SAFETY OF DIGESTATE BIOFERTILISER FOR LAND APPLICATION

DBPAS 08 Version 1

Bioenergy Association
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Legal Disclaimer:

Biofertiliser producers are not legally obliged to obtain accreditation. Accreditation is voluntary for those producers who wish to benefit from membership of the Bioenergy Association Accreditation Scheme.

Please note that the terminology ‘digestate biofertiliser’ and ‘biofertiliser’ are used interchangeably within this document.

The purpose of this document is to assist producers demonstrate their facility meets industry best practice in the production of Fertmark certified digestate biofertiliser.

Compliance with this publication cannot confer immunity from legal obligations.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application. In addition to the requirements of this, for application in New Zealand attention is drawn to the following statutory requirements:

Animal Products Act 1999

Animal Products Regulations 2021

Agricultural Compounds and Veterinary Medicines Act 1997

Biosecurity (Ruminant Protein) Regulations 1999

Resource Management Act 1991

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Each version of the document will have a version number and a control sheet which will record its status and a brief comment about the changes that have been made to it.

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Version	Status	Bioenergy Association approval	Date	Significant changes from previous version
1	Consultation draft			

Introduction

This Technical Note provides scientific evidence around the safety applying of certified digestate biofertiliser to land.

This document reviews risk assessments that have been undertaken on the use of digestate derived from source segregated food waste in overseas markets to address the risk of the spread of diseases. Scientific evidence informs these assessments, which help establish guidelines and regulations for safe use.

Executive Summary

The term Biofertiliser refers to certified digestate which is the residual material remaining following the anaerobic digestion of organic matter such as food waste or agricultural residues. It is commonly used on land due it's high nutrient content for crop growth. In the UK and Europe specifications and regulations are in place for the safe processing and spreading of biofertiliser onto land. The EU has specific legislation for feedstock that contains Animal By Products (APB) and groups them together depending on their level of risk and associated processing requirements,

The scientific risk assessment discussed in detail in this Technical Note was undertaken by Longhurst et al. and uses a Quantitative Risk Assessment (QRA). Firstly, for there to be a risk of harm there must be exposure to a hazardous agent. Without exposure there can be no risk. Secondly, the dose at the point of exposure must be sufficient to cause harm. Process variables and the exposure pathway were both considered when defining the high hazard scenarios to then calculate the status of pathogens. The results calculated from the QRA for each category were then compared to the current context in terms of numbers of infections per year in the UK, years between infections, and the probability of current infections from using AD biofertiliser. 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.

Responsible management practices at all points of the value chain and vigilance at the border and on farm, play a vital role in safeguarding against exotic diseases.

The NZ Digestate Biofertiliser Certification Scheme (DBCS) is based on the quality assurance principles and specifications of the UK PAS110 and EU APB categories for input feedstock. These strict criteria stipulate that only materials that were previously fit for human consumption are approved as a feedstock for biofertiliser. Any diseased animals or waste from rendering operations are excluded from the DBCS.

The controls and monitoring described in the DBCS comply with existing biosecurity regulations and international AD best practice. The Bioenergy Association will update the DBCS if there are any future changes to local regulations and policies.

Background

Digestate is one of two products of anaerobic digestion (AD) of source segregated food and organic wastes. It is a nutrient rich liquid which contains essential plant elements and is a source of organic carbon which can be returned to the soil. It has been used successfully on farms and agricultural land in the UK and Europe for many years, but anaerobic digestion and digestate are new to NZ. The term 'biofertiliser' is used to describe digestate that meets the strict quality criteria in certification schemes such as PAS 110 and the NZ Digestate Biofertiliser Certification Scheme.

The recent mandate from the Ministry for the Environment has an obligation on councils to provide food and organic waste collections so as to divert these valuable materials away from landfill. This creates an opportunity for AD technology to be part of the circular economy by converting food waste into a biofertiliser. However, for the circle to be completed, the biofertiliser must be able to be beneficially used on land. One market that is most suited to applications of biofertiliser is pasture and grazing land, ie dairy, sheep and beef farms. Use of renewable fertilisers such as digestate biofertiliser will help reduce the reliance on the importation of synthetic fertilisers.

The PAS 110 specification was developed in the UK and 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 digestate i.e. biofertiliser (WRAP, 2022). It builds on 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.

The DBCS is built on the fundamentals of PAS110 standard and ADQP quality criteria and it has included these requirements into all aspects of the scheme. For example, Table 1, Feedstock Materials in Digestate Biofertiliser Certification Scheme DBPAS 05 shows the input feedstocks that are approved for use for biofertiliser, which specifically prohibit brain matter and spinal cord from any abattoir material. This also extends to the rejection of diseased animals (or parts thereof) and waste materials from rendering operations.

Furthermore, the DBCS only accepts feedstock materials that were originally intended for human consumption for example kerbside organic collections, restaurant food waste and 'spoiled' food.

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 Renewable Fertiliser Matrix (WRAP, 2022) which details when and where certified digestate can be safely used to grow different crops such as arable, grass and forage. Where appropriate, the Renewable Fertiliser 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.

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 1. 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.

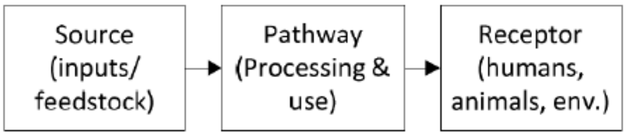

Figure 1 – Quantitative Risk Assessment Model.

In Figure 1 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. Application to land or Receptor considers the decay after spreading and/or incorporation.

Figure 2 provides the process variables and details 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.

Work by Hartnett et al. (2004) of assessments of the import of illegally imported meats into the food chain were used to calculate viruses that are exotic to the UK, i.e. not currently present in any livestock animals in the UK. These estimates were incorporated into the risk assessment model alongside the calculation of the total meat (home produced and imported) potentially being sent to AD if all material were processed in this manner.

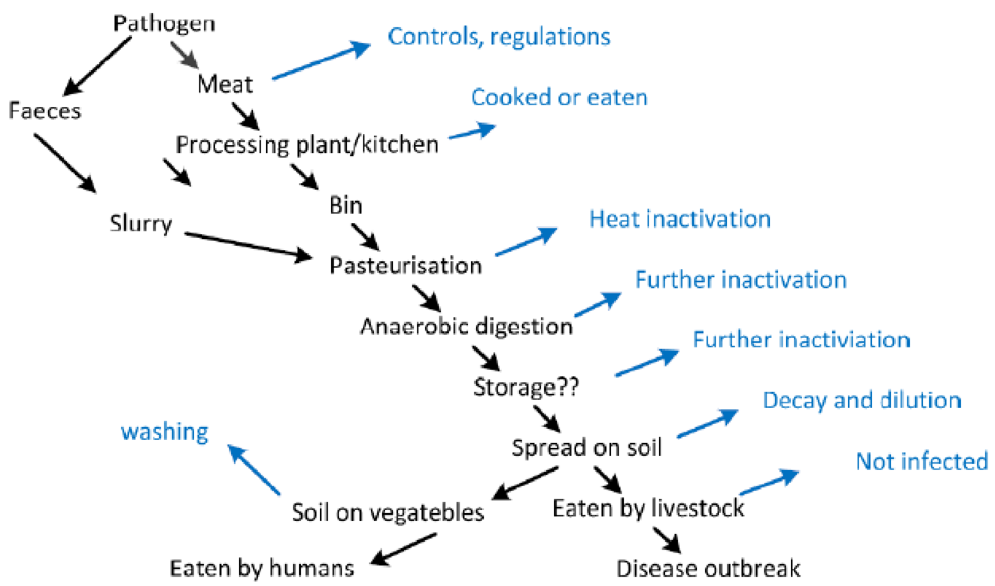

Figure 2 – Conceptual model of exposure for pathogens.

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 per year. Scrapie is an endemic disease in the UK with a predicted >67,000 infections per year in flock. The additional infections predicted through the application of digestate would be <0.00007% of the total in the UK. The higher risk for scrapie is attributable to in part to the fact the authors have assumed no significant reduction from batch pasteurisation but a partial reduction from mesophilic anaerobic digesters[1].

Pathogen control and monitoring

Scientific studies are not able to test for every single exotic disease pathogen, so the accepted methodology of using indicator organisms is often applied to demonstrate if pasteurisation or other treatments have been effective. An increased number of indicator organisms, usually *Escherichia coli* and *Enterococcus* spp. indicate a possible increase in pathogens. Both *Clostridium* spp. and *Bacillus* spp. are spore forming bacteria but *Clostridium* spp. only grow anaerobically. (*E. Bagge et al, 2005)*.

The E. Bagge study found that pasteurisation and digestion do not reduce the number of spore forming bacteria and they will still persist in the final digestate. However, more studies have to be done in order to determine if the digestate has an acceptable hygienic standard regarding the risk of recontamination and spore-forming bacteria. It should be noted that the AD plants in this study received pig and dairy slurry feedstocks as well as food waste.

The microbiological status of the output digestate from any AD facility is dependent on the quality of the input feedstock and on the process configurations of the digester such as pre-treatment (pasteurisation), digestion temperature, pH and nitrogen concentration.

The inactivation of pathogens to safe levels can be confirmed by:

- process monitoring, control and documentation at the AD facility showing that the process time and temperature requirements of the pathogen inactivation process have been achieved; and
- by testing of digestate samples for the presence of pathogens and pathogen indicator organisms. (Canadian Digestate Management Guide)

Digestate produced from an AD facility that includes a pasteurization process will reliably contain numbers of pathogen and pathogen indicator organisms below the maximum acceptable levels set out in the Digestate Biofertiliser Certification Scheme reproduced in *Table 3* and is thereby considered safe for handling and application.

Table 3: Pathogen Limits for Digestate Biofertiliser

Organism	**Level**
Salmonella	Less than 2 MPN/g
E coli (faecal coliforms)	Less than 100 MPN/g
Campylobacter	Less than 1/25/g

NZ Context

New Zealand has had no recorded cases of BSE during or after the UK crisis during the late 1980's and early 1990's. There has been one major 'scare' with scrapie in 1952 and a second in the mid 1980's when 5,000 sheep were slaughtered and disposed of on Mana Island, purely as a

[1] 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)

precaution. Clear protocols are in place to manage the risk of importing 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 spontaneously appear in NZ, then all food chain disposal routes, composting facilities, piggeries, landfills etc will be at risk. This includes disposal of on-farm dairy effluent. The only way biofertiliser from an AD facility could be a vector for spreading disease would be the sudden unexpected appearance of an infectious disease in the environment.

In translating the results of the UK QRA analysis into the NZ context, there is a major difference to consider. This 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 this country would therefore have to reach a similar level for the 0.00007% risk of increase to become a reality.

There are similarities between scrapie and anthrax in the New Zealand context. Both diseases are caused by incredibly heat resistant and stable microorganisms, prions in scrapie and spore forming bacillus anthracis for anthrax. The few outbreaks of scrapie were in 1952-54 and 1976-77 and the last outbreak of anthrax in livestock was in 1954. New Zealand is free of scrapie and anthrax and maintains strict biosecurity controls for livestock and imported meat. The important consideration for digestate biofertiliser is the risk of any exotic disease being present in the end product at a level that would cause an outbreak.

Conclusions

The following conclusions can be drawn from the literature review;

1. The risk of increasing the spread of spongiform encephalopathy by application of digestate to grazing land is substantially low and acceptable. The risk is slightly increased for scrapie but is still acceptably low. The risk assessments are based on realistic worst case exposure scenarios.
2. The digestate certification framework was implemented in the UK since 2010. No new cases of BSE have been recorded since the 1980's outbreak.
3. The risks associated with the use of PAS110 compliant digestate in agriculture are acceptably low.
4. The draft Digestate Biofertiliser Certification Scheme for New Zealand is built on the quality principles and input restrictions from the UK PAS110 and ADQP protocols. The scheme draws on the established scientific risk assessments that show that digestate biofertiliser that meets the requirements of the Scheme is safe for application to land, including pasture for grazing animals. It follows that the risks with the use of certified digestate biofertiliser are low and acceptable.
5. AD Facilities built in New Zealand to meet the requirements of the Digestate Biofertiliser Certification Scheme will have to be designed to the same high standards as facilities in the UK.
6. The research (Miles, S, et al, 2013) 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.

7. The protocols, controls, and monitoring for input feedstocks and certified digestate biofertiliser described in this Technical Note are in compliance with existing New Zealand regulations. These management controls will be updated if there are any changes to the current regulations.

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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)