Digestates: Characteristics, Processing and Utilisation

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Training the Trainers
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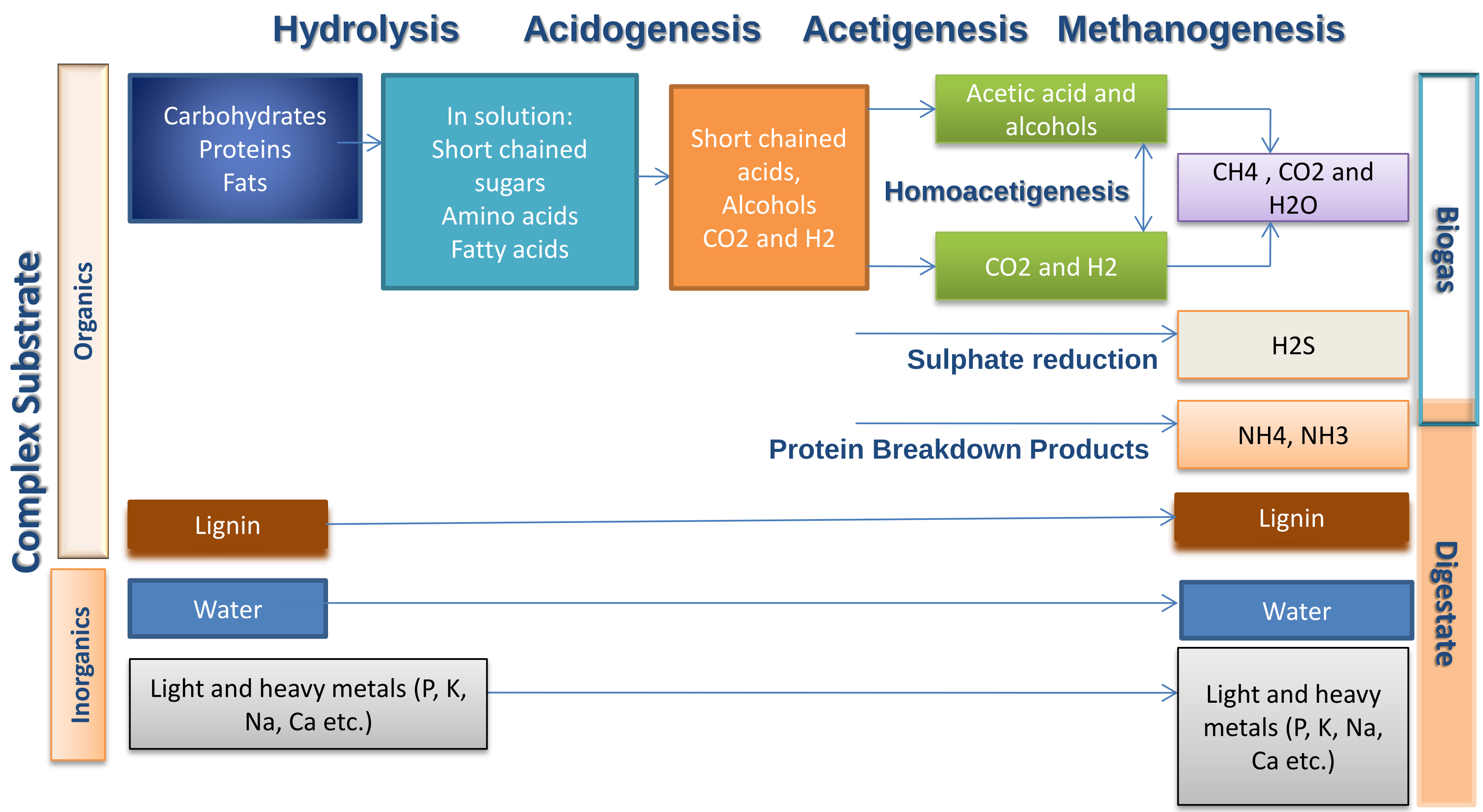
Contents

Anaerobic Digestion



Characteristics of Digestates

- Can vary according to input material and operating conditions
- Low dry matter (typically between 1-8 % solids)
- High water content
- Undigested material e.g. lignins and cell debris
- Inorganic nutrients (ammonium-N and P)
- May contain potentially toxic elements (PTEs) e.g. heavy metals
- Whole digestate can be separated into fibre and liquid fractions
- Classed as a waste or non-waste

Nutrient content of digestates

wrap — Material change for a better environment

Environment Agency

Waste Protocols Project

Anaerobic Digestate

Partial Financial Impact Assessment of the introduction of a Quality Protocol for the production and use of anaerobic digestate

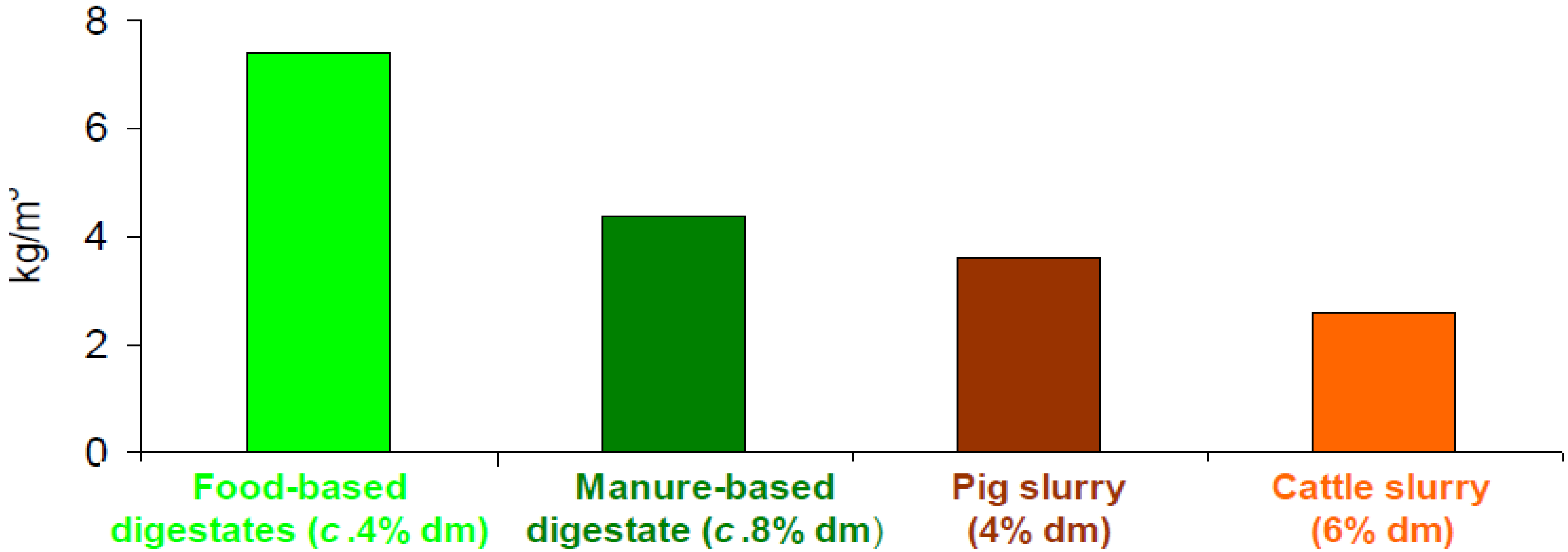
Table 6: Example nutrient contents of further selected digestate products [8, 4, 21]

Parameter	Digested cow slurry			Digested pig slurry			Mixed digester output (30% cow, 50% pig 20% C&I)		
	Whole	SL	SF	Whole	SL	SF	Whole	SL	SF
Dry matter (DM) (%)	7	3.1	23	5	1.5	30	4	1	30
Total N (kg/tonne)	5.47	4.6	9	5.05	4.36	9.56	5.15	4.49	12.5
Available N (kg/tonne)	3.29	3.3	3.3	3.78	3.79	3.72	4.12	4.13	4
Organic N left (kg/tonne)	2.18	1.3	5.7	1.27	0.57	5.84	1.03	0.36	8.5
Phosphate (kg/tonne)	1.02	0.2	4.2	1.21	0.56	5.49	1.16	0.37	10
Estimated value (total N,P)	£3.73	£2.22	£9.65	£3.82	£2.62	£11.69	£3.79	£2.41	£19.22
Accounting for availability	£1.74	£1.46	£2.86	£2.01	£1.79	£3.48	£2.14	£1.87	£5.17

SL = separated liquor

SF = separated fibre

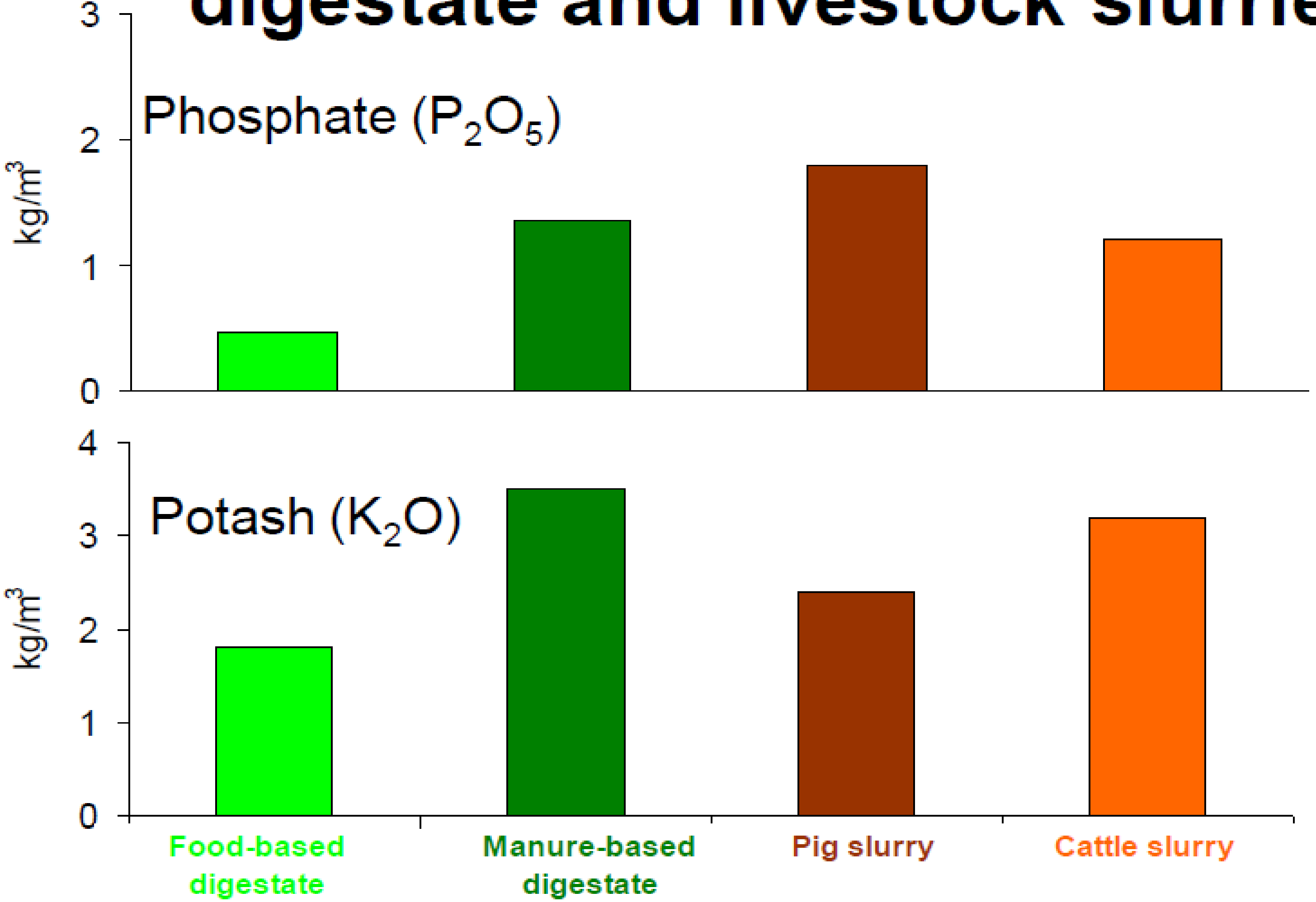
Total nitrogen (N) in digestate and livestock slurries (kg/m³)



'Typical' slurry values taken from "Fertiliser Manual (RB209)"

Fertiliser Manual (RB209) Defra June 2010 (http://archive.defra.gov.uk/foodfarm/landmanage/land-soil/nutrient/documents/rb209-rev-100609.pdf)

Total phosphate and potash in digestate and livestock slurries



'Typical' slurry values taken from "The Fertiliser Manual (RB209)"

Fertiliser Manual (RB209) Defra June 2010 (http://archive.defra.gov.uk/foodfarm/landmanage/land-soil/nutrient/documents/rb209-rev-100609.pdf)

Heavy metal concentrations (mg/kg dry matter) in digestate & livestock slurries

Heavy metal concentration	Digestate (food)	Digestate (manure)	PAS 110	Pig slurry	Cattle slurry
Total Zinc	104	200	**400**	*870*	196
Total Copper	21.5	127	**200**	*279*	137
Total Cadmium	0.9	0.6	**1.5**	0.3	0.1
Total Nickel	19.7	11.4	**50**	3.9	3.4
Total Lead	6.1	11.3	**200**	3.5	4.8
Total Chromium	10.0	10.4	**100**	2.3	2.9
Total Mercury	<0.05	<0.05	**1**	n.d	n.d

n.d = no data

Slurry data from Nicholson *et al.* (2010)

Potential Markets

Biofertiliser
certification scheme

- Land applications e.g. Fertiliser
- Soil conditioner
- Converted to compost
- Growing medium for plants
- Land regeneration projects
- Building materials (pressed into blocks)
- Drying and pelletizing for use as a solid fuel or dried fertiliser

AgroEnergien

Biofertiliser - Certification Scheme - Windows Internet Explorer

http://www.biofertiliser.org.uk/

Biofertiliser
certification scheme

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What is BCS for?

The Biofertiliser Certification Scheme (BCS) provides assurance to consumers, farmers, food producers and retailers that digestate produced from anaerobic digestion is safe for human, animal and plant health. Biofertiliser is the name adopted for the quality digestate that meets the PAS110 & ADQP or ASRS specification.

Who we are

BCS is part of Renewable Energy Assurance Ltd, a subsidiary of the Renewable Energy Association. Plants are assessed by two independent Certifying Bodies and an independent Panel oversees the BCS.

Read more about who we are.

Why join BCS?

Digestate that achieves certification is no longer classed as a waste and can be spread beneficially to land without the need for an Environmental Permit, providing a valuable source of organic, carbon-free fertiliser.

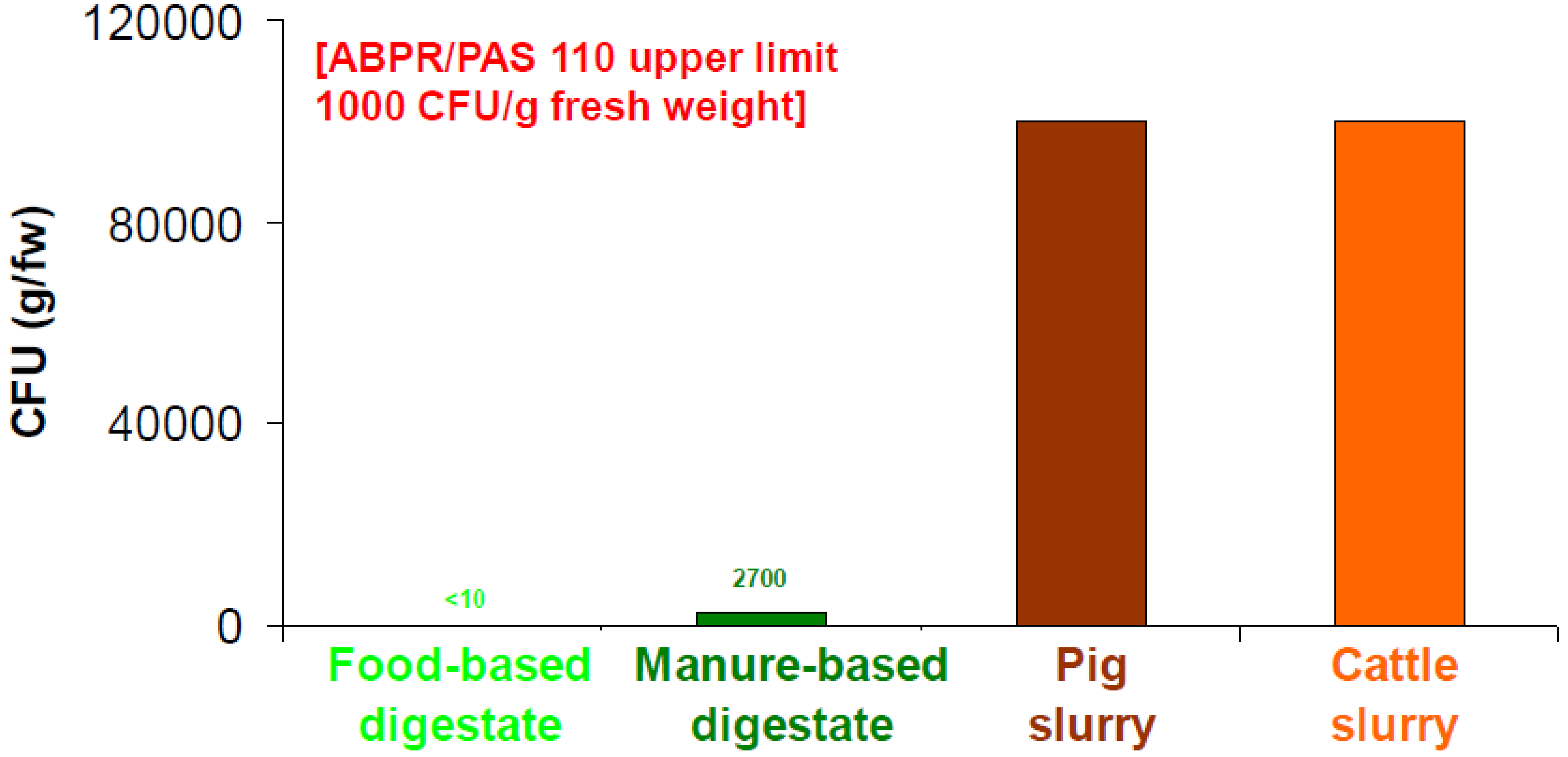
See our how to join BCS.

Internet | Protected Mode: On

Impacts when applied to agricultural land

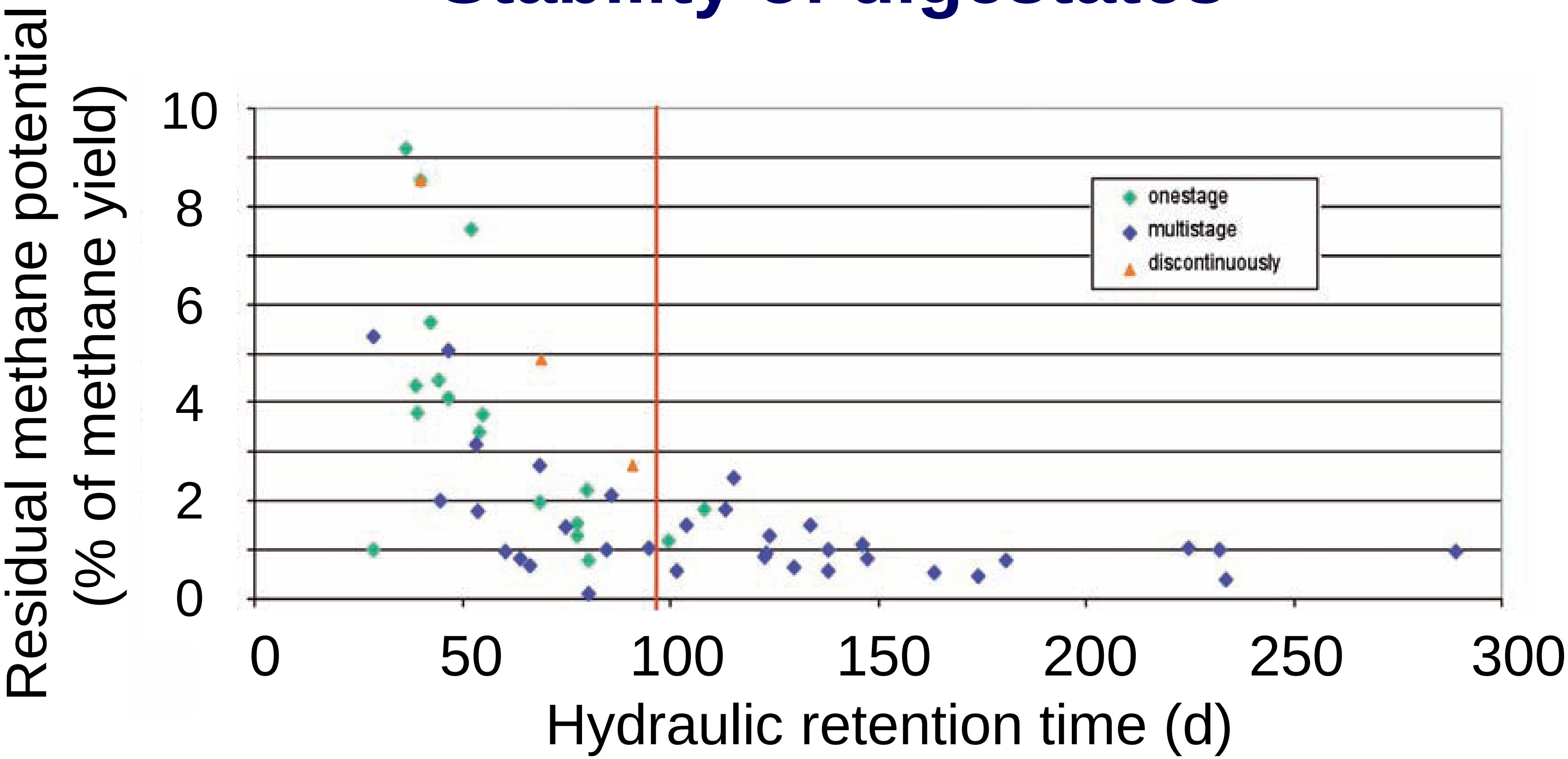
- May affect the nutrient balance of soil
- Risk of phytotoxicity
- Nitrate leaching
- Risk of methane and ammonia emissions
- Odour
- Risk to the public e.g. pathogens ,allergens and Potentially Toxic Elements (PTEs)
- May affect microbial activity in soils
- Transportation costs (carbon footprint)

Microbial pathogens - *E.coli;* colony forming units (CFU)/g fresh weight



*Data from Defra FIO-FARM project

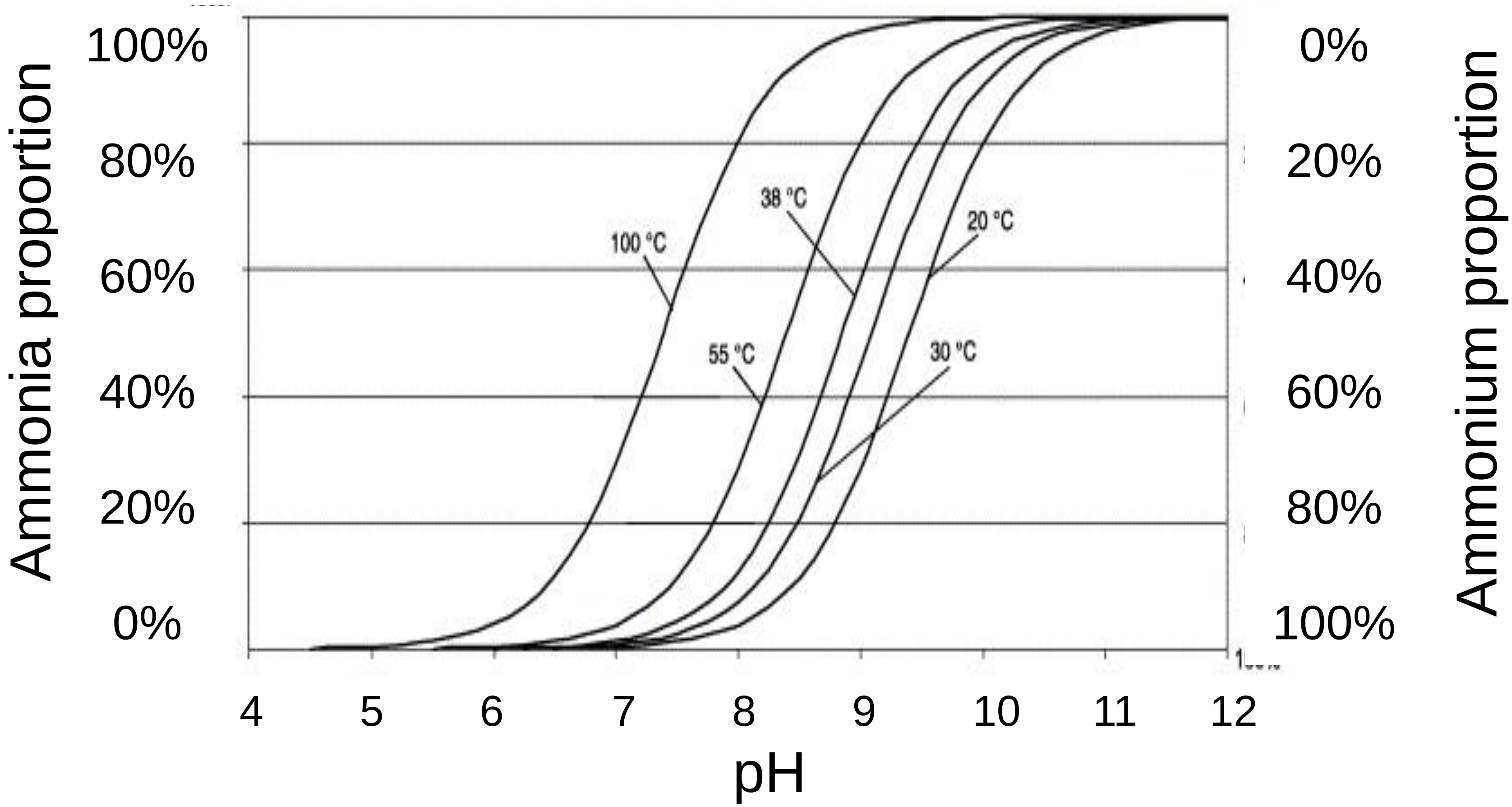
Stability of digestates



Losses of methane from digestate stores

Weiland P (2009). Biogas- Messprogramm I 61 Biogasanlagan im Verlich. Erstellt durch Johann Heinrich von Thunen-Institut (VTI), Gulzow, Germany

NH_3 Emissions



Dissociation balance between ammonia/ammonium depending on pH and on temperature (calculated according to Kollbach *et al.*, 1996)

Fricke *et al.*, 2007

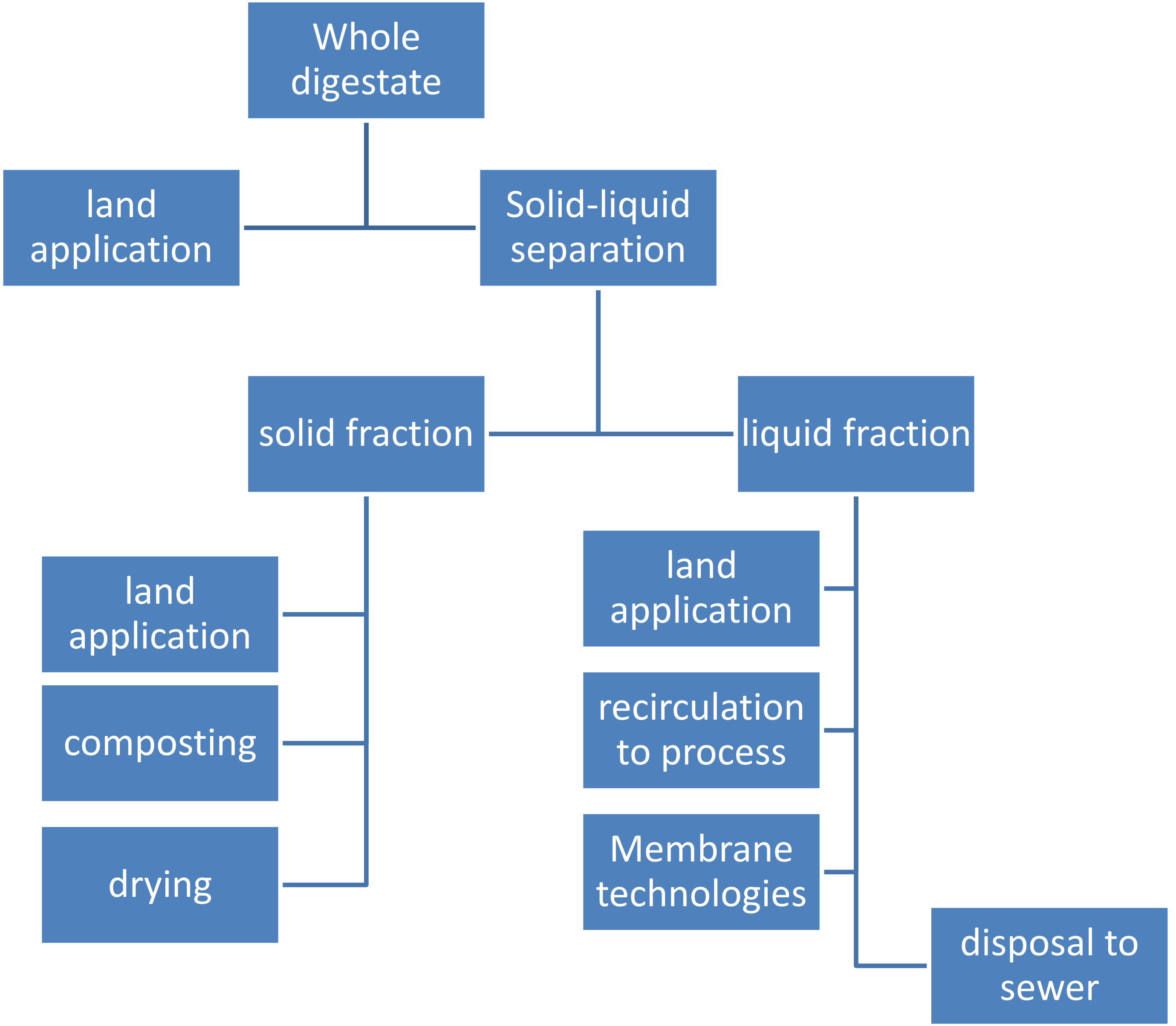
Odorous compounds in digestates

- Hydrogen sulphide
- Ammonia
- Amines
- Volatile organic acids
  - Propionic acid
  - Butyric acid
- Reduced sulphur compounds

Emissions and Odour Control

- Digestate storage tanks covered
- Sealed tankers for transporting liquor digestates
- No spreading of digestates, shallow injection will minimise emissions and odours

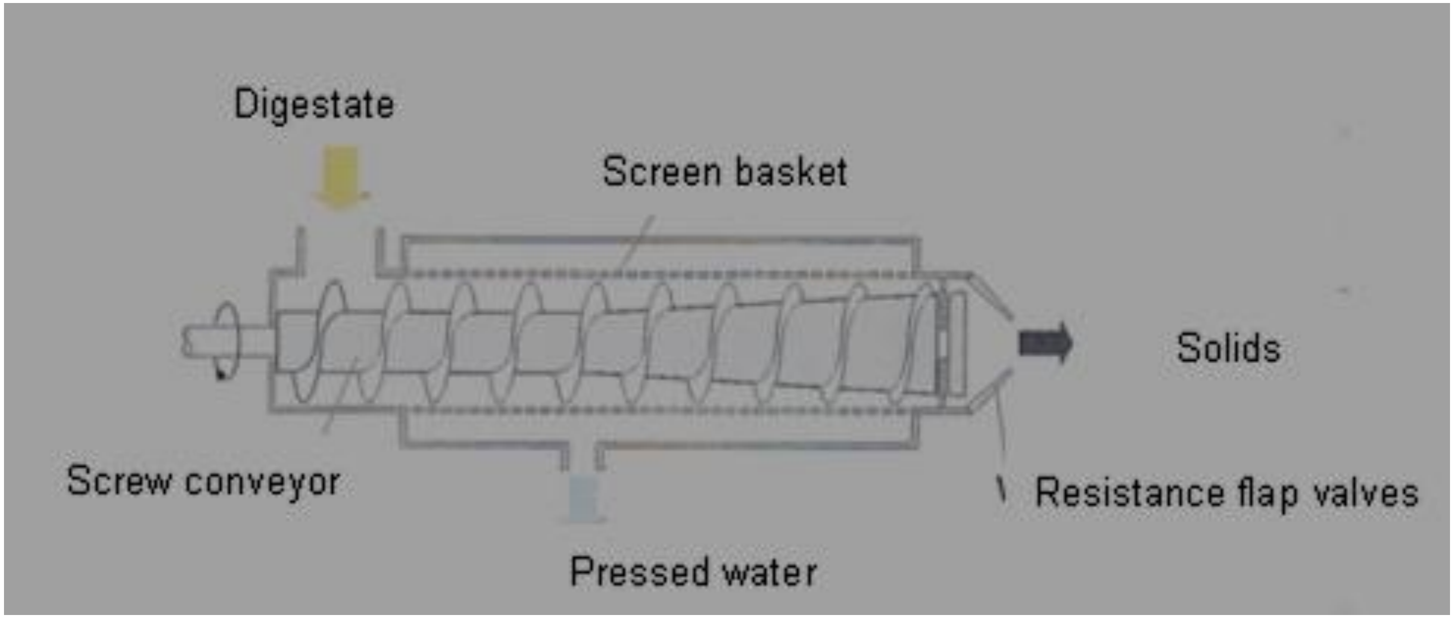
Digestate processing



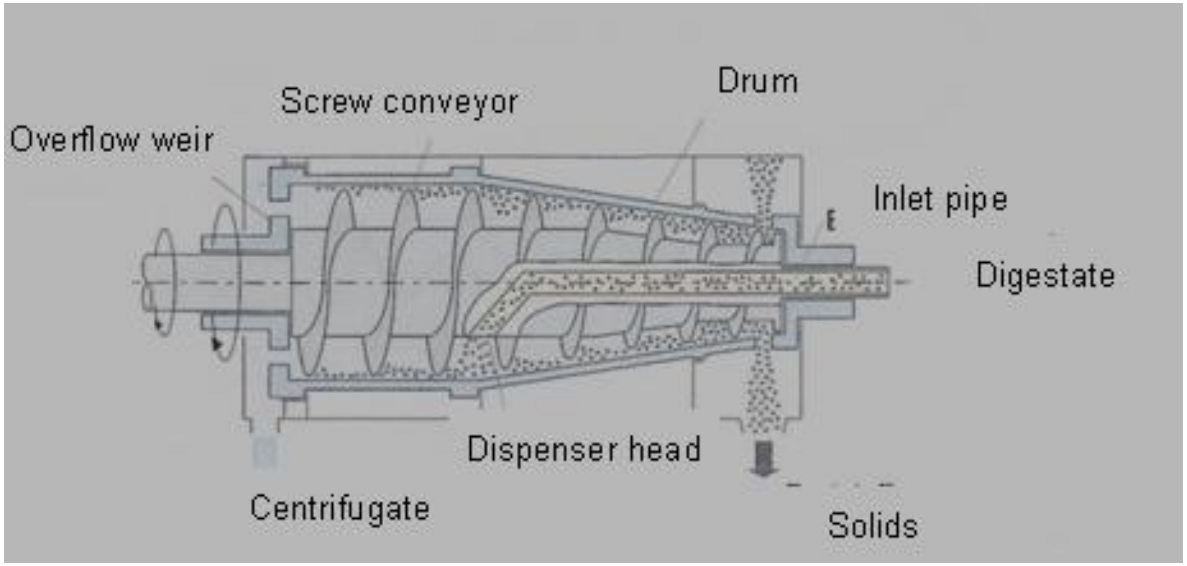
Dewatering technologies for solid-liquid separation of manures/digestates

- Sedimentation
- Flotation
- Screen separator
- Belt press
- Centrifuges
- Screw press
- Drying/evaporation technologies

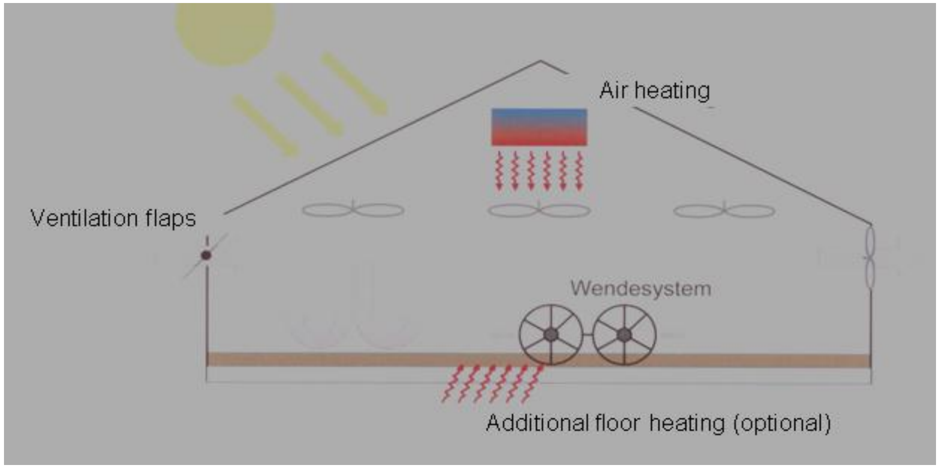
Dewatering technologies: Screw press



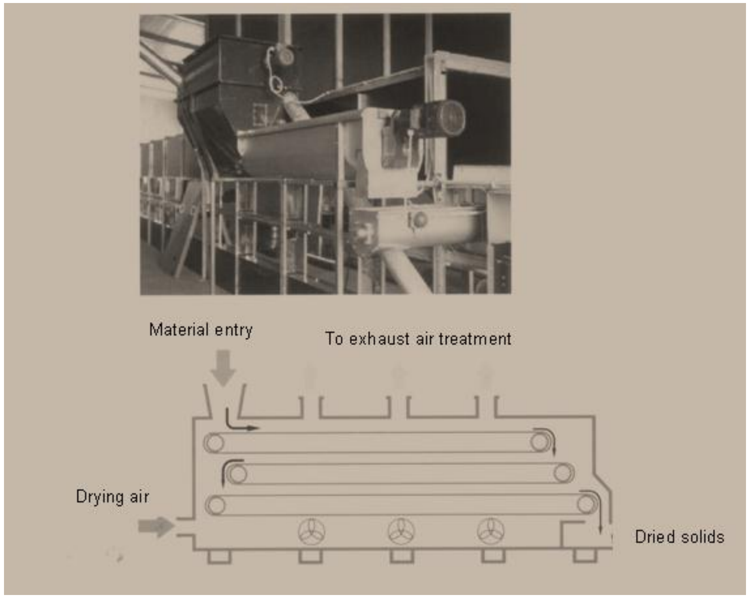
Dewatering technologies: Decanter centrifuge



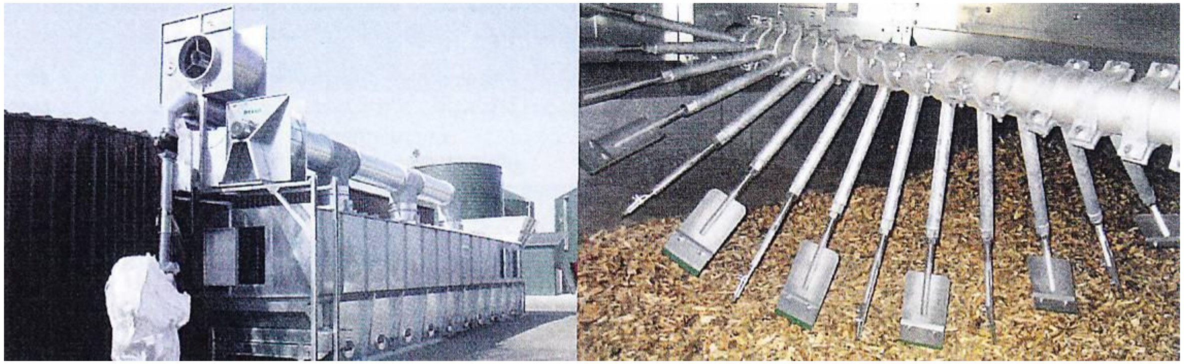
Processes for further treatment of the solids: Composting and drying



Solar drying of digestate



Belt dryer



Feed-and-turn dryer

Fuchs & Drosg, 2010 Technologiebewertung von Garrestbehandlungs- und Verwertungskonzepten. Eigenverlag der Universitat fur Bodenkultur Wien

Dewatering technologies: Evaporator unit

Source: HRS

Summary of parameters using different solid-liquid separation technologies

Technology	Input DM (%)	Output DM Solid fraction (%)	Energy consumption kWh/t	Typical throughput m^3/ h
Sedimentation	0.5	5		
Flotation	0.5	5		
Screen sieves	0.5 - 5	10	0.2 – 0.9	10
Belt press	3 - 7	21 – 25	0.08 – 0.12	10 - 40
Centrifuge	1.7 – 8.1	18 – 30	1.8 – 7	0.7 – 40
Screw press	1 - 16	25 - 40	0.24 – 1.1	2 – 100

Data collated from several studies

Choice of methodology to employ for dewatering

- Type of feedstock treated
- Characteristics of the digestate
- Financial considerations
- Throughput
- Energy requirements
- Chemical addition requirement
- Separation efficiency in terms of solid or mineral removal

Effectiveness of the technologies for water removal

Water is present in many different forms:

- Free water
- Bound water (intracellular water or within extracellular polymers)

- Mechanical separators can remove the free water
- Bound water may require drying (evaporation) or disruption of the cells

Efficiency of solids separation

Depends on the separator employed

e.g. Separation efficiency of the screw press is low because it only retains particles > 1mm in diameter.

Compare with decanter centrifuge retains all particles >0.02 mm

Depends on the composition of the digestate

- TS and fibre content
- particle size distributions

Treatment with flocculants

Table 11: Separator efficiency[1] of some common mechanical manure separators for dry matter (DM), nitrogen (N), phosphorus (P), potassium (K) and volume reduction (VR). Without polymer addition unless otherwise stated. (Derived from [*]Burton and Turner, 2003; [+]Frost and Gilkinson, 2007)

	Separator efficiency[1] (%)				
	DM	N	P	K	VR (%)
Belt press[*]	56	32	29	27	29
Sieve drum[*]	20 – 62	10 – 25	10 – 26	17	10 – 25
Screw press[*]	20 – 65	5 – 28	7 – 33	5 – 18	5 – 25
Sieve centrifuge[*]	13 – 52	6 – 30	6 – 24	6 – 36	7 – 26
Decanter centrifuge[*]	54 – 68	20 – 40	52 – 78	5 – 20	13 – 29
Brushed screen[+] (cattle slurry)	36	18	26	15	14
Decanter centrifuge[+] (cattle slurry) no polymer with polymer	 51 65	 25 41	 64 82	 13 13	 13 increased
Brushed screen[+] (pig slurry)	19	6	7	5	5
Decanter centrifuge[+] (pig slurry) no polymer with polymer	 53 71	 21 34	 79 93	 8 11	 8 increased

[1] Percentage of component in total slurry input that was partitioned to solid fraction

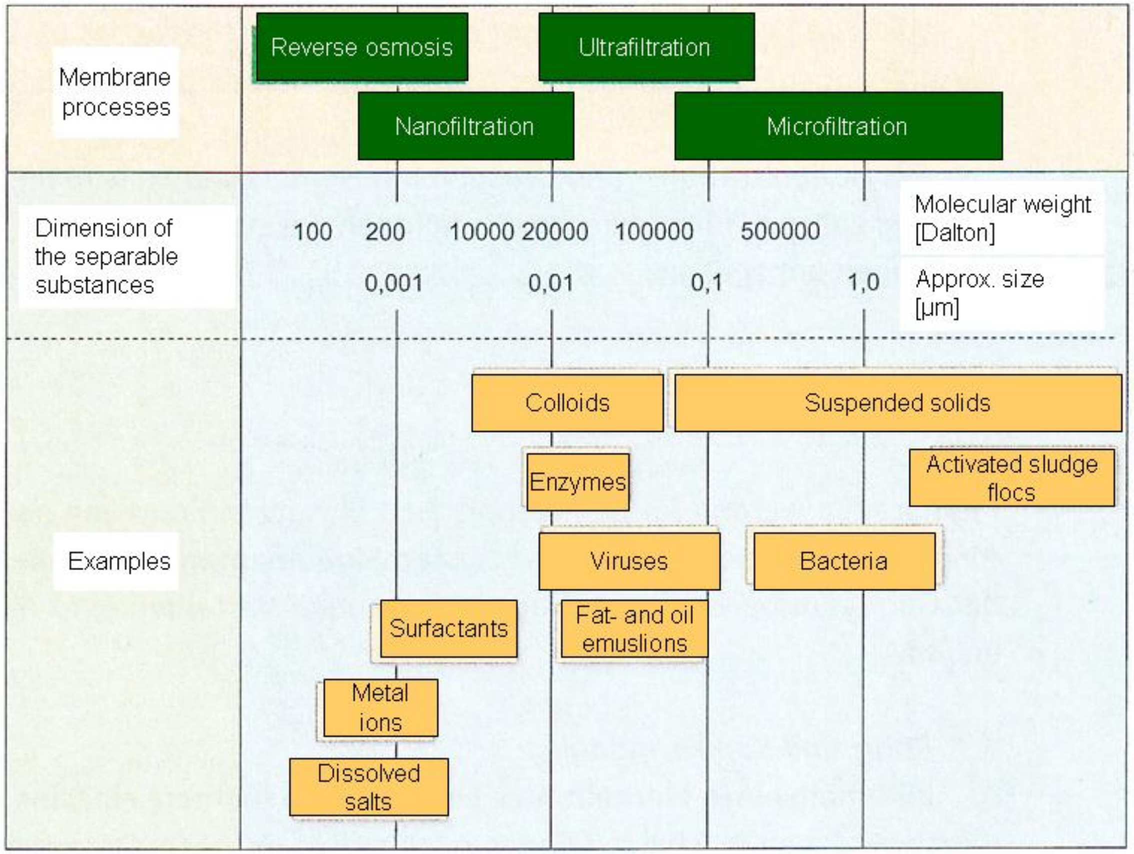
Separation efficiencies (%) for DM, N, P and K of various manures and digestates using various technologies

Technology	DM	N	P	K
Belt press	65	32	29	27
Centrifuge	54-68	20-40	52-78	5 -20
Screw press	20-65	5-28	7-33	5 -18

(Data collated from several studies)

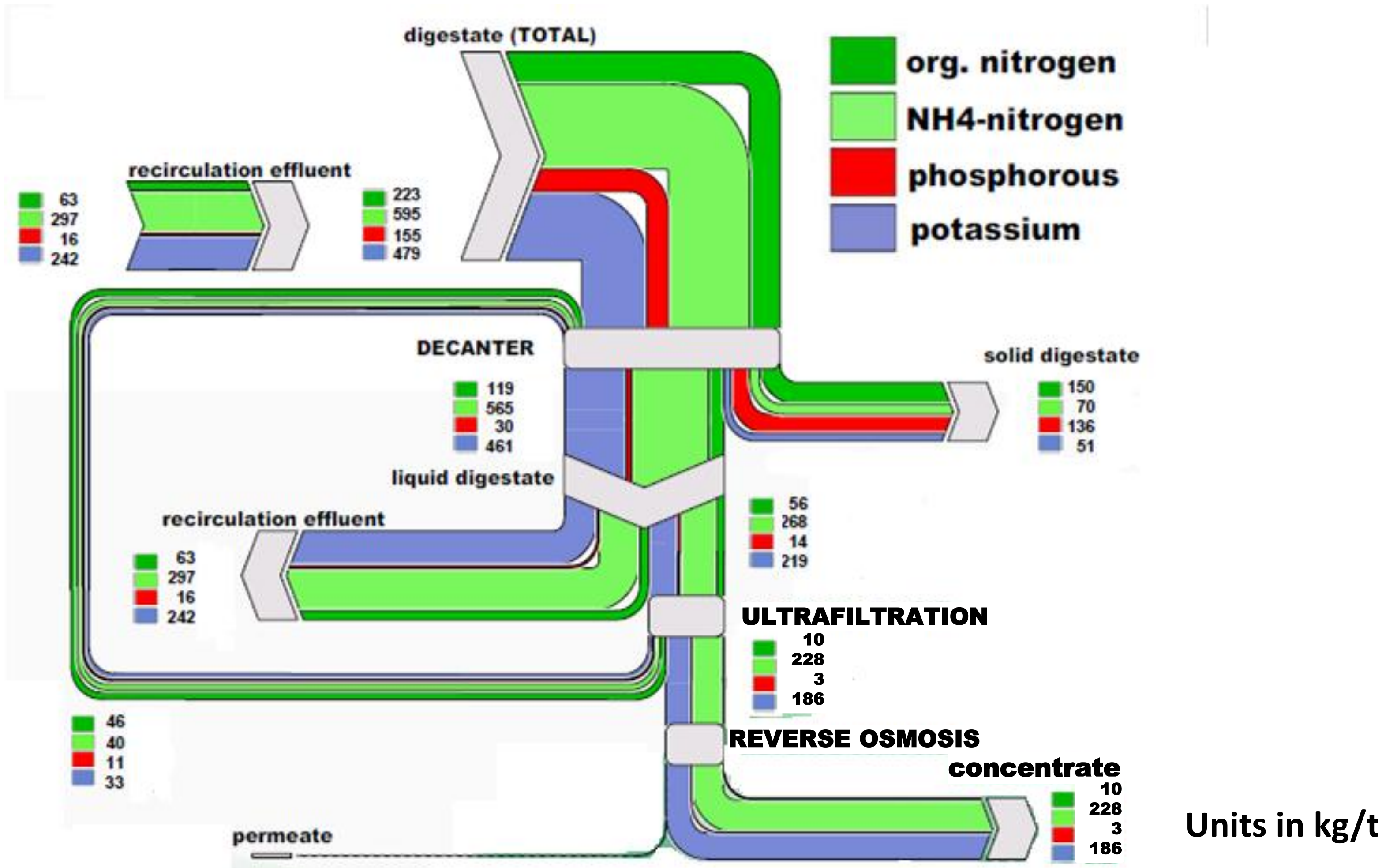
The proportion of a constituent partitioned to the solid fraction, relative to the amount in the slurry or digestate

Processes for the treatment of the liquid phase



Fuchs & Drosg, 2010 Technologiebewertung von Garrestbehandlungs- und Verwertungskonzepten. Eigenverlag der Universitat fur Bodenkultur Wien

Nutrient flows during the digestate treatment process



Source. Fuchs et al (2010) Digestate treatment: comparison and assessment of existing technologies. *Third International Symposium on Energy from Biomass and Waste. Venice.*

Conclusions

Consider the available options for the use of the digestate. Is their a sustainable market?

Digestates contain valuable nutrients that make them a suitable alternative to chemical fertilizers.

Separation technologies may be employed for partitioning of solids and nutrients (NPK)

An important consideration when deciding on the choice of separator will be the intended application for the digestate

Abbreviations

- BCS Biofertiliser Certification Scheme
- CFU Colony Forming Units
- CHP Combined Heat & Power
- DAF Dissolved Air Flotation
- DM Dry Matter
- NPK Nitrogen Phosphorous Potassium
- PTE Potentially Toxic Elements
- SL Separated Liquor
- SF Separated Fibre

Thank You

Questions