Top 20 Food waste streams

Deliverable D6.9

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Authors

Graham Moates, Institute of Food Research

Nina Sweet, WRAP

Kate Bygrave, WRAP

Keith Waldron, Institute of Food Research

With thanks to:

Åsa Stenmarck, IVL

Jan Broeze, Wageningen University & Research

Project coordination and editing provided by WRAP.

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AD	Anaerobic Digestion
EU	European Union
FA	Framework for Action
PWP	Pilot Working Platform
WP	Work Package

1 Executive Summary

1.1 Objectives of work

REFRESH is an EU H2020 funded research project (which runs for 4 years until June 2019) taking action against food waste. Twenty-six partners from 12 European countries and China are working towards the project's aim to contribute towards Sustainable Development Goal 12.3 of halving per capita food waste at the retail and consumer level and reducing food losses along production and supply chains, reducing waste management costs, and maximizing the value from un-avoidable food waste and packaging materials.

This piece of analysis sits within REFRESH Work Package 6: Valorisation of waste streams and co-products. One of the key objectives of this Work Package is to increase the exploitation of food and packaging waste by helping business stakeholders to identify waste streams appropriate for valorisation regarding

a) their robustness of supply, quality and composition and

b) for which products and outputs might be realised that are technologically feasible, economically viable, legislatively compliant and environmentally sustainable / beneficial.

The research and analysis covered in this report aims to further refine the most appropriate edible and inedible waste streams for valorisation focussing specifically on those from foodstuffs which have the greatest environmental impact, which are present in sufficient quantities, and which are unavoidable. The methodology used is therefore integral to the longer term aims of the REFRESH project.

1.2 Approach

In order to scope the efforts of the REFRESH project, a selection process was undertaken to identify the most significant waste streams with respect to European consumption and environmental impact. This process is described in detail bySweet, Bygrave, Moates and Waldron (2016). Thirty-seven priority waste streams were identified as a result of this exercise. These waste streams (shown in Annex A) form the input to this task.

This piece of work forms part of a two-step process to categorise and record the valorisation approaches and technologies currently used to exploit the top impacting waste streams. The first step has provided a systemic method to identify then prioritise the top waste streams across the EU, which has resulted in the 37 waste streams referenced above. The next step was to assess these waste streams for high level business plan criteria (e.g. quantities, locations, likely economies of scale and seasonality issues) to guide the research towards bulk industries rather than niche opportunities. Following this further refinement, this resulted in an output identifying the top 20 waste streams. The resultant list includes well-known examples of spent grains and other organic waste streams from the production of alcoholic beverages (ales, lagers, cider, wines and spirits),

press cakes from vegetable oil processing and meat & dairy side-streams, such as slaughter by-products and whey protein.

1.3 Next steps

The production system and valorisation approaches will be researched and identified for each of the top 20 waste streams. Valorisation chain models will then be prepared for each waste stream in order to provide guiding principles for the economic and environmentally beneficial exploitation of these wastes.

Key to this next step is seeking interaction with industry, for example through the route of the National Piloting Working Platforms in the REFRESH piloting countries (Netherlands, Germany, Hungary and Spain) and/or through direct dialogue with relevant industrial stakeholders. These will provide guidance on business and consumer acceptance of these valorisation approaches and the exploitation of waste accordingly. In order to evaluate the approaches identified for the top 20 waste streams, further literature reviews will be undertaken to identify new technologies and approaches that are not currently in widespread use by industry. This information will feed into the construction of a compositional database, which will be made available via a 'Community of Experts' – an online resource developed within the REFRESH Project. This database will provide users with easy access to data on the composition (nutrients, bioactives, etc.) of agri-food chain wastes to assist identification of valorisation & exploitation routes.

2 Introduction

2.1 REFRESH

REFRESH is an EU Horizon 2020 funded research project (which runs for 4 years until June 2019) taking action against food waste. Twenty-six partners from 12 European countries and China are working towards the project's aim to contribute towards Sustainable Development Goal 12.3 of halving per capita food waste at the retail and consumer level and reducing food losses along production and supply chains, reducing waste management costs, and maximizing the value from un-avoidable food waste and packaging materials.

This piece of work sits under Work Package 6 entitled "Valorisation of waste streams and co-products".

2.2 Aim of Workpackage

WP6 – Valorisation of waste streams and co-products

The aim of the workpackage is to increase the exploitation of food & packaging waste by:

- helping business stakeholders to identify waste streams (organic and packaging) that are appropriate to valorise due to their robustness of supply, quality and composition, and for which products and outputs might be realised that are technologically feasible, economically viable, legislatively compliant and environmentally sustainable/beneficial;
- valorising post-consumer putrescible waste
- helping policy makers to identify and implement improvements to the legislation that will reduce unnecessary restrictions on valorisation (including use in feed production, whilst maintaining appropriate safety and quality standards).

2.3 Description of related Task

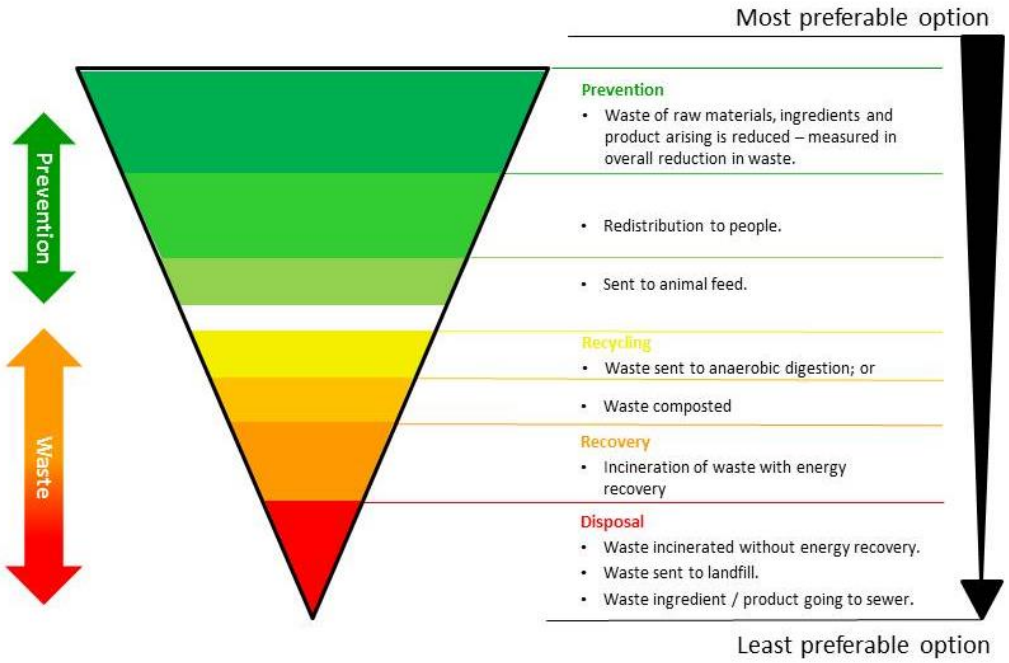
Modelling and assessment of selected valorisation approaches

Categorisation and selection of top 20 waste stream valorisation approaches. The 37 waste streams identified in a prior scoring exercise (Sweet, Bygrave, Moates and Waldron, 2016) have been assessed based on high level business plan criteria, such as quantities, locations, potential economies of scale and seasonality issues. They have been ranked accordingly and then the top 20 have been selected for modelling.

2.4 Methodology

2.4.1 Categorisation and selection of top 20 waste stream valorisation approaches.

A selection process was undertaken to identify the most significant waste streams with respect to foodstuffs having the highest EU consumption and environmental impact. Thirty-seven priority waste streams were identified as a result of this exercise and these waste streams (shown in Annex A) form the input to this task. All of the 37 priority waste streams had an existing valorisation route (other than AD or composting). However, one of the aims of the REFRESH project is to assess whether the existing situation can be further improved in terms of the relative position of the valorisation approach in the waste hierarchy. In the UK, WRAP has designed a specific hierarchy for food and drink businesses as shown in Figure 1.



.Figure 1. Food & drink material hierarchy (WRAP, 2016)

All businesses within the EU have a duty to act within the principles of the waste hierarchy as enshrined in the revised EU Waste Framework Directive (European Commission, 2008) and the associated member state legislation.

The most preferable option to reduce the impact on the environment is to reduce the amount of raw materials, ingredients and product ending up as waste – such actions may involve system mapping to understand, measure and re-design processes to eliminate waste. Examples are vegetable off-cuts being utilised as input to a juicing process / soup production line or simply eliminating / reducing losses such as changeover losses through more efficient production planning.

Feeding to people usually through charitable redistribution is the next preferred option for unavoidable wastes although this is dependent on the perishability of

the product and the necessary logistical capacity to transport and store in a safe and hygienic manner.

The feeding of wastes and co-products such as apple pomace to livestock - which in turn enter the human food chain – is the next option reducing the need for the cultivation of virgin crops.

The remaining options are all forms of waste management with recycling through anaerobic digestion and composting preferred over incineration with energy recovery. The last resort option is that of disposal to landfill, incineration without energy recovery or via the sewer.

2.4.2 Internal REFRESH peer review

The research team used an internal review process to independently evaluate the 'medium' list of 37 waste streams identified previously.

The Evaluation Panel worked with each of the identified experts to identify which waste streams were very similar and could be amalgamated, where there was effective duplication with the same waste stream emerging in more than one product category, and where there were grounds to evaluate similar waste streams from a process together as a single waste stream. Examples of this include whey, whey concentrate and whey permeate from cheese production which are all derived from a common production system and, hence, could be considered sufficiently similar to be amalgamated for the purposes of this exercise.

It was also possible to identify waste streams from a common production system which, whilst being important in their own right, could be deselected because they involve smaller volumes than the selected waste stream. Examples of this are yeast, trub and spent hops from brewing, which involve smaller volumes of waste than spent grains.

The deselected waste streams, along with the reasons for deselection are listed in Annex B.

The resulting list of top 20 food waste streams is shown in Table 1 with the motivation for inclusion of each waste stream. It can be observed that many of these residues are sometimes used for animal feed; hence, it will be important to consider the environmental impacts of substitute feeds when modelling alternative valorisation scenarios. The increasing demand for e.g. protein, and the recognition that meat production has a very high carbon footprint, is consistent with an aim to evaluate the additional valorisation potential of waste streams and co-products. The valorisation of waste streams for incorporation as food ingredients will be evaluated to assess its true position in the food waste hierarchy.

3 Results

3.1 Top 20 food waste streams appropriate for valorisation

The priority waste streams identified (organised alphabetically by food product) along with their current management are shown in the table below.

Table 1: Top 20 food waste streams appropriate for valorisation

Food product	Waste stream	Current management	Reason for selection
Ales, lagers & spirits	Spent grains, distillers dark grain & draff	Animal feed, composting, anaerobic digestion	High volumes of solid wastes (~20kg/hl) widespread across EU-28.
Apples	Pomace	Production of animal feed	High volumes, widespread production although seasonal within Europe, potential rich source of fibre & polyphenols.
Cheese	Whey, whey concentrate and whey permeate	Production of foodstuffs (whey powder, demineralised whey, WPC, WPI, WPT, WPP, lactose, Ricotta cheese, cream), production of animal feed (raw for pigs, whey powder, lactose), production of fertilizer, production of microbial culture medium (whey powder, lactose), fermentation and anaerobic digestion, transformation to peptides and glucose	Annual EU production of whey products is currently 1.5 to 2 million tonnes of dry matter (EWPA 2016)
Cider	Pomace	Animal feed, anaerobic digestion	High volumes, regionally important for United Kingdom, France, Spain, Ireland & Germany, potentially rich source of polyphenols.

Eggs	Egg shell waste (shell)	Source of calcium for use in animal feed and pet food, landspreading, filler for use in plastics, other potential uses under investigation	High disposal costs.
Lamb, beef, pork & poultry	Blood	Production of foodstuffs (raw, plasma, albumin), production of pharmaceuticals, plants, production of animal feed (blood meal, raw, albumin), anaerobic digestion	Production & processing widespread across EU-28.
Lamb, beef, pork & poultry	Bones	Production of animal feed (fat, bone meal), production of chemicals (glue, detergent), production of foodstuffs / pharmaceuticals (gelatin), composting, anaerobic digestion, production of low gel, low viscosity products	Production & processing widespread across EU-28.
Lamb, beef, pork & poultry	Hair, feathers, hooves & feet	Production of chemicals (glue, gelatin, collagen, glycerin, soap), production of pharmaceuticals (Ca, P, gelatin, collagen, fat, insulin, heparin, pepsin, steroids, cholesterol), production of animal feed (meat meal, fat), production of foodstuffs (sausage casing, catalase, additives), anaerobic digestion, composting, production of feather meal (animal feed and fertilizer), production of pillows & eiderdown	Production & processing widespread across EU-28.
Lamb, beef, pork & poultry	White and red offal incl guts & giblets	Production of chemicals (glue, gelatin, collagen,glycerin, soap), production of pharmaceuticals (Ca, P, gelatin, collagen, fat, insulin, heparin, pepsin, steroids, cholesterol), production of animal feed (meat meal, fat), production of foodstuffs (sausage casing, catalase, additives), anaerobic digestion	Production & processing widespread across EU-28.
Lamb, beef, pork & poultry	Proteinaceous matter incl. Category 3 material from slaughter plus carcass fat	Production of chemicals (glue, gelatin, collagen, glycerin, soap), production of pharmaceuticals (Ca, P, gelatin, collagen, fat, insulin, heparin, pepsin, steroids, cholesterol), production of animal feed (meat meal, fat), production of foodstuffs (sausage casing, catalase, additives), anaerobic digestion	Production & processing widespread across EU-28.

Light wines	Pomace (skin and seeds)	Production of ethanol, extraction of antioxidants & pigments, production of grapeseed oil (cooking oil & beauty ingredient) & grapeseed flour (food ingredient), production of resveratrol, production of bio-based packaging	High volumes produced within EU (approx. 70% of global wine production; Martí et al, 2014), regionally important for Italy, Spain, France & Germany.
Oranges	Citrus zest, peel, seed, membrane residue after juice extraction	Cattle feed	High volumes, regionally important for Spain, Italy, Greece & Portugal.
Potatoes	Fibre, concentrated fruit juice & protein from potato starch production	Protein extraction, production of animal feed	High volumes – the European Starch industry has 77 plants operating in 21 countries within the EU and processes 7 million tonnes of starch potatoes per annum (Starch Europe 2012).
Potatoes	Peelings	May be used directly as potato feed or combined with potato puree to give potato puree feed	High volumes available from centralised processing facilities particularly in Germany, France, Poland, The Netherlands & United Kingdom.
Spirits	Organic wastes, mash from grain, fruit or potato	Animal feed, composting	High volumes, regionally important for United Kingdom, France, Germany, Poland & Italy.
Sugar	Sugar beet pulp	Marketed in fresh / ensiled form as pressed pulp or blended with molasses to give molassed sugar beet feed (MSBF)	High volumes, regionally important for France, Germany, United Kingdom & Poland.
Tomatoes	Pomace (skin, pulp & seeds)	Animal feed	High volumes, regionally important for Spain, Italy, Greece & Portugal, rich source of lycopene.
Vegetable oil & margarine	Crude & extracted press cake or spent meal	Production of fuels, industrial uses (kernel oil, wood, activated carbon)	High volumes of meal produced across Europe (~30 million tonnes, FEDIOL 2016), particularly in Germany, France, Spain, Netherlands & United Kingdom.

Vegetable oil	Olive stones	Production of fuels, industrial uses (kernel oil, wood, activated carbon)	High volumes, regionally important for Spain, Italy, Greece & Portugal.
Wheat milling products	Wheatfeed / wheat middlings	Feed for use by cattle, sheep and pigs	Production & processing widespread across EU-28.

4 Next steps

Production system and valorisation approaches will be researched and identified for each of the top 20 waste streams. These will be modelled in subsequent tasks, particularly in collaboration with colleagues experienced in environmental and economic modelling. This will help to assess whether the existing valorisation approach can be improved in terms of its relative position in the waste hierarchy.

A wider list having a greater level of granularity has been used as the input to the development of a Food Waste Compositional Database. This database will provide users with easy access to searchable data on the composition (nutrients, bioactives, etc.) of agri-food chain wastes to assist identification of valorisation & exploitation routes. The wider list containing 75 waste streams provides sufficient detail to allow each waste stream to be adequately described and its composition determined. An example is represented by apple pomace from the pressing of apple juice and pectin production, which appears as 'Apple, pomace' in the list of 37 priority waste streams. However, in the wider list of 75 priority waste streams, this is defined in greater detail as 'Apple, pomace (single-pressed)', 'Apple, pomace (double-pressed)' and 'Apple, pectin-extracted fruit', all of which can originate from the same production system.

The findings of this research are also of key importance for other workpackages within the REFRESH project, particularly for the development of pilot projects under 'Business Engagement – Frameworks for Action'. Understanding where the priorities are, and having the drive to implement innovative ideas in the area is something that will be picked up in forthcoming PWP meetings, involving key industry members including retailers, manufacturers and suppliers.

5 Conclusions

This piece of work is part of a two-step process to categorise and record the valorisation approaches and technologies currently used to exploit the top impacting waste streams. The first step has provided a systemic method to identify and prioritise the top waste streams across the EU, which has resulted in the 37 waste streams listed in Annex A. Following further refinement, the top 20 waste streams for further study within the REFRESH project were identified within this report. These are listed in Table 1.

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7 Annexes

7.1 Annex A: Medium list of waste streams appropriate for valorisation

The medium list of priority waste streams (organised alphabetically by food product) identified previously (Sweet, Bygrave, Moates and Waldron, 2016) along with their current management is shown in the table below.

Table 2: Medium list of waste streams appropriate for valorisation

Food product	Waste stream	Current management	Reference(s)
Ales	Malting by-products (malt powder, malt culms, malt residual pellets	Animal feed	Zero Waste Scotland 2014; Crawshaw 2001; KW Alternative Feeds 2016d,e
Ales	Barley screenings	Animal feed	Crawshaw 2001
Ales, lagers & spirits	Spent grains, distillers dark grain & draff	Animal feed, composting, anaerobic digestion	Fillaudeau et al 2005; Mathias et al 2015; Zero Waste Scotland 2014; Crawshaw 2001; KW Alternative Feeds 2016a,c,h
Ales	Spent hops	Soil conditioner, composting, anaerobic digestion; feed fraction	Zero Waste Scotland 2014; Crawshaw 2001
Ales	Surplus product / ullage	Feed for ruminant and monogastric animals	AC Shropshire Ltd 2015; Crawshaw 2001

Ales, lagers & spirits	Trub and yeast	Animal feed; marketed to the food and pharmaceutical industries; soil conditioner, sewer	Mathias et al 2015; Zero Waste Scotland 2014; Green Feeds Ltd 2016; AC Shropshire Ltd 2015; Crawshaw 2001; Talve 2001; Fillaudeau et al 2005
Apples	Pomace	Production of animal feed	Crawshaw 2001
Cheese	Whey	Production of foodstuffs (whey powder, demineralised whey, WPC, WPI, WPT, WPP, lactose, Ricotta cheese, cream), production of animal feed (raw for pigs, whey powder, lactose), production of fertilizer, production of microbial culture medium (whey powder, lactose), fermentation and anaerobic digestion, transformation to peptides and glucose	AWARENET 2004; Green Feeds Ltd 2016; AC Shropshire Ltd 2015; Crawshaw 2001; WRAP 2015
Cheese	Whey concentrate	Liquid feed for pigs	Crawshaw 2001; KW Alternative Feeds 2016j
Cheese	Whey permeate	Animal feed	Crawshaw 2001; KW Alternative Feeds 2016k
Cider/perry	Pomace	Animal feed, anaerobic digestion	WRAP 2012a; Crawshaw 2001
Eggs	Egg shell waste (shell)	Source of calcium for use in animal feed and pet food, landspreading, filler for use in plastics, other potential uses under investigation	Galloway 2013; EGGNOVO 2016; Capriovus 2016; Anon 2015
Fish & seafood	Mollusc shell / shell particles	Production of chemicals (plastics, paints), production of construction materials, production of fertilizer	AWARENET 2004

Lamb, beef, pork & poultry	Blood	Production of foodstuffs (raw, plasma, albumin), production of pharmaceuticals, plants, production of animal feed (blood meal, raw, albumin), anaerobic digestion	WRAP 2011; AWARENET 2004; Leo Group Ltd 2016
Lamb, beef, pork & poultry	Proteinaceous matter incl. Category 3 material from slaughter plus carcass fat	Production of chemicals (glue, gelatin, collagen, glycerin, soap), production of pharmaceuticals (Ca, P, gelatin, collagen, fat, insulin, heparin, pepsin, steroids, cholesterol), production of animal feed (meat meal, fat), production of foodstuffs (sausage casing, catalase, additives), anaerobic digestion	WRAP 2011; AWARENET 2004; Leo Group Ltd 2016
Lamb, beef, pork & poultry	Bones	Production of animal feed (fat, bone meal), production of chemicals (glue, detergent), production of foodstuffs / pharmaceuticals (gelatin), composting, anaerobic digestion, production of low gel, low viscosity products	AWARENET 2004; Leo Group Ltd 2016
Lamb, beef, pork & poultry	Hair, feathers, hooves & feet	Production of chemicals (glue, gelatin, collagen, glycerin, soap), production of pharmaceuticals (Ca, P, gelatin, collagen, fat, insulin, heparin, pepsin, steroids, cholesterol), production of animal feed (meat meal, fat), production of foodstuffs (sausage casing, catalase, additives), anaerobic digestion, composting, production of feather meal (animal feed and fertilizer), production of pillows & eiderdown	AWARENET 2004; Leo Group Ltd 2016
Lamb, beef, pork & poultry	White and red offal incl guts & giblets	Production of chemicals (glue, gelatin, collagen,glycerin, soap), production of pharmaceuticals (Ca, P, gelatin, collagen, fat, insulin, heparin, pepsin, steroids, cholesterol), production of animal feed (meat meal, fat), production of foodstuffs (sausage casing, catalase, additives), anaerobic digestion	AWARENET 2004; Leo Group Ltd 2016
Light wines	Pomace (skin and seeds)	Production of ethanol, extraction of antioxidants & pigments, production of grapeseed oil (cooking oil & beauty ingredient) & grapeseed flour (food ingredient), production of resveratrol, production of bio-based	AWARENET 2004; The Kerfoot Group 2016; McDougall 2014; Veuve Clicquot 2016; Anon 2016; A+S BioTec 2016; Martí et al, 2014

		packaging	
Margarine	Stalks, leaves, hulls	Production of animal feed, production of pharmaceuticals (terpenic acids, oleoropein)	AWARENET 2004
Margarine	Crude & extracted press cake or spent meal	Production of fuels, industrial uses (kernel oil, wood, activated carbon)	AWARENET 2004
Oranges	Peel, seed, membrane residue after juice extraction	Cattle feed	Wilkins et al 2007; Crawshaw 2001; KW Alternative Feeds 2016b
Oranges	Citrus zest and peel	Food ingredients (zest & peel)	Orchard House Foods 2016
Potatoes	Fibre from potato starch production	Production of animal feed	AWARENET 2004
Potatoes	Concentrated fruit juice / protein from potato starch production	Protein extraction, production of animal feed	AWARENET 2004
Potatoes	Peelings	May be used directly as potato feed or combined with potato puree to give potato puree feed	Somsen 2004; Crawshaw 2001
Spirits	Organic wastes, mash from grain, fruit or potato	Animal feed, composting	WRAP 2012b, WRAP 2013

Spirits	Pot ale (still residue post-distillation)	Animal feed, anaerobic digestion	WRAP 2012c; Zero Waste Scotland 2014; Crawshaw 2001
Sugar	Sugar beet pulp	Marketed in fresh / ensiled form as pressed pulp or blended with molasses to give molassed sugar beet feed (MSBF)	AWARENET 2004; Crawshaw 2001; KW Alternative Feeds 2016g
Tomatoes	Pomace (skin, pulp & seeds)	Animal feed	Lazos and Kalathenos 1988
Vegetable oil	Crude press cake	Production of fuels, industrial uses (kernel oil, wood, activated carbon)	AWARENET 2004; KW Alternative Feeds 2016f
Vegetable oil	Olive stones	Production of fuels, industrial uses (kernel oil, wood, activated carbon)	AWARENET 2004
Vegetable oil	Extracted press cake or spent meal	Production of fuels, industrial uses (kernel oil, wood, activated carbon)	AWARENET 2004
Vegetable oil	Gums	Production of animal feed, production of pharmaceuticals (lecithin, phosphatides)	AWARENET 2004
Vegetable oil	Distillate	Production of animal feed, production of pharmaceuticals (vitamin E, sterols)	AWARENET 2004

Wheat milling products	Wheatfeed	Feed for use by cattle, sheep and pigs	Crawshaw 2001; KW Alternative Feeds 2016i
Wheat milling products	Wheat middlings	Feed for use by cattle, sheep and pigs	Crawshaw 2001

7.2 Annex B: De-selection of food waste streams

The deselected waste streams (organised alphabetically by food product) along with the reason for their deselection are shown in the table below.

Table 3: De-selected food waste streams

Food product	Waste stream	Current management	Reason for deselection
Ales	Malting by-products (malt powder, malt culms, malt residual pellets	Animal feed	Total volume is low compared to the volumes of other solid wastes (e.g. spent grains) arising from production of ales.
Ales	Barley screenings	Animal feed	Total volume is low compared to the volumes of other solid wastes (e.g. spent grains) arising from production of ales.
Ales	Spent hops	Soil conditioner, composting, anaerobic digestion; feed fraction	Total volume is low compared to the volumes of other solid wastes (e.g. spent grains) arising from production of ales.
Ales	Surplus product / ullage	Feed for ruminant and monogastric animals	Total volume is low compared to the volumes of solid wastes arising from production of ales.
Ales, lagers & spirits	Trub and yeast	Animal feed; marketed to the food and pharmaceutical industries; soil conditioner, sewer	Total volume is low (1.5kg/hl) compared to the volumes of other solid wastes (e.g. spent grains 20kg/hl) arising from production of ales, lagers & spirits.
Cheese	Whey concentrate	Liquid feed for pigs	Amalgamated with 'Cheese – Whey' due to common production line

Cheese	Whey permeate	Animal feed	Amalgamated with 'Cheese – Whey' due to common production line
Fish & seafood	Mollusc shell / shell particles	Production of chemicals (plastics, paints), production of construction materials, production of fertilizer	Total waste (~620,000 tonnes/year, AWARENET 2004), although locally significant, is low compared to other waste streams.
Margarine	Stalks, leaves, hulls	Production of animal feed, production of pharmaceuticals (terpenic acids, oleoropein)	Amalgamated with 'Cheese – Whey' due to common production line
Margarine	Crude & extracted press cake or spent meal	Production of fuels, industrial uses (kernel oil, wood, activated carbon)	Amalgamated with 'Vegetable oil – Crude press cake' due to common production line
Oranges	Citrus zest and peel	Food ingredients (zest & peel)	Amalgamated with 'Oranges - Peel, seed, membrane residue after juice extraction' due to common production line
Potatoes	Concentrated fruit juice / protein from potato starch production	Protein extraction, production of animal feed	Amalgamated with 'Potatoes – Fibre from potato starch production' due to common production line
Spirits	Pot ale (still residue post-distillation)	Animal feed, anaerobic digestion	Total volume is low compared to the volumes of solid wastes arising from production of spirits.
Vegetable oil	Extracted press cake or spent meal	Production of fuels, industrial uses (kernel oil, wood, activated carbon)	Amalgamated with 'Vegetable oil – Crude press cake' due to common production line
Vegetable oil	Gums	Production of animal feed, production of pharmaceuticals (lecithin, phosphatides)	Total volume is low compared to the volumes of solid wastes (press cake) arising from production of vegetable oil & margarine.

Vegetable oil	Distillate	Production of animal feed, production of pharmaceuticals (vitamin E, sterols)	Total volume is low compared to the volumes of solid wastes (press cake) arising from production of vegetable oil & margarine.
Wheat milling products	Wheat middlings	Feed for use by cattle, sheep and pigs	Amalgamated with 'Wheat milling products – Wheatfeed' due to common production line.