Aotearoa New Zealand Baseline Food Loss and Waste Project

FINAL REPORT

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Executive Summary

The findings of the New Zealand food waste baseline project provide insights into the extent and distribution of food loss and waste across the country. Around 30 million tonnes of food enters the supply chain (production and imports) in New Zealand annually, and of this, around 1 million tonnes are lost or wasted, or 237 kilograms (kg) per capita per year. Taking into consideration that data for some stages of the food supply chain is limited or unavailable, it is estimated that between 5-10% of food entering the food supply chain in New Zealand is lost or wasted.

The majority of annual food loss and waste in New Zealand occurs at three stages of the food supply chain: primary production (0.46 million tonnes (37%)), processing (0.33 million tonnes (27%)), and households (0.37 million tonnes (30%)). This report discusses these numbers in more detail, including analysis of specific food groups and final food destinations. In addition to the 1.22 million tonnes of food that is lost or wasted, an estimated 2.26 million tonnes are reused in some way, and is not considered waste. Of the total 3.48 million tonnes of food that is not consumed as originally intended, 0.63 million tonnes (18%) is used as animal feed, 1.5 million tonnes (42%) goes to bioprocessing, and 0.62 million tonnes (18%) is sent to landfill.

New Zealand	Food Loss & Waste (Tonnes)	Reused[1] (Tonnes)
Primary production	457,580	278,860
Processing	331,517	1,932,349
Wholesale/retail	15,611	48,784
Transport	No Data	No Data
Consumer Household	366,096	0
Consumer Hospitality	40,629	No Data
Consumer Institutions	11,297	No Data
Total	**1,222,730**	**2,259,993**

[1] Reused refers to food loss or waste that is reused for humans, fed to animals, upcycled, or made into non-food products.

While the findings of this baseline research offer valuable insights into the magnitude and distribution of food loss and waste, caution must be exercised in their interpretation. We recommend that results are viewed holistically and that the production, reuse amount, loss rates, wasted rates, destinations and edible proportions are all considered in tandem. As stated above, data gaps exist, particularly in sectors such as primary production, for which overseas loss rates were often used. Transport, hospitality, and institutions also had significant data gaps. It is also important to note there was incomplete data for most foods and commodities which led to assumptions, particularly with regard to waste destinations. When reviewing the findings it is essential to consider the data quality and note that improving data quality over time will likely result in changes to overall tonnages and percentages. Despite these data limitations, the project sheds light on the amount of

imported and produced food in New Zealand that is not consumed as is intended and where it ends up as well as areas for future improvement in data collection.

Moving forward, we recommend efforts to address food loss and waste in New Zealand prioritise the refinement of measurement frameworks and collaborative approaches across stakeholders to achieve meaningful reductions in food loss and waste that align with global sustainability targets.

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1. Background

Globally, it is reported that 30-40% of food is lost or wasted somewhere along the food supply chain (United Nations, 2023; World Wildlife Fund – UK, 2021). When food is lost or wasted, all the resources that were used to produce this food are also wasted, this includes water, pesticides, fertilisers, and fuel. Furthermore, if the waste is sent to landfill, the production of greenhouse gas emissions contributes to climate change. Clearly, there are significant economic, environmental and social costs associated with food loss and waste.

In 2015 the United Nations released 17 Sustainable Development Goals (SDG), which aim "to provide a better planet". The focus of SDG 12 is Sustainable Cities and Communities while Target 12.3 aims "to halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses" by 2030 (United Nations, 2021). New Zealand is a member of the United Nations, and SDG Target 12.3 provided the impetus for the "Briefing to investigate food waste in New Zealand", a report of the Environment Committee (Environment Committee, 2020). Key recommendations of the briefing included: 1) a baseline measure of national food loss and waste; 2) a national food waste reduction target; and 3) a food waste reduction strategy. These recommendations align with a three-step process internationally used to address food loss and waste known as the "Target, Measure, Act" approach (Champions 12.3, 2020).

In New Zealand, food loss and food waste has been measured by a variety of stakeholders at some points in the food supply chain, however, this information has, to our knowledge, not been consolidated. The aim of this research was, for the first time, to measure food loss and waste across the food supply chain in New Zealand. The information from this baseline project will help identify the most effective actions needed for New Zealand to make progress towards the SDG 12.3 target.

2. Defining food loss and waste

There is no globally accepted definition of food loss and waste (Teuber and Jensen, 2020) which makes comparisons across studies difficult. Definitions may vary depending on how the system boundaries start and finish, where food products end up, and whether the inedible fraction of food is included. In 2023, after consultation with a variety of stakeholders including New Zealand Food Waste Champions 12.3, the food industry, food rescue organisations, government agencies, academic institutions and the horticulture sector, the Ministry for the Environment released the following definitions:

Food waste and loss *is imported or domestically produced food and drink, including inedible parts, which leave the food supply chain from the point that crops and livestock are ready for harvest or slaughter onwards to the point of consumption, to be recycled, recovered or disposed of in Aotearoa New Zealand.*

Food loss *is imported or domestically produced food and drink, including inedible parts, which leave the food supply chain from the point that crops and livestock are*

ready for harvest or slaughter through to the processing and manufacturing stage (including transportation and storage) to be recycled, recovered or disposed of in Aotearoa New Zealand.

***Food waste** is imported or domestically produced food and drink, including inedible parts, which leave the food supply chain from the wholesale, retail and marketing sectors onwards to the point of consumption, to be recycled, recovered or disposed of in Aotearoa New Zealand.*

The Ministry for the Environment has summarised where food loss and waste occurs along the supply chain in the following Figure 1.

Figure 1 Food loss vs food waste across the supply chain (Ministry for the Environment, 2023)

3. Methodology

This New Zealand baseline food loss and waste research was informed by the approach used in Australia: the National Food Waste Baseline conducted in 2016/2017 (Arcadis, 2019) and the National Food Waste Baseline Update in 2018/2019 (FIAL, 2021). New Zealand and Australia have a long-standing and close relationship, which includes food. New Zealand and Australia share the same Food Standards Code, and the key regulatory body, Food Standards Australia New Zealand, is a trans-Tasman body. New Zealand and Australia also have similarities regarding food production; both countries produce and export large quantities of food per capita. However, Australia has a bigger population, and produces food across a larger area, under different growing conditions.

The Australian government committed to SDG Target 12.3 in 2016 and developed the National Food Waste Strategy in 2017. The consulting company Arcadis was employed to undertake the 2016/2017 Australian National Food Waste Baseline study; the report notes that there were “no formal data capture systems to collect comprehensive food waste generation information in any

part of the Australian supply chain". The report also states that "gaps occur in all sectors of the food supply and consumption chain". In 2018/2019, the consulting company FIAL undertook the National Food Waste Baseline Update, taking advantage of new sources of information. Total food waste in Australia for 2016/2017 was estimated at 298 kg per capita per year which increased to 312 kg per capita per year in the 2018/2019 report, which highlights the impact of including more data across the food supply chain.

In 2023, the dataset underlying the 2018/2019 Australian National Food Waste Baseline study was made available to the Food Waste Innovation research team at Otago; the Australian dataset was used as a template for the work undertaken for this research, but with modifications as outlined further on. It is important to acknowledge from the outset, that there are even more data gaps in the New Zealand food supply data than the data gaps which affected the 2016/2017 Australian study. Thus, the baseline research project was limited, from the outset, by a lack of information.

3.1 Scope of work

The list of parameters defining the scope of the food loss and waste inventory were sourced from the Food Loss and Waste Accounting and Reporting Standard (Food Loss + Waste Protocol, 2016). The definition of these parameters is reported in Table 1. Because data related to all products and stages of the food supply chain were not available for a specifically stated (i.e., single) year, the timeframe was adjusted to a 12-month time period rather than a specific year; data for production and processing was primarily from 2020-2022, however, data for retail food waste was obtained in 2017, and the different datasets used for household food waste were from 2015-2022.

Table 1 Food loss and waste baseline parameters.

Parameters		
Timeframe	12 months, with the year 2022 as the final 12-month period.	
Material type	Food including edible and inedible parts	
Destination	Reuse (diverted, non-waste) • Food redistribution • Processing to non-food products • Upcycling to other food products • Animal feed Recycle or recovery (waste) • Aerobic digestion/compost • Anaerobic digestion • Land application • Non-harvested/ploughed in • Other	Disposal (waste) • Combustion • Landfill • Refuse/discard • Sewer/wastewater
Food category	Food and beverages commonly consumed in New Zealand (n=61)	
Life cycle stage	Entire food value chain	
Geography	New Zealand	
Organisation	All sectors	

3.2 Destinations

The European Commission (2024) has proposed a food use hierarchy that captures a number of options for food before it becomes waste (See Appendix A). In 2023, when the Ministry for the Environment published a national definition of food loss and waste, bioprocessing — such as the conversion of fat into skin care products or hides into leather — was included as a destination for food waste. Since then, the Ministry has acknowledged that bioprocessing results in valuable non-food products and more closely aligns with resource recovery than waste disposal. This report recommends that the Ministry updates the definitions to better distinguish between waste and productive reuse streams, reflecting international perspectives, including those of the Food and Agriculture Organisation of the United Nations (FAO) and other countries. Given this, for this report:

1. Reuse is considered a non-waste destination, and includes materials diverted to food redistribution, upcycling to other food products, animal feed, and processing to non-food products.
2. Recycle or recovery includes aerobic digestion/compost, anaerobic digestion, land application, non-harvested/ploughed in, and other. These destinations are considered waste, despite being utilised for a beneficial purpose, because this food is removed from the human food supply chain.
3. Disposal is considered waste and includes combustion, landfill, refuse/discard, and sewer/wastewater.

Obtaining information on non-waste and waste destinations along the food supply chain in New Zealand is problematic; there were notable data gaps and, when information was available, it was often presented as rough estimates. Given this, we have primarily focused on destinations for which some data was available including food redistribution, animal feed, land application (i.e. ploughed in), bioprocessing, and landfill. Notably, New Zealand's first biogas plant was opened in October 2022 and therefore is not represented as a waste destination in the data accumulated for this report. There was no information on sewer/wastewater, so this was not considered in this report. More information about non-waste and waste destinations can be found in sections 3.5 and 3.6.

3.3 Foods and commodities

Any project measuring food loss and waste must take into account primary production which is the source of the entire food supply. In this project, primary production of "crops and livestock ready for harvest" is an important focus. New Zealand produces and exports large quantities of commodities; some fruit and vegetables are exported without being processed but other products such as meat and dairy are exported as processed products. Consequently, the form in which a product is predominantly exported, and associated losses, was of particular relevance to New Zealand's food loss and waste figures. A key point to note is the inclusion of food loss and waste associated with all food produced and processed in New Zealand, including food that is exported. For example, if an export product has been processed onshore, the associated food loss and waste is accounted for up until the point of export. Accounting for food loss and waste

associated with export product more accurately represents New Zealand's food landscape, and the country's role as a high food-producing nation.

For the baseline research, primary commodities were selected based on food consumption patterns in New Zealand utilising two sources of information. The first and main source of information was the food list prepared for the 2016 New Zealand Total Diet Study (2016 NZTDS) undertaken by the Ministry for Primary Industries (Ministry for Primary Industries, 2018). The second source of information was obtained from Statistics New Zealand (Stats NZ) on the average weekly food expenditure for households in 2019 (Statistics New Zealand, 2019), see Appendix B for data. More recent national data on food consumptions patterns in New Zealand were not available.

The 2016 NZTDS food list was used to construct the baseline's list of 61 primary products. The baseline list included fresh produce commonly consumed in New Zealand such as fresh fruit, vegetables, and dairy products, and primary products that were the basis of processed foods commonly consumed in New Zealand such as processed cuts of meat, breads, confectionary products, and non-dairy based beverages. Some individual processed products from the 2016 NZTDS were captured in the food processing stage such as apple juice, beer and wine. However, many foods were collapsed into a single food group; for example grain bread, wheatmeal bread and white bread were all considered 'bread', and beef rump, corned beef and beef mince were all considered 'beef'.

As there is anecdotal information that food consumption patterns have changed in the last decade, a few additional foods were added to this list based on the study by Kliejunas et al (2023); these include soyabean (i.e., increased intake of soy-based foods such as soymilk and tofu), and coconut (i.e. increased popularity of coconut milk and coconut cream). Data from Statistics New Zealand (2019) was used to confirm the foods chosen for this project were in food categories that represented the highest proportion of household spending. The resulting primary production list included in this study is 61 food items (Table 2).

The 61 identified primary products were then grouped into eight different food categories (Table 2). The food categories used for the New Zealand baseline project were selected by reviewing international recommendations including the FLW reporting standard (2016), the Australian updated Baseline Report (FIAL, 2021), Codex Alimentarius (Food and Agriculture Organisation of the United Nations, 2021) and New Zealand food waste studies completed to date, noting there is no consistent approach in studies conducted in New Zealand with regard to food categories. For this project, we have taken a pragmatic approach and selected food categories that best aligned with international standards and the New Zealand studies.

It was difficult to align the categories used for primary production with other stages of the food supply chain. For example, in primary production, barley would be considered a grain and therefore grouped with other grains in the bakery category. However, for human consumption, barley is predominantly used in beer production which is considered a non-dairy based beverage. In these situations, the final product produced informed the food category assigned to the primary product. For some food categories, we were unable to obtain detailed primary production data, thus we collapsed categories. For example, all fish and shellfish was placed in a

single category. From the wholesale/retail stage of the food supply chain onwards, individual foods were also collapsed into the eight core food categories.

Table 2 Foods included in the New Zealand food loss and waste baseline

Food category	Food	
Fruit	Apples	Mandarins
	Apricots	Mangoes
	Avocados	Melons
	Bananas	Oranges
	Blackcurrants	Peaches
	Blueberries	Pears
	Boysenberries	Pineapples
	Cherries	Strawberries
	Coconut	Table grapes
	Kiwifruit	Nuts & edible seeds
	Lemons	Peanuts
Vegetables	Broccoli & Cauliflower	Onions
	Cabbage	Peas
	Capsicum	Potatoes
	Carrots & Parsnips	Buttercup Squash
	Celery	Silverbeet
	Courgette	Spinach
	Cucumber	Spring onions
	Garlic	Sweet corn
	Kumara	Taro
	Head lettuce	Tomatoes
	Mushrooms	Soyabean
Meat	Beef/Veal	Sheep/Lamb
	Pork	Chicken
Seafood	Fish & Shellfish	
Dairy	Eggs	
	Milk	
Bakery (grains)	Rice	Wheat
	Oats	
Staples	Honey	Oil (mixed varieties)
	Sugar	
Beverages (non-dairy)	Barley	Wine Grapes
	Coffee	Tea

3.4 Modelling the food supply chain

Food loss or waste was determined at four stages: primary production, processing, wholesale/retail, and consumer (see Figure 1). However, the food supply chain is complex, and not all commodities or foods move through the supply chain in the same way.

If data was available, food loss for each commodity in the production and processing stages of the food supply chain has been estimated; this is referred to as a "bottom-up" approach (FIAL, 2021). At the wholesale/retail stage, "it is very difficult to estimate loss and waste on a commodity-by-commodity level, as retail and consumption stages will handle all types of commodities, and waste is generally reported as an aggregate" (FIAL, 2021). Therefore, food waste at wholesale/retail, at home (i.e., household), and away from home (i.e., cafes/restaurants and institutions) are often determined by audits and referred to as "top-down" data (FIAL, 2021).

3.4.1 Primary production and processing

Primary production refers to the amount of harvested foods, for example, fresh picked apples, raw potatoes, or live animals. Primary production typically represents activities taking place on land or at sea. Primary food processing is the first step in making foods edible, but varies by commodity; examples include sorting apples, milling wheat, or slaughtering animals. Secondary processing turns the commodities into other foods or ingredients, apples can be made into apple juice, the carcass of an animal is used to produce different cuts of meat, and fresh milk can be made into yoghurt. Tertiary processing typically involves the production of complex foods which contain multiple ingredients; examples include tinned baked beans, processed meats such as salami, and baked goods such as biscuits. In the Australian reports, these foods are referred to as "complex products". The 2018/2019 Australian baseline study also included three stages of processing (FIAL, 2021).

For the New Zealand baseline research, grading losses were accounted for in primary production. However, it was difficult to obtain data on the proportion of a product that is sent fresh-to-market versus to food processing; when New Zealand data was not available, assumptions were made using Australian data (Hort Innovation, 2023). There was even less New Zealand data about the breakdown of produce directed to secondary and tertiary processing. Therefore, no distinction was made in this baseline research with regard to secondary or tertiary food processing.

In this project, information on primary production was, for the large part, obtained from industry reports (e.g. United Fresh 2021 or United Fresh 2023), Stats NZ data on imports and exports (New Zealand Statistics, 2022), and the 2021 Food Balance sheets available on the FAOSTAT website (Food and Agriculture Organisation of the United Nations, 2010-). New Zealand data from the FAOSTAT website is based on an annual national survey of agriculture production conducted by the Ministry for Primary Industries. In many industry reports, primary production information had already excluded known primary processing loss (e.g., loss due to food being "off-spec" or not meeting specifications such as not being the right size, shape, or colour), thus, if the percentage of primary loss was reported for that commodity, total production was

determined by adding back the primary loss. If there was no New Zealand estimate for percentage primary loss, Australian estimates were used from the CSIRO publication by Juliano et al. (2019) and Downham et al. (2022).

In some instances only a portion of whole food production was reported. Therefore, for those foods, the non-edible portions were added back so that production is reported as production of the whole food. These foods included beef, sheep, pork and chicken; the inedible portion of these foods, otherwise known as the dressing rate (Wiedemann and Yan, 2014), was added to the reported processed figures to give primary production totals. Similarly, data for sweetcorn was reported as processed sweetcorn. The inedible proportion of a sweetcorn cob was added to the processed value.

The quantity of food available for food processing has been calculated by determining total food production for 61 foods/commodities as described above, and then adjusting this figure for food losses, exported food, imported food, food produced for animal feed, and food sent fresh to market.

Food losses at the food processing stage of the food supply chain were calculated based on the processing loss rates reported for different products such as apple juice or canned peaches. Loss rates were sourced from industry reports and international literature. The majority of the produce sent to food processing is converted into one product. Secondary products are produced for some foods. For example, 100% of wheat is converted to wheat flour (the primary product), then 47% of wheat flour is converted to bread (a secondary product) and 53% is converted to assorted wheat products for which loss rates are represented by pasta (another secondary product).

3.4.2 Transportation

Food and food products are then transported to distribution centres, warehouses or directly to retailers. Distributors and wholesalers often buy large quantities of food products and then sell them to retailers or food service providers. Losses in transport or at distribution centres are generally considered low and were not included in the Australian baseline reports. The situation in New Zealand is expected to be similar. There was no research sourced for this stage of the food supply chain, thus food loss and waste during transport or storage was not included.

3.4.3 Wholesale and retail

In the current New Zealand baseline model, the retail stage represents both wholesale and retail. Data on retail food waste including diversions was obtained from a study conducted by Goodman-Smith et al (2020). The estimated national level of retail food waste from this study was 12.5 kg/person/year (Goodman-Smith et al, 2020), which was multiplied by the population of New Zealand in 2022 (Statistics New Zealand, 2023).

3.4.4 Consumer including hospitality, institutions, and households

Food waste at the consumer stage was divided into three segments: hospitality (e.g. cafes, restaurants, fast food/takeaway, hotels etc.); institutions (e.g. aged care, prisons, schools, hospitals, universities, etc.); and households. Individual food waste reference units were determined for each type of entity. Cafes and restaurants presented food waste as average kg per business per day, while hospitals presented average food waste as kg per bed per day. These data were then multiplied by the number of relevant units (i.e., total number of cafes/restaurants, or hospital beds in New Zealand) sourced from Stats NZ for 2022, which was the last year of the research timeframe (see Table 1). As consumer food waste data is often presented per day, yearly totals were calculated using 365.25 days/year. Based on discussions with sector representatives, there is currently no food waste data collected in prisons and for schools taking part in the Ka Ora, Ka Ako free school lunch programme. Information on household waste was obtained from waste audit results reported by five different district councils, two household studies conducted by WasteMINZ (2015 and 2018) and a report completed for the Ministry for the Environment (Sunshine Yates, 2023). The average kg food waste per household per week was calculated and multiplied by the estimated total number of households for 2022 (Statistics New Zealand, 2023).

3.5 Commodity-specific information

As stated earlier, the production and export of dairy and meat and meat products per capita is high for both Australia and New Zealand (Our World in Data, 2024); given this, extra attention was focused on understanding the production and processing of milk and meat products, and the waste destinations of by-products.

Over 21 million tonnes of milk are produced per annum in New Zealand, of which ~95% is exported (Dairy Companies Association of New Zealand, date unknown.). Fresh milk is both exported and consumed in New Zealand, but most milk is processed to powders used in a range of products including infant formula, and some to cheese and butter (Dairy Companies Association of New Zealand, 2024). An estimate of dairy loss in primary production was obtained in confidence, however, there was limited data made available on dairy losses for processing and waste destinations. Furthermore, there were no international dairy food loss and waste data within the baseline reference years. A further complication when quantifying dairy industry losses is the change in water content between the liquid food (milk production on farm) into solid form dairy products such as milk powders, cheeses and butter. In the baseline research, the amount of milk needed to produce dairy products was included in the model, rather than the weight of the solids present in the different foods. Large quantities of liquid are lost during the production of dairy products either as water from milk powder production or whey from cheese production. Liquid whey contains 6.3% solids and 93.7% water. For this baseline study, water was not considered a waste. Although the solid content of whey was recorded as a loss, 92.1% was upcycled (e.g., protein powder).

In 2023, O'Hare et al (2023) undertook a project to map Auckland's food system, and at that time, made an Official Information Act request for fisheries-related data which was

unsuccessful; no further attempts were made as part of this research to obtain this information. Other documents sourced by the baseline research team did not provide individual production data for different types of fish and shellfish. Consequently, data for different fish and shellfish was collapsed into a single "fish and seafood" category and New Zealand data was obtained from the FAOStat website.

3.6 Destination of lost and wasted food

Currently, there is very little data on the destinations of food loss and waste in New Zealand. Discussions with stakeholders throughout the project helped to form assumptions about the proportions of food loss that went to the different destinations. For primary production, the most common destinations for fruit and vegetable loss were not harvested, aerobic digestion (i.e., compost), and animal feed. For processed fruit and vegetable loss, the most common destinations were animal feed and landfill. For all meats, fish and shellfish, the most common destination for loss was bioprocessing. The largest amount of retail food waste went to animal feed, followed by landfill, bioprocessing, and redistribution. Most of the food waste from institutions, hospitality and consumers was assumed to go to landfill.

It is important to note that at the time of this research, the Biosecurity Regulations (Parliamentary Counsel Office, 2016) resulted in some territorial authorities (i.e., city or district councils) sending food loss and waste to landfill rather than aerobic digestion. Despite meeting with stakeholders, we were unable to obtain information on the quantity of food loss and waste that went to anaerobic digestion.

3.7 Edible vs non-edible food loss and waste

Not all components of a food are able to be consumed, with some of the food considered inedible. For example, fruit and vegetable peels and bones are typically not eaten. What is considered inedible can reflect historical or cultural practices (e.g., apple peels, chicken feet), but sometimes it is not possible for humans to eat some food parts without further processing (e.g., shells of nuts, animal bones). The definition of food loss and waste provided by the Ministry for the Environment includes the inedible parts of food. However, the fraction of edible and inedible food loss and waste is often of interest. Some studies classify food waste as avoidable and unavoidable. Although there are subtle differences between avoidable and edible, the 2021 Food Waste Index Report (United Nations Environment Programme (UNEP), 2021) considers them to be comparable; the same approach was used in this research. At primary production, the amount of edible food loss was determined using information on the edible portion of foods obtained from the New Zealand Food Composition Data (Institute for Plant and Food Research, 2024). At processing, most of the edible portion of food is made into another food (e.g., tinned tomatoes, jams), and the inedible portion can be turned into non-food items such as pharmaceuticals, pet food, cosmetics and leather. The proportion of edible food at retail and institutions reported by UNEP (2021) was 85% and 67%, respectively. For hospitality, the proportion of edible food waste was 61% (WasteMINZ 2018b). Using data presented in two New Zealand studies, 52%

of household food waste was considered inedible (WasteMINZ 2015 and 2018a), similar to the 49% reported by UNEP (2021).

3.8 Sources of information to inform the project

The research team used many ways to obtain data for this project, ranging from reading online reports and publications produced by New Zealand-based industries, government data, scientific articles, and numerous (mostly online) meetings with people working on food loss and waste. Some information was obtained from informal discussions with stakeholders and has been anonymised. When no New Zealand data were available, international (mostly Australian) data sources were used, if appropriate, especially for food loss rates associated with different fresh produce.

A variety of different types of information was used to source data. Industry/stakeholder reports were the most common. Another source of information at primary production was the FAOStat food balance sheets for New Zealand. Every year, the Ministry for Primary Industries undertakes a national survey of agricultural production obtaining data on ~45 food commodities following a standardised format required by FAO. Information from the FAOStat balance sheets includes production, export, import, and losses (typically at primary production).

Each source of data was assigned a data quality score which was calculated as an average of four categories, shown in Table 3. The scoring system was modified from that used in the Australian 2018/2019 National Food Waste Baseline Update, so it better reflected the difference between the two countries.

Table 3 Data quality scoring

Score	Geography	Age	Regularity	Type
5	National	Year stated	Monthly	Official statistical data Industry data
4	Region-specific	<3 yr	Quarterly	Extrapolation based on statistical data Self-reported survey results Government data Scientific publication results Market report
3	Global average	>3 yr, <6 yr	Annual	International data Qualified estimate
2	Other region	>6 yr, <10 yr	Irregular	News outlet data Assumption
1	Unknown	>10 yr or unknown	Once	Single publication Unknown

In Australia regional data was prioritised over a national average but in New Zealand national data was prioritised over regional data. National food waste studies conducted in New Zealand sourced data from around the country, therefore accounting for differing factors such as climate and waste destination infrastructure that could impact the loss or waste rate at a regional level. It is important to note that the scoring system is not a validated tool and should be used with caution. Of the 105 data sources used for the current baseline project, the average data quality score was 3.5 out of 5 for all sources.

4. Results

Around 30 million tonnes of food enter the food supply chain in New Zealand annually, and of this, 1.22 million tonnes are lost or wasted, or 237 kg per capita per year. Although there are studies on food loss and food waste at different stages of the food supply chain, few studies have measured food loss and waste across the entire supply chain.

To put these figures into a global context, Table 4 provides a summary of total food loss and waste estimates that includes data from at least four stages of the food supply chain, including primary production, primary and secondary processing, retail, institution (including hospitality) and households (van der Werf and Gilliland, 2017; FIAL, 2021). The variation across countries in estimates of food waste and loss reflects differences in how food loss and waste is defined, measured and categorised. Other factors will also affect food loss and waste, such as differences in commercial requirements, food safety, and consumer behaviour. The higher value for New Zealand of 237 kg per capita per year compared to the European Union value of 132 kg per capita per year (Eurostat, 2024) and 111 kg per capita per year in the UK (WRAP, 2025) reflects, in large part, a difference in the measurement of food loss in primary production.

Table 4 Comparison of food loss and waste across regions

Region	Year	Primary	Processing	Retail	Institution	Household	Total
		kg/capita/year					
NZ	2015-22	89	64	3	10	71	237
Australia	2018	68	52	22	60	100	312[1]
UK	2021	NA[2]	21	4	16	71	111
EU	2022	10	25	11	15	72	132

[1] Does not include food loss and waste at distribution stage of food supply chain.
[2] NA= Not Available

The distribution of food loss and waste across the different stages of the food supply chain for this baseline research are reported in Table 5. The highest quantities of food loss and waste occurred in primary production, processing, and in households, like Australia and the

European Union. The relatively low quantities of food loss and waste in hospitality and institutions reflect a lack of New Zealand data in these sectors; currently there is no information available on food waste in prisons, schools, hotels, and fast-food restaurants and very little information for hospitals, aged care, cafés, and restaurants.

Table 5 Distribution of food loss and waste and reused food, across the supply chain in New Zealand

New Zealand	Food Loss & Waste (Tonnes)	Reused[1] (Tonnes)
Primary production	457,580	278,860
Processing	331,517	1,932,349
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Total	**1,222,730**	**2,259,993**

[1] Reused refers to food loss or waste that is reused for humans, fed to animals, upcycled, or made into non-food products.

A more detailed breakdown of production, processing, wholesale/retail and consumer food weights for each of the eight food categories can be found in Appendix C. Of the 1.46 million tonnes of fruits and 1.46 million tonnes of vegetables produced in New Zealand, about 9% (0.13 million tonnes) and 10% (0.14 million tonnes) are lost either at primary production or processing, respectively. Of grains, ~5% (0.02 million tonnes) of food is lost at primary production or processing. For milk and eggs, ~1% (0.22 million tonnes) of food is lost at primary production or processing. While for meat 5% (0.14 million tonnes) is lost at production or processing.

As stated earlier, there are ~30 million tonnes of food produced in New Zealand, of which 3.48 million tonnes is not consumed as originally intended. Of this, 1.22 million tonnes are lost and wasted, and 2.26 million tonnes of this food is reused in some way. More than half (65%) of the 2.26 million tonnes of reused food goes to bioprocessing (i.e., non-food items such as cosmetics, biofuel, and leather). Examples of food that is reused for animal feed includes stripped corn cobs, brewers' spent grain, and wheat bran for broll, all fed to stock animals.

The baseline research estimated that ~3.6 million tonnes of food was available at wholesale and retail, with 71% of this going to households or 2.6 million tonnes (Figure 2). Of this, approximately 14% (366,096 tonnes) of food is wasted in New Zealand households; in Australia this value was 18%. Of the 366,096 tonnes of food waste generated by households, a large amount is edible (see Table 7).

Figure 2 Comparison of household food waste compared to food available for households

This research shows that most of the food loss or waste that exits the food supply chain in New Zealand goes to bioprocessing (42.1%) (Table 6). Animal feed is a significant destination (18.1%) at primary production, processing, and wholesale/retail. About 0.62 million tonnes of food goes to landfill (19.6%). See Appendix D for more detailed information on destinations by stage of the food supply chain.

Table 6 Breakdown of destinations

Food destinations	Tonnes	% of destinations
Reuse (non-waste destinations)		
Redistribution (rescued)	13,153	0.4
Animal feed	628,947	18.1
Upcycled	153,038	4.4
Bioprocessing	1,464,855	42.1
Recycle/Recovery (waste destinations)		
Aerobic digestion	123,721	3.6
Anaerobic digestion	3,218	0.1
Land application	156,562	4.5
Not harvested	197,494	5.7
Disposal (waste destinations)		
Combustion	No data	-
Landfill[1]	616,035	17.7
Refuse[2]	691	<0.1
Other	125,010	3.6
Total	**3,482,723**	**100.00**

[1] Landfill - Sending food to an area of land or excavated site specifically designed to receive waste.
[2] Refuse - Abandoning food on land or in the sea. This includes open dumps, open burns, and fish discards.

A large amount of food that leaves the food supply chain is edible (Table 7). Approximately 79% of food lost (581,788 tonnes) at primary production is edible. A high proportion (85% or 54,736 tonnes) of edible food is wasted at wholesale/retail. Just over half (52% or 190,370 tonnes) of food wasted by households is edible.

Table 7 Edible and inedible breakdown of all food lost and wasted including diverted

	Total (Tonnes)[1]	Edible (Tonnes)	Inedible (Tonnes)
Primary production	736,440	581,788	154,652
Processing	2,263,866	90,555	2,173,311
Wholesale/retail	64,395	54,736	9,659
Transport	No data	No data	No data
Consumer Household	366,096	190,370	175,726
Consumer Hospitality	40,629	24,784	15,845
Consumer Institutions	11,297	7,569	3,728
Total	3,482,723	949,801	2,532,922

[1] Includes food loss and waste that is diverted to non-waste categories.

The results of the current project should be interpreted with caution. No food or commodity had complete data for every stage of the supply chain. There is even less information known about the proportion of food loss and waste for each waste destination, requiring numerous assumptions. Further, the data was obtained for different years from 2015-2022, rather than a single 12-month period.

5. Conclusions

The aim of this research was, for the first time, to estimate food loss and waste across the food supply chain in New Zealand. Around 30 million tonnes of food enters the supply chain in New Zealand annually, and of this, around 1 million tonnes are lost or wasted, or 237 kg per capita per year. Taking into consideration that data for some stages of the food supply chain was limited or unavailable, it is estimated that between 5-10% of food that enters the food supply chain in New Zealand is lost or wasted. This is considerably lower than the global estimate of 30-40% (United Nations, 2023; World Wildlife Fund – UK, 2021). The lower proportion for New Zealand is not unexpected. New Zealand produces large quantities of food, which is then exported and any waste associated with consuming that food further down the supply chain will occur outside New Zealand, in another country. Furthermore, New Zealand has a small population (~5.1 million people), so the waste generated within New Zealand will be small in proportion to the amount of food produced. Several other

factors will also reduce food loss and waste in New Zealand such as a temperate climate; good systems for growing, harvesting, storing, and transporting food; disease control practices; the Recognised Seasonal Employer (RSE) scheme used to recruit workers from overseas countries; an efficient and continuous cold chain; and strict food safety regulations.

The largest quantities of food loss and waste occurred at primary production (37%), processing (27%) and at the household level (30%). Although some efficiencies could be made in primary production including increased production of upcycled foods, changes in consumer expectations and systems for handling food would be required. This needs to be offset against concerns regarding food safety.

A further aim of this research was to estimate how much food loss and waste was diverted, and the waste destinations. About 18% of food that exits the human food supply chain goes to feed animals. A similar amount (18%) of food goes to landfill; additional research could be conducted into why this happens along the food supply chain and how this could be reduced. According to the food waste hierarchy (Teigiserova *et al,* 2020), it would be more environmentally beneficial to develop strategies to prevent food waste rather than diverting it.

Because national reporting of food loss and waste across the food supply chain has not been previously conducted in New Zealand, undertaking such a project highlighted gaps in knowledge and data. The implementation of a system to improve reporting, taking into consideration the quality of the data, and prioritising information about the commodities/foods with the highest quantities of food loss and waste, should follow this first baseline estimate (see Recommendations). Obtaining this information needs to take into consideration the commercial concerns expressed by many stakeholders, who viewed data on food loss as confidential. Furthermore, most industry reports focused on exports, rather than domestic supply. As more data becomes available, it is likely that subsequent studies may report higher amounts of per capita food waste. However, an increase in reported food loss and waste may be offset by activities that reduce food loss and waste.

For the past several years food waste has been a major topic of interest for the Office of the Prime Minister's Chief Science Advisor (OPMCSA). To date, the OPMCSA has published four reports on various aspects of food loss and waste, as well as a summary report (OPMCSA, 2024). Together, the reports provide a comprehensive overview of the causes, consequences and challenges of addressing food loss and waste in New Zealand. These reports include numerous well-informed, systematic and strategic recommendations, many of which are relevant to the current baseline project. Given this, the recommendations listed below relate specifically to measuring food loss and waste across the New Zealand food supply chain, based on the experience of the research team in undertaking this baseline research.

6. Recommendations

Highest Priority: completed by 2026

- Revise the waste destinations outlined by the Ministry for the Environment in 2023, particularly recognising the processing into non-food items (bioprocessing) as a reuse destination. By recognising the value of converting potential food waste systems into non-food items such as pet food and fertilisers, New Zealand will be in line with the food waste definitions adopted in Australia and the UK.

High Priority: completed by 2027

- Specifically focus on addressing the lack of food loss and waste data for the New Zealand dairy industry. Commission research to determine food loss rates across the dairy supply chain and particularly for dairy processing. The development of a sector-wide action plan may enable a collaborative approach for the industry to measure and act upon any food loss and waste across the supply chain.

- Determine the most effective way to present food loss and waste data for the New Zealand dairy industry so that international comparisons can be made. Dairy products incur significant fluid loss across the food supply chain, notably between primary production as milk through to food processing where it is predominantly converted to milk powders. Consequently, accurately reflecting food loss and waste is challenging with different countries taking different approaches.

- Commission research to determine food loss rates for commonly consumed fruit and vegetables in New Zealand in primary production, like the study by Ambiel et al (2019). Many of the food loss rates for fruits and vegetables in this New Zealand baseline research used Australian values that may not be reflective of growing conditions in New Zealand.

- Incorporate food loss and diversion questions into the annual Agricultural Survey undertaken by the Ministry for Primary Industries for FAO.

Intermediate Priority: completed by 2030

- Ensure the Ministry for the Environment tracks food loss and waste across the food supply chain every five years. Build inhouse capability within the Ministry to measure food loss and waste, as this will facilitate coordination, including data collection, across various government departments and build capacity to develop and drive effective food waste policy.

- Data on commodities and foods are often reported differently across government departments. Harmonise the reporting of food, including import and export products, that align with higher level food categories to facilitate tracking food waste.

- For this initial New Zealand food loss and waste baseline, data was compiled for 61 commonly consumed primary products. As more production data and New Zealand specific loss data becomes available, additional foods should be identified and added to the original list of primary commodities. Foods added to the original list of commodities should be those that are likely to contribute significantly to food loss and waste produced, using information on the top commodities exported and household consumption data.

- Establish mandatory food loss and waste reporting across the food supply chain, including total food loss or waste produced by an organisation and a percentage breakdown to different waste destinations. Reports should be updated every five years, so they can contribute to the national estimate. Notably, there is currently no New Zealand data available on the quantity of food loss and waste sent to anaerobic digestion. Mandatory food loss and waste reporting may also support industry bench-markings and sharing of best practice within and across industries. Guidance as to how food processers and manufacturers can report on this waste destination will be required.

- Invest in a central hub with guidance and resources that enable organisations throughout the food supply chain to conduct individual food loss and waste audits. Resources should also support organisations to collect high level standardised food group data, (i.e., fruit, vegetables, meat, dairy) and information on waste destinations when conducting food loss and waste audits.

Lowest Priority: completed by 2033

- Facilitate the central collection of data on food production, export, import, and loss in agricultural commodities that is publicly available, with a particular focus on the top commodities produced and consumed. In Australia, Hort Innovation (2023) provides summary data in a single report on key commodities.

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Appendix A: Food waste hierarchy

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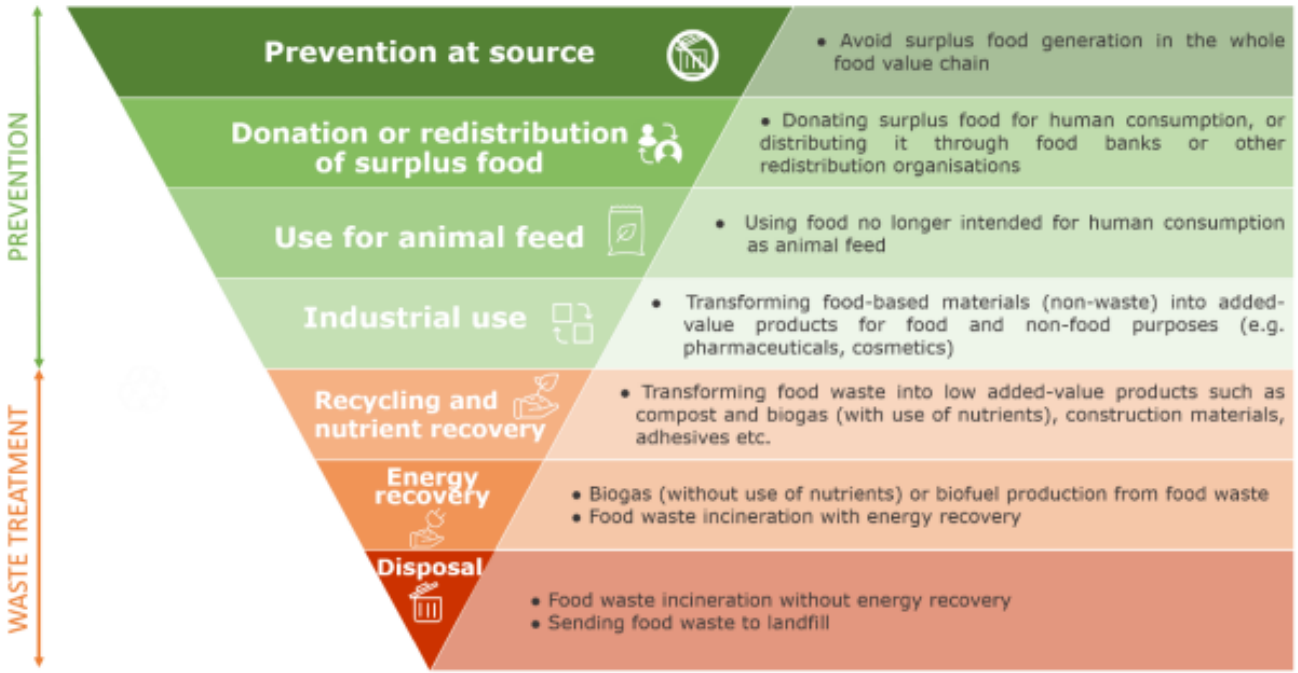
Figure 1. Hierarchy for the prioritisation of options to manage food surplus, by-products from food processing and food waste – 2024 update



Source: updated from Sanchez Lopez et al. (2020)

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Appendix C: Food lists

2016 Total Diet Study Food list (Ministry for Primary Industries, 2018)

Almonds	Chocolate beverage	Milk, cow	Prunes
Apple	Coconut cream	Milk, soy	Pumpkin
Apple juice	Coffee instant powder	Mixed berries	Rice
Avocado	Coffee, brewed	Mixed vegetables	Rice dish
Bacon	Confectionary	Muesli	Salad dressing
Baked beans	Corn	Muffins and scones	Sausages
Banana	Cornflakes	Mushrooms	Silverbeet
Beef, rump	Courgette	Mussels	Slimmer sauce
Beef, corned	Cucumber	Nectarines	Snack bars
Beef, mince	Dairy dessert	Noodle dish	Snacks, flavoured
Beer	Egg	Noodles, instant	Soup
Beetroot	Fish cakes	Oats	Spaghetti
Biscuit, chocolate	Fish, battered	Oil	Strawberries
Biscuit, cracker	Fish, canned	Onions	Sugar
Biscuit, plain	Fish, fingers	Orange juice	Sultanas/raisins
Branflakes	Fish, fresh	Oranges	Sushi
Bread, grain	Fruit drink	Other breakfast cereals	Table spread
Bread, wheatmeal	Grapes	Oysters	Taro
Bread, white	Ham	Pasta	Tea
Broccoli/cauliflower	Hamburger	Peaches, canned	Tofu
Butter	Honey	Peanut butter	Tomato sauce
Cabbage	Hummus	Peanuts	Tomato, canned
Caffeinated beverage	Ice cream	Pear	Tomato, fresh
Cakes and slices	Jam	Peas	Water, bottled
Capsicum	Kiwifruit	Pineapple, canned	Water, municipal
Carbonated beverage	Kumara	Pizza	Wheat biscuits
Carrot	Lamb	Pork	Wine, red
Celery	Lettuce	Potato crisps	Wine, white
Cheese	Liver	Potatoes, hot chips	Yeast extract
Chicken	Mandarins	Potatoes with skin	Yoghurt
Chicken takeaway	Meat pie	Potatoes peels	
Chocolate	Melon	Prawns	

2019 New Zealand Household Expenditure (Statistics New Zealand, 2019)

NZHEC Code	Expenditure group, subgroup, class	Total weekly expenditure	Average weekly expenditure per household	Aggregate annual expenditure by all households	Relative sampling error	Percentage of households reporting expenditure	Data quality
1.3	Grocery food	180,761,400	102.8	9,424.898	3.3	94.2	R
1.2	Meat, poultry and fish	49,305,800	28.1	2,570.803	5.4	70.7	R
1.1	Fruit and vegetables	41,365,600	23.5	2,156.803	4	76.8	R
01.2.01	Meat and poultry	40,915,900	23.3	2,133.356	5.3	67.0	R
01.3.01	Bread and cereals	32,078,100	18.3	1,672.555	4.2	77.8	R
01.3.02	Milk, cheese and eggs	27,176,800	15.5	1,417.000	4.5	75.0	R
01.1.02	Vegetables	24,496,800	13.9	1,277.262	4.5	70.5	R
01.3.05	Confectionary, nuts and snacks	23,067,400	13.1	1,202.734	6.1	68.5	R
1.4	Non-alcoholic beverages	20,189,400	11.5	1,052.675	6.6	67.1	R
01.1.01	Fruit and vegetables	16,868,800	9.6	879.541	4.7	64.7	R
01.4.02	Soft drinks, waters and juices	13,251,300	7.5	690.923	6.4	55.5	R
01.2.01.6	Preserved, prepared and processed meat	12,272,300	7	639.880	7.1	48.7	R
01.3.01.2	Cakes and biscuits	10,516,800	6	548.345	6.5	55.2	R
01.3.01.1	Bread and cereals	10,200,900	5.8	531.877	4.9	34.8	R
01.2.01.4	Poultry (fresh, chilled or frozen)	9,271,800	5.3	483.434	7.5	34.4	R
01.3.04	Food additives and condiments	9,129,500	5.2	476.012	6.9	51.8	R
01.2.01.4.1	Chicken (fresh, chilled or frozen)	9,080,600	5.2	473.464	7.6	34.1	R
01.2.01.1	Beef and veal (fresh, chilled or frozen)	8,942,300	5.1	466.253	11.3	27.4	R
01.2.02	Fish and other seafood	8,389,900	4.8	437.447	10.4	30.5	R
01.2.01.6.1	Prepared meats and smallgoods	8,367,400	4.8	436.275	8.2	37.5	R
01.3.02.1	Fresh milk	8,235,200	4.7	429.382	4.6	59.1	R
01.3.02.4	Cheese	7,376,900	4.2	384.631	7.7	37.5	R
01.3.02.1.01	Fresh milk (unflavoured, including milk tokens)	7,351,200	4.2	383.294	4.6	56.5	R
01.4.01	Coffee, tea and other hot drinks	6,938,100	3.9	361.752	11	36.0	R
01.3.05.5	Snack foods	6,654,100	3.8	346.947	7.1	43.5	R
01.2.01.4.1.01	Chicken (pieces, marinated pieces (fresh, chilled or frozen)	6,316,100	3.6	329.320	7.9	26.8	R
01.3.05.1	Chocolate	3,176,000	3.5	322.015	9.6	37.0	R
01.3.03	Oils and fats	5,753,700	3.3	299.997	7.8	35.4	R

Appendix D: Detailed data by food supply stage and food categories

	Fruit	Vegetables	Meat	Seafood	Dairy and Eggs	Grains	Staples	Beverages	Other	Total
Food production and supply (tonnes)										
Primary Food Production	1,464,238	1,460,862	2,775,960	552,572	21,705,486	445,417	21,000	836,702	0	29,262,236
Processed Food Production	140,853	318,693	1,231,197	71,715	4,085,034	532,156	380,196	465,224	0	7,225,068
Wholesale & Retail Food Supply	471,066	769,309	348,604	56,601	1,006,001	640,998	507,700	271,802		4,072,081
Consumer - Household Supply[1]										2,845,458
Food loss or waste (tonnes)										
Primary Food Loss	117,280	96,070	55,519	1,381	155,768	8,908	0	22,653	0	457,580
Processed Food Loss	15,181	43,326	89,355	42,312	60,319	13,626	420	66,978	0	331,517
Wholesale & Retail Waste	2,628	4,173	2,710	227	927	3,555	464	309	618	15,611
Consumer - Household Waste	78,711	93,355	37,161	3,110	14,644	43,932	14,644	14,644	65,897	366,096
Consumer Hospitality Waste	3,620	13,677	5,197	435	2,414	12,470	0	0	2,816	40,629
Consumer - Institution Waste[2]										11,297
Total										1,222,730
Diverted Food (tonnes)										
Primary Production	14,751	12,232	0	1,381	234,718	8,908	0	6,869	0	278,860
Processed Food	33,791	96,435	1,399,889	29,403	252,488	32,510	0	87,833	0	1,932,349
Wholesale & Retail	8,211	13,041	8,468	709	2,898	11,109	1,449	966	1,932	48,784
Total										2,259,993

[1] Of total wholesale and retail food supply, 71% used by households (FIAL, 2021).

[2] Data on institutional food waste was not disaggregated by food category.

Appendix E: Detailed data on destinations by food supply stage

Destination	Primary Food	Processed Foods	Wholesale & Retail	Consumer			Total (tonnes)	Total (%)
				Households	Hospitality	Institutions		
Rescued	2,679	717	9,757	0	0	0	13,153	0.4
Animal Feed	276,181	322,845	29,921	0	0	0	628,947	18.1
Upcycled	ND[1]	153,038	0	0	0	0	153,038	4.4
Bioprocessing	0	1,455,749	9,106	0	0	0	1,464,855	42.1
Aerobic Digestion	63,032	55,813	650	3,661	ND	565	123,721	3.6
Anaerobic Digestion	3,218	0	0	0	0	0	3,218	0.1
Land Application	155,768	794	0	0	0	0	156,562	4.5
Not Harvested	197,494	0	0	0	0	0	197,494	5.7
Combustion	ND	ND	ND	ND	ND	ND	ND	ND
Landfill	37,333	149,946	14,960	362,435	40,629	10,732	616,035	17.7
Refuse	691	0	0	0	0	0	691	<0.1
Other	45	124,965	0	0	0	0	125,010	3.6
Total							3,482,723	100

[1] ND is No Data.