D6.7 Supplementary materials

This document should only be read in conjunction with the *REFRESH Technical Guidelines on Animal Feed – The safety, environmental and economic aspects of feeding treated surplus food to omnivorous livestock* by Luyckx et al. (2019), available from https://eu-refresh.org/results.

1 Brussels expert panel agenda and participants

REFRESH Animal Feed Technical Seminar Programme 29- 30 October 2018

Monday 29 October 14:00 – 17:45
Venue: GS1, Blue Tower, Avenue Louise 326, 1050 Brussels (Tramstop Vleurgat on tramlines 8 and 93) 14th floor, meeting room "Trust". GS1 Contact person: Diane Taillard If you have trouble finding us: Laetitia +44 7561 321 472 Martin + 44 7816 088210 Karen +44 758 321 0525
PART 1: System design Key participants: • Professor Tomoyuki Kawashima, Ecofeed Expert, Miyazaki University • Dr. Juan Hernandez, porcine health management expert from Cambridge University / European Board of Veterinary Specialisation • Paul Featherstone, President of the European Former Foodstuff Processors Association, and Chairman of the UK Former Foodstuff Processors Association • Arne Skjoldager, Vice President of the Federation of Veterinarians of Europe • Ir. Peter Geerdink, University of Wageningen, specialised in scale up of food process, side-stream valorisation and protein engineering

• Diane Taillard, Director, Consumer Safety and Traceability, GS1 • Dr Jennifer Davis, LCA expert of Research Institute Sweden (only Tuesday LCA workshop) • Wolfgang Trunk, DG Sante, European Commission Via conference call: • Dr Fabio de Menna, LCC expert, University of Bologna (only Tuesday LCA workshop)			
	14:00 - 14:40	**Introduction to Japanese system**	• Presentation y Tomo: Overview of Japanese processing system focussed on mixed food waste from retail and catering. • Questions and clarifications
	14:45 - 16:15	**Traceability workshop**	This workshop will be led by Diane Taillard who will present an initial proposal for managing traceability in mixed food wastes in non-ruminant feed in Europe, as a starting point for discussions to begin developing traceability recommendations.
	16:30 - 17:45	**Systems design and upscaling workshop**	In this workshop, Peter Geerdink will discuss the work planned by the Wageningen system engineers on upscaling the system we know from JFEC. Peter will work with the other participants to develop the processing flow scheme that will be used for the up-scale modelling
	Conference call details for Monday 29 October Join from PC, Mac, Linux, iOS or Android: https://zoom.us/j/652563785 Or iPhone one-tap : US: +16699006833,,652563785# or +16468769923,,652563785# Or Telephone:		

	Meeting ID: 652 563 785 Find your national dial-in number here: https://zoom.us/u/abkny4Wmie	
	Tuesday 30 October	
	Venue: European Institute for Asian Studies (EIAS) 26, Rue de la Loi, 10th fl. | B-1040 Brussels Metro Stop Arts – Loi / Kunst- Wet on Metro lines 2 and 6 If you have trouble finding us: Laetitia +44 7561 321 472 Martin + 44 7816 088210 Karen +44 758 321 0525	
	09:30 - 10:30	**LCA / LCC workshop** (participants as part 1 System Design)	Jennifer Davis and Fabio de Menna will present intermediary results of the REFRESH LCA and LCC analyses using the operational cost data provided by JFEC, food waste compositional data for the UK and France and feed market data. The session is aimed at improving the interpretation of the data and analysis through conversation with the other experts.
		Break	
	Part 2: Nutrition (Venue EAIS as above) Key participants: • Professor Tomoyuki Kawashima, Ecofeed Expert, Miyazaki University • Dr. Juan Hernandez, porcine health management expert from Cambridge University / European Board of Veterinary Specialisation • Prof Pier Sandro Cocconcelli, EFSA Feedap 2015 - 2018 • Dr Hannah Van Zanten, Feed and livestock LCA expert, University of Wageningen • Prof Helen Miller, Pig Nutrition Expert and Leeds University Farm Manager • Paul Featherstone, President of the European Former Foodstuff Processors Association, and Chairman of the UK Former Foodstuff Processors Association • Arne Skjoldager, Vice President of the Federation of Veterinarians of Europe • Wolfgang Trunk, DG Sante, European Commission		

	Via conference call (specific sessions TBC): • Ir. Carine van Vuure. Nutrition, Regulatory Affairs & Market Access, Darling Ingredients International (only Nutrition workshop 1) • Inge Verwoerd, Agricultural Industries Confederation, Technical Manager for Feed and FAR (Feed Adviser Register) and Adviser UKFFPA • Professor Marcel Zwietering, Dr Masja Nierop-Groot and Dr Hasmik Hayrapetyan, Wageningen University microbiologist (only Nutrition workshop 2)		
	11:00 - 12:30	**Workshop on Nutrition 1**	• New introductions • Presentation by Tomo: food waste feed formulation and the effects of ecofeed on animal performance. • Presentation by Hannah to share initial findings of energy and lysine availability in mixed food waste streams in the UK and France • Discussion to develop criteria / recommendations for ecofeed formulation with a focus on optimum ecofeed / conventional feed mix
	Lunch		
	13:45 - 15:30	**Workshop on Nutrition 2 and Microbiological Safety**	• Presentation by Wageningen University microbiologists on disease inactivation options (heat treatment, fermentation- acidification). • Discussion on impact of disease inactivation on nutrition, with focus on liquid feed. • Brainstorm on recommendations for policy makers, industry and academia.
	Conference call details		

	Join from PC, Mac, Linux, iOS or Android: https://zoom.us/j/873093975 Or iPhone one-tap : US: +16699006833,,873093975# or +16468769923,,873093975# Or Telephone: Meeting ID: 873 093 975 Find your national dial-in number here: https://zoom.us/u/abJBz8HKCT		
		Break	
	16:30 - 18:00	**Public policy seminar for EU civil servants, MEP advisers, other policy makers and industry representatives**	See separate invitation

2 Disease Table

In this table, we list diseases affecting pigs, information on their heat sensitivity and any relevant information on transmission. We understand these disease are not normally transmitted via feed, but we have not been able to determine whether transmission via feed is a theoretical risk.

Name of Disease	Heat Sensitivity	Transmission
Nipah	inactivated by heating at 100°C for more than 15 minutes[1]	To date, Nipah has only been reported from Malaysia, Bangladesh and India.
Transmissible gastroenteritis (TGE)	inactivated after 45 minutes at 50°C[2]	
Crimean-Congo Hemorrhagic Fever	destroyed by heating at 56°C (133°F) for 30 min[1]	
Encephalomyocarditis (EMC)	inactivated at 60°C for 30 minutes[3]	
Erysipelas	rapidly destroyed by heat[3]	

Swine Influenza	Influenza A viruses can be inactivated by heat of 56- 60°C (133-140°F) for a minimum of 60 minutes (or higher temperatures for shorter periods) [1]	Viruses spread by snout to snout contact, droplet infection and aerosol from pig to pig within a pen or within an airspace, and from contaminated drinkers, feeders and toys. Recovered pigs may be carriers of the virus and be responsible for spreading the infection to naïve animals. Spread from farm to farm is usually be means of carrier pigs, but aerosol infections occur, particularly in pigs with access to the open air or those housed outside. Influenza viruses can be introduced to pig units by humans and by birds[1]
Echinococcus	inactivated by heat (hot water of 85°C or above is effective) [1]	
Trichuris eggs	destroyed by dehydration and sunlight. T. trichiura eggs die above 52ºC	
Trichinella spiralis	is killed in 47 minutes at 52°C (125.6°F), in 6 minutes at 55°C (131°F), and in < 1 minute at 60°C C (140°F)[4]	
Japanese Encephalitis	Destroyed by heating for 30 minutes above 56°C; thermal inactivation point (TIP) is 40°C[5]	
New World Screwworm	larvae can be killed by immersion in hot water (> 80 °C) for 15-30 s and then stored in formalin or 80%-100% ethanol at ambient or lower temperatures[6]	
Trypanosomes (incl. Surra)		Only survive short periods outside the host. T. evansi disappears quickly from the carcass after death. Flies no longer transmit the parasites after 8 hours[5]
Taenia solium (Porcine cysticercosis)	Cysticerci can be killed by cooking meat to 56°C throughout[5]	
Transmissible gastroenteritis	Inactivated after 45 minutes at 50°C	
Porcine parvovirus	killed after exposure to 80°C for 5 minutes[3]	
Pasteurellosis P. multocida	killed by heating to 60°C[3]	
Porcine Circovirus		Occurs by direct contact[1]

Key to Sources (full references in main D6.7 report):

1 = CFSPH. Swine Diseases and Resources of the Centre for Food Security and Public Health of the University of Iowa (CFSPH 2018). Disease Information produced by the CFSPH of the University of Iowa is frequently used by the OIE (see for OIE example technical disease card for Avian Influenza)

2 = Veterinary Diagnostic and Production Animal Medicine - Index of Diseases (Iowa State University, 2018)

3 = Pig Progress A-Z Pig Diseases https://www.pigprogress.net/Health/Health-Tool/

4 = Animal and Plant Health Inspection Service. US Department of Agriculture. https://www.aphis.usda.gov/vs/trichinae/docs/fact_sheet.htm

5 = OIE Technical Disease Cards. http://www.oie.int/animal-health-in-the-world/technical-disease-cards/

6 = Mastrangelo, T. and Welch, J.B., 2012. An overview of the components of AW-IPM campaigns against the New World screwworm. *Insects*, *3*(4), pp.930-955.

3 Traceability for transforming mixed food wastes into non-ruminant feed in Europe

Author: Diane Taillard, GS1

The objective of this section is to provide a starting point to develop further recommendations, should the use of mixed food wastes for non-ruminant feed be allowed in Europe. It focuses on achieving traceability across the supply chain when involving multiple operators. It is based on the core of regulatory requirements and industry best practices in adjacent sectors.

3.1 About traceability

Traceability is the ability to trace the history, application or location of an object (ref. ISO 9005:2015). When considering a product or a service, traceability can relate to : origin of materials and parts; processing history; distribution and location of the product or service after delivery.

Traceability has become a priority in many sectors across the world. In addition to enabling efficiencies in logistics and other business processes, traceability is a key element to manage quality and safety : it enables fast and targeted recalls, helps combat counterfeiting and fraud, enables more informed decision making to manage risks in procurements. Moreover, in sectors such as the food sector, traceability has become critical to enable

transparency and meet the increasing consumer demand for information about the product they are eating and its origin. In short, traceability is the ability to respond to questions about a product and its supply chain.

3.2 Traceability for mixed food waste in feed

In the context of managing mixed food wastes in non-ruminant feed, the need for traceability is particularly driven by the need to ensure safety and to meet market expectations and the regulatory framework from the food sector.

Mixed food waste involves high risks ingredients such as meat, fish, or eggs. Heat treatment during processing is expected to address the risks yet it is the expectation of the food industry to have traceability and to know were food and its ingredients come from. Moreover there is no risk zero (risks are not only microbiological) and it is important to be ready to handle recalls just like for any food and feed product.

3.3 Responsibilities

Traceability across the supply chain relies on the responsibility from each successive operator.

Each member of the supply chain should, at a minimum, be able to trace back to the direct suppliers of the products they received, to what happened (ref. critical tracking events) while the products were under their responsibility and to track forward to the direct recipients of the products. They should manage their internal traceability and external traceability with their trading partners.

This enables the possibility for all parties to gain access to relevant data further upstream and downstream through queries of direct trading partners, often referred to as a “one-step-up, one-step-down” approach.

Depending on each specific supply chain, some operators may have to manage more traceability information or to handle more complexity than others. For example, traceability for a pig farmer who only has one supplier for feed with mixed food waste is likely to have a more simple traceability system than a feed processor with multiple food waste suppliers and customers.

Fig n - Supply chain for mixed food waste to non-ruminant feed

The food waste supplier can be :

- Retailer
- Food manufacturer
- Catering
- Rendering processor or slaughterhouse

Wholesalers, carriers or third party logistics can be involved in between these key actors.

3.4 Traceability principles

A few principles are core to traceability whatever the technologies, sectors and applications of traceability. They would apply as well to mixed food waste for feed.

Traceability means managing a flow of information in parallel to the physical flow. The links between the successive products should be maintained whatever the events and transformation that may occur. So does the link between the data that are produced and the physical items. In order to do so, foundational functions from traceability systems are :

- identification of products, locations and parties;
- labelling of all products and levels of packaging;
- data capture and recording;
- enabling access to the data, i.e. data sharing

At the heart of any traceability system is the identification of the products. Generally three main levels of identification can be distinguished : Class-level identification, Batch/lot-level identification, Instance-level identification. The level of identification is usually chosen considering the level of the risks when safety is the driver for traceability, balancing risks/benefits and feasibility/costs to implement.

3.5 Traceability data

Traceability is powered by data. Traceability data is generated through execution of a variety of business processes carried out by each organisation.

Each organisation should first look at its internal business processes. The organisation should identify which steps in those business processes are important from a traceability perspective, at minimum for safety. Subsequently, the organisation will need to establish processes to define and capture all of the relevant data about these business process steps.

At the core of this are two concepts:

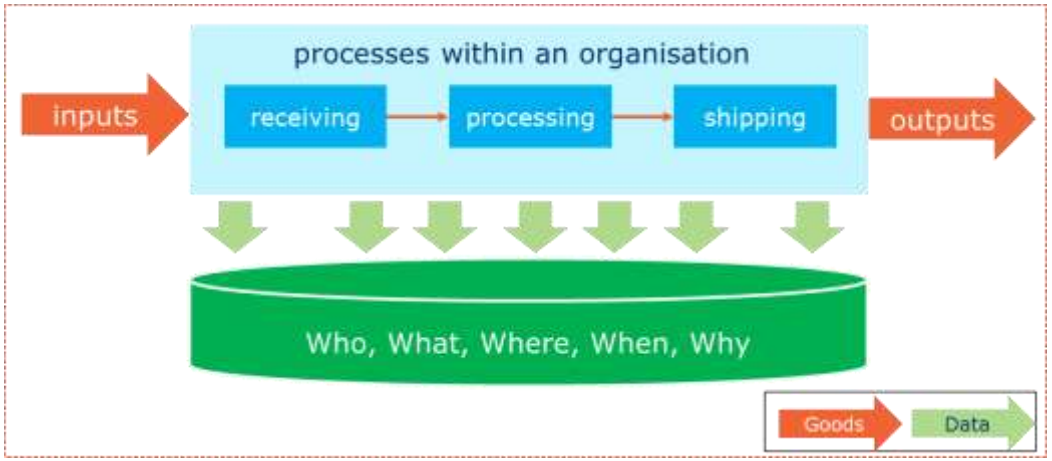
- Critical Tracking Events (CTEs)

  These are the actual events that occur to the traceable objects during their lifecycle, such as receiving, transforming, packing, shipping, transporting.

- Key Data Elements (KDEs)

  These are the pieces of data that describe the actual instances of the CTEs. The data will commonly cover five dimensions : Who, What, Where, When, Why.

Figure n Generation of traceability data - single company view (source : GS1)



When we extend the view to a full supply chain, it becomes clear that each organisation will manage its own set of traceability data. In order to achieve end-to-end supply chain traceability, it will be necessary to access and combine data from multiple organisations.

3.6 Data sources

Four sources or types of data have to be considered. They may be managed in different systems of an organisation and with different technologies, but together they provide the full context of traceability data.

- Master data: they are the single source of common business data used across all systems, applications, and processes for an entire organisation. They are typically static data about products (e.g. product name, product code, composition…), locations and assets, relation data about customers and suppliers.
- Transaction data: They are recorded as a result of business transactions, such as the completion of a transfer of ownership (e.g. orders, invoices) or a transfer of custody (e.g. transport instruction, proof-of-delivery).
- Visibility event data: They are records of the completion of business process steps in which the products are handled, e.g. producing, shipping, receiving. Each visibility event captures who was involved, what products participated in the process, when the process took place, where the objects were and will be afterwards, and why the product participated in the process (who, what, where, when, why).

3.7 Interoperability

Traceability data are spread among many stakeholders along the chain. All these stakeholders have different traceability systems. In order to access information from upstream or downstream trading partners, these traceability systems needs to be able to talk to each other or be "interoperable".

This does not mean that all actors in the supply chain need to use exactly the same systems, but to ensure that their various systems use a common language, i.e. that they are all built on a common set of standards. Their systems will be able to share information in an automated way and to understand the data in the same way.

GS1 standards are the common language for traceability solutions. The GS1 system of standards provides a comprehensive set of standards to identify, capture and share information about objects throughout their lifecycle, providing the core foundation for interoperability. They already power information sharing about products and places for more than one million companies across supply chains, including in the food and agriculture sector. Most GS1 standards are ISO standards. GS1 standards are developed and maintained by GS1, a neutral, not-for-profit, global organisation with local organisations in 110 countries.

Figure n The GS1 system of standards

3.8 In practice

Collaboration is fundamental to traceability. Each company will need to define the exact data they will manage for traceability and to decide how they will capture, record and potentially share them (process, technology and tools). Discussion with direct trading partners and within the sector with all

stakeholders including authorities best enables to have efficient traceability systems to meet everyone's needs and constraints and to ensure the sustainability of everyone's investments (ref. interoperability).

Beyond the minimum about "who, what, where, when, why" for each Critical Tracking Event including :

- identification of the stakeholder involved / supplier/ customer
- identification of the products involved (corresponding to the marking) at every level of packaging and quantities
- identification of the locations
- date or time stamp
- nature of the events that happened (receiving, aggregating, shipping… including links between inputs and outputs when involved a transformation, mode of treatments…)

the following information may be relevant to record or not for example :

- Some dates (expiry date, product date…)
- Information about species, or just when a specific species is involved (e.g. capturing when beef is involved or just ensuring there is no left over from pork pie factory for example)
- Further information about the origin of the ingredients (more upstream suppliers or history of the product)
- information about the cold chain
- …

The following questions could also be considered :

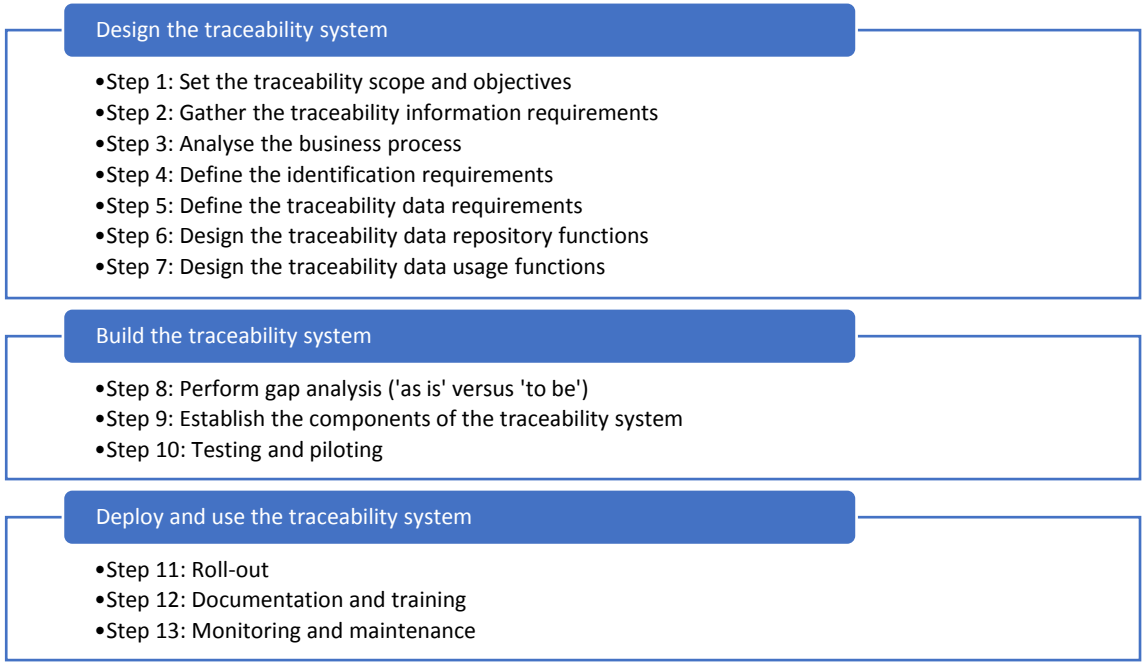
- To whom should the data be accessible ?
- How fast should the information be accessible ?
- How long should it be recorded ?
- How important is data quality ?
- Do some data need to be authentified ?
- How precise does the identification of the products need to be ?
- Which technologies will be used to capture the data (handwriting, scanning with barcodes, RFID…), to record and share the data (paper, EDI, internet, blockchain….) ?

- ...

Best practices for traceability in the supply chain and existing industry practices and legal framework in adjacent sectors such as the food sector, former foodstuff or petfood are good references for the above discussions.

The following methodology to design traceability systems can be used :

Figure n Traceability Methodology (source : GS1)



4 Legislative systems for feeding food waste to pigs

Country	System	Country currently officially free from FMD, BSE and CSF? (OIE 2018a)	Heat treatment requirements?	Acidification requirements?
Japan	Licensed premises or farms have to heat livestock feed containing meat or catering/household food waste to regulated temperatures, before can be fed to non-ruminants. Strict regulations keep ruminant and non-ruminant feed, and processed and unprocessed feed, separate.	Free from FMD without vaccination, negligible BSE risk status, free from ASF (OIE 2018a) No disease outbreaks linked to the use of swill in Japan and South Korea (Muroga et al., 2012; Park et al., 2013, from zu Ermgassen, 2016). FMD outbreak in 2010/11, and BSE outbreak in 2001. CSF outbreak in 2018, not considered to be linked to ecofeed.	Yes. Any by-products and former foodstuffs containing Animal Origin Protein, and all catering and kitchen waste, must undergo heat treatment to inactivate pathogenic micro-organisms (30 minutes or more at 70 °C or for 3 minutes or more at 80 °C (MAFF 2006).	Not required by law. But practiced in some pigfeed factories – for instance, the Odakyu Food Ecology Centre inoculates its feed after heat treatment with Lacto-bacillus, a bacterium similar to that used to turn milk into yoghurt, which lowers the pH.
US	Licensed premises must boil livestock feed containing meat or catering/household food waste to regulated temperatures, before can be fed to non-ruminants. Exemptions allow individuals to feed household garbage to their own swine.	Free from FMD without vaccination, negligible BSE risk status, free from ASF (OIE 2018a) The United States has been free of foot-and-mouth disease (FMD) since 1929.	Yes. The federal Swine Health Protection Act (SHPA) requires that before feeding to pigs, animal-based "garbage" must be heated at boiling temperature (212 degrees Fahrenheit/100 degrees Celsius at sea level) for at least 30 minutes by someone who holds	No. However, food scraps consisting of animal products that were industrially processed or rendered can be fed to pigs without being brought to boiling temperature for at least 30 minutes if they have either already been heat-treated to

		(according to industry) (FootAndMouthDiseaseInfo.org 2018) (A.P.H.I.S. 2013). Classical swine fever (hog cholera) eradicated from US in 1978.	a valid license or permit for the treatment of garbage (Leib et al. 2016, 3)	this level in processing/rendering or been "subjected to an industrial process demonstrated to provide an equivalent level of inactivation of disease organisms" (Leib et al. 2016, 3). So acidification, if it rendered food safe, could be used in substitute for heat treatment in this case.
New Zealand	To our knowledge, most treatment happens on-farm.	Free from FMD without vaccination, negligible BSE risk status, free from ASF (OIE 2018a)	Pig feed must be boiled at 100 degrees Celsius for one hour, while stirring frequently (New Zealand Legislation 2005)	No
Pre-Foot and Mouth UK system	Legal to feed catering food waste and food waste containing animal products to non-ruminants, as long as it is heat treated to regulation temperatures first.	BSE outbreak between 1986 and 2001, FMD outbreak in 2001 linked to animal feed not properly heat treated.	Food waste Order 1973, and the subsequent Animal By-Products Order 1999 (UK Government 1999) and its amendments required that any waste containing meat be cooked (100°C for 1 hour)	No. Although one approved rendering method (for equatic animals) does include both heat treatment and mixing the feed with formic acid to reduce the pH to an approved level (UK Government 1999 Part II, Method 6).
UK and EU – current system	EU Regulation 999/2001 bans using animal protein in animal feed – from 2002 onwards this has included non-ruminants/omnivores EU Regulation 1069/2009 bans using kitchen left-overs and catering waste for livestock feed	UK's current status: Free from FMD without vaccination, controlled BSE risk status, free from ASF (OIE 2018a)	N/A – because blanket ban on catering waste and feed containing animal protein	N/A – because blanket ban on catering waste and feed containing animal protein

	Farms can mix or process feeds on their own farm (Red Tractor 2010)			
Japan	Not sure.	Japanese law prohibits the entry of animal by-products without permission from the "Animal Quarantine Service" (MAFF 2017a) Separation of Category A and B feedstuffs is also enforced at the importation stage (MAFF 2017a).	Yes. Animal feed is divided into 2 categories: 1) Category A, Feedstuffs permitted for ruminants, and Category B: All other feedstuffs, only permitted for poultry, pigs and fish. Rigorous regulations ensure these do not come into contact (MAFF 2017a).	Yes. See hygiene requirements according to legislation in Part 7 of these supplementary materials.

US	Yes. Most US states (48 out of 53) allow individuals to feed household garbage to their own swine, usually without requiring a license, usually on condition that the pigs should not be sold or removed from the premises, and should be only for the owner's use only (Leib et al. 2016). The federal Swine Health Protection Act (SHPA) does not regulate this type of pigfeed, including unprocessed meat which has not undergone the SHPA boiling procedure (Leib et al. 2016, 3). However, although 15 states have prohibited both individuals and facilities from feeding to swine any food scraps containing any animal parts or material, and 9 of these states go even further and ban the feeding of vegetable waste to swine (Leib et al. 2016, 8).	The state of Georgia only allows the "feeding of animal-derived and vegetable waste to swine provided that it is fed by a licensed facility that does not import or export swine or swine products to or from the premises" (Leib et al. 2016, 21)	Yes. The Food and Drug Administration's (FDA) Bovine Spongiform Encephalopathy (BSE)/Ruminant Feed Ban Rule prohibits the use of mammalian protein (i.e., animal tissue) in feeds for ruminant animals (Leib et al. 2016, 4)	Yes. The federal Swine Health Protection Act (SHPA) : Untreated garbage must be stored in covered, leak-proof containers until it is treated (US Government 1982). Treated garbage must not come into contact with untreated garbage or with containers or vehicles that were used for untreated garbage before disinfection with approved disinfectants.

New Zealand	Imports: Importer must ensure that "the imported feed does not have physical contamination of a type or nature at a level that will result in harm to the animal for which the feed is intended" (Ministry for Primary Industries 2018b). Exports: There are no legal requirements for export-only pet food, animal feed, and dietary supplements under the Agricultural Compounds and Veterinary Medicines (ACVM) Act 1997. However, export-only product must be kept separate from product to be sold in New Zealand. (Ministry for Primary Industries 2018a).	Ruminant feed must be kept separate from ruminant protein – for instance, through storing ruminant feed away from sources of contamination (Ministry for Primary Industries 2018c)

5 Consumer Survey – Attitude to pork from pigs reared on food waste feeds

5.1 Objective:

To study the attitudes of UK consumers to eating and buying "eco-pork" from pigs reared on food surplus – including issues of perceived safety and environmental impact.

5.2 Methodology:

An online survey was created on SurveyMonkey, and then distributed primarily via newsletters to the mailing lists of Wahaca restaurants, Feedback's supporters, Riverford Organics customers and Leon customers, compromising 90% of respondents. The remaining 10% was from the combination of Bath & North East Somerset Council staff internally circulating the survey, a mention in a Women's Institute newsletter, and social media sharing from Toast Ale, Sustainable Food Cities, Mumsnet and Our Bright Future.

Sources of information:

Source	No. of respondents	% of respondents
Wahaca customers – mailing list	1,822	52%
Feedback supporters – mailing list	679	19%
Riverford Organic customers – mailing list	350	10%
Leon customers – mailing list	344	10%
Bath & North East Somerset Council	102	3%
Women's Institute	93	3%
Others	101	3%
Total	**3,491**	**100%**

5.3 Possible biases (summary):

It is possible that this survey was vulnerable to self-selection biases – people more likely to have a pre-formed opinion on the issue may have been more likely to fill out the survey – and this must be considered when interpreting the below. If self-reporting of buying behaviour is to be trusted, buyers of higher welfare pork (organic and free-range) were also over-represented in the study, and this may have affected the results – so results for buyers of different types of pork have been disaggregated for key question results. Feedback supporters may also have been exposed to Feedback's Pig Idea campaign, which argues in favour of changing the law to expand the feeding of surplus food to pigs. Wahaca's customers may have been exposed to Pig Idea campaign communications also – but as Wahaca had not communicated on this issue since 2014, many of the respondents from their mailing list would be likely not to have heard of the campaign. When excluding Feedback and Wahaca respondents, however, this did not significantly affect the results. Supporters of environmental groups like Feedback, and customers of environmentally conscious businesses like Riverford Organic, Wahaca and Leon may also be more likely than most to care about environmental issues than the general population. All of these potential biases should be considered when approaching the results of this survey. Regardless of the representativeness of the survey of the general UK population, it demonstrates the significant enthusiasm of a notable segment of society for eco-pork, and indicates the high potential for broad-based support, particularly after greater awareness raising and public education on the subject. More detail on potential biases can be found in the section "Possible biases" at the end of this document.

5.4 Demographics:

- **33% of respondents were aged 30-45, 21% were aged 18-30, 27% were aged 45-60, 17% were over 60, and only 1% were under 18.**
  - **Wahaca restaurant customers** were more likely to be aged 18-45.
  - **Feedback supporters** were likely to be older – with 30% aged 45-60, 25% 30-45 and only 10% 18-30 (though still a low number over 60).
  - **Riverford customers** were the oldest group – with 47% over 60 and 35% 45-60.
  - **Leon customers** were more likely to be aged 30-45 (46%)
- **61% of respondents lived in a household with 1-2 people, followed by 32% with 3-4 people, 6% with 5-6 people and 1% with 6 + people.**
  - **Wahaca customers** are mildly less likely to be in a 1-2 person household, and slightly more likely to live in a 3-4 person household

  - **Feedback supporters** were morely likely to live in a 1-2 person household (66%) and less likely to live in a 3-4 person household (27%).
  - **Riverford customers** were more likely to live in a 1-2 person household (70%) and less likely to live in a 3-4 person household (24%)
  - **Leon customers** were very slightly more likely to live in a 3-4 person household (36%).
- **71% of respondents lived in urban regions, and 29% lived in rural regions.**
  - **Wahaca customers** are slightly more likely to live in urban regions (80% of respondents)
  - **Feedback supporters** were more likely to live in rural regions (43% of respondents)
  - **Riverford customers** were more likely to live in rural regions (47% of respondents)
  - **Leon customers** were more likely to live in urban regions (81% of respondents)
- **34% of the respondents usually buy mid-price range pork, 25% buy free-range pork, 14% buy organic pork and 4% buy value-range pork. 17% don't buy meat because they are vegetarian or vegan, and 5% don't buy meat for other reasons, like religion or cost.** In the survey answers below, non-meat eaters are sometimes filtered out of the results to gain a specific impression of the target audience for meat-eaters where appropriate.

5.5 Key Findings:

- **Q2 - Perceived environmental impact: 88% of respondents thought pork raised on food waste was more environmentally friendly than pork raised on conventional feed** – with 6% thinking they were about the same, 3% unsure, and only 2% thinking it was less environmentally friendly.
- **Q3 - Legal reform: 93% of respondents would "support the law being changed to allow more food waste to be fed to pigs, if this could be proved to be done safely"**, with 5% unsure, and only 2% not supporting the law being changed.
- **Q4 - Buying "eco-pork": When asked whether they would "buy pork which comes from pigs fed on food waste (after it's been heat-treated to make it safe)", 83% said yes (47% said they'd buy it in preference to other types of pork, and 36% said they'd give it a try), with 5% saying "maybe" and 12% saying "no".**

- **When counting only meat-eaters** – i.e. when those who do not eat meat because they are vegan/vegetarian, or don't eat meat for other reasons (e.g. religion, cost) are filtered out – **the proportion saying "no" falls to 2%, with 94% saying "yes"** (52% said they'd buy it in preference to other types of pork, and 42% said they'd give it a try) and 5% saying maybe.
- Within the meat-eaters category, consumers of organic and free-range pork were more likely to say that they'd buy eco-pork in preference to other types of pork (58% of free-range pork buyers and 56% of organic pork buyers chose this option), whereas a slightly lower percentage of mid-price and value-range pork chose this option (48% and 39% respectively). However, the percentage of people saying "no" they wouldn't try eco-pork remained 1-2% of respondents for all meat-eating respondents, and the percentage of respondents saying "maybe" also remained at around 4-5% for all categories – except current buyers of organic pork, which was slightly higher at 7% "maybe" - possibly indicating concerns over whether the surplus food fed to pigs would be organic. Thus, those not choosing to buy eco-pork in preference to other types of pork generally answered "Yes – I'd give it a try", with buyers of lower price pork more likely to choose this option, indicating they are slightly less enthusiastic than current buyers of organic and free-range pork, but generally very willing to try eco-pork.
- **Q5 - Price willing to pay for eco-pork: When asked "How much would you be willing to pay for "eco-pork" from pigs fed on food waste?", 51% of respondents said they'd be willing to pay extra as long as the pigs are guaranteed to have been reared to organic welfare standards, an additional 8% said they'd pay extra, 29% said they'd pay the same price as for average pork, but no more, 11% said they wouldn't buy it whatever the price, and only 1% said it would have to be cheaper than other pork for them to buy it.**
- **The number who wouldn't buy it whatever the price falls to 1% once non-meat eaters are excluded.**
- **This question was very sensitive to what types of pork customers currently bought** – for instance, the answer "I'd pay extra as long as the pigs are guaranteed to have been reared to organic welfare standards" was selected by 79% of respondents for organic pork buyers and the figures for buyers of other types of pork were 67% (free-range), 39% (mid-price) and 31% (value-range). We can thus see that **if eco-pork was priced at a premium, the main markets would be from the current buyers of organic and free-range pork, but potentially about a third of buyers of mid-range and value-range pork too.** 49% of buyers of mid-range pork would pay the same price as for average pork, but no more, increasing to 56% for buyers of value-range pork, whereas this falls to 20% for free-range pork buyers and 10% for organic pork buyers. We can thus see that **if eco-pork was priced at the same level as average pork, it would attract considerably more buyers from the mid-range and value-range pork markets.**

- **Q6 - Attitudes to different food waste feeds: When asked "How comfortable would you feel about the inclusion of the following in pig feed?", respondents gave the following responses:**

Foodstuff	Weighted average (Very comfortable = +2, Quite comfortable = +1, Indifferent/unsure = 0, Quite uncomfortable = -1, Very uncomfortable = -2,)	Standard Deviation
Mixed restaurant leftovers (may contain meat, heat-treated)	0.83	1.27
Confectionery like biscuit crumbs from factories	1.23	1.14
Unsold bread from supermarkets	1.56	0.88
Unsold egg sandwiches from supermarkets (heat-treated if risk come into contact with meat)	1.15	1.14
Unsold bacon sandwiches from supermarkets (heat-treated)	-0.45	1.54
Unsold chicken sandwiches from supermarkets (heat-treated)	0.58	1.39
Mixed household food leftovers (may contain meat, heat-treated)	0.72	1.28

5.6 Discussion

- **Respondents feel somewhere between quite and very comfortable with food surplus not containing meat being fed to pigs** – including eggs which are heat-treated if there is a risk they have come into contact with meat.
- **Respondents feel generally quite comfortable with heat-treated mixed restaurant leftovers which may contain meat being fed to pigs. They are slightly more uncertain about heat-treated mixed household food leftovers which may**

contain meat, and unsold chicken sandwiches from supermarkets (heat-treated), but are still on average closer to being "quite comfortable" with these being fed to pigs than "indifferent/unsure". There is a larger standard deviation for these categories of food surplus, indicating some variety of opinion – for instance, 12% of respondents felt very uncomfortable with unsold chicken sandwiches being fed to pigs, and 12% felt quite uncomfortable (the highest level of discomfort for products except pork – see below).

- We examined the level of comfort with heat-treated mixed restaurant leftovers which may contain meats disaggregated by which types of meat consumer current buy – the values were: respondents who currently buy organic pork (+0.95), free-range pork (+0.89), mid-range price (+0.97) and value-range (+1.02). This indicates broadly positive reactions across the spectrum amongst the meat-eaters – the overall average is skewed downwards by vegetarian/vegans (see below).

- **The only surplus food which respondents were on average uncomfortable about was "Unsold bacon sandwiches from supermarkets (heat-treated)" – they were on average between indifferent/unsure and quite uncomfortable (-0.45).** This is also the category with the largest standard deviation of responses. **When non-meat eaters are excluded from the results, the level of discomfort slightly falls to -0.36.**

- **Among meat-eaters, 20% are very comfortable with heat-treated bacon sandwiches from supermarkets being fed to pigs, 11% are quite comfortable, 15% are indifferent/unsure, 20% are quite uncomfortable and 34% are very uncomfortable.** This illustrates that this is a very divisive issue. It is **worth noting that even with minimal public information assuring the public that feeding pork to pigs is safe, 31% of meat-eating respondents are already comfortable with this**, and on average the respondents were closer to indifferent/unsure than quite uncomfortable.

  - Within the meat-eaters, those who were comparatively less comfortable with heat-treated bacon sandwiches from supermarkets being fed to pigs were buyers of organic pork (39% very uncomfortable, 18% very comfortable, weighted average -0.53) and buyers of free-range pork (39% very uncomfortable, 16% very comfortable, weighted average -0.53). Consumers who were comparatively more comfortable with the bacon sandwiches in feed were buyers of mid-price range pork (29% very uncomfortable, 23% very comfortable, weighted average -0.21) and buyers of value-range pork (24% very uncomfortable, 31% very comfortable, weighted average +0.05). **This demonstrates that the level of discomfort with pigs eating pork tends to rise in consumers who buy higher animal welfare pork. This becomes particularly relevant if eco-pork is sold at a premium price, since as Q5 indicates, organic and free-range**

customers are the most enthusiastic about paying extra for eco-pork, mainly on the condition that it is raised according to organic welfare standards. There is a risk these consumers may not consider pigs raised on pork as conforming to high welfare standards. To test this hypothesis further, we filtered this question based on how people responded to Q5 – **but on average, those who were willing to pay extra for eco-pork were not more likely to be uncomfortable about pork being fed to pigs than those who were willing to pay the same as for average pork but no more.**

- Although those who do not buy pork, either because they are vegan/vegetarian or for other reasons, are not the target market for eco-pork, it is important to factor in their opinions in public discourse. This category had higher than average discomfort with feeding bacon sandwiches to pigs (49% very uncomfortable, 16% very comfortable, weighted average -0.75), and although it was still on average comfortable with every other food category being fed to pigs, it was notably less comfortable for some key categories – for instance, regarding feeding
- **For chicken sandwiches, the average level of comfort with pigs eating these in feed ranges from +0.56 (organic) to +1.00 (value-range), with the other types of pork falling in between, showing a similar variation of about 0.5 between the extremes. For mixed restaurant waste, the average ranges from +0.95 (organic) to +1.02 (value-range)**

- **Whether respondents were comfortable with pigs eating bacon sandwiches was strongly correlated with whether they were comfortable with them eating chicken sandwiches (r = 0.57)**, and also nearly as strongly correlated with whether they were comfortable with pigs eating mixed household waste (r = 0.51) and mixed restaurant waste (r = 0.50). It was more weakly correlated whether they were comfortable with pigs eating egg sandwiches (r = 0.36), confectionary (r = 0.25) and bread (r = 0.20). Whether they were comfortable with pigs eating mixed restaurant waste and mixed household food waste was most strongly correlated (r = 0.79).

- **Q7 - Effect of positive education: We then asked the respondents to read some educational text (see Appendix 1), and they were then asked "After reading the above statement, would you feel more or less comfortable about eating pork from pigs fed on food waste?". 43% said they felt a lot more comfortable, 28% said they felt slightly more comfortable, 26% said they felt as comfortable/uncomfortable as before, and only 2% said they felt either slightly less or a lot less comfortable.** Of the people who in Q6 said they were either quite uncomfortable or very uncomfortable with pigs eating bacon from supermarkets, 34% said they felt a

lot more comfortable, 34% said they felt slightly more comfortable, and 28% said they felt as comfortable/uncomfortable as before after reading the statement – although the question was not specifically about bacon, so it is possible this reflects their general feelings about other food waste feeds more than it does their views on feeing bacon to pigs. However, this indicates that generally consumers respond well to education assuring them feeding surplus food to pigs is safe – showing good potential for reservations about feeding pork to pigs to be alleviated.

- **Q8 - Remaining concerns: In Question 8, "Are there particular types of food waste which you still feel uncomfortable being fed to pigs, and if so why?", the most common response was concern about feeding pigs pork on the grounds of moral opposition to cannibalism**, so this is clearly a potential barrier in public perception. There were 171 mentions of "cannibal/cannibalism" and 889 mentions of "pork" raised as concerns out of 2,679 responses to this question. Although some of these 889 mentions of pork and cannibalism were arguing against the idea that this was a problem, the vast majority of mentions express concern over pigs eating pork, usually on moral grounds. This is consistent with the findings of Q6, and shows that even after reading the text before Q7, consumer reservations about cannibalism may remain. **Another (less) common theme was people concerned about feeding meat generally to pigs** (446 mentions of "meat", mostly in a concerned context), **and concerns around animal diseases like Foot and Mouth Disease** (12 mentions) **and BSE** (39 mentions + some mentions of "mad cow" disease) – there are 62 mentions of disease. **106 responses also mention "processed" foods as a concern, and 85 mention high sugar foods – indicating a concern for pig nutritional health.**
- **Q9 - Effective measures for assuring public over safety: When asked "What measures would assure you that eating pork fed on food waste is safe?", for meat-eating respondents a certification mark and the public support of academics/experts emerged as the most important measures, with licensing of farms and processors and the public support of farmers also very important.** The support of friends and celebrities were the least important measures. **37% of respondents were already convinced that eating pork fed on food waste is safe**, **and 22% of respondents said the government making it legal would be enough to convince them it was safe**.

Measure	% of (meat-eating) respondents who were assured by this measure (multiple options could be chosen by each respondent)

Certification mark introduced to show eco-pork sourced from licensed farm and pigfeed processor	59%
Academics and experts publicly back the safety of pork fed on food surplus	56%
Food waste feeds are only legally obtainable through licensed, off-farm processors	46%
Pig farmers publicly back the safety of pork fed on food surplus	40%
I am already convinced	37%
The government making it legal would be enough to convince me	22%
It is available through organic shops/schemes	15%
It is widely available in supermarkets and shops	15%
My friends had tried it and recommended it	2%
Celebrities publicly back the safety of pork fed on food surplus	2%

- **Those who answered "I am already convinced" were about half as likely to tick the other options** (e.g. 29% said "Academics and experts publicly back the safety of pork fed on food surplus", 29% said "Certification mark introduced to show eco-pork sourced from licensed farm and pigfeed processor", 23% said "Pig farmers publicly back the safety of pork fed on food surplus", and 19% said "Food waste feeds are only legally obtainable through licensed, off-farm processors") – although about the same proportion (slightly lower at 16%) said "The government making it legal would be enough to convince me".
- **For current buyers of organic pork (479 of respondents), the same proportion said they were already convinced (37%), and more than average said they would be reassured by it being available through organic shops/schemes (30% compared to average of 15%)** – whereas they were slightly less likely to select some of the other options (e.g. 32% compared to an average of 40%

said "Pig farmers publicly back the safety of pork fed on food surplus" and 7% compared to an average of 15% saying "It is widely available in supermarkets and shops").

- **For current buyers of mid-price range pork (1,192 of respondents), slightly less than average said they were already convinced (34% compared to average of 37%), and more than average said they would be reassured by it being widely available in supermarkets and shops" (19% compared to average of 15%) and by Pig farmers publicly backing the safety of pork fed on food surplus (45% compared to average of 40%).**
- **For current buyers of mid-price range pork (884 of respondents), the percentages of respondents answering each option were less than 2% different to averages.**
- **For current buyers of value-range pork (132 of respondents), more than average said they were already convinced (42% compared to average of 37%), but less than average said they would be reassured by Academics and experts publicly back the safety of pork fed on food surplus (48% compared to average of 56%), a certification scheme (50% compared to average of 59%), and Food waste feeds being only legally obtainable through licensed, off-farm processors (39% compared to average of 46%).**
- **Certification is popular across buyers of organic, free-range and mid-price range pork – being within no more than 2% higher or lower approval than the average.**
- **Q10 - Attitudes of organic buyers to "eco-pork": The respondents who buy organic pork were asked "Would you buy eco-pork from pigs which were reared on organic welfare principles, but fed on food which may not have been grown organically?". 51% responded "Yes, definitely", 31% said "Maybe", 10% said "I'd need more convincing" and 8% said "Definitely not".** This indicates to organic pork producers that their customers would in many cases be interesting in buying pork fed on non-organic food surplus.

5.7 Notable differences based on demographics:

Since pigs eating heat-treated bacon sandwiches from supermarkets was one of the most contentious issues, below is a breakdown of some demographic variations in attitude to this issue:

- **Age: Respondents over 60 years old were far more comfortable than the average with pigs eating heat-treated bacon sandwiches from supermarkets** – the only age group to have an average positive impression (+0.10). This could be partially because they are more likely to remember the "pig clubs" and where food waste was fed to pigs during the Second World War and its aftermath. There was a large overlap between the over 60s category and Riverford customers, so this may also be a factor. Within this age group too, though, there was considerable variation, with 23% feeling very uncomfortable with it, and 17% feeling quite uncomfortable compared to 29% feeling very comfortable and 15% feeling quite comfortable. Other age groups were quite similar in their attitude to pigs eating heat-treated bacon sandwiches from supermarkets – all ranging from -0.5 to -0.6, i.e. slightly uncomfortable.
- **Source: Feedback supporters were less likely to be uncomfortable with pigs eating heat-treated bacon sandwiches from supermarkets** (with 23% very comfortable with its inclusion in pig feed) – although they were still on average opposed to this (-0.23).
- **Rural/urban: People living in rural regions were slightly less uncomfortable (-0.35) than people living in urban regions (-0.47) about pigs eating heat-treated bacon sandwiches from supermarkets.**

5.8 Possible biases:

- **It is possible there may have been a self-selection bias in respondents to the survey** – participants who are willing to spend the time on the survey and provide an answer, are more likely to be those who have already formed an opinion on the topic.
- Although "some 43% of consumers say they buy free-range products whenever they can" (Source: BBC), just 1-2% of pigs in the UK are reared as organic or free-range (Source: Guardian). The high proportion of the respondents of the survey who claim to buy organic or free-range pork is likely to indicate either that there is an over-representation of organic and free-range pork in the survey, possibly biasing overall results, *or* that the survey respondents are over-reporting how much they actually buy free-range or organic pork (in line with the disparity between reported behaviour and actually buying habits mentioned above). In order to make transparent the impact that buyers of organic and free-range pork have on results, the results for buyers of different types of pork was disaggregated in many of the key questions analysed above, with results for mid-price range and value-range pork given separately – a rough indication of the views of these separate market segments can therefore be gleaned.
- Feedback supporters are likely to have had some knowledge of the issue of feeding food waste to pigs prior to the survey being sent out, through Feedback's Pig Idea campaign, which advocates for a change of law to allow food waste to be fed to pigs. Therefore, it is likely that they would have been sent some prior information about the safety of this procedure, and its environmental benefits.
- Wahaca customers may have had some knowledge about the Pig Idea campaign, because its founder, Thomasina Miers is a co-founder of the Pig Idea campaign. However, Wahaca's customers are likely not to have heard updates about the campaign since 2013/14

(Wahaca did not put out any public comms about the campaign between 2014 and this survey), and many of those on Wahaca's mailing lists may have joined since then, so are likely to have been relatively new to the campaign.

- Feedback supporters made up 19% of the survey respondents, and Wahaca customers made up 52%. **To check that Feedback and Wahaca's involvement with the Pig Idea has not biased the survey, the results for the survey without Feedback supporters and Wahaca customers was tested for some of the most significant questions. There was no significant difference observed in results** – for instance, 86% of respondents still viewed pork raised on food waste as more environmentally friendly than that raised on conventional feeds, and 91% were still supported the law being changed to allow more food waste to be fed to pigs, if this could be proved to be done safely (only 2% lower in both cases). Respondents were slightly less comfortable with different food surpluses being fed to pigs when Feedback and Wahaca responses were excluded, but this difference only ranged from 0-0.2 in difference – in most cases only 0-0.1 lower, and in the most controversial case of heat-treated bacon sandwiches from supermarkets, only 0.02 lower.
- Although Riverford Organic customers had no prior knowledge of the Pig Idea campaign, as buyers of organic food, they may be more environmentally minded than average consumers, and therefore more likely to be persuaded by the environmental positives of feeding surplus food to pigs. **We thus excluded Wahaca, Feedback and Riverford customers, to test whether the remaining respondents answered significantly differently – which resulted in slightly less favourable attitudes on average to eco-feed, but did not significantly alter the essence of the results.** They were marginally less likely to view food waste as more environmentally friendly than that raised on conventional feeds (81% chose this option, 5% less than average), and 88% said they would support the law being changed to allow more food waste to be fed to pigs, if this could be proved to be done safely (3% less than average). Removing Wahaca, Feedback and Riverford respondents from the survey does have some negative impact on comfort levels about feeding various types of surplus food to pigs, though without changing the broad findings. The level of comfort for non-Wahaca/Feedback/Riverford respondents with pigs eating feed containing mixed restaurant leftovers was a weighted average of +0.48 (0.35 less than average for all respondents), for pigs eating mixed household food waste comfort levels fell to +0.42 (0.3 less than average for all respondents), for unsold chicken sandwiches it fell to +0.26 (0.32 less than average for all respondents) and for unsold bacon sandwiches it fell to -0.67 (0.22 less than average for all respondents). However, despite these differences, respondents were still on average comfortable with all surplus food feeds being fed to pigs with the exception of bacon sandwiches.

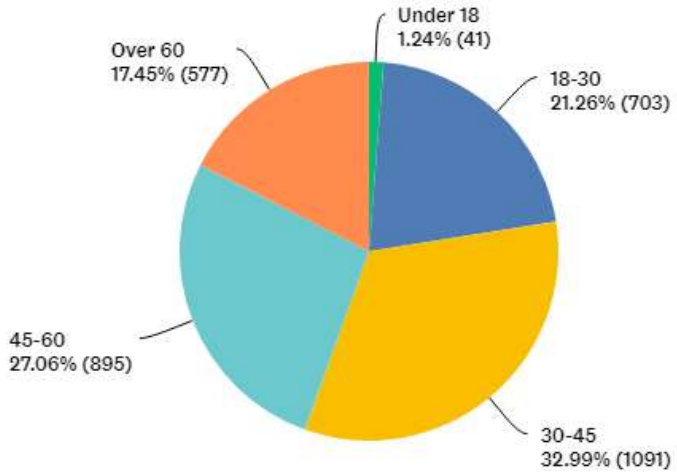
5.9 Text shown to respondents:

“Pigs (including for organic pork) are currently fed on soya and other cereal crops, which have a high carbon and water footprint, and contribute to land pressures leading to rainforest deforestation. Alongside this, a third of all food globally is wasted, much of which could be fed to pigs. Pigs are omnivores so are evolved to eat meat. Scientists have shown pigs can eat scraps of pork safely (they do so in the wild), and there is no evidence that pigs can contract BSE (mad cow disease). In 2017, a group of animal health and safety experts from the UK and Europe agreed it is possible to produce safe feed from food waste through heat treatment, potentially complemented with acidification (like in yoghurt production) which kills off all pathogens like Foot and Mouth disease. This is currently practiced in Japan. The experts concluded this would be safe in Europe as long as this is only done in licensed treatment plants which are off-farm,in a well-regulated way. Food waste feeds could benefit pig health directly through nutritional diversity, and save farmers money, enabling them to invest more in higher welfare, more environmental farming.”

Demographic Charts:

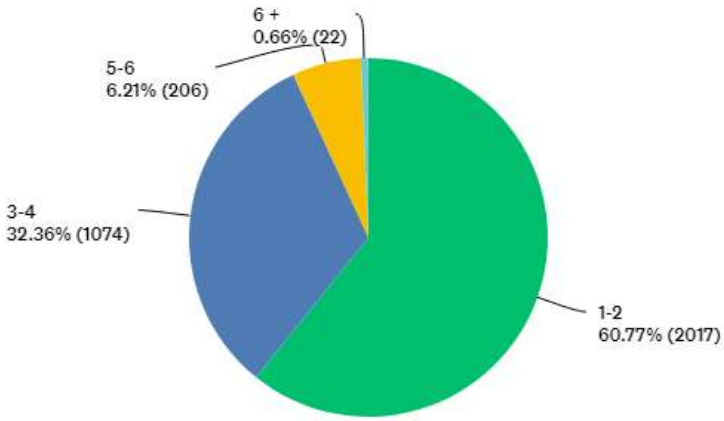
(Optional) What is your age?

Answered: 3,307 Skipped: 184



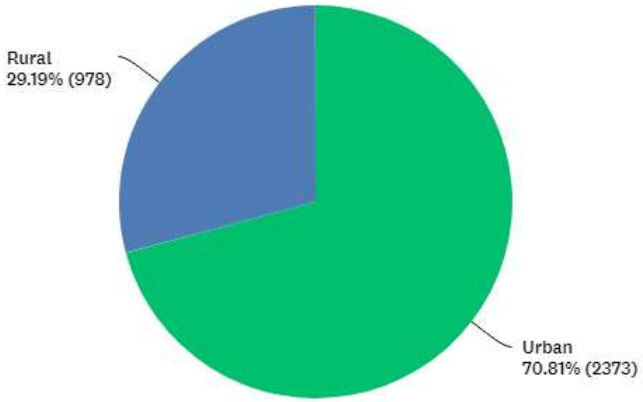
(Optional) What is your household size?

Answered: 3,319 Skipped: 172



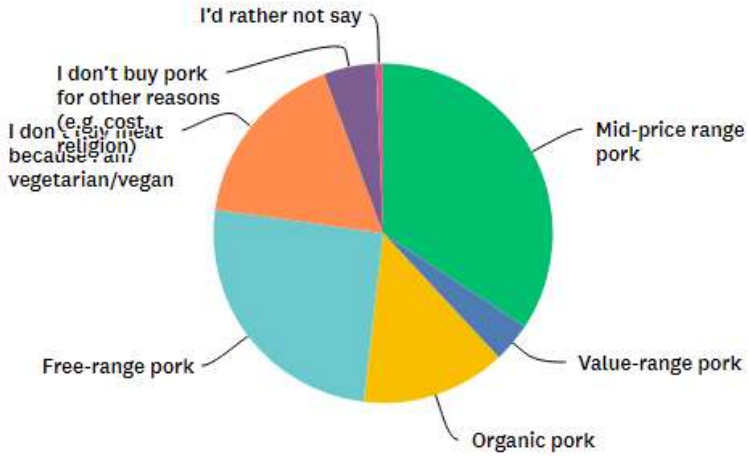
(Optional) Do you live in a rural or urban region?

Answered: 3,351 Skipped: 140



What type of pork do you usually buy, if any?

Answered: 3,478 Skipped: 13



6 Food safety legislation for the prevention of BSE in Japan

New Guidelines on Prevention of Intermixing of Animal Origin Proteins in Ruminant Feeds, issued by the Ministry of Agriculture, Forestry and Fisheries (MAFF), Japan. 15 Shoan No. 1570 dated 15 September 2003). http://www.famic.go.jp/ffis/feed/obj/1509161570_eng.pdf

(MAFF 2017a)

Objective: to prevent intermixing of animal origin proteins with ruminant feeds, at various stages of production, importation, distribution, storage, feeding, and handling of feeds and feed additives… to prevent the occurrence of transmissible spongiform encephalopathies such as bovine spongiform encephalopathy (BSE) and related diseases

Basic principles in the guideline:

Create two separate farm animal feed categories:

Category A: Feedstuffs and their raw materials permitted for ruminants

Category B: All other farm animal feedstuffs and raw materials, only permitted for poultry, pigs and fish

Definition of "Animal Origin Protein" is similar to ABPs currently prohibited in EU legislation. Animal Origin Protein:

Includes protein originating from mammals, poultry, fish and shellfish, including Animal Origin Protein in surplus food and food waste, ruminant fat

Excludes dairy and egg products, non-ruminant fat. Gelatine and collagen only if approved by MAFF

Animal Origin Protein is prohibited in Category A (ruminant) feed

Ruminant blood and bone meal is prohibited in Category A and Category B feed

Overall principles to prevent Category A feed from becoming contaminated with Animal Origin Protein or Category B feed:

Applied to each stage of feed chain: production, importation, distribution, storage and feeding

Clearly holds the final feed manufacturer and farmer responsible to ensure that any subcontracted phase of feed production or transport is done safely

If there is even the possibility of Category A feed having become contaminated with Category B; this feed must automatically be downgraded to Category B

Feed business operators are expected to have written operational procedures.

Segregation procedures are not applicable to facilities dealing only with Category B feed and farms where there are no ruminants

Procedures and measures to ensure full and continuous segregation are expected to cover:

Use of fully segregated and closed areas for production, internal transport within feed manufacturing premises, packaging, reception and dispatch of raw ingredients and finished product: ie at all stages of production

Transportation to be done in containers exclusively used for Category A feed with clear labelling and colour-coding. Containers can be allocated to Category A feed after being cleaned rigorously. Cleaning procedure is also defined.

Handling and cleaning equipment should also be designated for exclusive Category A feed

Containers, packaging, handling equipment and storage and transport bags for each feed category need to be stored separately when not in use

Quality control and testing:

Category A feed needs to be regularly tested to ensure procedures are effective, a designated quality control officer needs to be appointed, and detailed records need to be kept

7 Japanese legislation relating to safe use of by-products, surplus food and food waste in animal feed

Guideline for Ensuring Safety of Feeds Using Food Residues. Shoan No. 6074. Issued by Ministry of Agriculture, Forestry and Fisheries (MAFF), Japan on 30 August 2006. *Unofficial translation* provided by MAFF of the updated version including partial amendment Shoan No. 3615 of 22 December 2016. http://www.famic.go.jp/ffis/feed/obj/Guideline_for_Feeds_Using_Food_Residues.pdf

(MAFF 2006)

Heat treatment

Any by-products and former foodstuffs containing Animal Origin Protein, and all catering and kitchen waste:

Must undergo heat treatment to inactivate pathogenic micro-organisms (30 minutes or more at 70 °C or for 3 minutes or more at 80 °C as set out in provisions for the prevention of Classical Swine Fever, available only in Japanese).

a processor must not rely solely on the temperature settings of the treatment technology alone but should continuously monitor the actual temperature in the food waste under treatment

Food waste categories

The following categories of food waste are regulated for:

By-products containing Animal Origin Protein (II.1.(3)), as defined in TSE guideline above

Former foodstuffs (II.2)

Catering kitchen waste (II.3-1) only from domestic sources (it is not permitted to use waste from international flights, ships or other foreign facilities)

Household kitchen waste (II.3-2)

Catering left-overs and plate scrapings (II.4-1) only from domestic sources (it is not permitted to use waste from international flights, ships or other foreign facilities)

Household left-overs and plate scrapings (II.4-2)

Quality and hygiene responsibilities of food waste supplier

It is the responsibility of the supplier of the food waste for animal feed (referred to as “discharger” in the translation) to ensure that the above categories of food waste:

are each stored and transported separately in a dedicated container, which must be cleaned or sterilised after each use, and kept in the best possible conditions to preserve freshness (cold storage if necessary and minimise the storage period) and to ensure the food waste cannot be accessed by birds, rodents, cats, dogs, insects and the like

have clear recording and thorough monitoring of

status of separation / labelling of source of food waste

status of freshness (discard batches with fungi growth or which are decomposing)

absence of packaging and other foreign materials. It is only allowed to use catering left-overs and plate scrapings if the supplier has ensured all harmful materials such as toothpicks of cigarettes have been removed through thorough visual inspection

It is not normally permitted to use household food waste, unless for food waste education purposes. If household food waste is used, thorough separation is required to avoid contamination with foreign matters such as pet food.

Responsibilities of the feed processor or farmer

The feed processor or farmer procuring the food waste for use in feed (referred to as “obtainer” in the translation) is required to:

confirm that the food waste supplied meets the above requirements, and if it does not, take appropriate action. For example, if the food waste has started decomposing during transport, it must be discarded.

Use additional mechanical means to ensure all foreign objects and packaging materials are removed (magnets, sieves in addition to visual inspection)

if there is no refrigerated transport available, the food waste shall only be transported over very short distances

process or use the food waste as feed as soon as possible

apply heat treatment as described above

comply with the segregation requirements regarding Category A (ruminant) and Category B (non-ruminant) feed as described in Part 1 of this summary

have written operational procedures to ensure compliance with all legal requirements, including quality control

keep extensive records on all aspects of feed treatment, transport, storage, handling, feeding etc, as detailed in the guideline

Additional responsibilities for the feed processor

visit its food waste supplier periodically to confirm compliance of the contract

provide training to the food waste supplier to ensure all requirements regarding separation, freshness, storage, removal of foreign materials etc are complied with

label processed Category B feed with the wording: “This feed shall not be used for cattle, sheep, goats and deer” (penalties applicable) and “This feed shall be stored in such a way that it cannot contaminate feed or ingredients used in feed for cattle, sheep, goats and deer.”

Quality and safety control

The feed processor is also responsible for sample testing and quality control as follows:

samples shall be tested for mycotoxins, pesticide residues, heavy metals, pathogenic micro-organisms, lipid oxidation, salt, nitrate, volatile basic nitrogen. Analysis frequency and item shall depend on the product, as set out in the testing technical guidelines and methodology http://www.famic.go.jp/ffis/oie/sub1e_activity.html

list the date of manufacturing, date of collection of samples, analyst, analysis result, measure which was implemented based on the analysis result, etc. in a quality control ledger and preserve it for 8 years.

Contract between supplier and processor / farmer

The supplier and the processor or farmer must agree a written contract to ensure shared responsibility for the above requirements. If applicable, such contract must be extended to the third party involved in the collection and transport of the food waste.

8 Calculations of meat availability in ecological leftover scenario

Calculations done by Hannah Van Zanten based on nutrition data from REFRESH analysis in De Menna et al. 2018. Nutrition composition calculated on the basis of total amount of food waste from retail, manufacturing and catering sectors, minus the volume that already gets transformed into feed as former foodstuffs.

Pig requirements according to Van Zanten cited in De Menna 2018						
	Feed intake	NE (MJ) g/kg	LYS g/kg	NE (MJ)	Lysine, g	Lysine/MJ
Growing pig	226	9.59	7.59	2167	1715	0.79
Piglets	30	9.68	11.7	290	315	1.08
Gilt	6.7	9.24	8.99	62	32	0.6
Sow	40	9.06	7.42	362	297	0.82

8.1 France

calculation amount of pork based on energy		**calculation amount of pork based on lysine**	
kcal food waste per year	6,068,887,708,291	total g lysine	23,575,352,083
total MJ available from food waste per year	25,414,074,167		
Total MJ needed for one pig	2,167	toal lysine needed for one pig	1,715

total pigs produced	11,727,768	total pigs produced	13,746,561
kg life weight	1,360,421,137	total life weight	1,594,601,074
kg edible weight	721,023,202	Edible weight	845,138,569
kg protein	136,994,408	Total protein	160,576,328
kg protein per person per year	2	protein per person per year	2
kg meat per person per year	11	meat per person per year	13
g meat per person per day	29	g meat per person per day	34
g meat protein per person per day	6	g meat protein per person per day	7
g meat per person per week	206		
divided by half to get to realistic value based on Japan recycling achievements	103		

8.2 UK

calculation amount of pork based on energy		calculation amount of pork based on lysine	
kcal food waste per year	4,344,389,649,567	total g lysine	27,388,163,654
total MJ available from food waste per year	18,192,566,097		

Total MJ needed for one pig	2,167
total pigs produced	8,395,277
kg life weight	973,852,177
kg edible weight	516,141,654
kg protein per year	98,066,914
kg protein per person per year	1
kg meat per person per year	8
g meat per person per day	21
g protein per person per day	4

toal lysine needed for one pig	1,715
total pigs produced	15,969,775
total life weight	1,852,493,868
Edible weight	981,821,750
Total protein	186,546,133
meat per person	15
protein per person	3
g meat per person per day	41
g meat protein per person per day	8

g Meat per person for 10 days	214
Divided by half to bring in line with Japan recycling achievement	107

9 Greenhouse gas emissions savings at EU level

Data from Fusions 2016	
x1000 tonnes	
Total EU food waste	88,000
Sum of percentages for retail, manufacturing and processing	36%
Food waste from these sectors (36% of total)	31,680
Current former foodstuffs already used in Animal Feed, not included in food waste figures (data from EFFPA)	5,000
Total EU surplus food flows from catering, manufacturing and processing (of which 5 million tonnes go to animal feed, and the rest goes to AD, incineration, landfill etc)	36,680
Japan government data: 52% of food industry surplus recycled into animal feed. Apply this percentage to EU total available surplus:	19,073.60
Sustract current former foodstuffs already going to animal feed to arrive at **total volume of food leaving the supply chain immediately suitable for animal feed (x1000 tonnes)**	14,074

Data from de Menna et al. 2019	France	UK
Volume of surplus food theoretically available for feed (x1000 tonnes)	4,386	2,547
Savings GHG emissions in tonnes of CO2 eq.	1,900,000	1,000,000
GHG emissions savings in tonnes of CO2 eq/ thousand tonnes of food waste	433	393

Average between France and UK of GHG emissions savings in tonnes of CO2 eq/ thousand tonnes of food waste	413	
Minimum immediate GHG emissions savings in tonnes of CO2 eq. available from changing legislation supporting a surplus food to feed industry (Total volume of surplus food currently leaving supply chain but immediately suitable for animal feed * Average GHG savings for France and UK). As we progressively reduce food waste, the aim is to increase percentage uptake of surplus in feed, partly through rolling out to household surplus. As a result these savings can continue in the medium to long term. With improvements on existing transport and treatment facilities, further GHG savings are possible.	5,811,097	
By way of comparison, this is equivalent to annual per capita emissions of how many EU citizens (8.7 tonnes is average EU per capita emmissions) https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_rd300&plugin=1	667,942.20	

10 Avoided soya

Taking total volumes of soya avoided for the French and UK cases calculated in D5.5, a similar further calculation can be done to estimate how much soya might potentially be replaced throughout the EU:

	France	UK
Soybean replaced as calculated in REFRESH D5.5	293,194	125,929
Tonnes of soybean replaced in pigfeed per thousand tonnes of food waste	67	49
Average tonnes of soybean replaced in pigfeed per 1000 tonnes of Food waste	58	
Tonnes of soybean that could be replaced at EU level	818,308	