**Reducing the Environmental Footprint of Food: A Comprehensive Management system**

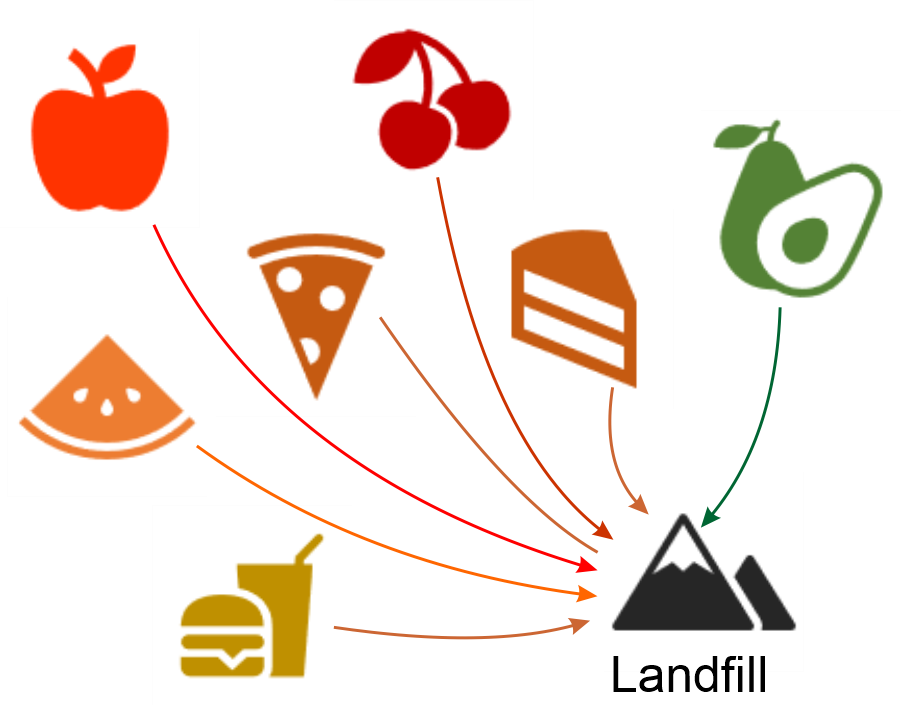
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**Food future: how to reduce the environmental footprint of food waste**



**Too much food is wasted globally, with much going to landfill.** About one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. Globally, food waste produces about 2.1 billion tonnes of CO2-eq, as anthropogenic green house gas emissions. In this report I look at solutions to this major issue, by sector.

# Executive summary

#### Food waste

Food waste is a national and global issue, due to its impact on the environment, including green house gas emissions. About one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. Globally, food waste produces about 2.1 billion tonnes of CO2-eq, as anthropogenic green house gas emissions.

Food waste can be defined when food that is fit for human consumption is thrown away, which is substantially a result of human factors. In comparison, food loss usually happens in the earlier stages of food production where things like pests, weather, or other factors make the food inedible so resulting in it being lost, which are mainly non-human factors. This report focusses on food waste.

The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems.

The causes of food losses and waste in medium/high-income countries mainly relate to consumer behaviour as well as to a lack of coordination between different actors in the supply chain. Food loss and waste occurs at each stage in the food cycle.

The majority of food waste occurs at home, followed by hospitality and food services, manufacturing and processing, retail, and lastly, wholesale.

#### Addressing food waste

The framework for addressing food waste, is the circular economy, with integration of the food waste management hierarchy.

#### Developing countries

The food supply chains in developing countries need to be strengthened by, inter alia, encouraging small farmers to organize and to diversify and upscale their production and marketing. Investments in infrastructure, transportation, food industries and packaging industries are also required. Both the public and private sectors have a role to play in achieving this.

#### Developed countries

in medium/high-income countries there needs to be a main focus on changing consumer behaviour as well as improving coordination between different actors in the supply chain.

**Recommendations by sector**

#### At home

Reducing food waste at home requires campaigns that include information on the personal values of food, and the value of reducing food waste.

* Food waste can be minimised by planning meals, shopping smart, cooking waste-free and storing food correctly.
* Remaining domestic food waste can be turned into compost, at home or by councils.
* Reduce and recycle your packaging waste.
* Shop for sustainable food.

#### Cafes and restaurants

to begin with, it is important to conduct a food wastage audit in your hospitality business. This will also be the basis for assembling a waste reduction plan.

Specific factors to reduce food waste in your business are; better temperature control, optimise portion sizes, label food well, manage your stock mindfully, test your new menus, go shopping with a plan and recycling cooking oil.

Alternative destinations for unused or waste food are food rescue organisations, food waste collection services, on-site compost system or worm farm, livestock and chicken feed. You can also use food waste recycling equipment to pre-treat food waste.

Starting with results of a waste audit you can set forward targets. Your waste reduction plan can also include attention to the six specific factors that can help reduce food waste, and a specific alternative destination for unused or waste food.

#### Supermarkets

Create a range of edible but imperfectly looking fruit and vegetables, to allow shoppers to buy the fruit and vegetables of this range, that may otherwise be rejected or thrown away.

In addition, reducing storage temperature can increase shelf-life which in turn can lead to reduced waste, though with a trade off on power costs.

if food waste cannot be prevented, the options of donation to charity and anaerobic digestion of the waste have the greatest potential to reduce the carbon footprint.

#### Food manufacturing and processing facilities

Food manufacturers play a major role in reversing the food waste trend, by 9 strategies; improving the accuracy of forecasting, optimizing the supply chain, wider produce selection, recycle frying oil, adopt process management software, improve packaging options, standardize date labels, help consumers to better value food through traceability, and support better consumer education.

#### Industrial scale food recycling

Options for recycling food waste at industrial scale, in preferred order, are food rescue, composting, reprocessing, and food waste to energy.

#### Reducing the environmental footprint of waste oils

Oils are used in cooking food at home and in restaurants, and for lubrication of machinery in food manufacturing systems. Oils and related products, such as vegetable oils and lubrication oils can contaminate environmental areas with serious impacts.

Used cooking fats and oils may be treated by a range of methods. Optimally the first treatment option for used oil is reconditioning, to allow reuse. Other options are, to transform the used oil to biofuel, or use as a component of stockfeed.

For recycling lubricating oils the hierarchy of waste oil reuse options should be followed, in descending order; re-refining in lubricating oil refinery, re-refining in dedicated onsite unit, reprocessing in primary refinery, reprocessing to fuel, burning untreated, and disposal.

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# Introduction

Food security is a major concern in large parts of the developing world. Food production must clearly increase significantly to meet the future demands of an increasing and more affluent world population. It is, then necessary to fight imbalances and reduce tensions between the necessary increase in consumption and the challenging increase in production, and is to also promote food loss reduction which alone has a considerable potential to increase the efficiency of the whole food chain (FAO 2011).

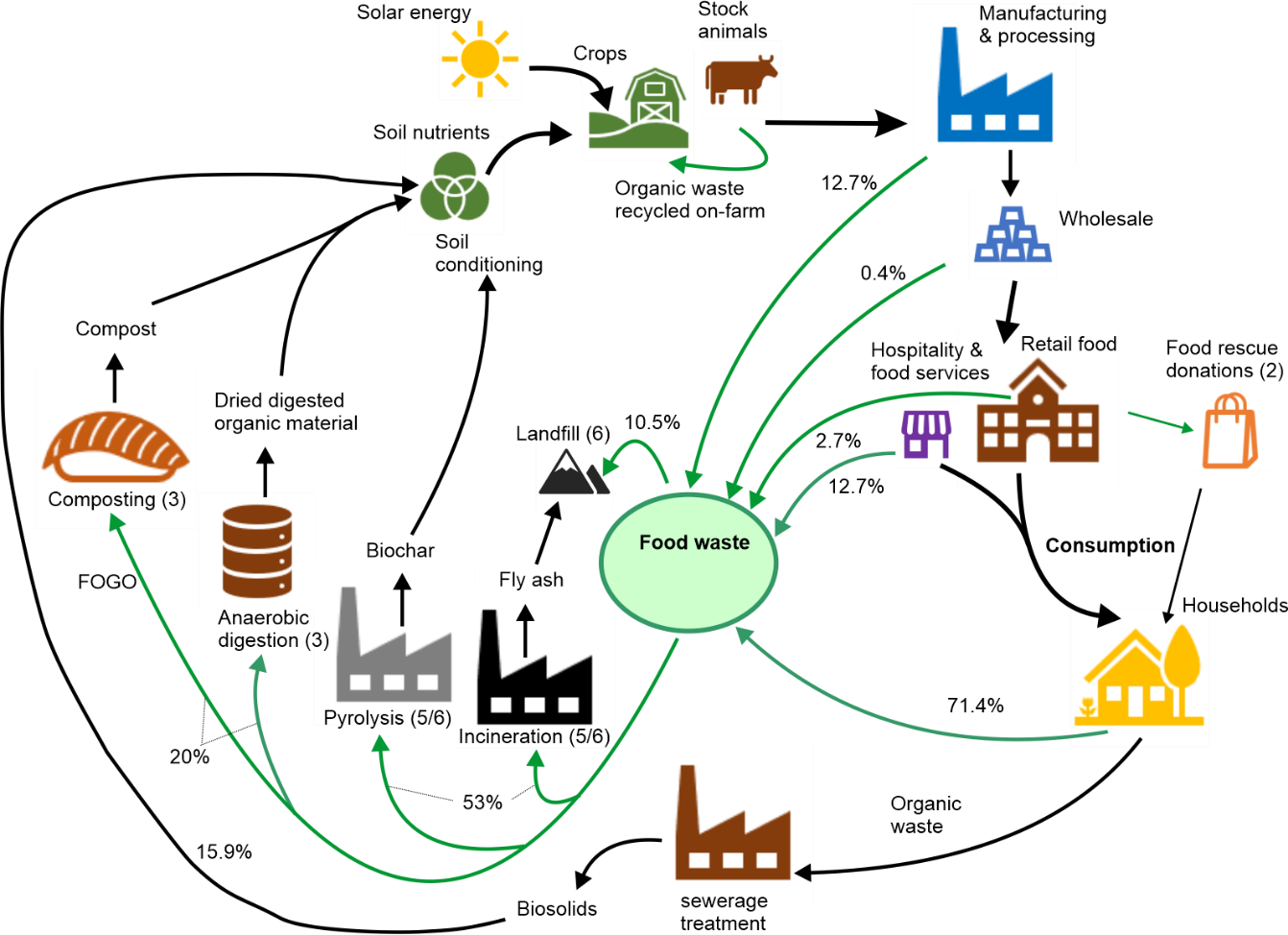
In this report I discuss food waste as a national and global issue, due to its impact on the environment, including green house gas emissions. About one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. Food waste produces 2.1 billion tonnes of CO2-eq, as anthropogenic green house gas emissions. Then I look at the causes of food waste, and the framework for addressing food waste, and any other waste, which is the circular economy, with integration of the food waste management hierarchy. I then make specific recommendations to reduce food waste for homes, food services, supermarkets, and food manufacturing and process facilities. This is followed by describing industrial-scale food recycling systems, by level of the food waste management hierarchy. Finally, I look at reducing the environmental footprints of oils, including cooking fats and oils, used in food services, and lubrication oils, used in food manufacturing equipment.

In a world with limited natural resources (land, water, energy, fertilizer), and where cost-effective solutions are to be found to produce enough safe and nutritious food for all, reducing food losses should not be a forgotten priority (FAO 2011).

Food waste can be defined when food that is fit for human consumption is thrown away, which is substantially a result of human factors. In comparison, food loss usually happens in the earlier stages of food production where things like pests, weather, or other factors make the food inedible so resulting in it being lost, which are mainly non-human factors (Mehta 2020). This report focusses on food waste.

## Food waste: a national and global issue

The food cycle has multi-stages and complex organizational structure, Figure 1. Due to the complexity of the process, rational food flow management represents a significant challenge. As a result of errors, the rise in the volume of goods available to purchase, and the extension of distribution and logistics channels, the scale of food loss and food waste (FLW) is increasing globally.



**Figure 1 The food cycle, including food waste flows.** FOGO, Food Organics and Garden Organics kerb-side collection by local councils. Numbers in brackets indicate level in food waste management hierarchy, Figure 2 and Table 2. If pyrolysis and incineration provide energy, these are at level 5, if not, then at level 6. Percentages on the right inside indicate the proportion of edible food waste from post farmgate, by particular sources; percentages on the left side indicate the proportion of food waste treated by particular processes. Data source (Wrap 2021). Image source, the author.

Roughly one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. This inevitably also means that huge amounts of the resources used in food production are used in vain, and that the greenhouse gas emissions caused by production of food that gets lost or wasted are also emissions in vain (Gustavsson et al 2011).

### Green house gas emissions

The food supply chain creates about 15.7 billion tonnes of carbon dioxide equivalents (CO2-eq), corresponding to 30 percent of anthropogenic green house gas emissions. Of this, 72 percent (11.2 billion tonnes CO2-eq) emissions are from agriculture, 15 percent (2.4 billion tonnes CO2-eq) from processing, transport, packaging and retail, while 13 percent (2.1 billion tonnes CO2-eq) arises from food waste (Poore and Nemecek 2018).

### Regional and national food waste data

Food losses and waste in industrialized countries are as high as in developing countries, but in developing countries more than 40 percent of the food losses occur at post-harvest and processing levels, while in industrialized countries, more than 40 percent of the food waste occurs at retail and consumer levels (Gustavsson et al 2011).

Overall, on a per-capita basis, much more food is wasted in the industrialized world than in developing countries. The per capita food waste by consumers in Europe and North-America is

estimated as 95-115 kg/year, while this figure in sub-Saharan Africa and South/Southeast Asia is less than 10 percent of this, only 6-11 kg/year (Gustavsson et al 2011).

Next, I look at the food waste data in Australia and the UK.

Food waste is a major problem in Australia (Commonwealth of Australia 2017):

* Food waste costs the economy around $20 billion each year.
* Each year we waste around 7.3 million tonnes of food, which equals about 300 kg per person or one in five bags of groceries.
* Food waste accounts for more than five percent of Australia’s greenhouse gas emissions.

Food loss occurs at each stage in the food cycle, Table 1. Households are responsible for the majority of waste, as 71 percent of total edible waste, followed by manufacturing & processing, and hospitality & food services, around 13 percent. At retail level, unsold foods amounted to around 3 percent of total edible surplus foods.

#### Table 1 Post-farmgate food waste by sector, UK data, 2018

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Waste type** | **Household** | **Hospitality & Food**  **Services** | **Wholesale** | **Retail** | **Manufacturing & Processing** | **Total** |
| Total food waste (Mt) | 6.6 | 1.1 | 0.04 | 0.28 | 1.5 | 9.52 |
| Total food waste (%) | 69.3 | 11.6 | 0.5 | 2.9 | 15.8 | 100 |
| Edible food (Mt) | 4.5 | 0.8 | 0.03 | 0.17 | 0.8 | 6.3 |
| Edible food (%) | 71.4 | 12.7 | 0.4 | 2.7 | 12.7 | 100.0 |

Source (Wrap 2021).

Total on-farm food waste in the UK is estimated at around 2.2 Mt per year (range 0.9 to 3.5 Mt) (Wrap 2021). This is not included in Table 1 due to the uncertainty.

### Causes of food waste

The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems. Given that many smallholder farmers in developing countries live on the margins of food insecurity, a reduction in food losses could have an immediate and significant improvement on their livelihoods (Gustavsson et al 2011).

The food supply chains in developing countries need to be strengthened by, inter alia, encouraging small farmers to organize and to diversify and upscale their production and marketing. Investments in infrastructure, transportation, food industries and packaging industries are also required. Both the public and private sectors have a role to play in achieving this (Gustavsson et al 2011).

The causes of food losses and waste in medium/high-income countries mainly relate to consumer behaviour as well as to a lack of coordination between different actors in the supply chain. Farmer- buyer sales agreements may contribute to quantities of farm crops being wasted. Food can be wasted due to quality standards, which reject food items not perfect in shape or appearance. At the consumer level, insufficient purchase planning and expiring ‘best-before-dates’ also cause large amounts of waste, in combination with the careless attitude of those consumers who can afford to waste food (Gustavsson et al 2011).

Food loss and waste occurs at each stage in the food cycle for a range of reasons, Table 2. For instance, at the agricultural production stage, losses may arise due to overproduction or grading because of quality standards. In food production and distribution, losses may result from unwanted components of raw ingredients and excess stock. At the stage of consumers, losses may occur due to consumer preferences or the preparation of oversized meals (Gorzeń-Mitka et al 2020).

The main goal of the Australian National Food Waste Strategy is to achieve a 50 percent reduction in food waste by 2030 (Commonwealth of Australia 2017).

#### Table 2 Where food waste occurs: main causes by stage

|  |  |
| --- | --- |
| **Stage** | **Causes of food waste** |
| **Agricultural production** | * Product loss due to pests and diseases or weather * Excessive stock or stock damaged or discarded during production, packing or handling * Fall in market prices making it unprofitable to harvest * Inability to meet contracted produce specifications, such as quality or size * Changes in consumer tastes and preferences |
| **Processing and manufacturing** | * Product damaged during handling * Spoilage due to contamination or inadequate temperature control * Excessive trimming of vegetables for processed foods * Changes in production due to consumer demand * Equipment failure * Spillage on conveyor belts and transfer points * Inefficient inventory management * Damage to packaging resulting in food unfit for sale |
| **Distribution** | * Spoilage due to inadequate temperature control in transport and storage * Damage due to improper handling |
| **Retail** | * Poor stock management, including over ordering, improper stock rotation, storage and handling practices * Produce no longer meets quality standards * Last minute order changes that can leave suppliers with excess product * Limited access to facilities to recycle or repurpose food waste |
| **Hospitality and food service** | * Poor stock management, storage, and handling practices |
| **Households** | * Confusion over ‘use-by’ and ‘best-before’ date labelling * Over-purchasing of food that is then thrown away * Limited knowledge of how to safely repurpose or store food leftovers * Limited access to food waste collection systems |

Source (Commonwealth of Australia 2017).

In manufacturing and processing food waste is largely unavoidable, particularly for meat products, principally due to bones, carcasses, and organs that are not commonly eaten. Technical malfunctions also play a role, including overproduction, inconsistency of manufacturing processes leading to misshapen products or product damage, packaging problems leading to food spoilage, and irregular sized products trimmed to fit or discarded entirely (Monier et al 2010).

In Australia, in 2018-19, about 5.09 Mt of food waste was generated, of which 1.10 Mt, or 22 percent, was processed through composting or anaerobic digestion, Table 3. About 4.43 Mt (87

percent of the total food organics) was classified as non-hazardous. Of this, the majority, about 3.76 Mt (85 percent), was deposited in landfill, while 14 percent was composted and 2 percent was processed by anaerobic digestion. Hazardous food waste amounted to 0.66 Mt (13 percent of total food organics, which consists of grease trap sludge and wastes from abattoirs and tanneries (Blue Environment 2020).

#### Table 3 Progress in implementing the National Food Waste Strategy, estimated tonnes of food waste, Australia, 2016-17 to 2018-19†

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **2016-17** | **2017-18** | **2018-19** | **Progress** |
| Food waste generated | 5.39 | 5.20 | 5.09 | - 6% |
| Food waste to landfill | 4.06 | 3.87 | 3.76 | - 7% |

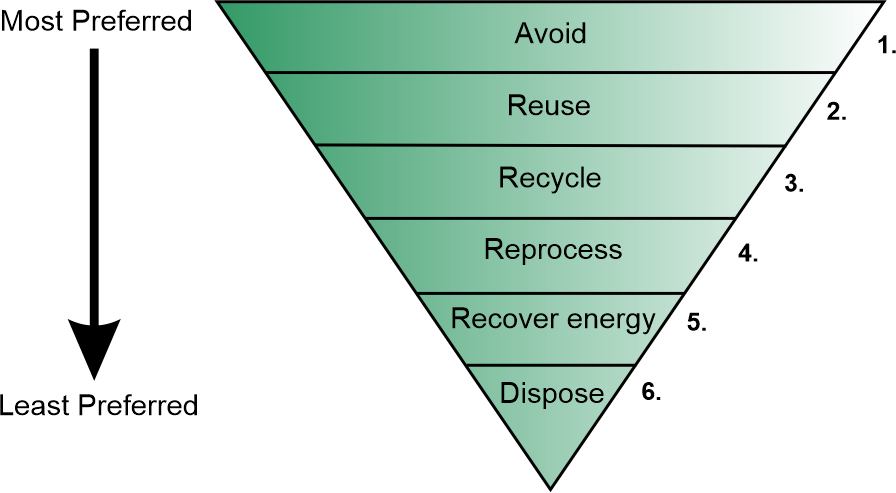
†, data in Mt. Reference (Blue Environment 2020)

# Toward better responses

The framework for addressing food waste, is the circular economy, with integration of the food waste management hierarchy.

## Circular economy options

Key principles of the circular economy are that products and materials are circulated at their highest value at all times, and that conserving resources is a high priority, based on the waste management hierarchy, Figure 2. General ways to address food waste by level of waste hierarchy are summarised in Table 4.



**Figure 2 Food waste management hierarchy.** Adapted from (Commonwealth of Australia 2017).

#### Table 4 Addressing food waste by waste hierarchy level

|  |  |  |
| --- | --- | --- |
| **No.** | **Waste**  **Hierarchy** | **Response** |
| 1 | Avoid | * Education campaigns * Research and development to support more efficient production methods * Packaging initiatives to improve shelf life |
| 2 | Reuse | * Food rescue donations * Repurposing aesthetically imperfect food (e.g., packaged carrot sticks) * Repurposing without processing for animal feed |
| 3 | Recycle | * Composting (windrows and anaerobic digestion) * Soil conditioners * Worm farms * Biotechnology solutions for animal feed |
| 4 | Reprocess | * Conversion to pharmaceutical and nutraceuticals * Conversion to cosmetic products |
| 5 | Recover energy | * Incineration and anaerobic digestion for energy recovery |
| 6 | Dispose | * Incineration for non-energy recovery * Food waste sent to landfill * Food waste going to sewer |

Source (Commonwealth of Australia 2017).

# How you can reduce food waste at home

## Addressing personal factors

The continuing high waste of food at home in developed countries (Gustavsson et al 2011), highlights a gap between personal awareness and an acceptance of households’ responsibilities on this issue. This gap between perception and reality makes behaviour change difficult.

Technological solutions, like mobile phone apps to share leftover food with strangers or refrigerator cameras that notify users when food will soon become spoiled, could prove important in addressing the problem. However, success will ultimately come down to how much people are willing to change the way they live (Jackson 2016). Thus, to design effective interventions to reduce food waste, better understanding of what underpins the behaviour is essential.

For citizens of developed countries, arguably the top three reasons for food waste are (Mehta 2020):

1. **People buy or cook too much food.** People who live in the middle class or higher often buy lots of food because they can. There’s nothing to stop them and they always feel like they need more. After buying it, they tend to put more on their plate than they can eat without ever stopping to think about the consequences.
2. **The limited time that we have in the 24/7 society.** When people don’t have time, it’s very simple to throw away food because it becomes an inconvenience. A common trend we’re starting to see is because a lot of us are privileged enough to have food every day, we don’t stop to think about what would happen if we don’t. That’s the root cause behind consumers wasting food.
3. **That people don’t have enough space to fit new food.** So, when buying new food they throw the older food out, even if still edible. Again, as soon as food starts to be an inconvenience we throw it out because there is nothing telling us not to.

Campaigns to reduce food waste, then, should include information on the personal values of food, and the value of reducing food waste. Personal values may include “having a balanced diet” and “saving money”, as main motivating factors. Other concepts include, “I don’t like to throw away

what I worked to pay for”, and the external importance to reduce “the impact that food production has on the environment” (de Bruin et al 2019).

I next look at practical ways to personally reduce food waste.

## Minimising food waste

Minimising food waste in the first place is the best way to ensure you are not wasting money or resources. There are many simple ways to minimise food waste (Sustainability Victoria 2021a). These include:

### Planning, shopping and cooking

Planning meals, shopping smart, cooking waste-free and storing food correctly reduce food waste and save money.

* The best way to reduce food waste is to avoid creating it in the first place, by planning meals, shopping smart, cooking waste-free and storing food correctly (Appendix A).
* You can plan your meals and write your shopping list using mobile apps (Appendix B).
* Storing food correctly keeps it fresher for longer. You’ll waste less, save money and help

the environment (Appendix C).

* When eating out, ask for best size portions for each family member, and if needed, a

‘family bag’ to take home uneaten food.

### Use-it-up recipes

Minimising food waste can be delicious! To find out how to use up the most commonly thrown out foods, see these [recipes](https://www.sustainability.vic.gov.au/recycling-and-reducing-waste/at-home/avoid-waste/food-waste/meal-plan-and-shopping-list-apps/recipes) (Sustainability Victoria 2021b).

### Getting the best value from food waste

The best way to deal with food waste is to not create it in the first place through buying only what you need and using up what you’ve got. But even for unavoidable food waste like peels and offcuts, there are a range of ways you can put their nutrients to good use rather than in the rubbish bin:

* Some councils have combined food and garden waste collections, to be turned into compost. See if your council offers one by checking your council website.
* Set up your own compost bin (Appendix F), bokashi bin (Appendix G) or worm farm (Appendix H). There's an option for every household type. Some councils even offer discounts on equipment.
* Find a compost near you. Some councils offer community composting sites or you can sign up to sharing apps like [ShareWaste](https://sharewaste.com/) (ShareWaste 2021).

Composting, by a compost bin, bokashi bin or worm farm, uses the natural processes of decomposition to convert organic waste matter into a nutrient-rich soil you can use in your garden. Reduce landfill, conserve resources and minimise greenhouse gases by composting your kitchen waste.

### Cut down on food packaging

Sustainable shopping includes consideration of the way your food and other purchases are packaged. For instance, Australians throw away around 1.9 million tonnes of packaging each year. Packaging takes a lot of energy, water and other natural resources to produce, and packaging waste pollutes our air, water and soil.

Reduce and recycle your packaging waste as much as possible to:

* Minimise use of raw materials to produce packaging
* Reduce energy expenditure and emissions associated with the manufacture of packaging
* Minimise waste sent to landfill

Also, healthy food tends to have less packaging, to you can both stay healthy and use less packaging. by avoiding processed food.

For top ten tips for reducing food packaging, see Appendix D.

### Shop for sustainable food

Sustainable food has been grown or produced with consideration of its health, environmental and social impact. As with all sustainable shopping, this includes where the food was made, the materials it was made from, how it is packaged and any energy efficiency or environmental ratings. Is your food sustainable?

The food we eat makes a bigger contribution to our ecological footprint than our home energy use and transport combined. Considering the sustainability of every piece of food you put into your mouth can be challenging. An easy way around this is to consider categories of foods and to support businesses that are taking a sustainable approach to growing, farming and producing food (Appendix E).

# How cafes and restaurants can reduce food waste

Food waste is a significant problem that impacts both the profitability of food services and the quality of the wider environment. However, in Australia, only around 22 percent of businesses in the food sector monitor how much food waste they produce (Nisbets 2016). This is surprising, because reducing food waste can increase the profits of a food service business. So, to begin with, it is important to conduct a food wastage audit in your hospitality business. This will also be the basis for assembling a waste reduction plan.

## Food wastage audit

The following section will outline two ways you can take to conduct a food wastage audit in your hospitality business. The first method is a simple way on how to measure your food waste on your own, with only four steps, and suits smaller food services. You can write out your own results in a physical table or in a simple computer spreadsheet. The second method is more in depth, with the support by free food waste templates from the global Food Loss and Waste Accounting and Reporting Standard. This method suits larger food services.

### Method 1: How to do your own simple food waste audit

If you are pressed for time or don’t use a computer much in your establishment, there is a simple way to check your food waste. If you’d rather go with a simple food wastage audit, just follow the four basic steps below (Nisbets 2016):

* **Get your staff informed and involved**. Get your staff informed and involved. For a food waste audit to go well, you’ll need the support and engagement of your employees for accurate results. Also, if you can get your staff interested early, your food waste solutions will run all the more smoothly later on.
* **Categorise your food waste.** Separate your waste into 3 categories:
  + Waste from storage
  + Waste from preparation
  + Waste from your customers' plates
* **Measure your food waste accurately.** Label your kitchen bins according to the three categories, and weigh these at the end of each shift or service. Do this using the same standard weighing technique each time.
  + This will help you create your waste reduction plan, and give you a more detailed picture about where exactly food is getting lost unnecessarily.
* **Compare your wastage results with your business activity**. Once you’ve weighed the bins,

record the weights against the number of people you served during the shift.

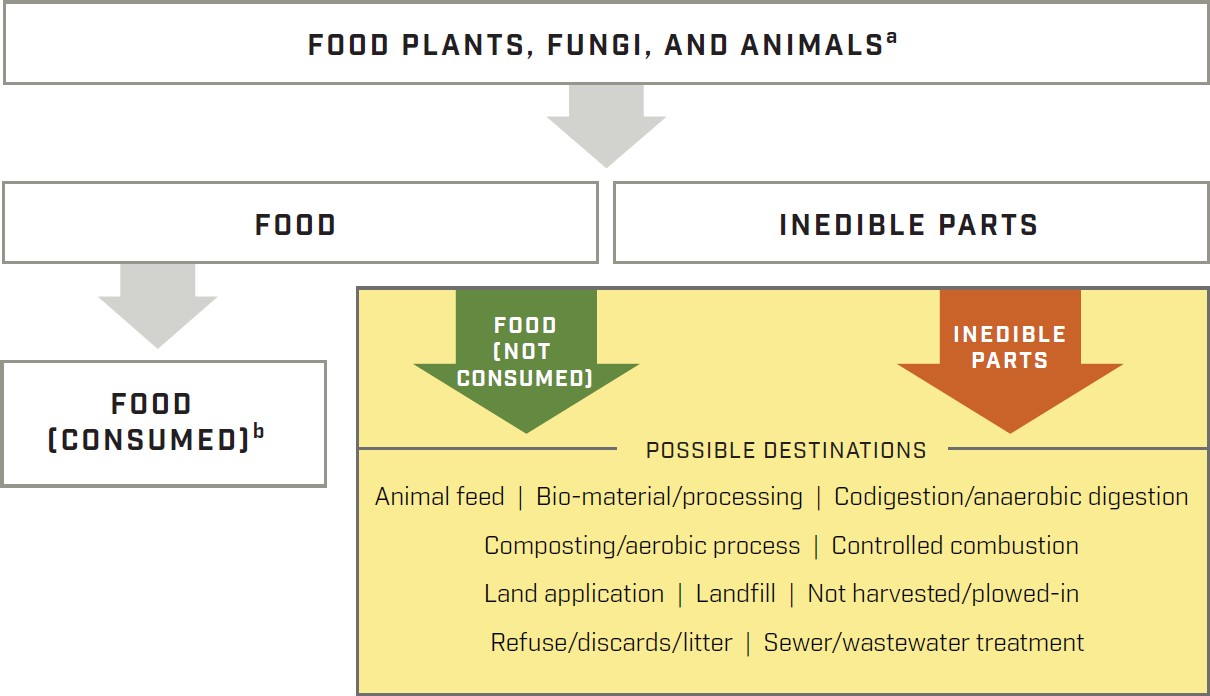
* + This is your base data that you can use as a reference point as you move forward with your waste reduction plan.
  + These important numbers will let you know what works and what doesn’t. You can also use these numbers to see how you stack up against industry waste minimisation benchmarks.

### Method 2: Download and use free food waste templates

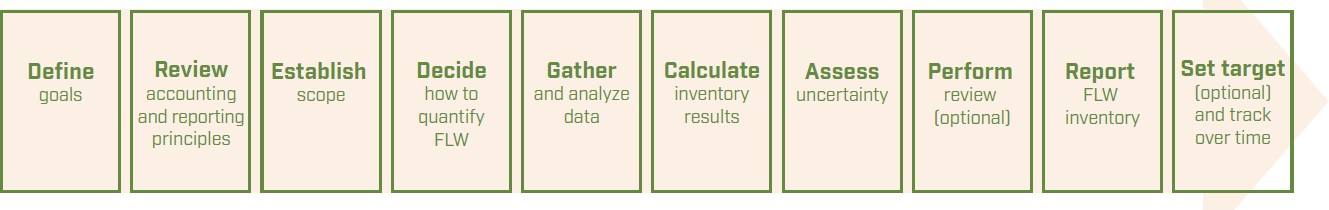
The global audit system is the Food Loss and Waste Accounting and Reporting Standard (or FLW Standard), which is a global standard that provides requirements and guidance for quantifying and reporting on the weight of food and/or associated inedible parts removed from the food supply chain, that is commonly referred to as “food loss and waste” (FLW). Using the standard enables your food service to develop inventories of how much FLW is generated and where it goes. These inventories can underpin, inform, and focus strategies for minimizing FLW (FLW Protocol Steering Committee 2016).

An overview of the food system in FLW format is shown in Figure 3. The FLW Standard provides accounting and reporting requirements and guidance for everything within the yellow shaded box (that is, everything removed from the food supply chain). An overview of the 10 steps in FLW Accounting and Reporting is shown in Figure 4. (FLW Protocol Steering Committee 2016). The last step, setting targets, is the basis for assembling a waste reduction plan.

Free food wastage management templates are available to download from this [**FLW Resources**](https://flwprotocol.org/flw-standard/tools-resources/) page (FLW Protocol 2021a). These templates go into depth, and in addition, have the potential benefit of contributing your data to a worldwide research project to understand food waste management and how to reduce their adverse environmental impacts. You can also find all the information needed to ensure your data follows the correct rules in this [**FLW Standard FAQs**](https://flwprotocol.org/flw-standard/faqs/) section (FLW Protocol 2021b).



**Figure 3 Food material types and possible destinations under the FLW Standard.** a, food materials Intended for human consumption (i.e., excludes crops intentionally grown for bioenergy, animal feed, seed, or industrial use); b, At some point in the food supply chain (including surplus food redistributed to people and consumed). Notes: The green (left) and red (right) arrows represent the two possible material types in an FLW inventory. These material types go to one or more possible destinations (listed within the yellow shaded box) once they are removed from the food supply chain. Source (FLW Protocol Steering Committee 2016).



**Figure 4 Overview of Steps in FLW Accounting and Reporting.** Source (FLW Protocol Steering Committee 2016).

## Basic waste reduction plan

Now that you have the basics down, you are ready to conduct food waste audits and monitor just how effective your reduction strategies are. After your first audit it will all become a habit, and part of the way your business is run.

## Tips for how your food service business can reduce waste

Next, I look at tips for how your food service business can reduce waste. First, I give an overview of waste management, then look at six specific factors to reduce food waste in your business.

### Overview of waste management

To reduce food waste, keep the following principles in mind and you can’t go too far wrong. Using the well-known ‘Three Rs’ strategy, you can turn your food wastage completely around (Nisbets 2016):

1. **Reduce** — You can stop food waste by pre-planning your food orders and only buying what

you need, and by offering portion sizes that won’t end up as plate waste.

1. **Reuse** — Think of second uses before throwing food into landfill. For example, vegetable peels and meat bones can be thrown into a professional stock pot, to make high quality and versatile stocks. A collection of preserving jars in a variety of sizes makes creating your own preserves and pickles easy; the resulting house-made product can be an attractive selling point and addition to specials. You can also donate food you know you won’t use to organisations that can distribute it to people who will.
2. **Recycle** — Spoiled food can be utilised in a better way before it heads straight to landfill. If your food has already turned, consider creating compost or fertiliser from it before you throw it away.

### Specific factors to reduce food waste in your business

Stop creating excessive organic waste that cuts into your profits with the 6 following strategies (Nisbets 2016). For best results, ensure your food waste audit includes checking that each of these points is up and running in your business. Make food waste management at least a monthly business activity to monitor, with checklists and quantitative measurements to ensure the job is done right.

1. *Better control temperatures*

End bacteria spoiling your food by using the right temperatures in both preparation and storage. Key temperatures include reheating to a core temperature of at least at least 70 °C for 2 minutes, keeping fridges between 1 to 4 °C, and freezers below -18 °C. Safe holding temperatures for hot food should be above 63 °C, and cold food below 8 °C.

All commercial refrigeration should be monitored daily and kept well maintained. The breakdown of fridges and freezers can lead to a huge loss of stock if not picked up on quickly.

1. *Optimise portion sizes*

People love to be full, but they also hate wasting food. Don’t force your customers to feel guilty about leaving food on their plates. Instead, offer a reasonable plate size that will end up in their belly instead of the bin. Using interesting and beautiful restaurant crockery can create the illusion of a filled plate, even if a serving size is relatively small. Train your wait staff to advise on ordering amounts and offer takeaway food containers for anything left over. For meals where it’s possible, environmentally friendly takeaway containers can be used.

1. *Label your food well*

No more mysterious containers should live in your cool room! Use professional food labels for everything, and include the dates of when you made or opened stock, so staff know what to use with priority.

1. *Manage your stock mindfully*

A way to ensure you use everything you have is to do regular stocktake of your pantry, storeroom and fridge, including the expiry dates. Using correct storage methods, such as airtight food storage containers and ingredient bins, will help stock stay fresher for longer. Managers, supervisors, chefs and kitchen staff should all be trained in the ‘FIFO’ rule; First In, First Out. This means rotate the inventory so the stock with the most imminent use-by date will not go to waste.

1. *Test your new menus before ordering ingredients you may not use*

The food world is full of fickle trends, but before you jump on the latest fad ingredient, make sure your customers will actually order it. Fad ingredients tend to be expensive, so it’s a good idea to make sure it will sell before you stock up too much.

1. *Go shopping with a plan*

Pre-planning your orders and shopping trips ensures you won’t over-buy or stock up on things you don’t need. Before purchasing anything, figure out what ingredients each dish requires and the quantities you need. A pre-meditated shopping plan significantly reduces food wastage in the storeroom. Even if deals are offered or there are ways to save if you buy in bulk, it won’t save you money if the ingredients don’t get used.

1. *Recycle cooking oil*

Cooking oil used in food services can preferably be reconditioned, using MAGNESORB product, manufactured by the Dallas Group (Dallas Group 2021). Grease trap inceptor waste can be composted.

### Alternative destinations for unused or waste food

Now I look at four alternative destinations for unused or waste food (Nisbets 2016).

1. *Donate your unused food to food rescue organisations*

Charities and not-for-profit organisations exist to redistribute your food to those who need it. Chances are, you can take advantage of an organisation who are more than happy to redistribute your unwanted food. Research and make contact with the food rescue organisations in your area so you are aware of their processes for picking up excess food. Once you know how it works, you’ll be more likely to reach out next time you accidentally over-order or over-cater an event. In Australia, try established food rescue organisations OzHarvest, Food Rescue and Second Bite. The Civil Liability Amendment (Food Donations) Act of 2002 limits the liability of individuals and businesses providing they meet certain food safety standards.

1. *Use a food waste collection service*

Connect with a licensed service or business that processes food waste to ensure it gets put to good use. This is a good option if your unwanted food is past the point of acceptable consumption, or if you don’t have the capacity for compost or something similar. When selected your contractor, choose to work with an EPA-approved facility by checking the public register.

1. *Make your own on-site compost system or worm farm*

Having a compost bin, worm farm, or an in-vessel composter is a good way to reduce the volume of waste on site and help create rich soil. Check with your local council before you set one up, and keep in mind that certain foods are not acceptable for worms or compost bins.

1. *Food waste for livestock and chicken feed*

While some foods are acceptable to feed to chickens or livestock, you need to make sure you are not giving any food that has made contact with meat products, or you could risk increasing disease in the animals. Some foods such as citrus also retains chemical residue, which is also not acceptable in stockfeed. Get in touch with your state Department of Primary Industries to check the regulations on what food waste can be safely given to animals.

You can also use food waste recycling equipment to pre-treat food waste. You can purchase your own small scale recycling equipment to do this on site. Macerators and rapid decomposition or dehydrated food waste containers are popular choices. Macerating is the process of turning solid food into pulp that can be picked up by a licensed commercial composting service. Rapid decomposition or dehydrated food waste containers require sewage hook-ups and a filter for the fumes. Check with your local Council to see the licensing or permit requirements for small scale recycling equipment in your area.

### Assistance with reducing your food footprint

This section outlines the organisations that will help you on your way to better food waste practices (Nisbets 2016).

*State Government*

New South Wales, Victoria and South Australia have a range of assistance on offer for improving food waste management. These include financial incentives for using alternatives to landfill for organic food waste, free food waste education programs, awareness initiatives, and public grants. Australian states and territories also have added levies for disposing of food waste in landfill, and use this money to support organic waste management and recycling.

Find the information for your state below:

* NSW: <http://www.lovefoodhatewaste.nsw.gov.au/>
* VIC: <http://www.lovefoodhatewaste.vic.gov.au/>
* SA: <http://www.zerowaste.sa.gov.au/at-home/food-waste>

## Improved waste reduction plan

Starting with results of a waste audit you can set forward targets. Your waste reduction plan can also include attention to the 7 specific factors that can help reduce food waste, and a specific alternative destination for unused or waste food.

# How supermarkets can reduce food waste

An investigation in Sweden indicated that food waste at supermarkets was dominated by fresh fruit and vegetables, and rejection on delivery was the main reason for this food being wasted. Expressed in terms of carbon footprint rather than mass, the relative importance of meat waste increased compared to fruit and vegetables (Eriksson 2015). In Australia, around 25 per cent of edible fresh produce is thrown away due to visual imperfection or cosmetic damage every year (Woolworths 2014).

To address this issue, in 2014, the Woolworths Supermarket group labelled edible but imperfectly looking fruit and vegetables as the “Odd Bunch”. This allows shoppers to buy the fruit and vegetables of this range, that may otherwise be rejected or thrown away. Generally, these produces are grouped in bags, to allow cheaper cost per unit, to promote purchasing by consumers.

Importantly, this range also directly benefit Australian growers and suppliers who will be able to sell more produce to the supermarket, so wasting less in the process (Woolworths 2014).

In addition, reducing storage temperature can increase shelf-life which in turn can lead to reduced waste. However, the way of achieving this temperature reduction is important for achieving a net saving in terms of both carbon footprint and money. When the temperature reduction was achieved by extended use of the current electricity mix, a net lowering of carbon footprint was only found for the meat department. For food products with a high carbon footprint, like beef, there was much greater potential to lower the carbon footprint by preventing waste through source reduction than by upgrading the waste management option. In contrast, by using renewable energy sources as main contributions to the electricity mix for cooling, net saving for products other than just meat would be possible (Eriksson 2015).

Further, if food waste cannot be prevented, the options of donation to charity and anaerobic digestion of the waste have the greatest potential to reduce the carbon footprint, depending on the substituted food value and biogas potential, respectively (Eriksson 2015).

# How food manufacturing and processing facilities can reduce food waste

Each year, globally, food manufacturers produce billions of kilograms of food waste, much of which is avoidable or reusable under alternative circumstances. Also, while much noise has been made over the last few years in regards to curbing food waste, there’s still a lot to be done (Fuchs 2017).

Food manufacturers play a major role in reversing the food waste trend. This can be done both through influencing supplier and end consumer behaviours, as well as through direct and tangible action. Let’s take a look at 9 strategies.

*1. Improve the accuracy of forecasting*

Many manufacturers unnecessarily waste raw ingredients because of inaccurate forecasting. They assume they need to produce a certain number of products and, therefore, order enough raw ingredients to fulfill these needs. But when they wind up needing less, perishable goods go to waste. With better and more accurate forecasting models, food manufacturers can spend less time guessing and more time maximizing the ingredients they have (Fuchs 2017).

1. *Optimize supply chain*

Use software solutions to optimize supply chains so your products ship and reach store shelves more quickly. Reducing the time it takes to get your products on store shelves can help to reduce food waste.

1. *Wider produce selection*

Just because produce doesn't look perfect doesn't mean it's inedible. Source “ugly” produce that might otherwise be discarded due to imperfections that don’t negatively affect the taste or quality of the product (Powers 2017).

1. *Recycle frying oil*

Used frying oil should be preferably reconditioned, using DALSORB product, manufactured by the Dallas Group (Dallas Group 2021). Other options are, to be transformed to biofuel, or as a component of stock feed (Table 6).

1. *Adopt process management software*

If you don’t currently have a process management information technology solution in place, then you’re most likely wasting thousands of dollars worth of food without even realizing it. Such software is the best solution for companies looking to mitigate food waste, save energy and cut processing costs. With a process management system, you can track ingredients, energy use, analyse shelf life, avoid overstocking, create accurate inventory orders, avoid cross contamination and everything in between (Fuchs 2017).

1. *Improve packaging options*

Packaging plays an important role in protecting and preserving food throughout the supply chain and in the home (Powers 2017).

* + To improve life time, package products in a range of portion sizes, using resealable packaging or individually sealed compartments.
  + In addition, consider developing more innovative packaging solutions, such as embedding silver nanoparticles into plastic milk storage bottles to double the length of time before milk spoils, or use packaging that can detect when the product inside has gone bad.
  + Develop natural, sustainable packaging solutions to the problem of food spoilage, such as an invisible, edible barrier, potentially made from unused parts of the produce such as leaves and stems, that protects from mould, water loss, oxidation, and bugs. Sustainable solutions like this may double the shelf life of certain food products.

1. *Standardize date labels*

Product date labels can be confusing to consumers. Instead of using a range of date labels that include terms like "sell by", "best before", "use by", "expires on", and so on, use standardized date labels that make it clear to the consumer whether the date indicates spoilage or just that the product is outside the window of peak quality (Powers 2017).

Also, look at offering better cooking/freezing/thawing information (Fuchs 2017).

1. *Help consumers to better value food through traceability*

In recent years, the concept of tracking ‘farm to fork’ has become increasingly popular, with more people interested in where their food comes from. Traceability systems allows manufacturers to track and record data of food produced through all stages of production, processing and distribution to the consumer, which could positively influence how consumers value food (Simonis 2019).

If consumers, for instance, could trace how long ago and where their meat was slaughtered, packaged and distributed, or if they could see what date their milk was produced and which farm it came from, they may better value the food and so reconsider throwing away food that is safe to eat, and so reduce food waste (Simonis 2019).

1. *Support better consumer education*

Food manufacturers can usefully be vocal about the problem of food waste and provide practical tips for customers looking to reduce their individual impact (Fuchs 2017). Educate consumers through tips and educational messages printed on food packaging, online and in social media.

Teaching consumers about shopping and meal planning, best practices for storing food, preserve leftovers, donating unwanted food, and composting can help them buy what they can use and use what they buy (Powers 2017).

Next, I discuss the value of adopting process management software (option 5 above) in more detail. Improving efficiency in food manufacturing can reduce both energy costs and food waste.

## Improving efficiency in manufacturing

To improve efficiency in existing factories often the simplest start is to assess piece counting, to determine the proportion of quality versus non-quality of products. Then an investigation can be agreed by management to find the source or sources of non-quality in the upstream processes (Coertze 2021).

In general, inefficiency in production is related to inefficiency in energy use. So, improving efficiency in manufacturing processes will generally lead to improved energy efficiency, and, then, reduced energy costs.

A useful measure of manufacturing efficiency is Overall Equipment Efficiency (OEE), especially for factories with unknown efficiency. An analysis of OEE can indicate bottlenecks and other particular inefficiencies in manufacturing processes (Rieusset 2021).

Often underperforming equipment can be the cause of lost manufacturing efficiency and energy efficiency. For instance, costly downtime may occur due to failure of a key motor. Sensors can be installed to determine if the motor is running outside specifications, and so in need of preventive maintenance. That is, a predictive maintenance system can be easily set up, in which sensor information can be sent to the computer of the factory’s operator, to indicate when preventive maintenance should occur. The aim is to minimize the occurrence of costly downtime events.

Further, the efficiency of older refrigeration systems, such as in food manufacturing, can be improved. For instance, this can occur by replacing low efficiency induction motors with high efficiency induction motors. This will result in significantly reduced energy consumption and so payback on the investment in a short time (Rieusset 2021).

Costly downtimes can occur due to disrupting variations in power supply to factories, which particularly may occur in regional areas. Installation of an Active Voltage Conditioner (AVC) at the factory can minimize changes in voltage in power supply, and so maintain effective operation of critical manufacturing processes (Rieusset 2021).

A particular quality issue is the need to recall products, an expensive event. For instance, in dairy manufacturing there is a risk of cleaning material being left in pipes before treated milk is pumped through these, and so contaminate the product. To reduce the risk of recall, in-pipe sensors can be installed, to indicate when pipes are safe to transport product (Coertze 2021).

Together, manufacturing efficiency, energy efficiency, and reducing food waste, can be improved in three sequential phases, Table 10. That is, to develop digital monitoring and analytical systems from basic to optimal levels in sequence, as benefits are assessed at each step, before deciding to go onto the next step.

#### Table 10 Phases of installing digital technology in factories to improve efficiency

|  |  |  |
| --- | --- | --- |
| **Phase** | **Step** | **Properties** |
| A, Connected  operations | 1 Computerisation | Factory process diagrams on paper or simple  computer programs |
|  | 2 Connectivity and integration | * Vertical and horizontal factory floor integration * Real time monitoring * IoT sensors |
| B, Effective operations | 3 Visibility | * Realtime dashboards: equipment performance and process status * Track and trace operational changes and maintenance work |
|  | 4 Transparency | * Measure OEE, quality, productivity |
| C, Optimized and autonomous  operations | 5 Predictive | * Scheduling production and preventive maintenance |
|  | 6 Cognitive | * Further automation, including robots * Advanced performance analysis: machine   learning, artificial intelligence. |

Based on (Rieusset 2021).

# Industrial scale food waste recycling

Options for circular economic depend on the type of food waste.

## Food rescue (level 2)

Food rescue, also called food recovery or food salvage, can be described as a not-for-profit model that supplies free surplus food to community agencies, motivated mainly by the food poverty and hunger that occurs in low socio-economic communities (Lindberg et al 2014).

Many non-perishable and unspoiled perishable foods can be donated to local food banks, soup kitchens, pantries, and shelters if the transaction is managed properly.

Food banks and food rescue programs are available across the USA to collect food, to address the wasted food of about 63 million tons, and redistribute it to those in need (USEPA 2021).

Food banks are community-based, professional organizations that collect food from a variety of sources and save the food in warehouses. The food bank then distributes the food to hungry families and individuals through a variety of emergency food assistance agencies, such as soup kitchens, youth or senior centres, shelters and pantries. Most food banks tend to collect non-perishable foods such as canned goods because they can be stored for a longer time.

Food rescue organizations operate food rescue programming, which includes the retrieval of excess food from donors and/or the delivery of donated food directly to clients or to other organizations that redistribute food to clients. These organizations may also offer other programming, such as education/skills training and the repurposing of donated food into meals or other food products, and many of them apply software solutions, like apps, to coordinate the redistribution of excess food by volunteers or other organizations.

Also, Australia’s food waste problem is being confronted head on by an ever-growing number of food rescue charities, which are organisations that collect excess food from businesses and redistribute it to charities that support Australians who suffer food poverty (Foodwise 2021).

The past several years has seen a burgeoning in this small sector, which looks to tackle and reduce the 1 million tonnes of food waste that is sent to landfill by Australian businesses each year.

A number of different food rescue charities are operational around the country, both in urban and regional areas. Many of these charities also rely and depend upon the support of their volunteers.

In the UK, there are more than 2,000 food banks operating with the largest number being operated by the Trussel Trust (Butler 2017). In the 2016/17 financial year, retailers redistributed more than 5,389 tonnes of edible food to charities. However, less than 1 percent of edible surplus food produced by UK manufacturers and farms was being sent to charities to help feed the hungry.

Vegetables that were perfectly edible were being left to rot in the fields, and other foods not sold to retailers were put into anaerobic digestion or sent straight to landfill (Smithers 2017).

There are two typical structures for these food banks, a warehouse model and the full distribution model. In the warehouse model, the food bank organisation does not directly hand out food, but provide food to charities. The second model involves a complex network of suppliers, warehouses and distribution centres (Maher 2018). Among the food-bank are a wide variety of access models: some faith-based, others non-religious; some with strict rules on the amount of food given to individual clients, others with open-ended commitments to families in need; some requiring clients to have a voucher validated by outside agencies, others operating a self-referral system (Butler 2017).

## Composting option (level 3)

While general food waste can be composted, there are limits to the composting option, as food waste is required to be mixed with green waste, to optimise the composting process. Food waste tends to have a high nitrogen content compared its carbon content, so optimally to be mixed with green waste, which has a low nitrogen content compared to its carbon content. The reported ideal ratio of Carbon to Nitrogen for thermophilic composting has been generally thought to be in the range of 25 to 40 (Haug 1993; Epstein 1997). The optimal moisture content for composting has also been thought to be around 50 percent (w/w) (Haug 1993; Epstein 1997). A more recent study indicates that the optimal ratio of Carbon to Nitrogen depends on the moisture content. In this study an optimal Carbon to Nitrogen ratio of 19.6 was associated with a range of moisture contents from 55 percent to 65 percent (Kumar et al 2010). Therefore, optimally composting food waste requires it to be mixed with a substantial amount of green waste. Further, the emerging option provided by councils of composting domestic food organics and garden organic (FOGO), for instance by the Surfcoast Shire (Surfcoast Shire 2021), is likely to limit the availability of composting substantial amount of waste food from commercial sources.

## Reprocessing (level 4)

Food currently lost or wasted throughout the production and consumption cycle can be converted into nutritious and tasty foods and components of pharmaceutical products. In addition, various studies have indicated that different kind of food wastes obtained from fruits, vegetables, cereal and other food processing industries can be used as potential source of bioactive compounds and nutraceuticals which has significant application in treating various ailments. For these purposes, different secondary metabolites, minerals and vitamins have been extracted from food waste, using various extraction approaches. In near future these approaches could provide an innovative approach to increase the production of specific compounds for use as nutraceuticals or as ingredients in the design of functional foods (Kumar et al 2017).

Using the apple industry, as an example of addressing food waste, around two-thirds of apples produced do not meet supermarket specifications. Meanwhile, when used for juicing, around a third of an apple's biomass, known as apple pomace or pulp, remains after the production process finishes, but is currently discarded or used in low-value animal feed or compost (CSIRO 2021).

This apple pomace is edible and highly nutritious, containing polyphenols, dietary fibres, protein and essential nutrients. However, with an unappetising appearance and texture, consumers are unlikely to adopt apple pomace alone as a daily food staple (CSIRO 2021).

Using apple pomace as a model food source, a CSIRO team developed a process for stabilising apple pomace to prevent its physical, chemical and microbial degradation. This creates a nutritious and functional ingredient that retains its flavour, nutritional values and complies with food safety regulations (CSIRO 2021).

The stabilised wet pomace can be used as a raw material for the extraction of high value bioactive components for nutraceuticals or supplements. The whole pomace can also be transformed into a shelf-stable, nutritious, functional ingredients in different formats for use in many different food applications. For example, the stabilised wet pomace can be converted into paste, powder, flake, granule or pellet and used as an ingredient or component in manufacture of different food products. The powders can be used in smoothies, desserts, yoghurts, sauces and jams, bakery and extruded products. Flakes, granules or pellets can be used as components in breakfast cereals and health bars (CSIRO 2021).

The stabilising process developed boy CSIRO can also be applied to other fruits, vegetables and horticulture products, such as broccoli, carrots, tomatoes, peach, olives and grapes. The value-added conversion of edible unutilised food biomass such as apple pomace is an attractive commercial opportunity for food processors and manufacturers to create a new industry, and can help to alleviate strains to food and nutrition security (CSIRO 2021).

Whey waste, produced from cheese making in the dairy industry, has a large range of uses in the food industry. A number of forms of whey are used; raw whey, whey concentrate or powder, whey protein concentrate or powder and lactose & permeate powder. Food types that include whey products as an ingredient, are; baby food, diet food, sports nutrition, clinical nutrition, sausages, soups, bakery, salad dressings, ice cream, whey spread/cheese, cheeses, beverages and confectionery. In addition, lactose extracted from whey is used in pharmaceutical formulations (Tetrapak 2021).

The GSK pharmaceutical company has identified potential new sources of glucose, for its formulations, from food manufacturing, using starchy by products such as bread heels and potato waste as a starting material. Following successful trials, it exploring significant opportunities to scale this process up to commercial-level. The starting materials also include protein-rich residues which have the potential to be used as a food ingredient (Biorenewables Development Centre 2021).

## Food waste to energy (level 5)

The production of energy by anaerobic digestion or pyrolysis or incineration is expected to provide zero net green house gas emissions, due to input of biomass, and therefore provide a saving in greenhouse gas emissions compared to energy provided by coal-fired power plants, through the national electricity grid.

However, as the energy provided by renewable energy sources continues to increase over time, as suppled through the national electricity grid, the savings of greenhouse gas emissions will be expected to fall to zero. According to planned closures of coal-fired power plants, emissions for these should fall by 50 percent by 2035, and 90 percent by 2048 (Rouch 2021). These are conservative dates, as coal-fired power plants are already becoming uneconomic, and so likely to close more rapidly in future. Therefore, the main aims of treating food wastes are to (a) remove the potential health risk of untreated food waste, and (b) to provide useful products, even if bioenergy systems become less competitive in future.

### Anaerobic digestion: food waste to energy (level 5)

Given the large amount of food waste produced by food manufacturing and processing, and potential lack of enough green waste to compost this type of waste, it is reasonable to view anaerobic digestion as an effective option to process food waste to digested organic material, along with producing biogas to provide bioenergy. That is, digested organic material has a significant economic value, as an organic fertiliser, similar to compost, with the associated advantage of bioenergy production.

A good example of converting food waste to energy by anaerobic digestion is the ReWaste facility of Yarra Valley Water. ReWaste can accept a range of organic wastes (ReWaste 2021), including:

* Fats, oils and grease (for example, grease trap waste)
* Food processing waste
* Cooked food waste from restaurants
* Dairy waste, for example, cheese whey
* Animal processing waste
* Dissolved Air Flotation (DAF) sludge
* De-packaged spoilt liquids
* Process upset wastes.

The process has 7 main steps:

1. Separately store solid and liquid organic waste [liquid waste stored in closed tanks)
2. Mix solid and liquid waste to make a slurry
3. Feed slurry to digestor
4. Collect biogas
5. Biogas burnt to make power: electricity to plant and grid
6. Waste heat to keep digester warm, at operating temperature
7. Transfer anaerobically digested sludge to the biosolids treatment process

The ReWaste takes in the equivalent of 33,000 tonnes of commercial food waste each year, around 140 tonnes per day. This diverts thousands of tonnes of waste away from landfill and can produce around 23,500 kilowatt hours of electricity per day (equivalent to a 0.981 MW system), the equivalent power demand of around 1,300 homes (Yarra Valley Water 2021).

A particular advantage of the anaerobic digestion system is the closed system, so that odours are minimised.

In addition, food wastewater from a food company may potentially also be treated by anaerobic digestion.

### Pyrolysis and incineration: food waste to energy (level 5)

The difference in treatment between pyrolysis and incineration is that pyrolysis mainly occurs in the absence of oxygen, while incineration occurs in the presence of oxygen. Among these two options, pyrolysis is preferable as a substantial amount of the carbon is transformed to biochar, a useful product for improving the qualities of soil. In contrast incineration simply produces fly ash, which is usually sent to landfill.

Wood chips can be used as the biofuel to heat a pyrolysis or incineration system. Importantly, the pyrolysis process is conditionally carbon neutral. For the pyrolysis process, biochar may represent 25–30 percent of total plant products. Then, to ensure net zero green house gas emissions, a minimum of 41 percent of the biochar should be returned to the field, to ensure net zero green house gas emissions (Yang et al 2016). Also, if wood chips are treated by composting the compost products have more useful value than biochar. Therefore, the use of wood chips in the pyrolysis process should be minimised, simply to provide enough biofuel to process the waste food or prescribed organic wastes.

*Products and emissions from pyrolysis*

The components of gas products from wood pyrolysis are mainly H2 (hydrogen), CO (carbon monoxide), CO2 (carbon dioxide), CH4 (methane), C2H4 (ethylene), C2H6 (ethane), C3H8 (propane) and water (Kinata et al 2013). The biogas, including methane, ethylene, ethane and propane, can be burnt to produce electricity.

Products from a fluidised bed woodchip system vary according to temperature, Table 5. Therefore, if gas production is maximised, the biochar production is minimised. That is, there is a trade-off between producing gas for energy and producing biochar to ensure net zero green house gas emissions.

#### Table 5 Changes in proportions of products by process temperature

|  |  |  |  |
| --- | --- | --- | --- |
| **Temperature** | **Gas** | **Liquid†** | **Biochar** |
| 400 | 10 | 25 | 28 |
| 500 | 19 | 38 | 25 |
| 600 | 25 | 31 | 23 |
| 700 | 35 | 25 | 20 |

†, includes liquid oils and moisture. Source (Xiao et al 2006).

Pyrolysis is suitable to treat wastes that contain prescribed contaminants, especially organic contaminants like herbicides, pesticides and PFAS, which are completely destroyed during the process. Pyrolysis may also be used to treat food wastes that have biosecurity issues. The product of pyrolysis, biochar, can be used as a soil conditioner.

*Emissions from incinerators*

Much of the health concern regarding incinerator emissions are about production of dioxins and furans (Batterman 2004). General conditions that lead to dioxin formation include the presence of fly ash, organic or inorganic chlorine, metal ions and among a common temperature range, of 250 ⁰C to 450 ⁰C (Huang 1996).

For both pyrolysis and incinerator facilities to meet modern emission limits, it is essential to Install air pollution control devices. Most frequently used controls include; packed bed, venturi or other wet scrubbers, fabric filter typically used with a dry injection system, and infrequently electrostatic precipitator (ESP) (Batterman 2004).

In general, for treating food waste, anaerobic digestion is preferable to pyrolysis and incinerator facilities, for two reasons, the absence of toxic air emissions that occur in the pyrolysis and incinerator processes, and the wider value of the product, as a soil fertiliser with both soil conditioner and soil nutrient properties.

## Wastewater treatment option

In addition to treating food processing wastewater through anaerobic digestion, a further option for treating wastewater from a food company could be an artificial wetland, located on the property.

This is a relatively low-cost option, with a good environmental profile, and might be useful if the volume of wastewater is excess to requirements for anaerobic digestion. A key value of artificial wetlands is to remove nutrients, microbes and potential sources of odour from the effluent, which can then safely enter the stormwater system.

# Reducing the environmental footprints of waste oils

## Introduction

Oils are used in cooking food at home and in restaurants, and for lubrication of machinery in food manufacturing systems. Oils and related products, such as vegetable oils and lubrication oils can contaminate environmental areas with serious impacts. Also, like many petroleum products, used lubrication oil can contain organic toxic compounds (e.g., benzene, toluene, naphthalene, phenols, and PNAs such as benzo[α]pyrene) at levels higher than health-based standards.

## Cooking fats and oils

Used cooking fats and oils may be treated by a range of methods, Table 6. Optimally the first treatment option for used oil is reconditioning, to allow reuse. For further processing the outcome depends on which type of company accepts the used oil. For example, if it goes to a treatment

company, the oil may be degraded by anaerobic digestion or composting, along with other organic components, including garden waste. Alternatively, if it’s sent to a biodiesel plant, it is filtered and processed into fuel that can be burned in most diesel engines, like trucks.

**Table 6 Options for treating cooking fats and oils.** Adapted from (EPAV 2017)

|  |  |
| --- | --- |
| **Types of materials** | **Treatment options** |
| * Used cooking fats and oils | * Reused (reconditioned) * Recycled * Used for the production of biofuel * Treated used cooking oil as a component of stock feed |
| * Grease trap inceptor waste * Residues after processing | * Applied to land * Composted |

Importantly, used cooking oils can be efficiently reconditioned utilising systems based on magnesium silicate substances, for instance DALSORB and MAGNESORB products, manufactured by the Dallas Group (Dallas Group 2021). Used product can be utilised for alternative purposes, including as a component of animal feed.

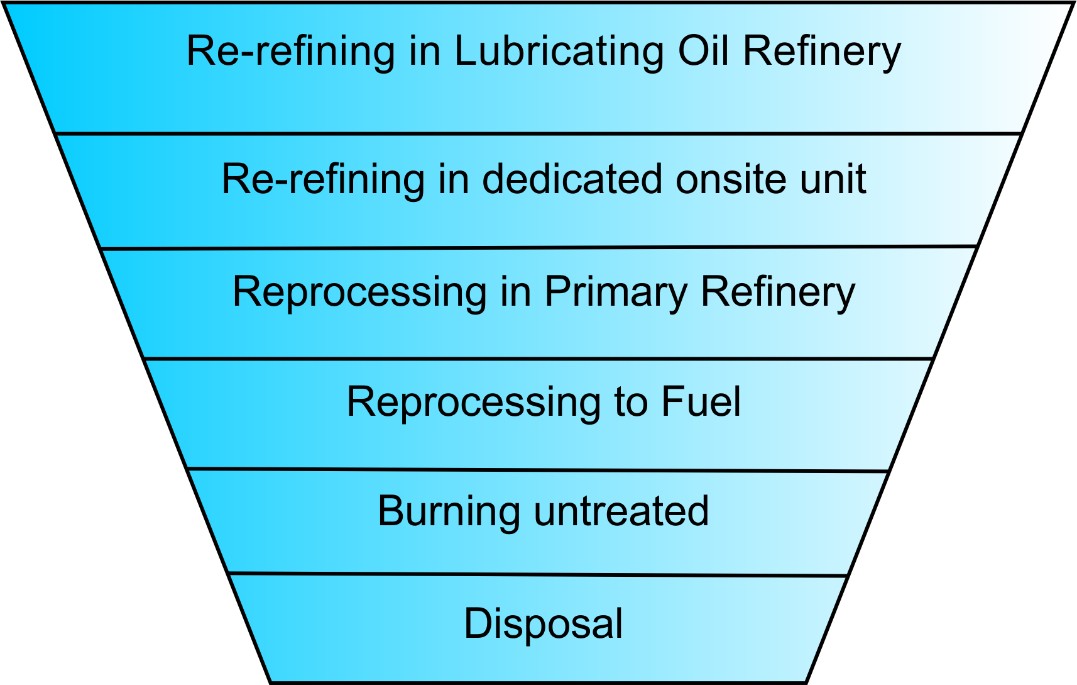
In biodiesel production Fats/oils are reacted with alcohol(methanol), using a strong alkaline catalyst (sodium hydroxide (NaOH) or potassium hydroxide (KOH)). This yields mono-alkyl methyl esters (biodiesel) and glycerin. Commercial biodiesel is sold as a “blend” with regular ultra low sulphur diesel (ULSD). for Example: B20, 20% biodiesel, 80% petroleum diesel (Rochester Institute of Technology, 2012).

### Regulation in Australia

Liquid waste cooking fats and oils are Category A prescribed industrial waste (PIW) under the Environment Protection (Industrial Waste Resource) Regulations 2009, in Victoria. This classification also recognises unprocessed used cooking fats and oils as a non-PIW, provided appropriate measures are in place to prevent pollution to the environment (EPAV 2019a).

## Lubrication oils

The United States Department of Energy and the University of Chicago has developed the hierarchy of waste oil reuse options Figure 5, considering both environmental and economic aspects (Giovanna et al. 2003).



**Figure 5 hierarchy of waste oil reuse options.** Adapted from (Giovanna et al. 2003).

Because of the energy savings associated with multiple use, re-refining is ranked higher than other consumptive reuses. Re-refining (reconditioning) in a lubricating oil refinery is ranked above re- refining in a dedicated onsite stand alone unit because of the opportunities for capital cost reductions, existing facilities and utilities utilization, recovery of higher-value by-products, and more efficient pollution control. Reprocessing in a primary refinery is ranked below re-refining in dedicated equipment, as treatment does not reproduce the same oil product, so not closing the circular economy loop.

Burning in space heaters, when heat is needed, avoids the energy consumption and environmental impacts associated with transporting and reprocessing oil. However, the uncontrolled emissions from space heaters, particularly in populated areas, may be more harmful than burning reprocessed oil at an industrial site that may be equipped with pollution control equipment.

Finally, used oil disposal or dumping is the least desirable alternative because the energy value of the oil is lost and the oil can potentially contaminate soil, groundwater and surface waters. Used oil disposed of in landfills or discharged to the ground or into sewers can contaminate soil, groundwater or surface waters.

### Reconditioning oil

Reconditioning, approximately corresponds to the reuse concept, and involves the filtration or other treatment of used oil on site to extend its useful life, before recycling. This type of treatment is sometimes applicable for large volumes of industrial oil.

Reconditioning involves the onsite treatment of used oil to remove impurities, typically extending the life of the lubricant. In some cases, firms contract to provide this service to a user, and in other cases, the facility owner reconditions their own oil. There are a wide range of systems and services that are offered for reconditioning. In general, reconditioning is most suitable for use in plants that have a large volume of similar oil (such as hydraulic oil) that is amenable to a specific process (National Oil Recyclers Association 2019).

### Re-refining (reconditioning)

Re-refining can also be described as reconditioning, which approximately corresponds to the reuse concept in the general waste management hierarchy, and involves the filtration or other treatment of used oil on site to extend its useful life, before recycling. This type of treatment is applicable for large volumes of industrial oil.

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Large volumes of used lubricating oils can be re-refined by utilizing a technology that is used in the crude oil refining industry: vacuum distillation. Vacuum distillation is followed by one of two technologies that produce high quality re-refined base oil: a) hydrotreating or b) solvent extraction (National Oil Recyclers Association 2019).

During vacuum distillation the lubrication oil is boiled away, and separately recovered. This leaves behind an asphalt residue, that is marketed for paving applications. The material that emerges from the vacuum distillation process has many of the properties of lubrication oil, but it still includes some contaminants.

The Hydrotreating technology removes contaminants by exposing the oil to hydrogen gas, at very high pressure and temperature, in the presence of a catalyst. The catalyst promotes chemical reactions that remove trace metals and other contaminants from the lubrication oil.

The solvent extraction process removes contaminants from the distillate by using an environmentally compatible solvent. At the same time, the valuable and reusable components of the oil are retained. The solvent used is also recycled and can be used again as often as necessary.

### Reprocessing for primary refining

In some cases, reprocessing is intended to convert the used oil into a product that can be introduced into the feed of a petroleum refinery, where it is converted into gasoline and other refinery fuels and by-products. Distillation is employed to remove the contaminants that are commonly found in used oil. The distilled material can then be sold as vacuum gasoil (VGO) which is used as a refinery feedstock (National Oil Recyclers Association 2019).

### Reprocessing to fuel

In some cases, the used oil is processed to remove water and particulates so that the used oil can be burned directly as a fuel, typically in industrial burners. The oil can be first treated utilising distillation to remove the contaminants that are commonly found in used oil. The distilled material can then be marketed as a fuel, including a ship boiler fuel called marine diesel oil (MDO) (National Oil Recyclers Association 2019).

Distillation Fuels Processing requires significantly less capital than a full re-refinery, that would convert the used oil to lubricating base oil.

Alternatively, a range of simpler treatment methods are used to remove small amounts of water and particulates from the used oil so that it can be burned as a fuel. There methods include gravity separation, heating, the addition of demulsifying chemicals, and filtration. The used oil that has

been processed can then be burned in an industrial burner. Large consumers of these used oil fuels include the asphalt industry, the forestry industry, the steel industry, and cement kilns (National Oil Recyclers Association 2019).

This type of used oil processing requires less capital than either a full re-refinery or a distillation fuels processing facility. This technique enables the recovery of valuable energy from the used oil.

### Regulation in Australia

The Product Stewardship for Oil Scheme (PSO) was introduced by the Australian Government in 2001 to provide incentives to increase used oil recycling. The Scheme aims to encourage the environmentally sustainable management and re-refining of used oil and its re-use.

The Product Stewardship (Oil) Act 2000 establishes the general framework and benefit entitlements of the PSO arrangements. The arrangements comprise a levy-benefit system, where an 8.5 cents per litre levy on new oil, helps fund benefit payments to used oil recyclers. These arrangements provide incentives to increase used oil recycling in the Australian community (Department of Environment and Energy, 2019a).

For a small amount of used oil from vehicles or farm machinery, this can be taken to a local used oil facility run by a local council or shire. Usually, the facility will be located at the landfill, waste transfer station or works depot. Some used oil facilities will also take oil filters, oily rags, and plastic oil containers.

Some industries including service stations produce more used oil than a local facility is able to take. Instead, used oil collectors will visit and remove the used oil (this may be free because used oil is valuable) (Department of Environment and Energy 2019b). Collectors may take engine oil, oily water, oil filters, hydraulic oil and sump oil.

# Conclusions and recommendations

#### Food waste

Food waste is a national and global issue, due to its impact on the environment, including green house gas emissions. About one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. Globally, food waste produces about 2.1 billion tonnes of CO2-eq, as anthropogenic green house gas emissions.

Food waste can be defined when food that is fit for human consumption is thrown away, which is substantially a result of human factors. In comparison, food loss usually happens in the earlier stages of food production where things like pests, weather, or other factors make the food inedible so resulting in it being lost, which are mainly non-human factors. This report focusses on food waste.

The causes of food losses and waste in low-income countries are mainly connected to financial, managerial and technical limitations in harvesting techniques, storage and cooling facilities in difficult climatic conditions, infrastructure, packaging and marketing systems.

The causes of food losses and waste in medium/high-income countries mainly relate to consumer behaviour as well as to a lack of coordination between different actors in the supply chain. Food loss and waste occurs at each stage in the food cycle.

The majority of food waste occurs at home, followed by hospitality and food services, manufacturing and processing, retail, and lastly, wholesale.

#### Addressing food waste

The framework for addressing food waste, is the circular economy, with integration of the food waste management hierarchy.

#### Developing countries

The food supply chains in developing countries need to be strengthened by, inter alia, encouraging small farmers to organize and to diversify and upscale their production and marketing. Investments in infrastructure, transportation, food industries and packaging industries are also required. Both the public and private sectors have a role to play in achieving this.

#### Developed countries

in medium/high-income countries there needs to be a main focus on changing consumer behaviour as well as improving coordination between different actors in the supply chain.

**Recommendations by sector**

#### At home

Reducing food waste at home requires campaigns that include information on the personal values of food, and the value of reducing food waste.

* Food waste can be minimised by planning meals, shopping smart, cooking waste-free and storing food correctly.
* Remaining domestic food waste can be turned into compost, at home or by councils.
* Reduce and recycle your packaging waste.
* Shop for sustainable food.

#### Cafes and restaurants

to begin with, it is important to conduct a food wastage audit in your hospitality business. This will also be the basis for assembling a waste reduction plan.

Specific factors to reduce food waste in your business are; better temperature control, optimise portion sizes, label food well, manage your stock mindfully, test your new menus, go shopping with a plan and recycling cooking oil.

Alternative destinations for unused or waste food are food rescue organisations, food waste collection services, on-site compost system or worm farm, livestock and chicken feed. You can also use food waste recycling equipment to pre-treat food waste.

Starting with results of a waste audit you can set forward targets. Your waste reduction plan can also include attention to the six specific factors that can help reduce food waste, and a specific alternative destination for unused or waste food.

#### Supermarkets

Create a range of edible but imperfectly looking fruit and vegetables, to allow shoppers to buy the fruit and vegetables of this range, that may otherwise be rejected or thrown away.

In addition, reducing storage temperature can increase shelf-life which in turn can lead to reduced waste, though with a trade off on power costs.

if food waste cannot be prevented, the options of donation to charity and anaerobic digestion of the waste have the greatest potential to reduce the carbon footprint.

#### Food manufacturing and processing facilities

Food manufacturers play a major role in reversing the food waste trend, by 9 strategies; improving the accuracy of forecasting, optimizing the supply chain, wider produce selection, recycle frying oil, adopt process management software, improve packaging options, standardize date labels, help consumers to better value food through traceability, and support better consumer education.

#### Industrial scale food recycling

Options for recycling food waste at industrial scale, in preferred order, are food rescue, composting, reprocessing, and food waste to energy.

#### Reducing the environmental footprint of waste oils

Oils are used in cooking food at home and in restaurants, and for lubrication of machinery in food manufacturing systems. Oils and related products, such as vegetable oils and lubrication oils can contaminate environmental areas with serious impacts.

Used cooking fats and oils may be treated by a range of methods. Optimally the first treatment option for used oil is reconditioning, to allow reuse. Other options are, to transform the used oil to biofuel, or use as a component of stockfeed.

For recycling lubricating oils the hierarchy of waste oil reuse options should be followed, in descending order; re-refining in lubricating oil refinery, re-refining in dedicated onsite unit, reprocessing in primary refinery, reprocessing to fuel, burning untreated, and disposal.

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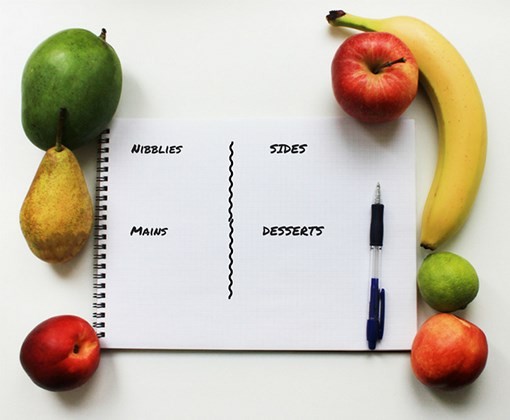
# Appendix A How to save food

Planning meals, shopping smart, cooking waste-free and storing food correctly reduces food waste and saves money. Also, there are a range of ways you can ensure unavoidable food waste is put to good use rather than ending up in the rubbish bin (Sustainability Victoria 2021a).

#### Planning

The best way to reduce food waste is to avoid creating it in the first place, and a bit of planning can help you do just that:

* Food planning, in whatever form works best for you, will save you time and money. It will help you make the most of what you already have and ensures you only buy the things you really need.
* Good planning involves checking what you already have, planning your meals and knowing what you need to buy.
* If planning every meal of the week seems daunting, you can try planning two to three days ahead, or for just your week-night dinners.



#### Shopping

Smart shopping can save you from throwing away thousands of dollars a year in wasted food. There are a few basic principles to remember:

* Know what you need to buy before you go. Writing a shopping list is essential but so is checking the fridge and cupboards first so that you know what you already have.
* Planning your meals around food that is in season is usually cheaper and these items are often fresher, so they last much longer.

#### Cooking

Waste-free cooking can be easy and makes cooking more fun and less stressful. The best things you can do to cook without waste are:

* cook to a meal plan
* get creative to use up ingredients
* cook the right amount to avoid leftovers.

A meal plan can save you both time and stress and will help you use up what you’ve bought.

If you find yourself with spare ingredients or leftovers, take the opportunity to get creative so that you use them up. Search online for recipes that use the specific ingredients you have or check out some [simple recipes](https://www.sustainability.vic.gov.au/recycling-and-reducing-waste/at-home/avoid-waste/food-waste/meal-plan-and-shopping-list-apps/recipes) for commonly-wasted items (Sustainability Victoria 2021b).

Cooking the right amount for what you need also helps reduce waste. If you want to avoid leftovers, it makes sense to be more cautious with your portion sizes. But if you love your leftovers, deliberately preparing larger portions to freeze or eat for lunch can actually save food, money and time.

Think some of your food is beyond rescue? Think again! If leftovers are the result of younger fussy eaters, there are lots of ways to involve kids in the food journey.

#### Food safety

It’s important to remember a few basic food safety rules to ensure you stay healthy and reduce your

food waste:

* Wash your hands before and whilst preparing food.
* Keep food out of the temperature 'danger zone'. Between five and 60 degrees Celsius is the range where bacteria, a common cause of food poisoning, can quickly reproduce. Be sure to store food in the fridge within two hours of serving.
* Prevent cross-contamination. Always keep raw meats separate from ready-to-eat food.
* Make sure all food (particularly seafood, poultry and meat) is cooked thoroughly.

#### Storage

Storing food correctly means your items can last weeks or even months longer, but it can be difficult to know what should go where. Do you keep your eggs in the fridge or pantry? Do tomatoes go in the fridge crisper or fruit bowl? Find out with our storage guide for fresh produce (Appendix C).

<!DOCTYPE html>

<html lang="en">

  <head>

    <meta charset="UTF-8" />

    <title>FeedOn - Register</title>

    <!-- Favicon, CSS & JS -->

    <link rel="icon" href="assets/logo.png" type="image/png" sizes="16x16" />

    <link rel="stylesheet" href="styles/common.css" />

    <link rel="stylesheet" href="styles/register.css" />

    <script src="js/client.js" defer></script>

    <!-- Font Awesome icons CDN -->

    <script src="https://use.fontawesome.com/4e51920be5.js"></script>

    <!-- Bootstrap CDN -->

    <link

      rel="stylesheet"

      href="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/css/bootstrap.min.css"

    />

  </head>

  <body class="bg-light" onload="getRegister()">

    <section class="container">

      <h1 class="center">FeedOn - REGISTRATION FORM</h1>

      <div id="user-info"></div>

      <form action="/login" class="form-container" method="POST">

        <p><b>Please enter your organisation's name:</b></p>

        <input

          type="text"

          name="name-input"

          placeholder="Enter organisation (Charity/Restaurant) name"

        />

        <p><b>Please register as charity or restaurant:</b></p>

        <select name="user-type">

          <option value="" disabled selected>Select user type here</option>

          <option value="charity">Charity</option>

          <option value="restaurant">Restaurant</option>

        </select>

        <p>

          <b>Please provide a description about your charity/restaurant:</b>

        </p>

        <textarea

          name="description-input"

          placeholder="Enter organisation description"

        ></textarea>

        <p><b>Pleace provide an address to your location:</b></p>

        <textarea

          name="location-input"

          placeholder="Enter organisation's address"

        ></textarea>

        <input type="submit" class="register-btn" value="Register" />

      </form>

    </section>

  </body>

</html>

# Appendix B Meal plan and shopping list apps

# Are you more of a digital planner? Here’s our list of apps you can use to plan your meals and write your shopping list (Sustainability Victoria 2021b).

#### Use a note app

Whether you have an iPhone or an Android phone, a note app will come built-in to your phone. Some note apps allow you to share your note with your family or household.

#### How to create a meal plan using a note app

1. Create a new note.

2. List the days of the week

3. Under each day of the week, list the meals you plan to make.

4. Remember to give yourself some nights off with leftovers or a freezer meal.

5. Add items you need to buy as you plan your meals for the week. Remember to check what .

<!DOCTYPE html>

<html lang="en">

  <head>

    <meta charset="UTF-8" />

    <meta http-equiv="X-UA-Compatible" content="ie=edge" />

    <meta name="viewport" content="width=device-width, initial-scale=1.0" />

    <title>FeedOn</title>

    <!-- Favicon, CSS & JS -->

    <link rel="icon" href="assets/logo.png" type="image/png" sizes="16x16" />

    <link rel="stylesheet" href="styles/common.css" />

    <link rel="stylesheet" href="styles/main.css" />

    <script src="js/client.js" defer></script>

    <!-- Font Awesome icons CDN -->

    <script src="https://use.fontawesome.com/4e51920be5.js"></script>

  </head>

  <body onload="controlButton()">

    <!-- Navbar -->

    <div id="navbar" class="navbar">

      <ul>

        <li>

          <a href="signin.html" id="sign-in-button">SIGN IN</a>

        </li>

        <li>

          <a href="register.html" id="register-button">REGISTER</a>

        </li>

        <li>

          <a href="#contact">CONTACT</a>

        </li>

        <li>

          <a href="#home">HOME</a>

        </li>

        <img src="assets/logo.png" class="navbar-logo" />

      </ul>

    </div>

    <!-- Heading -->

    <header class="showcase">

      <div class="content">

        <img src="assets/FeedOn.png" class="logo" alt="FeedOn" />

      </div>

    </header>

    <!-- Donation Form -->

    <a

      href="donation.html"

      class="donation-btn center"

      target="\_blank"

      id="donation-button"

      >MAKE DONATION</a

    >

    <!-- Donation Inbox -->

    <a

      href="inbox.html"

      class="inbox-btn center"

      target="\_blank"

      id="inbox-button"

    >

      INBOX

      <span id="numOfUnread" class="badge"> </span>

    </a>

    <!-- Tabs: Feed, Charities, Restaurants -->

    <section id="home" class="bg-light">

      <div class="container center tab">

        <button onclick="listAllMatches()">Donation Match</button>

        <button onclick="listAllCharities()">Charities</button>

        <button onclick="listAllRestaurants()">Restaurants</button>

      </div>

      <div class="data container"></div>

      <hr class="center" />

    </section>

    <!-- Contact Details -->

    <section class="bg-light" id="contact">

      <div class="container center">

        <h2>Get in Touch</h2>

        <p>To find out more, just drop us a line!</p>

        <a href="tel:+65-9126-2826"><i class="fa fa-phone"></i></a>

        <a href="" target="\_blank"><i class="fa fa-map-marker"></i></a>

        <a href="mailto:contact@feedon.com"><i class="fa fa-envelope"></i></a>

        <a href="https://www.linkedin.com" target="\_blank"

          ><i class="fa fa-linkedin"></i

        ></a>

      </div>

    </section>

    <!-- Footer -->

    <footer class="center bg-dark">

      <p>FeedOn &copy; 2020</p>

    </footer>

  </body>

</html>

<?xml version="1.0" encoding="utf-8"?>

<appengine-web-app xmlns="http://appengine.google.com/ns/1.0">

    <application>feed-on</application>

    <version>1</version>

    <runtime>java8</runtime>

    <threadsafe>true</threadsafe>

    <system-properties>

        <property name="java.util.logging.config.file" value="WEB-INF/logging.properties"/>

    </system-properties>

</appengine-web-app>

<?xml version="1.0" encoding="utf-8"?>

<appengine-web-app xmlns="http://appengine.google.com/ns/1.0">

    <application>feed-on</application>

    <version>1</version>

    <runtime>java8</runtime>

    <threadsafe>true</threadsafe>

    <system-properties>

        <property name="java.util.logging.config.file" value="WEB-INF/logging.properties"/>

    </system-properties>

</appengine-web-app>

# Appendix C Guide for storing fresh

# produce

Storing food correctly keeps it fresher for longer. You’ll waste less, save money and help the

environment! Foods are listed in alphabetical order (Sustainability Victoria 2021).

#### Avocado

Store in the fruit bowl until ripe, then move to fridge shelf. Wrap tightly in cling wrap or beeswax wrap with the stone left in. Press wrap against cut surface to seal.

Shelf life: Up to 1 week

Tip: Place in a paper bag with a ripe banana to speed up ripening. You can also mash up with a little lemon and freeze avocado. Seal it in portion sized bag/ container to use on the go.

#### Bananas

Store in the fruit bowl, away from any other fruit you don’t want to ripen.

Shelf life: Up to 1 week

Tip: Peel, cut and freeze over-ripe bananas to use in baking, smoothies or blitz for banana ice-cream.

Did you know…Overripe fruit produces extra ethylene, a gas that will quickly ripen other fruit and

vegetables nearby.

#### Berries

Store in the fridge crisper drawer. Leave in original packaging. Shelf life: 2 to 4 days

Tip: Only wash berries right before eating. You can also freeze them for a snack, a smoothie or to add to cooking later.

#### Biscuits

Store on a pantry shelf in an airtight container. Shelf life: Refer to date label

Tip: Sweet biscuits have low moisture content so can be frozen.

#### Bread

Store on a pantry shelf or bread box out of direct sunlight. Shelf life: 2 to 5 days

Tip: Freeze extra bread slices for toast or diced for croutons. Do not consume if mould is present.

Did you know…Bread is one most wasted foods. Save it from waste – freeze it for later or turn extra bread into breadcrumbs, croutons or bread and butter pudding.

#### Broccoli

Store in the fridge crisper drawer. Rinse in water and shake off excess. Wrap a tea towel around damp head and seal in a plastic, paper or cloth bag.

<!DOCTYPE html>

<html lang="en">

  <head>

    <meta charset="UTF-8" />

    <meta name="viewport" content="width=device-width, initial-scale=1.0" />

    <title>FeedOn - Inbox</title>

    <!-- Favicon, CSS & JS -->

    <link rel="icon" href="assets/logo.png" type="image/png" sizes="16x16" />

    <link rel="stylesheet" href="styles/common.css" />

    <link rel="stylesheet" href="styles/inbox.css" />

    <script src="js/client.js" defer></script>

  </head>

  <body class="bg-dark">

    <h1 class="center">DONATION OFFERS</h1>

    <!-- Donation card -->

    <div class="center">

      <button onclick="listUnreadInbox()" class="inbox-btn">

        UNREAD

        <span id="numOfUnread" class="badge"> </span>

      </button>

      <button onclick="listAcceptedInbox()" class="inbox-btn">ACCEPTED</button>

      <button onclick="listDeclinedInbox()" class="inbox-btn">DECLINED</button>

    </div>

    <div class="data container"></div>

    <hr class="center" />

  </body>

</html>

# Appendix D Top ten tips for reducing food packaging

Packaging takes a lot of energy, water and other natural resources to produce, and packaging waste pollutes our air, water and soil. Let's reduce, reuse and recycle packaging as much as possible. So here are the top 10 tips to avoid food packaging (Sustainability Victoria 2021d):

#### Grow your own food

With a small amount of space you can start a balcony food garden, a wall food garden, or an indoor food garden, and don't forget your local community garden. By growing your own food you will eliminate all packaging, plus the energy expenditure and emissions associated with transportation of food. You will also save money.

#### Cook at home, BYO containers, or have your food to stay

Takeaway food tends to include a lot of packaging and unnecessary waste, such as plastic and polystyrene containers, single-use plastic bags, napkins and disposable dinnerware. Add delivery to your takeaway and there may be emissions associated with the transportation. Take meals from home or have your food to stay at restaurants, to avoid unnecessary takeaway packaging. You can also BYO containers to pick food up at good shops, Figure D1.

|  |  |
| --- | --- |
|  |  |
| A. Dry goods dispensers | B. Liquid goods dispensers |

**Figure D1 Example of a retail goods shop where you bring your own containers.** Home containers: paper bags for dry goods, glass containers with lids, for liquid goods, or long-life plastic containers. Pre-weigh glass or plastic containers, and label with weights, before filling, for ease of use at the shop.

#### Use reusable packaging

Sandwich bags, freezer bags, garbage bags and so on. With so much plastic in our world do we really need to buy more? Rinsed out glass and plastic containers make great storage containers for leftovers or use bees-waxed cotton wraps. So, say goodbye to cling wrap. Try substituting a glass instead of plastic container for your leftovers. If you must buy plastic bags, buy those made from recycled plastic and remember to put your kerb-side recycling out loose.

#### Make a shopping list

Buying unnecessary food items can result in extra packaging waste, not to mention financial waste and potential food waste. Make a list before you leave home, of only the things you really need to buy.

<!DOCTYPE html>

<html lang="en">

  <head>

    <meta charset="UTF-8" />

    <meta name="viewport" content="width=device-width, initial-scale=1.0" />

    <title>FeedOn - Donation Form</title>

    <!-- Favicon, CSS & JS -->

    <link rel="icon" href="assets/logo.png" type="image/png" sizes="16x16" />

    <link rel="stylesheet" href="styles/common.css" />

    <link rel="stylesheet" href="styles/donation-form.css" />

    <script src="js/client.js" defer></script>

    <!-- Font Awesome icons CDN -->

    <script src="https://use.fontawesome.com/4e51920be5.js"></script>

    <!-- Bootstrap CDN -->

    <link

      rel="stylesheet"

      href="https://maxcdn.bootstrapcdn.com/bootstrap/3.4.1/css/bootstrap.min.css"

    />

  </head>

  <body onload="getBlobstoreURL()">

    <form

      id="donation-form"

      class="form-container"

      method="POST"

      enctype="multipart/form-data"

    >

      <h2 class="center">MAKE A FOOD DONATION</h2>

      <!-- Name -->

      <label><b>Restaurant Name</b></label>

      <input

        placeholder="Enter Restaurant name"

        name="restaurantName"

        required

      />

      <!-- Location -->

      <label><b>Restaurant Location</b></label>

      <input placeholder="Enter Restaurant location" name="location" required />

      <!-- Food Category -->

      <label><b>Food Category</b></label> Choose multiple options by pressing

      the command/ctrl key

      <br />

      <select

        class="mdb-select colorful-select dropdown-primary md-form"

        name="category"

        multiple

        searchable="Search here.."

      >

        <option value="" disabled selected>Select food categories</option>

        <option value="Vegetarian">Vegetarian</option>

        <option value="Non-Vegetarian">Non-Vegetarian</option>

        <option value="Halal">Halal</option>

      </select>

      <br />

      <!-- Date & Time -->

      <br />

      <label><b>Specify a date and time for donation:</b></label>

      <input type="datetime-local" name="pickUpTime" required />

      <!-- Supply -->

      <label

        ><b

          >Specify food amount by how many people it is sufficient for:</b

        ></label

      >

      <input

        type="number"

        step="1"

        placeholder="Specify food capacity"

        name="quantity"

        required

      />

      <!-- Special Instructions -->

      <label><b>Special Instructions</b></label>

      <input

        placeholder="Enter any special instructions"

        name="specialInstructions"

      />

      <!-- Images -->

      <br />

      <label><b>Upload an image:</b></label>

      <input type="file" name="image" />

      <!-- Submit & Cancel -->

      <button type="submit" class="btn">Submit Donation</button>

      <button type="button" class="btn cancel" onclick="">Cancel</button>

    </form>

    <script>

            /\* Make Donation button \*/

      .form-container {

          margin: auto;

          max-width: 1000px;

          padding: 15px;

          background-color: #f1f1f1;

      }

      .form-container h2 {

          margin: 10px;

      }

      /\* Full-width input fields \*/

      .form-container input {

          width: 100%;

          padding: 15px;

          margin: 5px 0 22px 0;

          border: none;

          background: #f1f1f1;

      }

      /\* When the form inputs are in focus \*/

      .form-container input:focus {

          background-color: #ddd;

          outline: none;

      }

      /\* Submit donation button \*/

      .form-container .btn {

          background-color: #4CAF50;

          color: white;

          padding: 16px 20px;

          border: none;

          cursor: pointer;

          width: 100%;

          margin-bottom: 10px;

          opacity: 0.8;

      }

      /\* Cancel button \*/

      .form-container .cancel {

          background-color: #333;

      }

      /\* Hover effects \*/

      .form-container .btn:hover,

      .open-button:hover

    </script>

  </body>

</html>

# Appendix E Choosing sustainable food

Considering the sustainability of every piece of food you put into your mouth can be challenging. An easy way around this is to consider categories of foods and to support businesses that are taking a sustainable approach to growing, farming and producing food (Sustainability Victoria 2021e).

#### Fruit and vegetables

Sustainable fruit and vegetable farming considers its impact upon the environment, our health, and workers. This approach can include minimal soil disruption and reduced or limited use of fertilisers and pest control. Buying seasonal produce and local fresh produce will support local farming and businesses, and reduce transportation and refrigeration associated with the food (food miles).

Wherever possible, buy directly from the source, at farmers' markets and co-ops. An even better option is to grow your own food. Buying seasonal food or growing your own will also save you money.

#### Meat

Sustainable meat farming focuses on animal treatment, the source of meat products, soil health and the health of the meat. It includes practices such as rotational grazing, which involves rotating cattle around pastures to encourage grass regrowth and minimise soil compaction. Sustainable farming also minimises the widespread use of antibiotics in industrial livestock production which contributes to antibiotic resistant bacteria or superbugs. Look for free-range or organic labelling on the meat, poultry and eggs you buy.

#### Fish

Sustainable fishing is about fishing practices that maintain the population of fish and fish stocks. Look for Marine Stewardship Council (MSC) certified fish, as certified fisheries meet international sustainability standards. The Sustainable Seafood Guide will help you avoid endangered fish and choose fish species with healthier population numbers.

#### Free-range and organic labelling

Free-range farming considers the welfare of animals throughout their lives, such as the amount of space they have to move in. It's important to carefully read any free-range or organic labelling on the meat, poultry and eggs you buy. Free-range poultry accreditors include FREPA (Free Range Egg & Poultry Association), RSPCA Approved Farming Scheme and Humane Choice. Humane Choice also certifies free-range sheep. There is even a free-range egg app you can use to confirm whether your eggs are truly free-range.

In addition to no pesticide or genetic modification, organic certification focuses on the provision of a natural environment for animals. Organic farming is better for the environment and more sustainable. Research shows organic farming also benefits insect biodiversity and the pollination of wild plants. To ensure the items you're buying have been produced to organic standards, check that they've been certified by a Department of Agriculture organic approved certifying organisation.

#### Fair trade

Fair trade is about ensuring farmers and workers in developing countries have good working conditions and are paid a fair price for their labour and products. It also focuses on environmentally- sustainable farming methods

const dataElement = document.querySelector(".data");

// Load the number of unread donations in the inbox as badge

fetch("/inbox-unread")

  .then((response) => response.json())

  .then((donations) => {

    document.getElementById("numOfUnread").innerText =

      donations.length.toString();

  });

// Display the information of all matched donations after clicking on the "Donation Match" tab

function listAllMatches() {

  getMatch().then((matches) => {

    dataElement.innerHTML = "";

    matches.forEach((match) => {

      const div = document.createElement("div");

      div.className = "card";

      const header = document.createElement("h3");

      header.textContent = `${match.restaurantName} & ${match.charityName}`;

      const contents = document.createElement("p");

      contents.textContent = `${match.quantity} meals were delivered to people in need by the successful collaboration between ${match.restaurantName} and ${match.charityName}.`;

      const category = document.createElement("p");

      category.textContent = `Food Category : ${match.category}`;

      const time = document.createElement("p");

      time.textContent = `Pick-up Time : ${match.pickUpTime}`;

      const address = document.createElement("p");

      address.textContent = `Location : ${match.location}`;

      const instructions = document.createElement("p");

      instructions.textContent = `Special Instructions : ${match.specialInstructions}`;

      div.appendChild(header);

      div.appendChild(contents);

      div.appendChild(category);

      div.appendChild(time);

      div.appendChild(address);

      div.appendChild(instructions);

      // If an image is uploaded in the donation form, display it

      if (match.imageURL != "N.A.") {

        const imageName = document.createElement("p");

        imageName.textContent = `Image : `;

        var img = document.createElement("img");

        img.src = match.imageURL;

        div.appendChild(imageName);

        div.appendChild(img);

      }

      dataElement.appendChild(div);

    });

  });

}

function listAllCharities() {

  getCharities().then((charities) => {

    dataElement.innerHTML = "";

    charities.forEach((charity) => {

      const div = document.createElement("div");

      const header = document.createElement("h3");

      header.textContent = charity.CharityName;

      const description = document.createElement("p");

      description.textContent = charity.description;

      const location = document.createElement("p");

      location.textContent = charity.location;

      div.appendChild(header);

      div.appendChild(description);

      div.appendChild(location);

      dataElement.appendChild(div);

    });

    loadingElement.style.display = "none";

  });

}

function listAllRestaurants() {

  getRestaurants().then((restaurants) => {

    dataElement.innerHTML = "";

    restaurants.forEach((restaurant) => {

      const div = document.createElement("div");

      const header = document.createElement("h3");

      header.textContent = restaurant.restaurantName;

      const description = document.createElement("p");

      description.textContent = restaurant.description;

      const location = document.createElement("p");

      location.textContent = restaurant.location;

      div.appendChild(header);

      div.appendChild(description);

      div.appendChild(location);

      dataElement.appendChild(div);

    });

    loadingElement.style.display = "none";

  });

}

// Get all entries from Donation-match datastore

function getMatch() {

  return fetch("/donation-match")

    .then((response) => response.json())

    .then((entries) => {

      return entries;

    });

}

function getCharities() {

  return fetch("/charities")

    .then((response) => response.json())

    .then((entries) => {

      return entries;

    });

}

function getRestaurants() {

  return fetch("/restaurants")

    .then((response) => response.json())

    .then((entries) => {

      return entries;

    });

}

// DONATION FORM

// Fetches Blobstore URL for form action to faciliate upload of images

function getBlobstoreURL() {

  fetch("/blobstore-upload-url")

    .then((response) => {

      return response.text();

    })

    .then((imageUploadUrl) => {

      const commentForm = document.getElementById("donation-form");

      commentForm.action = imageUploadUrl;

    });

}

// Display the information of all the unread donations in the Donation datastore

function listUnreadInbox() {

  getDonations("/inbox-unread").then((donations) => {

    dataElement.innerHTML = "";

    donations.forEach((donation) => {

      const div = document.createElement("div");

      div.className = "card";

      const header = document.createElement("h3");

      header.textContent = `Restaurant Name : ${donation.restaurantName}`;

      const category = document.createElement("p");

      category.textContent = `Food Category : ${donation.category}`;

      const quantity = document.createElement("p");

      quantity.textContent = `Quantity : ${donation.quantity}`;

      const time = document.createElement("p");

      time.textContent = `Pick-up Time : ${donation.pickUpTime}`;

      const address = document.createElement("p");

      address.textContent = `Location : ${donation.location}`;

      const instructions = document.createElement("p");

      instructions.textContent = `Special Instructions : ${donation.specialInstructions}`;

      // After clicking on Accept button, the corresponding donation will be deleted from Donation datastore

      // but be added into Donation-match datastore.

      var acceptButtonElement = document.createElement("button");

      acceptButtonElement.innerHTML = "ACCEPT";

      acceptButtonElement.type = "submit";

      acceptButtonElement.className = "accept-btn";

      acceptButtonElement.addEventListener("click", () => {

        acceptDonation(donation);

        div.remove();

      });

      // Decline button

      var declineButtonElement = document.createElement("button");

      declineButtonElement.innerHTML = "DECLINE";

      declineButtonElement.type = "button";

      declineButtonElement.className = "decline-btn";

      declineButtonElement.addEventListener("click", () => {

        declineDonation(donation);

        div.remove();

      });

      div.appendChild(header);

      div.appendChild(category);

      div.appendChild(quantity);

      div.appendChild(time);

      div.appendChild(address);

      div.appendChild(instructions);

      // If an image is uploaded in the donation form, display it

      if (donation.imageURL != "N.A.") {

        const imageName = document.createElement("p");

        imageName.textContent = `Image : `;

        var img = document.createElement("img");

        img.src = donation.imageURL;

        div.appendChild(imageName);

        div.appendChild(img);

      }

      div.appendChild(acceptButtonElement);

      div.appendChild(declineButtonElement);

      dataElement.appendChild(div);

    });

  });

}

// Display the information of all the accepted donations in the Donation-match datastore

function listAcceptedInbox() {

  getDonations("/inbox-accepted").then((donations) => {

    dataElement.innerHTML = "";

    donations.forEach((donation) => {

      const div = document.createElement("div");

      div.className = "card";

      const header = document.createElement("h3");

      header.textContent = `Restaurant Name : ${donation.restaurantName}`;

      const category = document.createElement("p");

      category.textContent = `Food Category : ${donation.category}`;

      const quantity = document.createElement("p");

      quantity.textContent = `Quantity : ${donation.quantity}`;

      const time = document.createElement("p");

      time.textContent = `Pick-up Time : ${donation.pickUpTime}`;

      const address = document.createElement("p");

      address.textContent = `Location : ${donation.location}`;

      const instructions = document.createElement("p");

      instructions.textContent = `Special Instructions : ${donation.specialInstructions}`;

      div.appendChild(header);

      div.appendChild(category);

      div.appendChild(quantity);

      div.appendChild(time);

      div.appendChild(address);

      div.appendChild(instructions);

      // If an image is uploaded in the donation form, display it

      if (donation.imageURL != "N.A.") {

        const imageName = document.createElement("p");

        imageName.textContent = `Image : `;

        var img = document.createElement("img");

        img.src = donation.imageURL;

        div.appendChild(imageName);

        div.appendChild(img);

      }

      dataElement.appendChild(div);

    });

  });

}

// Display the information of all the declined donations in the Donation datastore

function listDeclinedInbox() {

  getDonations("/inbox-declined").then((donations) => {

    dataElement.innerHTML = "";

    donations.forEach((donation) => {

      const div = document.createElement("div");

      div.className = "card";

      const header = document.createElement("h3");

      header.textContent = `Restaurant Name : ${donation.restaurantName}`;

      const category = document.createElement("p");

      category.textContent = `Food Category : ${donation.category}`;

      const quantity = document.createElement("p");

      quantity.textContent = `Quantity : ${donation.quantity}`;

      const time = document.createElement("p");

      time.textContent = `Pick-up Time : ${donation.pickUpTime}`;

      const address = document.createElement("p");

      address.textContent = `Location : ${donation.location}`;

      const instructions = document.createElement("p");

      instructions.textContent = `Special Instructions : ${donation.specialInstructions}`;

      div.appendChild(header);

      div.appendChild(category);

      div.appendChild(quantity);

      div.appendChild(time);

      div.appendChild(address);

      div.appendChild(instructions);

      // If an image is uploaded in the donation form, display it

      if (donation.imageURL != "N.A.") {

        const imageName = document.createElement("p");

        imageName.textContent = `Image : `;

        var img = document.createElement("img");

        img.src = donation.imageURL;

        div.appendChild(imageName);

        div.appendChild(img);

      }

      dataElement.appendChild(div);

    });

  });

}

// Get entries from Donation datastore according to status input

function getDonations(status) {

  return fetch(status)

    .then((response) => response.json())

    .then((entries) => {

      return entries;

    });

}

function declineDonation(donation) {

  const params = new URLSearchParams();

  params.append("id", donation.id);

  fetch("/inbox-declined", { method: "POST", body: params });

}

function acceptDonation(donation) {

  const params = new URLSearchParams();

  params.append("id", donation.id);

  fetch("/inbox-accepted", { method: "POST", body: params });

}

// Add with user's information to signin.html

// userType is either "charity" or "restaurant"

function addUserInfo(userEmail, userType, logoutLink) {

  var para = document.createElement("p");

  var message =

    "You are already logged in as " + userEmail + " of type " + userType;

  para.appendChild(document.createTextNode(message));

  document.body.appendChild(para);

  // create the link to return to main page (that is index.html)

  mainPageUrl = "index.html";

  var returnToMainPageElement = createParaWithLink(

    mainPageUrl,

    "click ",

    "here",

    " to return to main page"

  );

  document.body.appendChild(returnToMainPageElement);

  // create the link to logout

  var logoutElement = createParaWithLink(logoutLink, "Logout ", "here", "");

  document.body.appendChild(logoutElement);

}

function createParaWithLink(link, startText, linkText, endText) {

  var a = document.createElement("a");

  a.href = link;

  a.title = link;

  a.appendChild(document.createTextNode(linkText));

  var p = document.createElement("p");

  p.appendChild(document.createTextNode(startText));

  p.appendChild(a);

  p.appendChild(document.createTextNode(endText));

  return p;

}

//Populate signin.html with sign in related information

function handleSignInPage() {

  fetch("/login")

    .then((response) => response.json())

    .then((loginInfo) => {

      if (loginInfo.length == 1) {

        // means user is not logged in

        // loginInfo's first element stores the login link

        var loginLink = loginInfo[0];

        // redirect to Google's login page

        window.location.href = loginLink;

      } else if (loginInfo.length == 2) {

        // user has yet to register

        // direct user to a new page asking them to choose between charity and restaurant

        var registerLink = "register.html";

        window.location.href = registerLink;

      } else {

        var userEmail = loginInfo[0];

        var logoutLink = loginInfo[1];

        var userType = loginInfo[2];

        addUserInfo(userEmail, userType, logoutLink);

      }

    });

}

function getRegister() {

  fetch("/login")

    .then((response) => response.json())

    .then((loginInfo) => {

      if (loginInfo.length == 1) {

        // means user is not logged in

        var loginLink = loginInfo[0];

        window.location.href = loginLink;

      } else if (loginInfo.length == 2) {

        var userEmail = loginInfo[0];

        var userInfo = document.getElementById("user-info");

        var message = "Account being used for registration: " + userEmail;

        userInfo.appendChild(document.createTextNode(message));

      } else {

        // three element means user already registered

        var signInLink = "signin.html";

        window.location.href = signInLink;

      }

    });

}

function removeInboxButton() {

  var inboxButton = document.getElementById("inbox-button");

  inboxButton.parentNode.removeChild(inboxButton);

}

function removeDonateButton() {

  var donateButton = document.getElementById("donation-button");

  donateButton.parentNode.removeChild(donateButton);

}

function removeSignInButton() {

  var signInButton = document.getElementById("sign-in-button");

  signInButton.parentNode.removeChild(signInButton);

}

function controlButton() {

  // remove sign in and register button if user is already signin;

  fetch("/login")

    .then((response) => response.json())

    .then((loginInfo) => {

      // loginInfo has different length base on user's state

      // it has length of 1 if user is not logged in, 2 if user is logged

      // in but not registered, and 3 if user is logged in and registered

      var loggedInAndRegistered = 3;

      if (loginInfo.length != loggedInAndRegistered) {

        // user is not sign in

        removeDonateButton();

        removeInboxButton();

        return;

      }

      var userEmail = loginInfo[0];

      var registerButton = document.getElementById("register-button");

      registerButton.innerHTML = userEmail;

      registerButton.href = "signin.html";

      // can i change the inner href to point to signin.html?

      removeSignInButton();

      if (loginInfo.length == loggedInAndRegistered) {

        // the user-type is known

        const restaurantType = "restaurant";

        const charityType = "charity";

        if (loginInfo[2] == restaurantType) {

          removeInboxButton();

        } else if (loginInfo[2] == charityType) {

          removeDonateButton();

        }

      }

    });

}

# Appendix F Five steps to successfully set up and operate a compost bin

Start with a base layer of twigs, mulch or old potting mix to encourage air circulation and provide drainage.

Follow with layers of green and brown material — say garden clippings and kitchen scraps, then leaves and wet paper. *General rule of thumb - add two parts brown material to one part green material.*



A garden compost pile, with layers of green and brown materials

Add water after each layer to keep the pile moist but not too wet. Finish with a layer of soil or finished compost to help reduce odours.

Remember that the smaller the items are, the faster they will decompose.

Turn or aerate the compost with a fork every week or two. Another option is to poke garden stakes or plastic pipes through the heap to allow air in.

Covering the compost at the top, with the lid for a compost bin, will keep in heat and moisture, which are essential for the process.

package com.googlesps.feedon.data;

/\*\*

 \* Class for charity users

 \*/

public final class Charity {

    private final long id;

    private final String CharityName;

    private final String location;

    private final String description;

    public Charity(long id, String CharityName, String location, String description) {

        this.CharityName = CharityName;

        this.id = id;

        this.location = location;

        this.description = description;

    }

}

# Appendix G How to setup and use a Bokashi bin

A Bokashi bin is an eco-friendly composting system to be used in your kitchen (Bokashi 2021).

#### Bokashi bin on a kitchen counter with fresh carrots and tomatoes.How to setup and use a Bokashi bin

1. Assemble your Bokashi bin and get started by adding organic food waste.

What can I compost?

All kitchen waste, although it’s best to avoid large bones and excessive amounts of liquid.

* + fruit and vegetables
  + prepared foods
  + cooked and uncooked meats and fish
  + dairy
  + eggs
  + bread
  + coffee grinds
  + tea bags
  + wilted flowers and tissues

1. Cut bulky scraps into small pieces so they break down more rapidly.
2. Add 2–3 sprays of liquid Bokashi daily. The Bokashi One Mix, contains micro- organisms that promote fermentation of the waste. Press the waste all down using the trowel provided. This extracts air and helps the composting process. Close the lid to aid decomposition.

#### Signs of Success

The Bokashi One system is easy to use and it is highly unlikely that you will strike problems. A good sign which you may notice when the lid is removed is a subtle smell of pickles or cider vinegar.

Occasionally, particularly for longer fermentation periods, a white cotton-like fungi growth may appear on the surface. This is also a sign that the process is working well.

#### Liquid being extracted from Bokashi bin into watering can.Create liquid gold with Bokashi composting

After a few weeks, turn on the tap at the base of the bin and drain what gardeners call 'liquid gold'. This juice is filled with nutrients, as well as beneficial microbes. It makes a good liquid fertiliser for the garden and your indoor plants too.

package com.googlesps.feedon.servlets;

import com.google.appengine.api.datastore.DatastoreService;

import com.google.appengine.api.datastore.DatastoreServiceFactory;

import com.google.appengine.api.datastore.Entity;

import com.google.appengine.api.datastore.PreparedQuery;

import com.google.appengine.api.datastore.Query;

import com.google.appengine.api.datastore.Query.Filter;

import com.google.appengine.api.datastore.Query.FilterOperator;

import com.google.appengine.api.datastore.Query.FilterPredicate;

import com.google.appengine.api.datastore.Query.SortDirection;

import com.google.gson.Gson;

import com.googlesps.feedon.data.Restaurant;

import java.io.IOException;

import java.util.ArrayList;

import java.util.List;

import javax.servlet.annotation.WebServlet;

import javax.servlet.http.HttpServlet;

import javax.servlet.http.HttpServletRequest;

import javax.servlet.http.HttpServletResponse;

@WebServlet("/restaurants")

public class RestaurantsPageServlet extends HttpServlet {

    private static final String JSON\_CONTENT\_TYPE = "application/json";

    private Gson gson = new Gson();

    DatastoreService datastore = DatastoreServiceFactory.getDatastoreService();

    @Override

    public void doGet(HttpServletRequest request, HttpServletResponse response) throws IOException {

        Filter propertyFilter = new FilterPredicate("user-type", FilterOperator.EQUAL, "restaurant");

        Query queryRestaurant = new Query("user").setFilter(propertyFilter);

        PreparedQuery restaurantResults = DatastoreServiceFactory.getDatastoreService().prepare(queryRestaurant);

        List<Restaurant> restaurants = new ArrayList<>();

        for (Entity entity : restaurantResults.asIterable()) {

            long id = entity.getKey().getId();

            String name = (String) entity.getProperty("name");

            String location = (String) entity.getProperty("location");

            String description = (String) entity.getProperty("description");

            Restaurant restaurant = new Restaurant(id, name, location, description);

            restaurants.add(restaurant);

        }

# Appendix H How to create a worm farm

Creating a worm farm at home and using the products produced by the worms will be one of the most beneficial things you can do for your garden. Both the solid and liquid products can be used as soil improvers and fertilisers. It's also a fun and rewarding way to get the kids actively involved in conserving the environment.

Worms that make compost are different to earthworms. Compost worms live in leaf litter on top of and just below the soil surface, whereas those lovely fat earthworms chew their way deep into the soil.

Worm farms can be large or small, depending on the amount of food waste to be treated by the worms. They can be made of recycled material like an old bathtub or polystyrene box or they can be purpose built, from a shop.

Worm farms bought off the shelf usually come with three layers. The bottom layer is where the liquid generated from the worms collects, and this can be tapped off for use in the garden. The other two layers are where the worms live. Begin with the worms in one layer and when that is filled with worm castings the worms (with a bit of help from you) will move into a new box. The castings that remain in the bottom layer can then be used on the garden.

The worms will work their way through everything you feed them and their poo will pile up in the tray until eventually you'll need the worms to move to the next tray. Put their next layer box on top of the farm and encourage them to move by adding some food. Once all the worms have moved



Active worm farm. Image (Bunnings 2021).

* this will take a few days - you can remove the bottom layer box and use the contents in the garden. Then wash it out and keep it aside until the new layer box is full.

<?xml version="1.0" encoding="UTF-8"?>

<project xmlns="http://maven.apache.org/POM/4.0.0" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://maven.apache.org/POM/4.0.0 http://maven.apache.org/xsd/maven-4.0.0.xsd">

  <modelVersion>4.0.0</modelVersion>

  <packaging>war</packaging>

  <version>1.0-SNAPSHOT</version>

  <groupId>com.googlesps.feedon</groupId>

  <artifactId>FeedOn</artifactId>

  <properties>

    <!-- This project uses Java 8 -->

    <maven.compiler.source>1.8</maven.compiler.source>

    <maven.compiler.target>1.8</maven.compiler.target>

    <project.build.sourceEncoding>UTF-8</project.build.sourceEncoding>

    <failOnMissingWebXml>false</failOnMissingWebXml>

  </properties>

  <dependencies>

    <dependency>

      <groupId>javax.servlet</groupId>

      <artifactId>javax.servlet-api</artifactId>

      <version>4.0.1</version>

      <scope>provided</scope>

    </dependency>

    <dependency>

      <groupId>com.google.code.gson</groupId>

      <artifactId>gson</artifactId>

      <version>2.8.6</version>

    </dependency>

    <dependency>

        <groupId>com.google.appengine</groupId>

        <artifactId>appengine-api-1.0-sdk</artifactId>

        <version>1.9.59</version>

    </dependency>

    <dependency>

        <groupId>com.google.code.findbugs</groupId>

        <artifactId>jsr305</artifactId>

        <version>3.0.2</version>

    </dependency>

  </dependencies>

    <build>

        <plugins>

            <plugin>

            <groupId>com.google.cloud.tools</groupId>

            <artifactId>appengine-maven-plugin</artifactId>

            <version>2.2.0</version>

            <configuration>

                <!-- TODO: set project ID. -->

                <deploy.projectId>summer20-sps-40</deploy.projectId>

                <deploy.version>1</deploy.version>

            </configuration>

            </plugin>

        </plugins>

    </build>

</project>