REPORT

To: Vicki Melville - Ministry for Primary Industries

From: Amanda Peers-Adams, Alzbeta Bouskova - Ecogas

Date: 13 October 2022

CC: Fraser Jonker – Managing Director, Ecogas

Re: Risk assessment of digestate application on land

PURPOSE

This document provides scientific evidence of the risk associated with the use of food-waste digestate as a biofertiliser. The report presents a review of risk assessments completed in established overseas markets to address concerns regarding the spread of diseases. These risk assessments informed legislative settings for management strategies when using digestate in those markets and have served successfully for over a decade.

Ecogas seeks that Ministry for Primary Industries (MPI) considers this evidence and the system-wide implications and opportunities for any future legislative changes relating to the use of recovered materials on land.

PROBLEM STATEMENT

MPI is currently reviewing the risk framework for spontaneous BSE outbreak and the relevant legislation. **A complete ban on application of ruminant protein on grazing land is considered as a key measure in the revised risk minimisation strategy**.

An inability to apply ruminant protein on grazing land hinders the opportunity to recycle nutrients from food residues back to the place where it is most needed. The Ministry for the Environment (MfE) has consulted on a proposal for mandating recycling of food and organic waste, anchored in the principles of circular economy[1]. The positive environmental, social and economic benefits sought are going to be achieved only if the nutrients recovered from food residues can be returned to the place where they are mostly needed. In the context of New Zealand economy, this is grazing land for dairy, sheet and beef.

The implications of the ban would have long-term impact on the dairy industry and livestock farming. The industry currently relies largely on importing mineral fertilisers from overseas market with its inherent risk of price and supply chain volatility. The ability to use renewable fertilisers will reduce this exposure and increase sustainability and reduce carbon footprint of the dairy industry.

The proposed ban would have a substantial impact on Ecogas's ability to beneficially and cost-effectively reuse digestate from the Reporoa or other future sites. Ecogas Reporoa Organics Processing plant is the first full-scale anaerobic digestion facility in New Zealand, designed to treat 75,000 of mixed organic waste from household, commercial and industrial

[1] This is in line with other key government strategies, including the Infrastructure Strategy, Renewable Gas Strategy, etc.

outfits. It has been designed to the highest engineering standard to ensure maximum benefits and safety for the environment, people and animals.

BACKGROUND

DIGESTATE

Digestate is one of two products from anaerobic digestion of organic materials and residues. Digestate is a liquid suspension that contains all of the nutrients and minerals that have come into the process in the food waste. By using this product on land as a substitute or supplement to traditional fertilisers, these nutrients are returned back to its place of origin.

In addition to its nutrient value, digestate also provides large quantities of organic carbon to the soil, which is beneficial for soil and crop health. Research has proven that the use of digestate as biofertiliser leads to an increase in yield, protein content of crops and improved soil moisture-retention properties, and consequently increases quality and quantity of food without adverse effects on the environment.

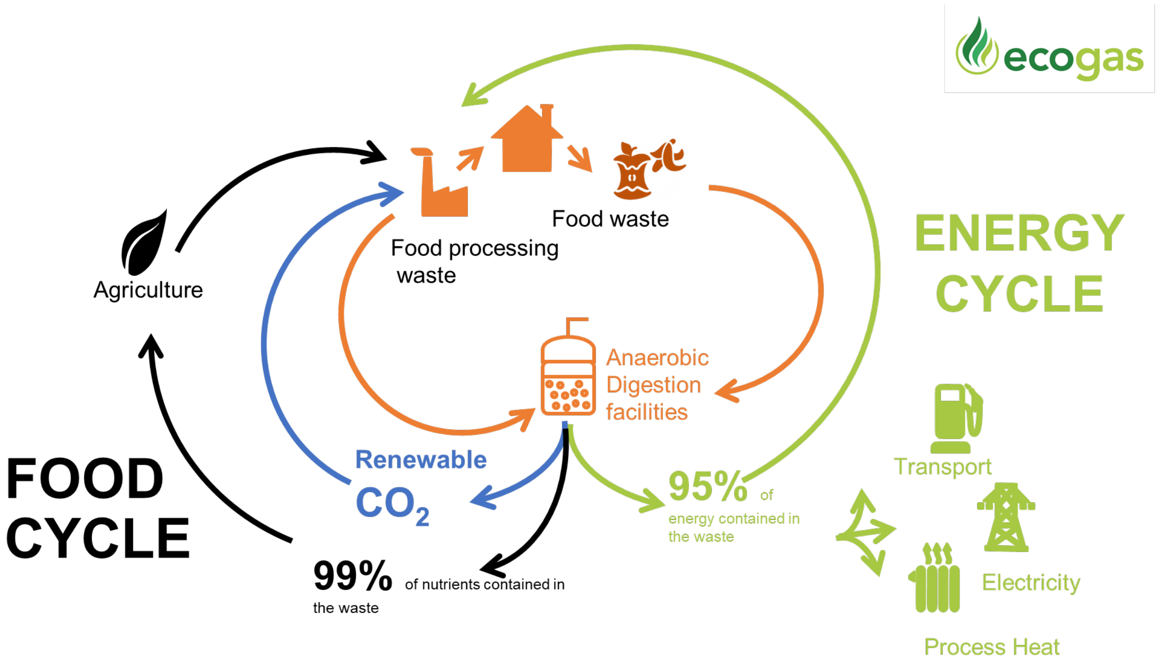

Figure 1 - The role food waste anaerobic digestion and digestate in circular economy.

Anaerobic digestion has been widely used around the world for the processing of waste organic materials and its popularity is still growing due to its key role in business and communities moving to adopt circular economy principles. In its most important role, anaerobic digestion can facilitate a diversion of large volumes of agro-industrial, domestic and commercial waste and by-products from landfill disposal and reduce the methane emissions this practice creates.

180 million tonnes of digestate are produced in the EU28 per year alone, almost half of this in Germany. 120 million tonnes is agricultural digestate (typically a mix of manure and plants, particularly energy crops). About 46 million tonnes the organic fraction of municipal waste, at least 7 million tonnes from source separated biowaste and smaller quantities, approx. 1.7

million tonnes each) from sewage sludge and agro/food industry by-products. The vast majority of digestate is used directly as a fertiliser.

ECOGAS

Ecogas Limited Partnership has been established in order to repurpose food waste and organic residues into renewable energy, CO_2 and biofertiliser through anaerobic digestion. The company's core business is well aligned with the government strategy to divert organic waste from landfills for beneficial reuse. The products, i.e., biogas and biofertiliser, are carbon-neutral and near direct replacement of existing fossil-derived alternatives. This offers additional opportunity to further offset carbon emissions in the key sectors of our economy (process heat and agriculture) and assist New Zealand on the path to Zero Carbon economy.

Our first facility in Reporoa, designed for 75,000 tonnes per annum of organic waste is commencing operation now. Following hundreds of examples from the EU, UK and US, this facility was designed to the highest engineering standards to ensure reliability, efficiency and safety. We selected the British PAS110 specification as the guiding standard for design and operation of food waste digestion plants due to its global recognition and acceptance.

The plant is designed and consented for food waste from households and commercial operations. The consent specifically excludes abattoir and rendering waste.

This plant has been located in Reporoa, due to the proximity to productive land. Following examples from overseas market and consultation with local experts, application on dairy grazing land has been determined as the highest value application for the biofertiliser from our plant. This has been consulted and accepted with key stakeholders, including the Dairy Industry Technical Advisory Group.

MPI's potential ban on using meat-derived product on grazing land has substantial implication for our business as it de-values the biofertiliser and raises negative perception of the market. Ecogas would need to resort to alternative strategies such as disposal of the biofertiliser to e.g. forestry or transport to cropping operations, cost of which is likely to be prohibitive.

PAS110 BIOFERTILISER CERTIFICATION

The EU and other developed markets have introduced quality assurance protocols in order to ensure that digestate is produced and applied according to the highest safety standards, minimising the risk to the environment, humans and animals. To further increase the credibility of the product, several countries have developed certification schemes to elevate digestate from waste to fertiliser product[2].

The BSI PAS 110[3] biofertiliser certification scheme provides a baseline quality standard for digestate, ensuring that it is consistent, safe and reliable to use (BSI, 2022). In 2009, the Quality Protocol for Anaerobic Digestate (ADQP) was launched in England, Wales and Northern Ireland to provide a clear framework for the production and supply of quality

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[2] The Bioenergy Association NZ recently carried out a review of existing biofertiliser certification schemes in order to recommend a suitable framework for similar scheme in New Zealand. Results of this review can be provided upon request.
[3] British Standard Institute Publicly Available Specification

digestate i.e. biofertiliser (WRAP, 2022). It builds on BSI PAS 110 by clarifying which waste materials can be used in quality digestate production and by ensuring accurate record keeping when PAS 110-compliant digestates are used in agriculture, field horticulture, landscaping and land restoration.

Where animal by-product (ABP) materials (Category 2 and 3) are included in the feedstock, an additional batch pasteurisation phase, i.e., 1 hour at 70°C, with a particle size <12 mm, either before or after digestion is legally required. Category 2 products need to be pressure rendered prior to digestion, unless specifically excluded from this requirement (manure, digestive tract contents, milk and milk products, eggs and egg products). Refer to Appendix A for details about the ABP product categories.

METHODOLOGY

The Ecogas Reporoa plant is designed to meet the requirements of the British PAS110 specification and will only treat wastes that are allowed as inputs into PAS110 certified facilities.

Ecogas has reviewed the risk assessment carried out in the UK and EU following the outbreak of BSE in the 1980's and 1990's. At the same time, a European directive Council Directive 1999/31/EC (European Council, 1999) has been introduced seeking to reduce the environmental impacts of landfills. As resource management in the UK shifted away from landfill, the processing of biological wastes grew rapidly; first through development of the composting sector and then with AD technology. Both developments prompted demands for public confidence in the safety of waste processing and of the resulting soil improvement and replacement fertiliser products; calls that intensified as source-segregated composts and AD digestates became notable replacements for conventional fertilisers (Longhurts, et al., 2019). This led to the development of a risk-based stakeholder engagement approach which ultimately informed the requirements captured in the PAS110 and the EU Animal By-product Regulation.

The review was particularly focused on the risk assessments related to the spread of spongiform encephalopathy and its variants.

Finally, Ecogas considered the risk assessment results in the New Zealand context and discusses the use of additional measures to increase MPI's confidence.

RESULTS AND FINDINGS

The risk-assessment and guidance that led to the development of PAS110 was carried out in early 2000's. The process first identified concerns for human, animal and environmental health, which were then assessed via semi-quantitative and quantitative risk assessment (QRA) approaches. In a number of cases, the concerns were directly relevant to best practice guidance on digestate (biofertiliser) use. This led to the development of the Biofertiliser Matrix (Table 1). Where appropriate, the Biofertiliser Matrix has been developed by building upon other guidance documents that are already in use, e.g., food safety standards for production of ready to eat crops or frozen foods. (Taylor, et al., 2012).

The controls introduced into PAS110 include: defined inputs to AD Plant, e.g. source segregated feedstocks; the influence of supply agreements with for example local authorities and commercial firm, e.g. on the QA of feedstock supply; plant process control including corrective actions in event of failures; pasteurisation. These include the Animal By-Product Regulation (ABPR) specification and requirements where digestates are moved between farms; as well as sampling and analysis including pathogens, potentially toxic elements (PTEs), physical contaminants, biochemical stability, and quality controls at the input stage.

Table 1: Biofertiliser Matrix (PAS110/ADQP input materials) – agriculture and field horticulture

Crop type		Pasteurised	Non-pasteurised
Fresh produce	Group 1	✓ before drilling/planting	✗ 12 month harvest and 6 month no drilling interval applies
	Group 2	✓ before drilling/planting	✗ 12 month harvest and 6 month no drilling interval applies
	Group 3	✓	✓
Grassland and forage		✓ [a] 3 weeks no grazing period and harvest interval applies	✓ [a] 3 weeks no grazing period and harvest interval applies
Combinable and animal feed crops		✓	✓ [b]

[+] Pasteurisation process compliant with Animal By-Products Regulations
[a] 2 months no grazing or harvest period for pigs
[b] If feedstocks contain maize, biofertiliser applications should be ploughed into the soil ahead of following cereal crops

It was recognised that a robust approach to risk assessment is necessary to inform the use of these materials and provide evidence-based guidance to ensure good agricultural practice in the use of biofertiliser. Further work is summarised in (Longhurst, et al., 2012).

The work by Longhurst et al. use a Quantitative Risk Assessment (QRA) captured in Figure 2. Two toxicological principles, of exposure and potency were considered. Firstly, for there to be a risk of harm there must be exposure to a hazard or hazardous agent. Without exposure there can be no risk. Secondly, the dose at the point of exposure must be sufficient to cause harm. Living organisms are routinely exposed to hazards which they tolerate and are resistant to. The highest plausible exposure that a sensitive receptor can be exposed to from the transfer of a hazard from its original source was determined for a range of hazards, including human and animal pathogens, organic compound contaminants and heavy metals, nematodes, plant pathogens; fungi and bacteria.

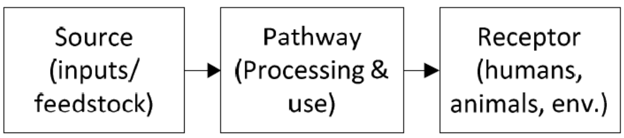

Figure 2 - Quantitative Risk Assessment Model. the source term details the hazard loading on the feedstock materials for anaerobic digestion, the pathway term details the effect of the hazard-reducing barriers during the anaerobic digestion process including pasteurisation and dilution and application to land considers the decay after spreading and incorporation.

Figure 3 provides the process variables and detail considered in defining the high hazard scenarios to then calculate the status of pathogens in growth or decay stages. Although no assessment was carried out specifically for Bovine spongiform encephalopathy (BSE), scrapie can be considered as an adequate substitute. The highest source of risk was considered the AD inputs with abattoir and food processing waste; meat e.g. household food waste. The high hazard pathway to high hazard receptors was considered through grazing of sheep and goats on land treated with digestate from PAS110 certified plant.

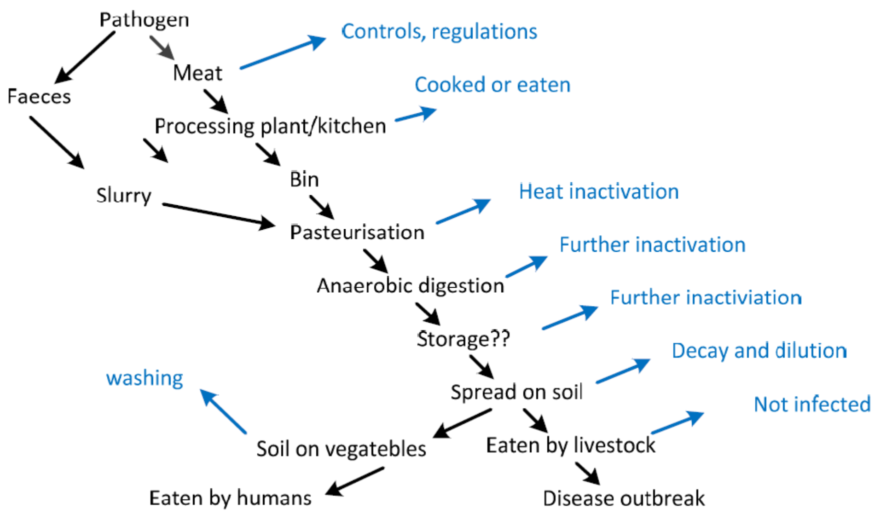

Figure 3 - Conceptual model of exposure for pathogens.

Results calculated from the QRA for each of category were then compared to the current context in terms of numbers of infections per year in the UK, years between infections, and the context of current infections from using AD biofertiliser. The results for scrapie are presented in Table 2.

Table 2 - Summary of results of scrapie QRAs in context with number of background infections

Hazard	Predicted no. of infections per year from AD	Predicted no. of years between infections from AD	Context: reported no. of GB infections in 2010	Predicted percentage increase in infections per year through AD
Animal Pathogens				
Classical scrapie[a]	0.038	26.5	21,616[e]	0.0002%
Atypical scrapie[a]	0.013	77.1	46,003[e]	0.00003%
Total scrapie	0.051	19.6	67,619[e]	0.00007%

[a] Assumes 15 day retention time for mesophilic anaerobic digesters
[e] Number of scrapie infections entering UK food chain per year based on 2009 prevalence data

Overall, the results of the QRAs suggested that the risks of pathogen-induced infection caused by the land-spreading of digestate are low, with many years predicted between infections for the majority of the pathogens considered. The risk predicted by the QRA for scrapie was 0.38 and 0.13 infections of classical and atypical scrapie, respectively, are predicted per year. Scrapie is an endemic disease in the UK with a predicted >67,000 infections per year in the UK flock; the additional infections predicted through application of anaerobic digestate would be <0.00007% of the total in the UK. The higher risk for scrapie is attributable in part to the fact that the authors have assumed no significant reduction from batch pasteurisation but a partial reduction from mesophilic anaerobic digesters[4].

NEW ZEALAND CONTEXT

New Zealand have had no recorded cases of BSE during or after the UK crisis during the late 80's early 90's. There has been one major 'scare' with scrapie in 1952 and a second in mid-80's when 5,000 sheep were slaughtered and disposed of on the Mana quarantine Island purely as a precaution. Clear protocols are in place to manage the import risk from BSE or scrapie with live animals (MAF Biosecurity New Zealand, 2011). These protocols control the main source of risk of infectious animal diseases.

If BSE or scrapie was to ever enter or, as is proposed by MPI, spontaneously appear in New Zealand, all food chain disposal routes, composting, piggeries, landfill etc will be at risk, including on farm diary effluent, etc.

In translating the results of the UK QR analysis into the New Zealand context, there are two differences. The first is the fact that there are no active cases of scrapie in NZ compared to 67,619 cases in the UK used for the analysis. Any potential outbreak in NZ would therefore have to reach a similar extent for the 0.00007% risk of increase to materialise.

The other variable that may affect the outcome of the QRA above is the proportion of ruminant protein in the food waste assumed in the analysis versus the proportion expected in New Zealand. Ecogas estimated that 0.1% of ruminant protein can be expected in the food waste entering the Reporoa facility. The assumptions of the QRA analysis by Longhurst et al. have been requested from the authors.

CONCLUSIONS

The following conclusions can be drawn from the literature review:

- The risk of increasing the spread of spongiform encephalopathy by application of digestate to grazing land is substantially low and acceptable.
- The digestate certification framework has been implemented in the UK since 2010. No new cases of BSE have been recorded since the 80's outbreak.
- Reporoa has been designed to the same standard and should therefore be assessed with the same level of risk.

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[4] A 4.2 log(10) decrease in infectious prions was observed under mesophilic conditions after 21 days of digestion of sewage sludge (Miles, Sun, Field, Gerba, & Pepper, 2013)

RECOMMENDATIONS

Based on the review and discussion above, Ecogas provides the following recommendations:

We recommend that MPI accepts the UK risk assessment as a basis for their atypical BSE risk framework evaluation. The data demonstrate that application of digestate to grazing land with a 3-week withholding period is of low risk to increase the spread of the disease.

Ecogas will adopt a proactive approach and secure access to an alternative safe disposal route in case of an outbreak of scrapie or BSE in New Zealand. This may be in form of forestry or growing of energy crops.

Ecogas will also provide MPI with access to the biofertiliser from the Reporoa facility for any testing MPI may wish to carry out. The research review suggests that prion detection is limited by the sensitivity level of currently accepted method or by the cost and time factors of bioassays. In addition, prion detection assays can be limited by either the unique or complex nature of matrices associated with environmental samples such as digestate or compost.

Ecogas recognises the wide-reaching impact a permanent ban on application of ruminant protein to grazing land will have on the meat industry and its ability to fully adopt the principles of circular economy. Ecogas proposes to partner with MPI and other key stakeholders under the Sustainable Food and Fibre Futures fund to develop a NZ-specific risk assessment for recycling of ruminant-protein residues to grazing land to inform any future or planned legislative changes.

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APPENDIX

APPENDIX A – ANIMAL BY-PRODUCT CATEGORIES

CATEGORY 1 ABPS

Category 1 ABPs are classed as high risk.

They include:

- carcasses and all body parts of animals suspected of being infected with TSE (transmissible spongiform encephalopathy)
- carcasses of wild animals suspected of being infected with a disease that humans or animals could contract
- carcasses of animals used in experiments
- parts of animals that are contaminated due to illegal treatments
- international catering waste
- carcasses and body parts from zoo and circus animals or pets
- specified risk material (body parts that pose a particular disease risk, eg cows' spinal cords)

CATEGORY 2 ABPS

Category 2 ABPs are classed as high risk.

They include:

- animals rejected from abattoirs due to having infectious diseases
- carcasses containing residues from authorised treatments
- unhatched poultry that has died in its shell
- carcasses of animals killed for disease control purposes
- carcasses of dead livestock
- manure
- digestive tract content

CATEGORY 3 ABPS

Category 3 ABPs are classed as low risk.

They include:

- carcasses or body parts passed fit for humans to eat, at a slaughterhouse
- products or foods of animal origin originally meant for human consumption but withdrawn for commercial reasons, not because it's unfit to eat
- domestic catering waste
- shells from shellfish with soft tissue
- eggs, egg by-products, hatchery by-products and eggshells
- aquatic animals, aquatic and terrestrial invertebrates
- hides and skins from slaughterhouses
- animal hides, skins, hooves, feathers, wool, horns, and hair that had no signs of infectious disease at death
- processed animal proteins (PAP)

PAP are animal proteins processed from any category 3 ABP except:

- milk, colostrum or products derived from them
- eggs and egg products, including eggshells
- gelatine
- collagen
- hydrolysed proteins
- dicalcium phosphate and tricalcium phosphate of animal origin
- blood products (although any processed blood would still be subject to this guide)