demonstrating complex behaviours.^{150,851,852}

However, a rapid review found a lack of evidence that cooking classes are effective.¹⁷⁹ Cooking classes and other instructional videos in the grey literature have not yet been evaluated.^{150,744}

6.4

Technological solutions

Extending product life

Extending product life can potentially reduce food waste across the supply chain by increasing the chance food will be sold and consumed.^{187,853} WRAP suggests increasing product life of perishable food by one day could prevent 0.2 million tonnes of household food waste.^{387,440}

There are various ways to extend product life, including through [packaging](#), safely reducing product life buffers, and storing food at correct temperatures.^{133,767,854,855}

However, the benefits of product life extension differs across products and retailers.^{767,789} Studies also show that there is no guarantee that extending product life will reduce food waste.^{91,133,218,560,580,581,767} For household food waste, this ultimately depends on consumer behaviour.^{86,108,743,789,856,857}

Packaging

Optimising packaging size and information

To reduce household food waste, studies recommend ensuring packaging:

- Contains the “right amount” of food by using smaller packs and portioned or divisible packaging, and
- Provides information about food safety, storage, and how packaging reduces food waste.^{103,104,108,574,575,581,588,767,782,789,855,858–861}

WRAP’s modelling suggests that changes to packaging and pack size could reduce household food waste.^{773,775,862}

However, determining the right amount of food for different households requires segmented consumer data that are rarely collected.^{781,782,789,855}

Smaller pack sizes also cost more per unit.⁷⁸² Studies disagree on whether consumers are willing and able to pay for this.^{103,782} Systematic reviews find that evidence of the cost-effectiveness of packaging solutions is lacking.^{179,588,858}

According to the Institute for European Environmental Policy (IEEP), the packaging industry has an economic interest in promoting smaller pack sizes as a solution to over-purchasing, as these use more packaging.¹⁰⁸ The IEEP argues instead that reusable or zero packaging approaches are a less wasteful solution for many products.

Zero packaging

Zero packaging allows customers to choose how much to buy and take products home in reusable packaging. Retailers can sell some products loose or use self-dispensing and refill systems. A small number of retailers now avoid any single-use plastic packaging.⁸⁶³

Several studies suggest that for many types of produce, zero packaging approaches can reduce food (and packaging) waste across the supply chain.^{108,773,864–866} However, reducing household food waste through zero packaging depends on consumers buying the right amount.^{103,773}

Zero packaging presents challenges for stock rotation, hygiene, providing information, and branding. However, studies suggest these can be addressed.^{103,108,773,863,867} WRAP has produced relevant guidance and reports that retailers have run successful trials.^{103,773,868} One retailer has a “refill price promise” that packaged alternatives will not be cheaper than refills.⁸⁶⁹

Experts highlight that zero packaging is still niche, accounting for 1.2% of the UK market.⁸⁷⁰ Studies conclude zero packaging approaches may have a role in easing trade-offs between reducing food and packaging waste (section 7.5).^{867,871} However, it is said that zero packaging is unlikely to be the “holy grail”.^{867,871}

Bio-based and biodegradable plastics

New plastics with biodegradable qualities may reduce packaging waste ([PN 606](#)).^{176,580,872,873} However, a systematic review has found these do not extend product life or reduce food waste.⁸⁷⁴

Government has outlined a preference that most plastics remain reusable or recyclable ([PB 39](#)).⁸⁷⁵ The House of Commons Environment, Food and Rural Affairs Select Committee has urged a focus on reducing single-use packaging over switching to compostable alternatives.⁸⁷⁶

Social media

Some commentators have argued that social media could replicate face-to-face communication and cost-effectively scale up informational interventions.^{124,188,706,745,827,877} Systematic and evidence reviews find that social media shows promise when combined with other strategies, but that more research is needed.^{878,879}

One UK academic study found that social media performed no differently from a magazine or e-newsletter.¹²⁴ The authors argue that it remains unclear whether social media can replicate face-to-face influence, but suggest it will have a limited role in reducing food waste.^{179,880,881}

Household apps

Several mobile apps seek to prevent household food waste by providing instruction, reminding households about expiration dates, and supporting food sharing ([Box 12](#)).^{150,597,612} Apps can cost-effectively scale up behaviour change by reaching large numbers of people and personalising messages.^{612,882,883}

However, studies conclude evidence demonstrating the effectiveness of apps in reducing food waste is lacking.^{14,38,612,882,884–886} One study argues that they place an undue burden on individuals (rather than systems).⁸⁸⁷

Apps can also support SFSCs, including meal kits ([Box 6](#)). One study found that meal kits created less household waste than traditionally cooked dinners (achieving a 38% reduction).⁸⁸⁸ However, the social and economic implications of meal kits are not fully understood.^{888–890}

Smart kitchen devices

Smart kitchen devices can provide information and feedback that could reduce household food waste.^{150,151,891,892}

For example, smart fridges can track inventory and offer recipe suggestions.^{99,103,891,894–896} Smart bins can provide feedback on waste by taking pictures or weighing contents.^{14,844,892} Smart bins can also underpin food waste league tables that harness social norms to reduce waste.^{844,892,897}

⁹⁹ These suggestions can also be accessed by other means, including various websites.^{48,893}

Academic reviews conclude there is a lack of evidence demonstrating the effectiveness of smart devices in reducing household food waste.^{14,179,594,612} These devices have also yet to saturate the market.^{103,612,891} Studies suggest that consumers may find them frustrating to use,^{891,894,898} and be ambivalent about the benefits.^{899,900} Smart fridges may also increase energy costs.³⁸⁶

Some commentators note that colour coding sections of fridges may be more cost-effective than smart devices, although accurate measurement has not yet been done.^{103,179,891,896,901} One study found a specially designed measuring cup helped consumers to cook appropriate portions and resulted in self-reported reductions in food waste.⁹⁰²

Studies suggest that optimising temperatures in domestic refrigerators could save £162.9 million worth of food annually and offset related energy costs.^{442,903} However, traditional storage techniques could also reduce food waste without relying on refrigeration. Examples include shelf and drawer combinations that use apples to prevent potatoes sprouting and watering bases made of marble to extend the life of leafy vegetables.^{103,900,904}

7 Governance

7.1 Waste law and AD

Studies have found subsidies for AD have encouraged landfill diversion instead of waste prevention, and disincentivised redistribution for human consumption.^{73,69,137–139,6,59,140,135,136,905}

However, a study, conducted by academic researchers for the NGO Feedback, has argued that the environmental and climate benefits of AD have been overstated by the AD industry.⁹⁰⁶ They estimate preventing food waste provides GHG emissions savings 9 times higher than sending food to AD, and recommend taxation of the lower stages of the food waste hierarchy.

Food waste prevention, using food waste as animal feed, and renewable energy from wind and solar, were considered better environmental alternatives overall.⁹⁰⁶ A small Swedish study found the net result of surplus food donation was almost twice the climate benefit of AD.⁴⁸⁷

The UK legal definition of waste^{hh} does not presently distinguish between edible and inedible food waste, so that AD subsidies apply to food fit for human consumption.⁶ Studies have also shown the waste hierarchy to be of limited use in ensuring legal accountability for food waste prevention.^{6,69} Concerns have been raised that statutory guidance has distracted from regulatory enforcement of the waste hierarchy.¹²²

The US Environmental Protection Agency has recently replaced the hierarchy with a Wasted Food Scale.⁹⁰⁷ The Scale is based on research that confirms that source reduction, donation and secondary processing are the best way to reduce the environmental impacts of wasted food.⁹⁰⁸

7.2 The voluntary approach to food waste

Outcomes of voluntariness

Academics have argued that the evidence base for the voluntary approach to food waste is limited.^{6,172,186,226}

^{hh} Section 75(2) of the Environmental Protection Act 1990 defines waste as “any substance or object which the holder discards or intends or is required to discard”.

WRAP reports that the voluntary approach has contributed to substantial reductions in post-farm-gate food waste.^{13,909} WRAP also concluded in 2020 that the UK is on track to meet UN SDG 12.3.⁶⁶

However, in 2023, WRAP reported that food waste levels have increased since 2018.⁸¹ The NGO Feedback has questioned whether prior reductions were substantial.^{79,264,910} It argues that changing methodologies and baselines watered down ambition and excluded significant portions of food waste from the Courtauld targets.

WRAP also notes that measured reductions can be attributed to changes in population and food prices.^{13,190,909} It is also difficult to evaluate the long-term impact of interventions given the limited literature and lack of measurement and data.^{13,190,909}

A macro-economic analysis of 33 developed countries found that non-legally binding initiatives have not had any significant impact on food waste.⁶⁷⁴ This is said to provide empirical support for scepticism about voluntary initiatives, despite the study's methodological limitations.

WRAP and voluntary governance

Researchers have highlighted the importance of WRAP's expertise, and its significant role as a trusted and neutral third party independent of business and government.^{122,127,166}

However, WRAP is funded mostly by government, and does not exist on a statutory footing.¹²¹ It is said that this may limit WRAP's independence, and its ability to critique the voluntary approach.^{172,121,911,186}

Concerns have been raised that WRAP itself is under-researched,⁹¹² and represents a legislative gap.^{745,172,122} A study in the grey literature argues that voluntary approaches should put people on notice that a governance gap exists.^{76,913} A systematic evaluation of voluntary environmental approaches in the grey literature concluded that voluntary approaches are "rarely, if ever" an effective substitute for regulatory measures.⁹¹⁴

Academic studies show there are benefits to voluntary approaches.⁹¹⁵⁻⁹¹⁷ These include flexibility; harnessing business expertise; ease of deployment; and improved information sharing. WRAP and its project partners under REFRESH have set out evidence of similar positive outcomes and success factors under Courtauld.^{66,166} A Norwegian study found voluntary measures could be effective in encouraging easier food waste prevention measures ("low-hanging-fruit"), but that government interventions were likely needed for increased ambition and compliance.⁹¹⁸

However, one academic study has argued that the REFRESH study provided little consideration of whether the voluntary approach tackles the causes of food waste.¹⁷² Based on qualitative data, the study argued that Courtauld is incapable of addressing power imbalances that cause food waste in the supply chain.

Ambition, the business case and pace of change

Academic and other commentators have criticised the non-binding food waste targets for a lack of ambition.^{122,914,919,920,392,921,922} Research also suggests that voluntary ambition across the supply chain is likely to be limited if overproduction and food wasted upstream and downstream is profitable for retailers.^{42,51,122,124,127,172,203,204,206,224,226,229,745,923,924} A robust business case for food waste reduction beyond a company's own operations is lacking (Box 15).

Box 15 The business case for "beyond the organisation" waste prevention

Research demonstrates financial benefits are a pre-requisite for engagement with voluntary initiatives, including on food waste.^{229,914} WRAP argues it has demonstrated a robust business case through a study finding most sites achieve a £14:1 return on food waste reduction investments.^{408,925} These represent costs and benefits realised within a single entity.⁹²⁵

However, one study has argued that WRAP's evidence is less clear on whether there is a robust business case, particularly for retailers, to engage in efforts to reduce food waste beyond a company's operations.³⁰⁸

One example in WRAP's study involved a £5:1 return on investment for food waste reductions by retailers and manufacturers collaborating. How the costs and benefits were shared across the companies is unknown. WRAP has described the business case for reduction efforts beyond a company's operations as sufficient (not robust). However, the NGO Feedback's Supermarket Scorecard has concluded that supermarkets are failing to reduce surplus in their operations.⁵⁷

Another example from WRAP's study involved a £250:1 reduction in household food waste. Costs were borne by the public and private sector, whereas financial savings accrued to households. WRAP concluded that the business case for household food waste was insufficient, and that government interventions were needed. Feedback's Scorecard has argued that no supermarkets are adequately addressing how their business models cause household food waste.⁵⁷

The Government Food Strategy 2022 indicated possible mandatory reporting of all GHG emissions across a companies' whole value chain (Scope 3 emissions), which may lead to increased business interest in reducing supply chain waste ([PN 702](#)). Guidelines have been developed by a working group of the Food Standards Agency Food Data Transparency Partnership led by Defra, which are due to be published shortly.⁹²⁶

Some qualitative studies have found that competition between food businesses has undermined collaboration to reduce food waste.^{168,172} For example, retailers have been found to be making slow progress

implementing voluntary Labelling Guidance due to the competitive advantages of non-compliance.¹⁷² Other NGO commentators have also described progress under Courtauld as slow.²⁶⁴

Research in the grey literature states that best practice guidance has likely reduced food waste.^{102,158,455} WRAP has also reported considerable progress in removing legally unnecessary date labels.⁴⁴⁰ However, WRAP's recent review found not enough is being done by businesses to implement parts of the voluntary Labelling Guidance.^{927,928} Media reports suggest some retailers have since announced they will remove some date labels (section 7.4).⁹²⁹⁻⁹³¹

Whether regulation would have reduced food waste more quickly than the voluntary approach is a counterfactual and challenging to assess.^{20,914,932-934} The Courtauld targets are underpinned by projections about the achievable reductions.⁹³⁵ However, the NGO Feedback has argued these projections are based on several flawed assumptions.^{264,910}

Academic research suggests government intervention will likely be needed to achieve ambitious and timely food waste reductions, particularly as fewer low-hanging fruits remain in reach.^{2,69,73,76,122,124,157,172,229,745,918}

Participation, transparency, and scope

The NGO Feedback has reported that only one-third of the UK's largest food businesses participate in the voluntary approach.⁷⁶ Studies show low participation can undermine the cost-effectiveness of voluntary approaches,^{166,172,914} and risk free-riding.^{184,918,936-938} There is some evidence that incentives for non-retailers to participate in voluntary food waste prevention measures are insufficient.^{136,166,172} The previous government intervened on occasion to try to boost participation.⁹³⁹

One study found that efforts to encourage supplier participation have reduced transparency by relaxing reporting expectations.¹⁷² Discussions within WRAP's working groups as to how best to reduce food waste are said to operate "behind closed doors" owing to commercial sensitivities,¹⁸⁶ also raising transparency concerns (section 7.2).¹²¹

Concerns have been raised about excluding farm-level food waste from the Courtauld targets (see 2.2).^{54,122,264} Some studies raise concerns that there has also been an overreliance on redistribution in meeting the Courtauld targets.^{122,172}

7.3

Food waste legislation

Academic, NGO and business commentators have expressed support for many of the legislative proposals to reduce food waste outlined in the Government's Resources and Waste Strategy 2018 (Box 5).^{13,122,166,172,264}

A systematic review notes that few legislative approaches have been adopted, so that new research is required to assess the impacts of food waste legislation being introduced.⁷³ However, NGO commentators also note

that lessons from other contexts have demonstrated the effectiveness of carefully designed waste legislation.^{13,76}

A legal study in 2020 commended the then Government for proposing specific measures to tackle food waste.¹²² It also welcomed legal powers relating to: the food supply chain (Box 7), food waste prevention targets; and extended producer responsibility (EPR) (see Box 16).

However, the study also argued there was too much emphasis on redistributing rather than reducing surplus, and that retailers' role in food waste and overproduction would not be legally addressed.

Several researchers have argued the previous Government's approach to food waste was "ad hoc" and "fragmented".^{55,122,940} One study described British efforts on food waste as a "policy failure on an institutionally grand scale" and lacking "a clear, firm policy direction".⁹⁴⁰

Commentators also highlighted that the Strategy lacked implementation mechanisms.^{122,941} In 2023 the National Audit Office⁹⁴² and the House of Common Public Accounts Committee,⁹⁴³ raised concerns about progress on the then Government's waste priorities.

Box 16 Food Waste Targets and EPR

Academic researchers have argued that mandatory targets have been instrumental in transforming the UK's record on waste.⁹⁴⁴ Studies in the academic^{2,6,73,122} and grey^{13,20,54,76} literature, and some businesses,^{73,76} support a mandatory food waste prevention target.

Some commentators have suggested that mandatory measurement and a robust baseline are a necessary first step for setting mandatory targets.⁹⁴⁵ However, others argue that delays in setting a target stand in contrast with the urgent need to prevent food waste.^{2,925} The NGO Feedback argues that evidence demonstrates a 50% reduction target is achievable, provided the right policies are in place.⁷⁶

Mandatory targets can feature in extended producer responsibility (EPR). These regimes place financial responsibility for products' lifecycle impacts on producers.^{408,941} Through targets, standards, and/or economic instruments, EPR aims to implement the polluter pays principle and "price in" the externalities of products.⁹⁴⁶

The Environment Act 2021 contains powers to make producer responsibility regulations and implement waste targets. The previous government stated that it could use these powers to prevent food waste in the future.^{178,947}

While legal research has demonstrated a conceptual case for EPR as a mechanism to share or distribute responsibility for food waste,^{6,122} there would be various challenges involved.^{259,948} Alternatives that could share or

distribute responsibility include a levy on retailers proportionate for food waste in their supply chains,⁷⁶ or food waste taxes.⁸⁰⁹

Landfill bans, waste taxes and separate collection

Evidence suggests mandatory restrictions will be needed to reach the aspiration to eliminate landfilling food waste by 2030.^{949–951}

Landfill bans tend to increase incineration levels,¹⁴⁷ so are commonly combined with other waste taxes.⁹⁵² The five EU Member States with the highest recycling rates apply landfill taxes and/or landfill bans; PAYT schemes; and convenient separate collection (section 7.3).⁹⁵² The European Environmental Bureau NGO have also called for the implementation of incineration taxes.⁹⁵³

The UK landfill tax applies to food and other biodegradable municipal waste.⁹⁵⁴ Evidence suggests it has reduced landfill volumes and waste generation,¹⁴⁰ but this may have been achieved through landfill diversion and recycling, not waste prevention.⁹⁵⁵

Defra initially announced that separate food waste collection requirements for households under Section 57 of the Environment Act 2021 would be introduced in 2023, but the SI was not laid before Parliament prior to dissolution in 2024.⁹⁵⁶ Defra later confirmed in 2023 that most local authorities would have until the end of March 2026 to implement weekly separate food waste collection for households.⁹⁵⁷

The previous government proposed requiringⁱⁱ local authorities in England to collect food waste weekly and residual waste at least fortnightly.^{957–959} It said that this would prevent waste building up outside homes. Up to £295m in capital funding will be available for local authorities to implement weekly food waste collections.⁹⁶⁰

However, concerns have been raised that increased frequency of food waste collection will undermine waste prevention efforts.⁹⁵⁹ In order to reduce food waste, some studies recommend reducing residual (black bin) collection frequency (combined with PAYT).^{103,512} Studies demonstrate that to encourage participation and compliance, separate collection systems should be convenient, easily accessible and reliable.^{952,961,962}

Tax incentives could also encourage surplus redistribution (section 4.2).³³⁵

Mandatory measurement and reporting

The previous government initially consulted on introducing mandatory food waste and reporting for large food businesses in June 2022.⁹⁶³ In July 2023, it announced that it would not proceed with the proposal.⁹⁶⁴ In November

ⁱⁱ Section 45 of the Environmental Protection Act 1990 imposes a duty on waste collection authorities to collect household waste, but there is currently no provision that imposes an explicit frequency of collection on authorities.

2023,^{jj} the then Government said that it would reconsider whether there should be mandatory food waste reporting in the future.⁹⁶⁶

Several studies and commentators support consistent or mandatory food waste measurement and reporting as a pre-requisite for designing and evaluating interventions to prevent waste.^{12,36,51,2,50,75,54,52,133,14,13,20,69,6,122,21,136,813,220,42,251,73,30,29,672,967,635} The NFU has raised concerns about the impact of mandatory reporting on its members.⁹⁶⁸ However, there is support for mandatory reporting amongst many businesses, including farmers.^{79,454,964,969}

Some academic and NGO commentators have criticised excluding farm-level food waste and food that is not harvested or ploughed in from reporting obligations.^{20,79,295} The NGO WWF has recommended incentives and support for farmers to measure food waste.¹ Concerns have also been raised that excluding medium-sized businesses would exempt most of HaFS from the reporting obligation.⁹⁷⁰

Academic and other commentators argue that delays and indecision around mandatory reporting have undermined the voluntary approach (Section 7.2).^{48,295,971} This is because evidence demonstrates a significant success factor in voluntary approaches is the threat of legislation.^{14,184,259,914,918} A legal academic has argued that reporting is a necessary but not sufficient measure to prevent food waste, in view of the limited evidence base for the voluntary approach.⁹⁷²

Media commentators have criticised Defra's environmental consultations under the previous government for delays, errors and for ignoring external and internal expertise and evidence.⁹⁷³ One legal study argued that there was a resistance on the part of the government to "open-minded" consultation.⁹⁷⁴ The NGO Feedback stated that the government's impact assessment estimated the cost of mandatory reporting would be offset by the savings businesses made from reducing food waste within a decade.⁷⁹

7.4 Date labelling and food safety governance

Several studies and commentators have recommend reforming food hygiene and date labelling rules to reduce food waste, by, for example:^{13,41,141,252,503}

- extending the date label exemption so that more products are labelled with best before rather than use by dates^{73,106,386}
- abolishing best before, sell-by and display-until dates^{21,57,136,975,976}
- replacing best before dates with production or packaging or "look, smell and taste after" dates^{106,977-979}
- reforming food safety governance^{6,21,134,172,503,510,777,976,980-982}

^{jj} After the NGO Feedback's legal challenge of the decision.⁹⁶⁵

Best before dates

A legal study argues that extending the date label exemption would not address the problem that some products bear a use by rather than best before date.⁵⁰³

There is some debate about how useful best before dates are where safety is not an issue and spoilage is self-evident.^{14,21,103,769,776} WRAP's modelling shows that removing best before dates for certain products could reduce waste.⁷⁷³ However, this would be ineffective without changes in consumer behaviour.¹⁸⁰

Studies suggest that the impact of removing, abolishing or replacing best before dates on food waste could be small, and differ across products.^{386,763,983,984} Some commentators also note that retailers and consumers find best before dates useful for quality and stock control.^{86,136,141,440,985} They argue that removing them from packaged products could thus be counterproductive.

Some studies argue that alternatives to best before dates could be accepted by consumers and help them to reduce waste.^{979,986,987} However, some are concerned that "look, smell, taste" dates place decision-making on consumers instead of governments and businesses,^{985,988} and there is limited data on likely consumer responses.

Food safety governance

Several academic and other commentators have argued for changes to the governance of product life and date labels.^{6,21,134,172,503,510,777,976,980-982}

Product life is usually determined by a food business' in-house expert in line with regulatory and industry standards.⁴⁴⁰

However, studies also note that setting product life is a balance between food safety, waste reduction and commercial interests.^{6,106} Product life or use by dates shorter than actual safety or durability periods increase the chance of avoidable food waste.¹⁰⁶ On the other hand, buffers between safe and stated product life that are too small create food safety risks.^{106,387,776} This risks harm to consumers and legal and reputational consequences for food businesses.

Concerns have been raised that food businesses set product life over-cautiously relative to the goal of preventing food waste.^{6,73,106,136,141,172,387,511,767,777,988,989} For example, academic researchers in work commissioned by the NGO Feedback found that milk from four UK supermarkets remained safe to drink seven days after the use by date.⁷⁷⁶ Some UK food businesses argue this highly risk averse approach has been caused by disproportionate enforcement.⁷⁷⁸

Peer-reviewed and pre-print studies have argued for regulatory frameworks that support transparency.^{503,990} Possible governance reforms include measures to place a clearer legal burden on businesses to justify product life and labelling decisions that depart from best practice.

A UK study has argued that Brexit provides opportunities for departing from EU food, hygiene and labelling regulations.²⁵² However, food exported to Northern Ireland and the EU would need to comply with EU law.⁹⁹¹

7.5 Packaging and food waste

Trade-offs and synergies

Packaging has many functions relevant to food waste, including:

- protecting food and extending product life
- complying with food hygiene, safety, and labelling requirements
- communicating product life and storage advice^{103,107,108,574,581,788,992–996}

However, studies show that packaging can cause upstream and downstream food waste across the supply chain.^{103,858,997} If food doesn't fit buyers' formats or sizes, this can cause overproduction and waste in the supply chain.^{42,53,59,95,108,223,378,575,998}

The previous government adopted various measures to reduce packaging waste ([CB-8515](#)). However, studies note that there is potential for trade-offs between reducing packaging waste, and reducing food waste.^{781,864,103,14,782,789,867,999} Packaging protects products and extends product life, so that reducing packaging can cause food waste.^{581,789} Adding packaging material to achieve relatively small food waste reductions of high impact foods like meat and dairy products may thus be justified.^{103,576,581,781,782,1000–1003}

However, most assessments of the overall environmental impact of packaging do not measure food waste prevention.^{108,579,581,1004–1006} Instead, they rely on estimated reductions assumed to be achievable by extending product life. As there is no direct relationship between extending product life and food waste reduction (section [6.4](#)),^{86,108,767,789} the benefits of food packaging may have been overstated.^{108,133}

The previous Government has encouraged further examination of the trade-offs between preventing packaging and food waste.¹⁷⁶ Studies are using new frameworks to prioritise interventions that minimise these trade-offs.^{995,1007,1008} Possible interventions including supporting SFSCs (Box [6](#)).^{108,863,940}

Packaging-related legislation

Several academic and other commentators argue that legally binding national and global rules are needed to reduce packaging and food waste.^{13,108,592,782,863,870,871,1009–1012} A recent study found that the in-store practices of UK retailers block, reduce, and sometimes undermine the UK's non-binding ambitions on packaging and food waste.⁸⁶⁷

Progress that has been made in the UK on refills and loose packaging have yet to be delivered at scale.^{871,1013–1016} WRAP and others have concluded that urgent and additional policy drivers are necessary.^{1016–1018}

Studies and commentators argue that law and policy should better account for packaging's contribution to food waste.

^{14,53,108,575,782,789,856,863,867,871,1010,1011,1019–1023} They recommend several measures that apply the waste hierarchy and support synergistic packaging and food waste reduction, such as:

- Mandatory targets and reporting relating to packaging prevention, and reusable and single-use packaging.
- Mandating self-serve sections for certain foods. (France has required certain supermarkets to dedicate 20% of floor space to refills by 2030).
- Targeting the use of multipacks and non-recyclable packaging.^{867,1024} (France has banned plastic packaging on most fresh produce).
- Using unfair trading rules against certain packaging practices.
- Financial incentives to sell products loose or in concentrates and reduce single-use packaging. Examples include EPR reforms and deposit return schemes; taxes on virgin material and single-use items; and funding for reusable packaging systems.

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