National Food Institute

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Veterinary safety in relation to handling of manure and animal by products and the use of biogas technologies

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- Introduction to the safety aspects in relation to handling of manure and animal by-products (ABPs)
  - WHY A RISK?
  - Pathogen reduction
- Risk assessment of biogas technology
- Regulation (EC) No. 1774/2002 of the European Parliament and the Council of 3 October 2002 laying down health rules concerning animal by-products not intended for human consumption incl. revisions
- Opinions from the European Food Safety Authority

Identification of hazards

- Bacteria, virus and parasites are natural parts of the animal intestinal flora

  - **Zoonotic agents** can cause infections in humans
    - viruses (e.g. rabies virus, influenza virus);
    - non-spore forming bacteria (e.g. salmonella, campylobacter, *Escherichia coli O157*, *Erysipelothrix rusiopathia*, *Listeria monocytogenes*, tuberculosis, brucellosis);
    - spore forming bacteria (e.g. anthrax, *Clostridium botulinum*);
    - parasites (trichinella, toxoplasma, taeniasis)
  - **Animal pathogens** – special focus on several viruses that can cause animal disease epidemics
    - e.g. swine fever virus, foot and mouth disease virus, blue tongue virus

Identification of hazards

- Initial concentration in raw materials
  - Infectivity in a given host – subclinical or clinical infection
- Propagation
  - Virus can not propagate out site the host
  - Some bacteria can propagate in the environment, other will decay
- Storage and initial processing

Identification of hazards

- Raw materials (manure and ABPs) contain micro-organisms representing the animal production of origin
  - different pathogens occur in different regions

➢ Use of manure as fertiliser within a specific region tends to maintain infections in the animal production

Use of local produced ABPs tend to maintain infections in the animal production and to higher the risk of spread of known infections among animal herds

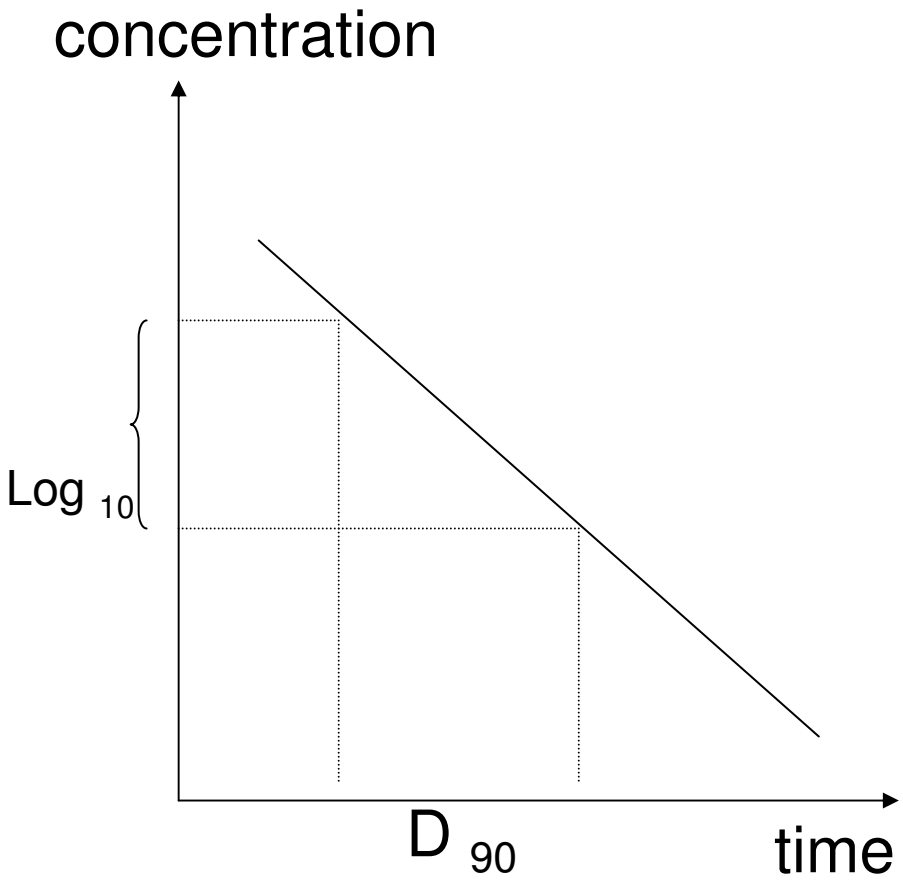
➢ Use of ABPs imported from another region tend to increase the risk of spread of new infections among animal herds

Reduction or inactivation of pathogens

- Reduction/inactivation of relevant pathogens can be done by applying physical, chemical or biological processes, sometimes a combination

  - steam sterilization - 133°C; 3 bar; > 20 min
  - “pasteurization” at temperatures at and below 100 °C
  - dry heat at high temperatur
  - radiation
  - chemical treatment (lime)

Reduction of pathogens



Decimation time D $_{90}$

- time necessary for a 90% reduction of the organism compared to start concentration

- depending of the type of organism and the treatment (eg. temperature)

Bacteria	Biogas plant		Slurry tanks	
	53℃ D90 (hour)	35℃ D90 (days)	18-21℃ D90 (weeks)	6-15℃ D90 (weeks)
S. Typhimurium	0,7	2,4	2,0	5,9
S. Dublin	0,6	2,1		
Escherichia coli	0,4	2,1	2,0	8,8
Clostridium perfr.	no reduction	no reduction	no reduction	no reduction
Bacillus cereus	no reduction	no reduction		
Erysipelotrix rhusiop.	1,2	1,8		
Staph. aureus	0,5	0,9	0,9	7,1
Mycobact. Paratb.	0,7	6,0		
GroupD streptococci		7,1	5,7	21,4
Strept. faecalis	1,0	2,0		

Larsen & Munch, 1982; Olsen et al., 1985

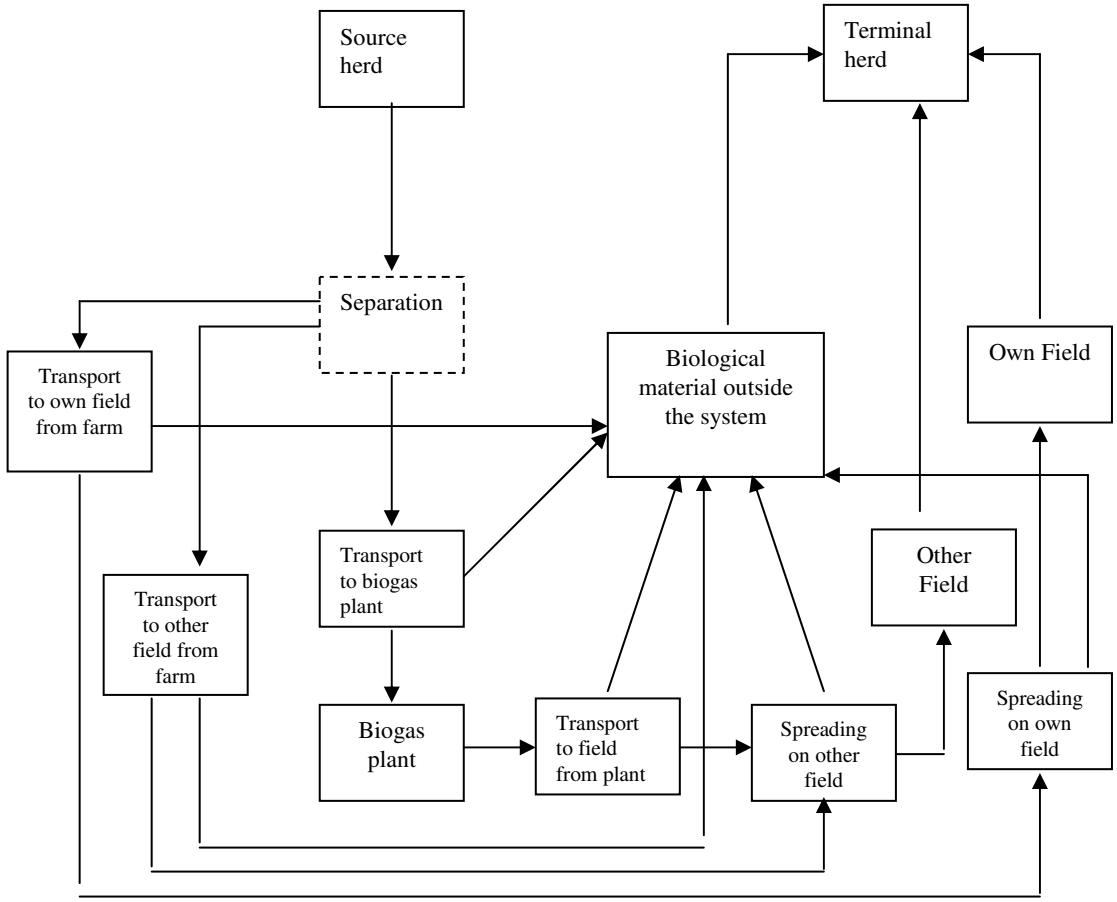
Virus	5 °C	20 °C	35 °C	55 °C
Parvo virus, pig	>40 weeks	>40 weeks	21 weeks	8 days
BVD, cattle	3 weeks	3 days	3 hours	5 min.
IBR, cattle	>4 weeks	2 days	24 hours	10 min.
Aujeszky virus, pig	15 weeks	2 weeks	5 hours	10 min.
Swine fever virus	> 6 weeks	2 weeks	4 hours	momentary

Bøtner, 1990

Risk assessment of handling manure and ABPs and use of biogas technology

- Modelling of the probability of transfer of infectious pathogens through the different steps of handling in different scenarios
  - Traditional handling without application of biogas technology
  - Handling through conventional thermophilic biogas plant incl. pasteurization (70 °C, 60 min., 12 mm.)
  - Handling through biogas plant with application of new technology
    - Separation of manure and/or digested biomass
    - Serial digesters
    - Wet oxidation
    - Recycling of fibers

Risk assessment model



Model based on….

Pathogen content in the manure

Risk of ”dropping off”

Probability of survival of the pathogen

Proces technology and stability

Risk assessment model

- Model based on
  - Literature, own laboratory results
  - Experts opinions
- Limited exact knowledge especially on the probability of transfer of pathogens through environment
  - Significance of ”drop off”
  - Significance of transfer by different mechanical vectors as human activity (boots etc) and wild life/pets
- Evaluation of relative risks in different scenarios
  - Highest impact of field infection
  - Highest impact on infection risk by handling

Relative risk by different biogas strategies

Highest impact of field infection

Highest impact on infection risk by handling

No biogas plant	15,4	2,72	1	0,82	0,80
Thermophilic biogas plant (reference)	1	1	1	1	1
Two serial digesters	0,02	0,02	0,02	0,02	0,02
Pressure boiling	1,27	0,64	0,55	0,54	0,54
Wet oxidation	1,27	0,64	0,55	0,54	0,54

Conclusions on risk assessment

- The balance between field infection and infection risk by handling activities is essential for the conclusions of the model
- As biogas plans has been used through several years without major outbreaks of infection, it is concluded that field infection must be of major significance compared to the risk followed by handling activities
- With the precondition of highest impact on field infection…
  - Use of biogas technology minimize the risk of spread of infection compared to conventional handling of manure
  - Use of new technologies reduce the risk further compared to traditional biogas technology
  - Strategies including separation at herd constitute a higher risk than those strategies where the total amount of material is transferred to biogas plants
- High level of hygiene measures is essential in order to control the risk by handling activities

Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3 October 2002…..and the following revisions

- Lays down health rules for the collection, transport, storage, handling, processing and uses or disposal of animal by-products not intended for human consumption, to prevent these products from presenting a risk to animal or public health
- The Regulation sets out clear rules for what must and may be done with the 16 million tonnes of animal materials that are excluded from the food chain in the EU each year.

Regulation (EC) No 1774/2002……

- Category 1 - animal by-products contaminated with BSE or scrapie, or with residues of prohibited substances (i.e. hormones used for growth promotion) or environmental contaminants (i.e. dioxins and PCBs)
- Category 2 - animal by-products presenting a risk of contamination with other animal disease (i.e. animals which have died on the farm or were killed in the context of disease control measures on the farm) or at risk of residues of veterinary drugs
- Category 3 - parts of a slaughtered animal that are not consumed by humans but come from animals declared fit for human consumption following veterinary inspection.

Regulation (EC) No 1774/2002……

- Category 1 materials must be totally disposed of as waste by incineration, or co-incineration after rendering (Article 4(2))
- Category 2 materials may only be recycled for uses other than animal feed (e.g. as fertilisers or soil improvers) after appropriate heat treatment (133 °C/20 min/3 bars) (Article 5(2)). Treated cat. 2 by-products may be used in biogas and composting plants to produce biogas, bio-fertiliser and compost
- Category 3 materials consisting of safe materials (i.e. come from animals declared fit for human consumption following veterinary inspection) may be used as fertiliser or soil improver after rendering (not necessarily 133 C/20 min/3 bars) or as biogas residues or as compost (Article 6(2)).

Approval of biogas plants

- Biogas plants shall be subject to approval by the competent authority
  - Position, organization, equipment, maintenance, hygiene
  - Control with and documentation of in- and output materials
- Establish control program based on HACCP principles
- Secure that digested biomass comply with microbiological criteria's stated in the legislation

- The competent authorities must control the plant and the control program

ABPs for biogas plants

- Category 2 material, treated by steam sterilization - 133°C; 3 bar; > 20 min
- Category 2 material: manure and digestive tract content separated from the digestive tract, milk and colostrum
- Category 3 material.
  - maximum particle size before entering the unit: 12 mm;
  - minimum temperature in all material in the unit: 70 ºC; and
  - minimum time in the unit without interruption: 60 minutes.

- Alternative treatment methods can be accepted by the competent authority following risk assessment and validation

Risk assessment of alternative methods

- A generic risk assessment for each waste management method based on a full definition of the APB processing conditions for each management method under consideration.
- A plant specific risk assessment that considers how the specified processing conditions are achieved in practice under normal and atypical situations

- It is impractical to determine the ability of each process to all the micro-organisms that may be present in ABP. Instead the risk assessments should be based on measurement of the degree of destruction of selected micro-organisms (test micro-organisms).

Validation of alternative methods

- The validation must show that the process achieves the following:
- Reduction of thermo stable viruses by a minimum of 3 log.
- Reduction of non-spore forming pathogenic bacteria by a minimum of 5 log.
- Reduction of parasites by at least 99.9 % of viable stages .

Microbiological criteria for the digested biomass

- Samples of the digestion biomass taken during or direct after the treatment at the biogas plant must comply with the following standards

- *Escherichia coli*: n = 5, c = 1, m = 1 000, M = 5 000 i 1 g

  or
- *Enterococci*: n = 5, c = 1, m = 1 000, M = 5 000 i 1 g

  and
- *Salmonella*: None in 25 g: n = 5, c = 0, m = 0, M = 0

Relevant opinions from European Food Safety Authority (EFSA) http://www.efsa.europa.eu/en/science/biohaz/biohaz_opinions.html

- Opinion of the BIOHAZ Panel on the biological safety of heat treatment of manure - Adopted on 7 September 2005. (Question N° EFSA-Q-2004-104)
- Opinion of the BIOHAZ Panel vis-à-vis biological risks of biogas and compost treatment standards of animal by-products (ABP). Adopted on 7 September 2005. (Question N° EFSA-Q-2003-097)
- Opinion of the Scientific Panel BIOHAZ on the safety vis-à-vis biological risk of the mesophilic process of biogas and compost treatment of Animal By-Products (ABPs). Adopted on 8 March 2007. (Question Nº EFSA-Q-2006-126)