ZERO WASTE SCOTLAND

Managing Food and Drink Waste in Scottish Breweries

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European Regional Development Fund
Investing in a Smart, Sustainable and Inclusive Future

Contents

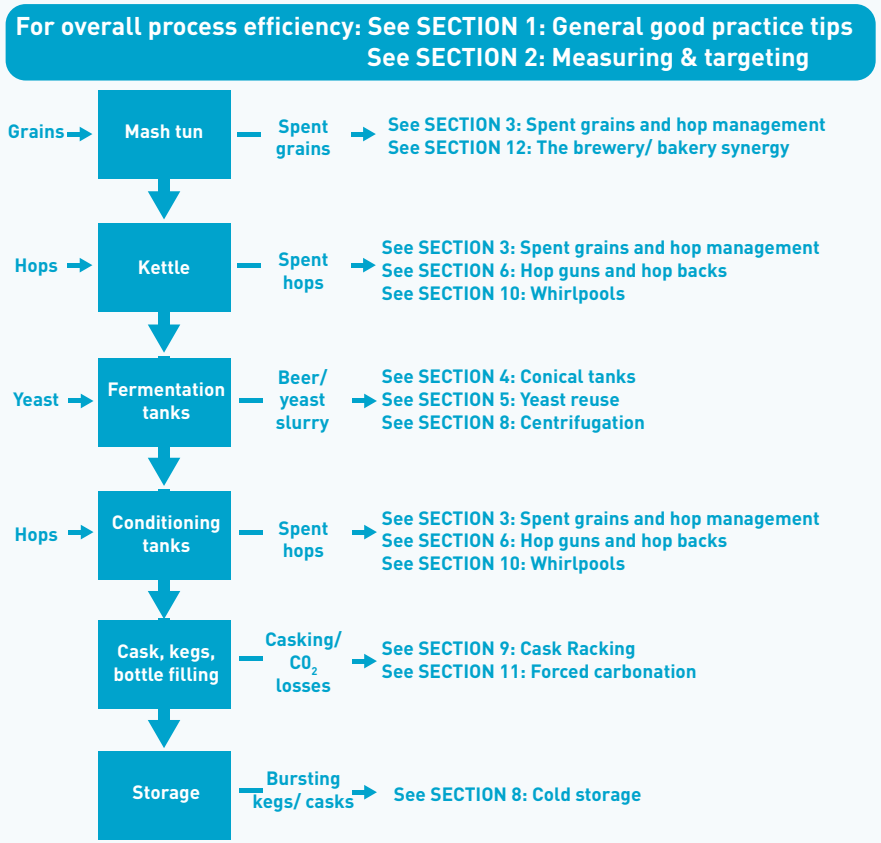
Guidance Note

According to the United Nations FAO, around a third of all food produced for human consumption is wasted.

A recent Intergovernmental Panel on Climate Change (IPCC) report stated that during 2010-2016 food waste contributed to 8-10% of total man-made greenhouse gas (GHG) emissions. In response to the need for urgent action, the Scottish Government has set the target of reducing per capita food waste to 33% below 2013 levels by 2025.

This guidance note is aimed at assisting breweries in reducing their food and drink waste, with measures aimed at saving money, generating revenue and making a significant contribution to Scotland's drive towards a more sustainable economy.

The following simplified brewery process flow diagram shows the different points at which food and drink wastage can arise in a brewery (some of which may not be immediately obvious), and the relevant section of this guide for eliminating or optimising it:



General Good Practice Tips

You can measure your total waste volume or measure what's being produced to identify waste hot spots.

Minimise pipe lengths and diameters – Designing a brewery with lower overall lengths and diameters of pipework can minimise the volume of leftover liquids in the system and thus reduce losses.
Maximise sugar extraction – check the sugar you extract from your grains against the supplier's quoted extractable sugar figure. If you are significantly below it, one or more of the following might require adjustment:

- Mashing time
- Mash tun operating temperature
- Mash tun efficiency – click here to find out more information

Flush pipes containing wort with hot water – this could help you recover remaining liquids in the system that may normally be wasted. The affected lines may be fitted with a sight glass so that as the hot water goes through the system, the brewer can stop flushing when the colour of the wort becomes lighter.

Measuring & Targeting

In order for Scotland to achieve national food waste reduction targets the internationally recognised 'Target, Measure and Act' (TMA) approach should be adopted by all food and drink businesses. TMA calls such businesses to:

- **Target.** Set a food waste reduction target for your own UK operations, aligned with or contributing to Sustainable Development Goal 12.3.
- **Measure** in a consistent way and share what you've learnt.
- **Act** to reduce your own food waste, to work in partnership with suppliers and to help your consumers reduce food waste.

Measuring and Targeting (M&T) is key to understanding where and why losses occur in the process and allow you to set your targets for reducing losses and food waste.

We recommend logging the wort and beer volumes into a spreadsheet for each stage of the process after every batch (from mash tun to packaging and storage).
The following quantities may also be tracked alongside waste to provide a baseline for different types of brews (if applicable):

- Fresh grains, hops and yeast added to process; and,
- Spent grains, hops and yeast slurry generation.

Simple calculations may then be carried out to identify the per batch:

- The wort to beer ratio and associated sales losses (as per diagram provided in Introduction);
- Grain, hop and yeast usage and associated raw material and uplift costs; and,
- Final product volume and associated sales.

Once these quantities are identified, you can define your own targets and Key Performance Indicators (KPIs) to measure your performance against. Robust KPI will allow you to evaluate the effect of any actions you undertake to reduce your food waste, based on recommendations presented within this Guide. Any savings arising from the potential improvements may be verified through the continuous measuring of the aforementioned quantities.

These volumes should be re-measured following any process changes to measure potential improvements or losses (e.g. hop gun or conical tanks installation).

Measuring & Targeting

Measuring Liquids: Depending on the size of your operation, liquid waste (e.g. wort, beer, yeast slurry) may be manually measured between each stage by transferring the waste wort/beer (if hygienically safe and practical) into graduated buckets or weighing them using scales. Alternatively, the liquid level in each vessel may be observed and compared to the vessel's capacity in order to obtain an estimation of wort/beer volume carried over.

Measuring Solids: Solid food waste, such as spent grains and hops, may be quantified by collecting them into buckets and manually weighing them before disposal.

Business Case Analysis: Measuring & Targeting	
Potential Savings	Vary depending on size of operations, volume and reason of losses / wastage.
Estimated Costs	Time investment. Some costs may be incurred if site does not own any buckets / weighing equipment.

REMEMBER!

‘Target, Measure, Act’ support may be obtained through Zero Waste Scotland

Call: 01786 433 930

Email: food.drink@zerowastescotland.org.uk

Web: zerowastescotland.org.uk/FoodDrink

Case Study

Zero Waste Scotland conducted an assessment for a brewery in Edinburgh. The trial included:

- One full day on site to identify and measure waste streams from part of the brewing process (mashing stage through to fermentation stage);
- A discussion with site personnel of waste streams from processes that were not measured during monitoring day (end of fermentation to final packaging); and,
- Generation of a bespoke spreadsheet based on monitoring results.

Some of the data gathered during the monitoring trial were previously unknown to the brewery, and the monitoring spreadsheet provided KPIs based on the percentage loss of final product, as well as a visual representation of each KPI, that could easily be utilised and amended by the brewery. The brewery committed to further investigate pipe liquid losses during transfers between vessels, which were highlighted during the monitoring and targeting visit.

Spent Grain and Hop Disposal

Spent grains are the largest brewery by-product, therefore, disposal can be costly if uplifted by a waste contractor. However, spent grains are commonly used to feed livestock and could potentially be uplifted through an arrangement with a local farmer or a dedicated animal feed manufacturer – representing a more sustainable (and often more cost effective) option.

Spent hops, another regular waste steam from a brewery, can make an excellent compost or land spreading material, and so they can be supplied to farmers, or uplifted through an arrangement with local area allotments. In some cases, breweries bag spent hops (using the bags in which the hops were supplied) and leave them out for local gardeners to collect.

Looking for a local farmer to uplift spent grains and/or hops?

• Contact your National Farmers' Union Scotland (NFUS) regional manager and ask them to share your spent hop and grain availability with their local members – their contact details can be found www.nfus.org.uk

• In your email make sure to mention:

- **Your preferred contact details**
- **Weekly volume of spent hops and grains available for free collection**
- **Accessibility (heavy vehicle) requirements**
- **Site location**

Please note that the NFUS regional manager is only able to circulate your request. It is the brewer's responsibility to engage with interested farmers and come to an agreement.

Spent Grain and Hop Disposal

Smaller breweries may not generate enough grain or hops to justify a dedicated collection from a farmer or feed manufacturer. In such cases, breweries can consider forming a brewery cooperative to pool spent grains and hops, meaning it is more likely that a collection can be arranged.

Business Case Analysis: Spent Grains and Hop Management	
Potential Savings	Waste disposal costs for spent grains and spent hops can be up to £100 per tonne.
Estimated Costs	The financial arrangement between a farmer or feed manufacturer and brewery for pickup of spent grains and/or spent hops is typically cost neutral.

Conical Fermentation Tanks

Conical fermentation tanks promote yeast settling, as they concentrate the solid yeast naturally falling to the tank bottom as the liquid (beer) rises to the top. This allows you to increase the volume of useable beer at the end of fermentation, thus improving product recovery. In addition, it can allow for easier yeast collection in the case of yeast reuse.

Business Case Analysis: Conical Tanks	
Potential Savings	Typical figures range from 7% to 20% reduction in wort losses. The potential product savings are best estimated by consulting with the supplier on vessel recovery potential.
Estimated Costs	Between £4,000 for a 1,000L tank to £12,000 for a 5,000L tank. These figures may vary depending on supplier.
Conical Tank Suppliers	Hoplex Ltd SSV Ltd Czech Brewery Systems S.R.O.

Case Study: Harviestoun Brewery

Harviestoun is an award-winning, independently owned brewery which produces a range of cask ales and bottled beers.

While still an SME, the significant size of Harviestoun's operations mean that they produce over 75 tonnes of spent yeast slurry per year. The disposal of this by-product costs them a significant amount of money via an external waste contractor.

Zero Waste Scotland conducted a free food waste audit at Harviestoun Brewery, and due to the large volumes of spent yeast slurry, there was a strong business case to install a conical settling tank. Installing this tank would reduce the liquid content of the yeast by settling the solids portion out of the yeast slurry.

Since these solids would have a lower weight and volume, this has the potential to greatly decrease yeast disposal costs. This recommendation would lead to estimated waste disposal cost savings of around £3,150/year, for an initial investment cost of an estimated £10,000.

Yeast Reuse

Business Case Analysis: Yeast Reuse	
Potential Savings	Up to 90% of fresh yeast costs
Estimated Costs	Additional time investment, refrigeration space if not available.

Yeast reuse involves collecting yeast from the end of a fermentation and storing it for use in the next batch at the beginning of fermentation, reducing the need to purchase fresh yeast and reducing waste yeast volumes.

Although not a large factor in terms of waste weight or volume, yeast is an expensive raw material, typically costing £30-75/kg.

An outline of the process is appended to this document, some general tips include:

- Yeast reuse is likely to require some trial and error to determine the volume of yeast to hold back and the number of viable reuse cycles. The costs of fresh yeast mean this can be a worthwhile time investment. Basic lab work such as cell counts can be carried out on site but are not mandatory for successful yeast reuse.
- Yeast may be reused for 10 or more cycles after being propagated from fresh packets of yeast. Lag time between addition of yeast and start of fermentation increases as number of cycles increases. If the lag time increases too much, fresh yeast should be used.
- 'Unhealthy' yeast (yeast which has been stored for long periods, heavily contaminated yeast, or yeast from slow fermentations) may respond poorly to acid washing and a shorter washing time, or higher wash pH value should be employed.
- Conical tanks improve yeast reuse efficiency.

Hop Guns and Hop Backs

Hop guns, also known as hop torpedoes, hop cannons or hop extractors represent an increasingly common alternative to the traditional dry hopping method of adding hops directly to conditioning tanks. Hop backs are an alternative to the addition of hops at the kettle / whirlpool stage.

They are external vessels which hold hop pellets or leaves, and through which unfinished beer (hop guns) or wort (hop backs) is pumped from the conditioning vessel or kettle. Hop guns typically are mobile to allow use across multiple conditioning tanks and have ports for the addition of CO2 and control of pressure. Hop backs are typically stationary and do not need CO2 control measures.

Advantages:

- Reduction in beer losses in the conditioning vessel or kettle.
- Improved beer-hops contact, allowing more flavour or aroma to be gained from the same mass of hops.
- Reduced hop usage and spent hops generation. At a typical cost of £10-30/kg, optimisation of hops use can have notable financial benefits.
- Potential time savings at the conditioning stage, as the active extraction process can take a day or less, compared to the standard dry hopping method which may take multiple days, potentially allowing increased production capacity from the available vessels.
- Cleaning may be easier compared to standard hopping methods as the hops will be contained within the vessel, rather than entering the kettle or conditioning tank.

Business Case Analysis: Hop Guns and Hop Backs	
Potential Savings	At the conditioning stage, hop savings could be up to 50% without noticeable differences in flavour or aroma profiles. This could represent a significant cost saving, as hop pellets can cost between £10 and £30 per kg.
Estimated Costs	Capital costs are between £5,000 - £20,000 for typical craft brewery capacity units, depending on size and manufacturer. It may also be necessary to purchase an additional dedicated pump as it likely to be in use for long periods of time. Operating costs consist of electricity to run the pump, which is likely to be small in comparison to hop / beer savings.
Hop Gun Suppliers	BrauKon GmbH Hoplex Ltd SSV Ltd Czech Brewery Systems S.R.O.

Centrifugation

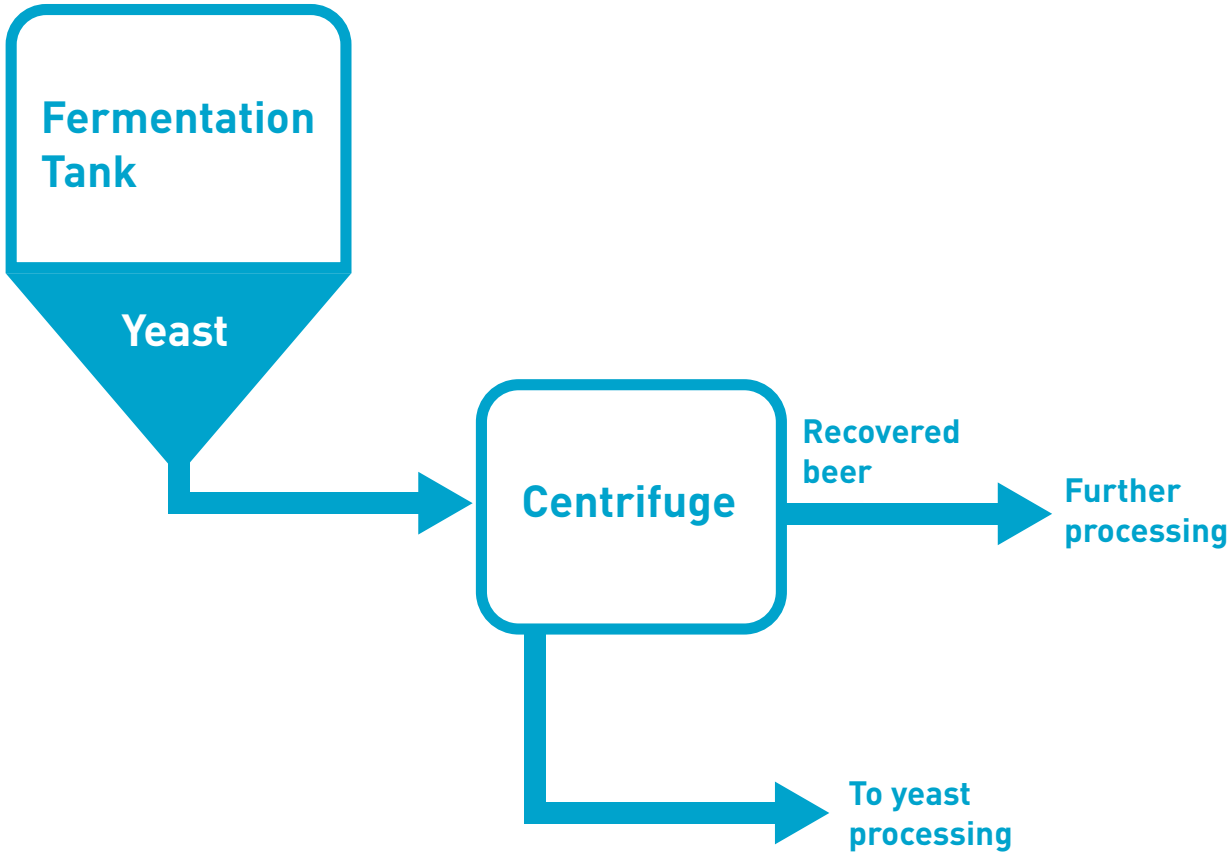
A centrifuge is used to separate yeast from beer, allowing efficient solid/liquid separation, and thus reducing beer wastage. Centrifuges function in a similar way to the spin cycle of a washing machine, spinning the excess yeast out of the beer.

This configuration is as per the diagram on page 16 following page (alternative uses for centrifuges include wort clarification and green beer clarification).

While a centrifuge can have a significant capital cost, it can also deliver many benefits to a brewery, including:

- Reduced beer losses and thus improved product yields.
- Reduced production time, through reduced beer conditioning time.
- Easier handling of excess yeast, through reduced yeast volumes.
- Potentially improved product quality, through a reduction in the number of finings necessary.

Business Case Analysis: Centrifugation	
Potential Savings	Suppliers typically quote 5% to 10% percent more beer from the same amount of raw ingredients (depending on beer recipe and brewing process).
Estimated Costs	Centrifuges can cost upwards of £50,000. Given these higher capital costs, most breweries at the smaller end of the market may be better suited to using a settling tank to manage their yeast waste stream, where yeast disposal costs are currently high.
Centrifuge Suppliers	GEA Afla-Laval



Case Study: Stewart Brewing

Stewart Brewing was founded in 2004 and has quickly established itself as one of Scotland's most successful and reputable breweries, and currently employs over 25 staff.

Previously, the brewery disposed of yeast via the traditional means of draining the excess yeast/ beer slurry from their fermentation vessels. This led to beer losses estimated at over 10% of current production levels. They were keen to improve on this and reduce the discharge of perfectly good product to drain.

Stewart Brewing signed up for a free Zero Waste Scotland opportunities assessment, during which a centrifuge was identified as a cost-effective means of reducing the levels of beer wastage. In fact, due to size limitations of the current site, the reduced production time and hence improved equipment utilisation that a centrifuge can deliver, it could also play an important part of Stewart Brewing's growth strategy.

As a result of the potential waste savings, unlocking of growth potential and identified cost savings, Stewart Brewing installed a centrifuge on site. With an estimated payback period of 3.2 years, the centrifuge can save the site over £15,000 per year by reducing beer losses to 5%.

Cold storage

When subjected to heating during the warm summer months, the beer can release more CO2 than normal, resulting in the pressure inside kegs and casks increasing. If left unchecked, pressures can increase to a point at which the keg can pop or burst, resulting in losses of valuable finished product.

One means of remedying this is to install a temperature controlled cold storage. This can take various forms, including a purpose-built insulated room with a refrigeration system to control the temperature inside, or a prefabricated refrigerated shipping container. In either case, the goal is to provide a temperature controlled (to perhaps 15°C) storage area which can prevent casks and kegs from popping during high summer temperatures.

Business Case Analysis: Cold Storage	
Potential Savings	Highly dependent on existing storage conditions and numbers of burst kegs and casks. However, with a well-designed and controlled cold store, the bursting of kegs and casks could be effectively eradicated.
Estimated Costs	Installation costs for cold storage can be estimated at approximately £230/m^3. When calculating the cost savings make sure to deduct the electricity cost associated with running the cold storage based on a 50 kWh/m3/year consumption (typical electricity costs are around £0.10/kWh).

Cask racking

A cask racker is a piece of brewery-specific equipment that fills casks to a set volume, and also allows the dosing of a set volume of finings.

This automation removes human error of manual filling via hose-based methods (especially in the changeover from one cask to another). Furthermore, its tight control over finings can improve the efficiency of their use, resulting in further cost savings.

Business Case Analysis: Cask Racking	
Potential Savings	The savings possible through cask racking will vary between sites, but research indicates typically 2.5% of beer losses could be prevented by using such a unit.
Estimated Costs	If the volume of product lost (and therefore lost revenue) during this stage is known, then you may estimate the cask racking unit's cost on a £3.25/L basis.
Cask racker suppliers	Brewology Ltd Alfred Gruber GmbH Cockayne Systems Ltd

Case Study: Swannay Brewery

Swannay Brewery is located on the north westerly tip of Orkney's mainland and currently produces over 300,000 litres of beer annually. The brewery has increased production over the years and is outgrowing its initial equipment and processes. As such, it incurred finished product losses in the cask filling process, and spillage occurred during the transfer between casks.

Following the recommendation identified via a free Zero Waste Scotland opportunities assessment, Swannay installed a cask racker in order to reduce beer losses. The cask racker will save the brewery almost £10,000 per year with a payback of less than 2 years.

"Receiving on-site support has been incredibly beneficial. As a successful SME, we already have a very good grasp of our on-site operations, but we are always trying to be more efficient and lessen our waste outputs. The potential for positive business impact, cost savings and waste reductions associated with the auditing process is very positive, and I would recommend that companies considering accessing the support available make time for the audit process."

– Lewis Hill, Manager, Swannay Brewery

Whirlpools

Whirlpooling is a method used in commercial breweries to separate hop pellets from the wort, following the kettle stage. The wort is pumped into a cylindrical vessel, known as a 'whirlpool', at high velocities through a pipe aligned tangentially to the vessel walls. As a result, a whirlpool is created which pulls the solids in the liquid in the centre of the vessel.

For the whirlpool to work properly, the vessel must be a vertical cylinder with a flat bottom and its diameter must be at least equal to the depth of the wort when the tank is full.

Once the whirlpooling process is completed (typically takes 10 to 20 minutes), the wort is allowed to stand for around 20 minutes to allow the hops to settle and form a compact 'trub cone' in the middle of the vessel.

The most common whirlpool design has a slightly pitched bottom towards the outlet drain to allow the clean wort to flow out the vessel, leaving the trub pile in the middle. The trub is then removed via a port in the centre of the whirlpool.

It should be noted that a whirlpool may be used instead of a hop back to separate the trub from the wort. However, a whirlpool does not improve beer-hop contact and as such a hop back may be considered if this feature is desirable.

Whirlpools

Advantages:

- Reduction in beer losses.
- Quicker wort cooling when used in conjunction with an immersion chiller, as whirlpooling allows for uniform distribution of heat.
- Improved hop flavour and aroma due to improved wort cooling.
- Clearer wort compared to traditional extraction methods.

Business Case Analysis: Whirlpools	
Potential Savings	Depended on whirlpool design and controls.
Estimated Costs	Highly depended on vessel capacity required and cooling/ cleaning additions. However, an average cost of £1.50/L of wort may be used to provide an indicative unit base cost.
Suppliers	GEA Afla-Laval Brauhaus Technik Gmbh

Forced Carbonation

In general, it is good practice to use an automatic keg filling and carbonating unit for onsite kegging, as opposed to utilising a secondary fermentation to carbonate kegs.

Secondary fermentation involves the manual filling of kegs with non-carbonated beer and the addition of sugar, before sealing the kegs. This results in the generation of carbon dioxide (a product of the fermentation process) which, due to the sealed keg, carbonated the product.

This is a controlled process and requires product to be stored for a set period of time at between 20 – 24 °C. Prior to the product being sent out from the site kegs must be tested to ensure that secondary fermentation has occurred, leading to product losses. If the carbonation is unsuccessful, entire kegs may be lost. Due to the process requiring fermentation to occur in each individual keg, adequate carbonation in the product is not guaranteed.

As such, automated kegging units provide a product of consistent quality and effectively eradicate losses associated with unsuccessful product carbonation and product testing (as less rigorous testing would be required due to the improved reliability associated with automated keg filling units).

Business Case Analysis: Forced Carbonation	
Potential Savings	The savings possible through forced carbonation will vary between sites but based on data available from breweries that used to utilise secondary fermentation, 12.5% of beer losses could be prevented by using such a unit.
Estimated Costs	If the volume of product lost (and therefore lost revenue) during this stage is known, then you may estimate the automated keg filling unit's cost on a £1.5/L basis.
Automated Keg Filling Unit Suppliers	Framax GEA Brewology Ltd

The Brewery-Bakery Synergy

The use of grain-based products in both breweries and bakeries means that some synergies exist between the two industries. These could be exploited by a brewery in two ways:

Baking with spent grains: Spent grain can be used as a base ingredient in the baking of bread or other baked goods, such as granola bars or dog biscuits. This could be done either on-site at the brewery, or off-site in partnership with a local bakery, by supplying them with spent grains for their own use.

Using bread products in brewing: excess bread products from a bakery which would otherwise be wasted can be used to replace a proportion of grains in the brewing process. Some examples of successful brewing with bread projects include:

- Toast Ale
- Jaw Brew
- Brussels Beer Project

Business Case Analysis: Brewery-Bakery Synergy	
Savings, Costs and Paybacks	Highly dependent on the specific approach taken and the level of reuse involved.

Further Information

For further information on any of the subjects discussed in this document, or to receive free Food Waste Reduction Business Support service, please contact Zero Waste Scotland by calling **01786 433 930** emailing **food.drink@zerowastescotland.org.uk** or visiting **zerowastescotland.org.uk/FoodDrink**

Remember!

The management of brewery food and drink waste and its possible avenues of reuse should be developed to comply with applicable legislation, such as:

- The Waste (Scotland) Regulations;
- The Regulation (EC) No. 852/2004 on the Hygiene of Foodstuffs;
- The EU Feed Hygiene Regulation (183/2005); and
- The European Food Information to Consumers Regulation No 1169/2011.

This list is not exhaustive. Any site looking to make a notable change to their management of food and drink waste should, where necessary, consult with a suitably qualified professional.

Appendix: Yeast Reuse Procedure

Equipment required: Equipment required: food grade phosphoric acid, sterilised containers and refrigeration space.
Process outline: The following general steps outline the yeast reuse process:

1. At end of fermentation, allow yeast to settle to the bottom of the fermentation tank.
2. Sterilise collection containers and any pumping pipework with caustic solution.
3. Draw yeast off via bottom outlet of fermentation tank.
4. Discard first part of yeast drawn off (yeast from the centre of the settled layer is more desirable).
5. Signs of healthy yeast include a lack of dark specks of dead yeast and a healthy creamy colour.
6. Bump the container into which the yeast is drained on ground repeatedly to release CO_2 and prevent liquid rising out of the container.
7. Take as much as required for next batch – judged via experience/trials – and discard rest before transferring yeast to suitable storage (fridge or chilled tank).
8. Wash the yeast using acid to reduce bacteria counts without affecting the yeast, by adding phosphoric acid solution to the yeast and stirring until the pH reaches 2-3.

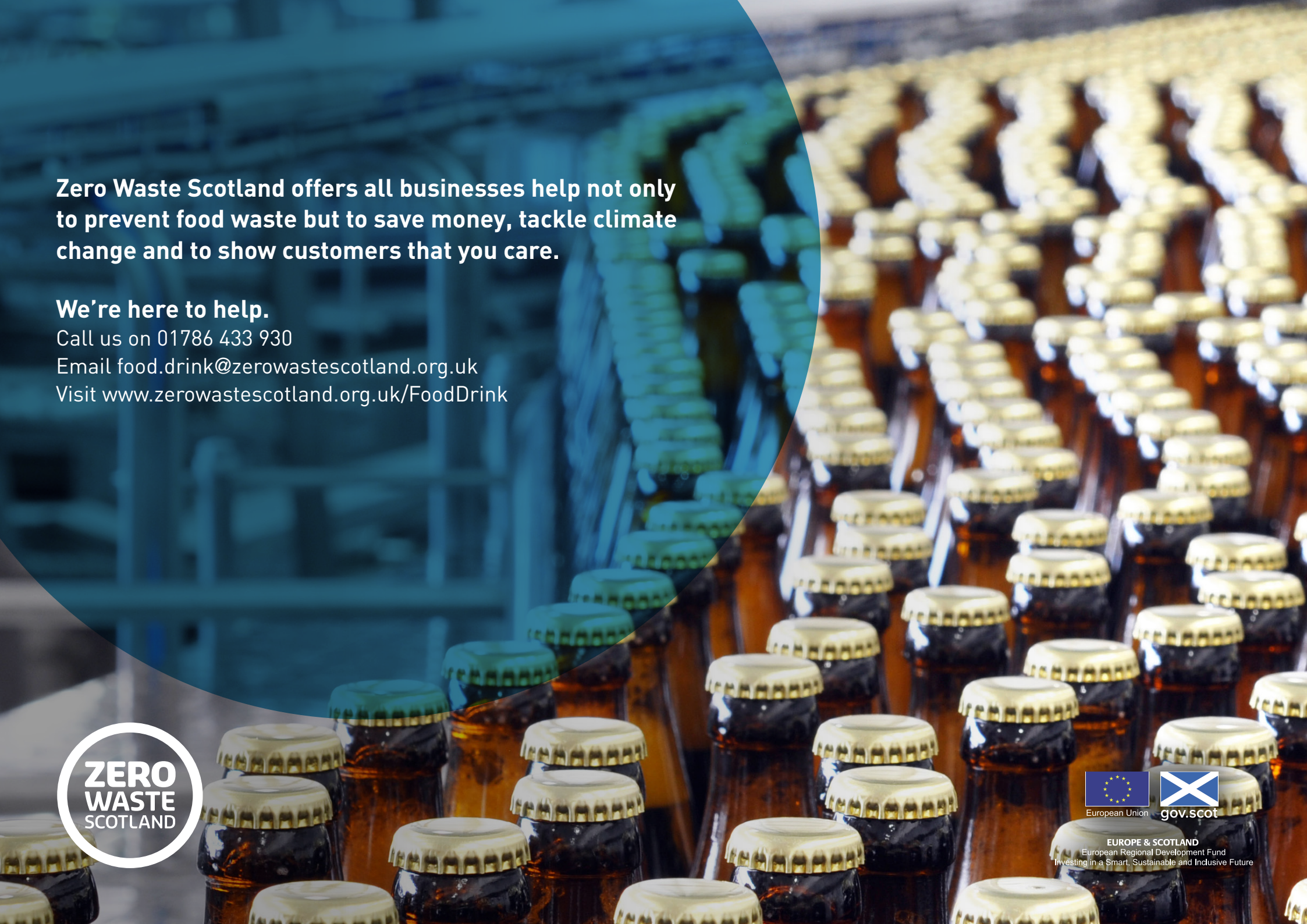
Keys to success:

- Use food grade acid.
- Chill the acid before use.
- Mix the yeast and acid well.
- Keep the yeast temperature low during washing.
- Pitch the yeast soon after washing.

9. Pitch the yeast into the next wort batch in fermenter to commence the next fermentation process.

The following resources provide more detail on the above process:

- Yeast Storage and Maintenance, White Labs Inc.



Zero Waste Scotland offers all businesses help not only to prevent food waste but to save money, tackle climate change and to show customers that you care.

We're here to help.

Call us on 01786 433 930
Email food.drink@zerowastescotland.org.uk
Visit www.zerowastescotland.org.uk/FoodDrink

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