Sustainable exploitation of biogas plant digestate within circular economy: high quality organic fertilizer production

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CONTENTS

Digestate as a fertilizer

- **Circular economy**
- Waste reuse
- Anaerobic digestion: digestate as a by product
  - Nutrient rich
  - Mineral fertilizer replacement
  - Cost reduction
  - Eco friendly

Digestate issues

Composition

Feed depended

Nutrients

High concentrations
Eutrophication

Volume

Treatment & storage

Hazards

Pathogens
Pharmaceuticals

Common AD feed

Food waste

Low solid content.
High nitrogen concentration
Impurities: Plastics

WWT Sludge

Low solids content
Impurities: Antibiotics, PCBs, PAH

Animal residues

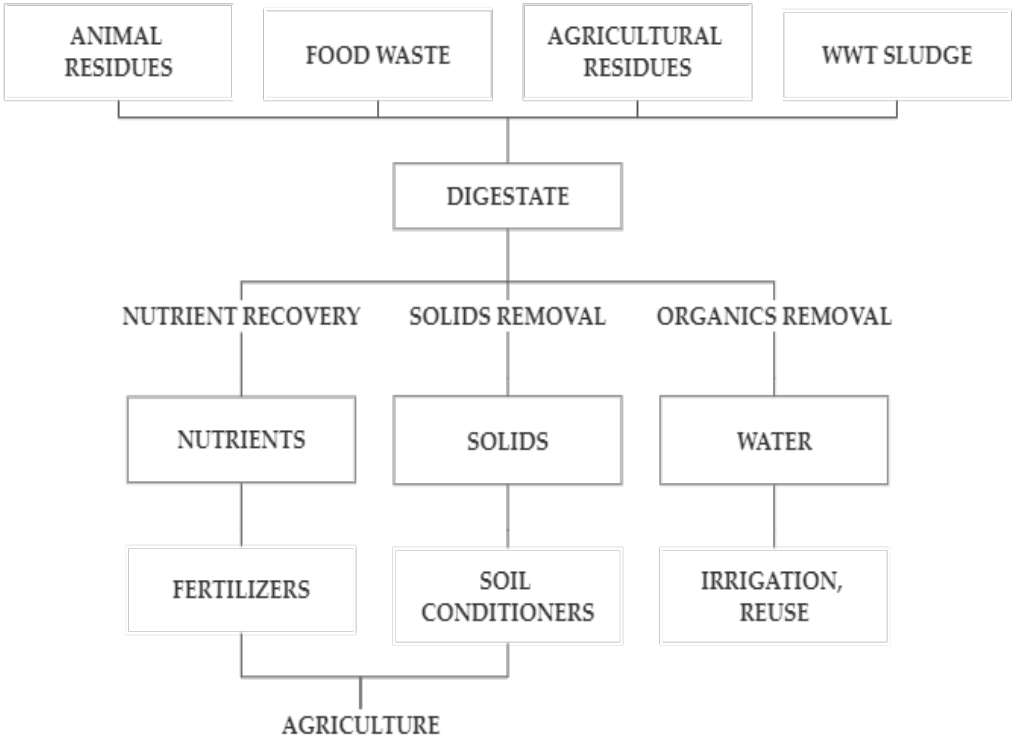
Very low solids content
High nitrogen concentration
Impurities: Antibiotics, heavy metals

Agricultural residues

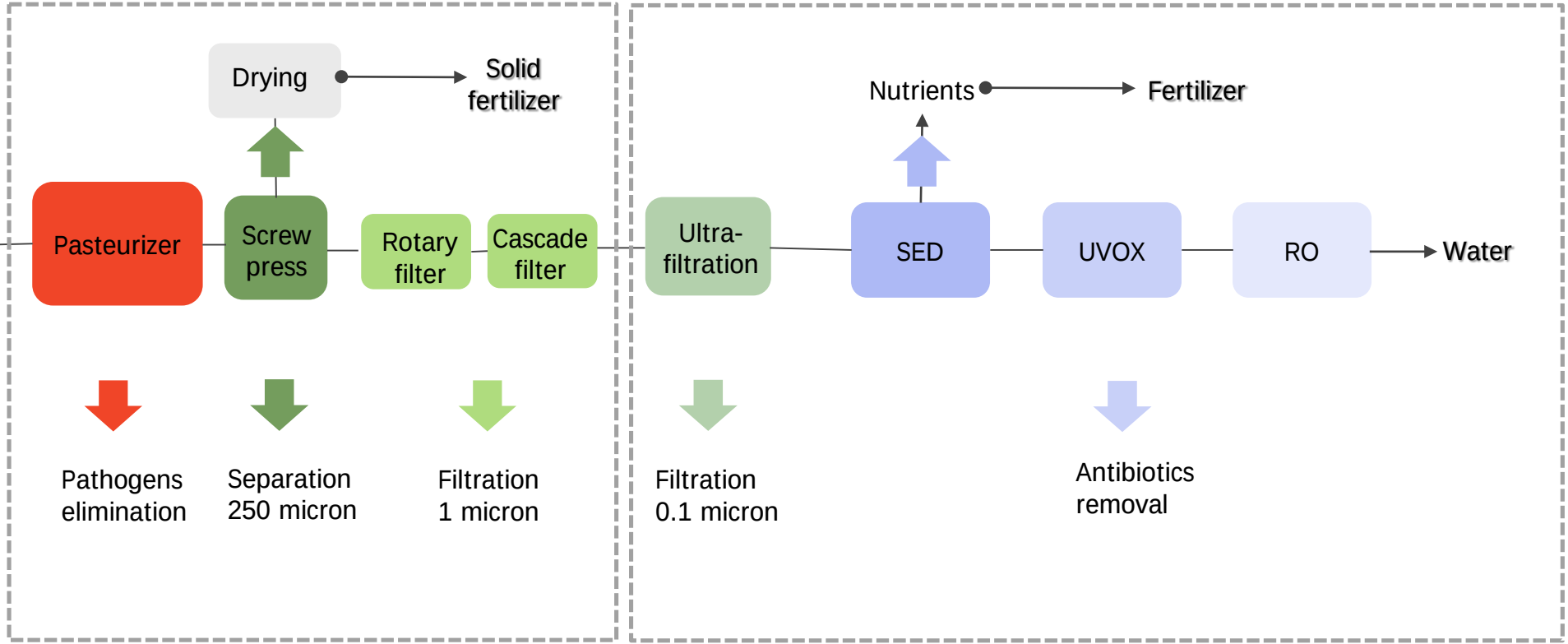
High solids content
Impurities: Pesticides, herbicides

Solutions

- Reduce digestate volume
- Recover nutrients, fibre and water
- Production of high quality fertilizers
- Elimination of pathogens
- Pharmaceuticals removal



Process scheme

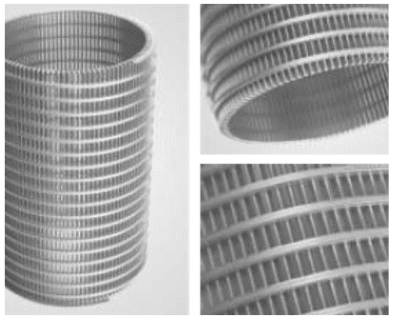


Pretreatment

Pasteurizer

Screw press

Ultrafiltration



Microfiltration

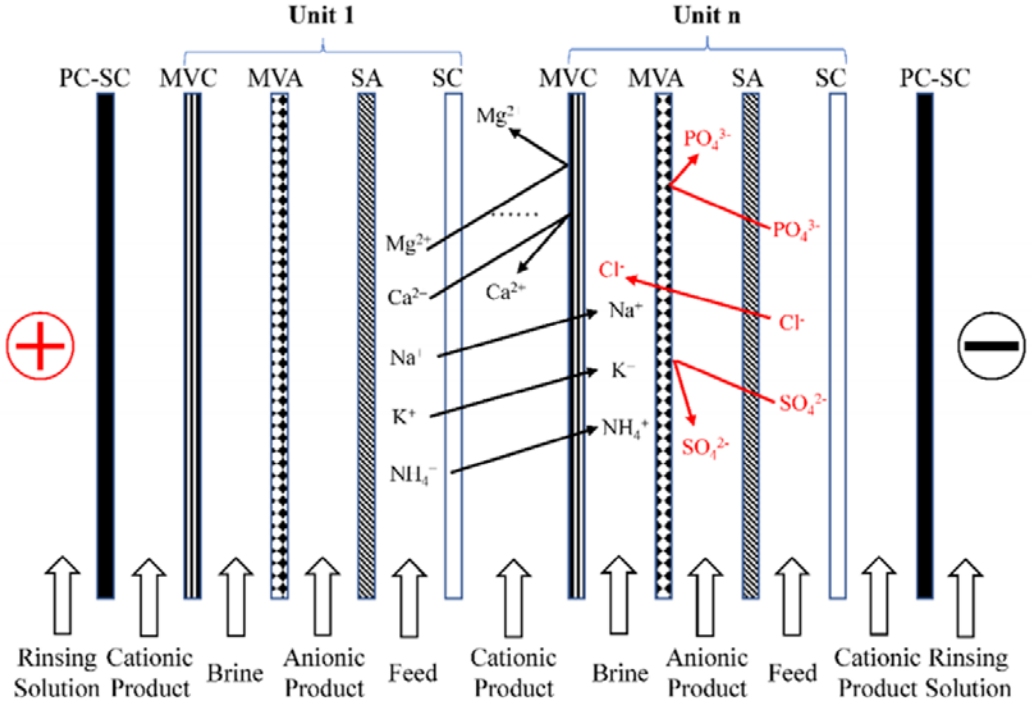
Main process

Selective Electrodialysis, SED

UVOX

Reverse osmosis, RO

Nutrient Recovery
Selective Electrodialysis, SED



Feed: Liquid fraction (<0.1µm)

Products:

1. Fraction free of ions
2. Cationic fraction: Ca^{2+}, Mg^{2+}
3. Anionic fraction: PO_4^{3-}, SO_4^{2-}
4. Monovalent ions fraction: K^+, NH_4^+, Na^+, Cl^-

Biogas plants

Food waste

Supermarket and kitchen food waste, kitchen and canteen catering food waste, waste from markets

Animal residues

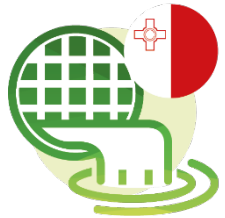
Animal faeces, urine, manure and corn silage

20-25 % cereal silage; 75-80% agro-industrial by-products (fruit and vegetable processing, olive pomace, manure)

Agricultural waste

Sludges from treatment of urban wastewater and Farmyard waste mixed with urban waste in the sewer collection network

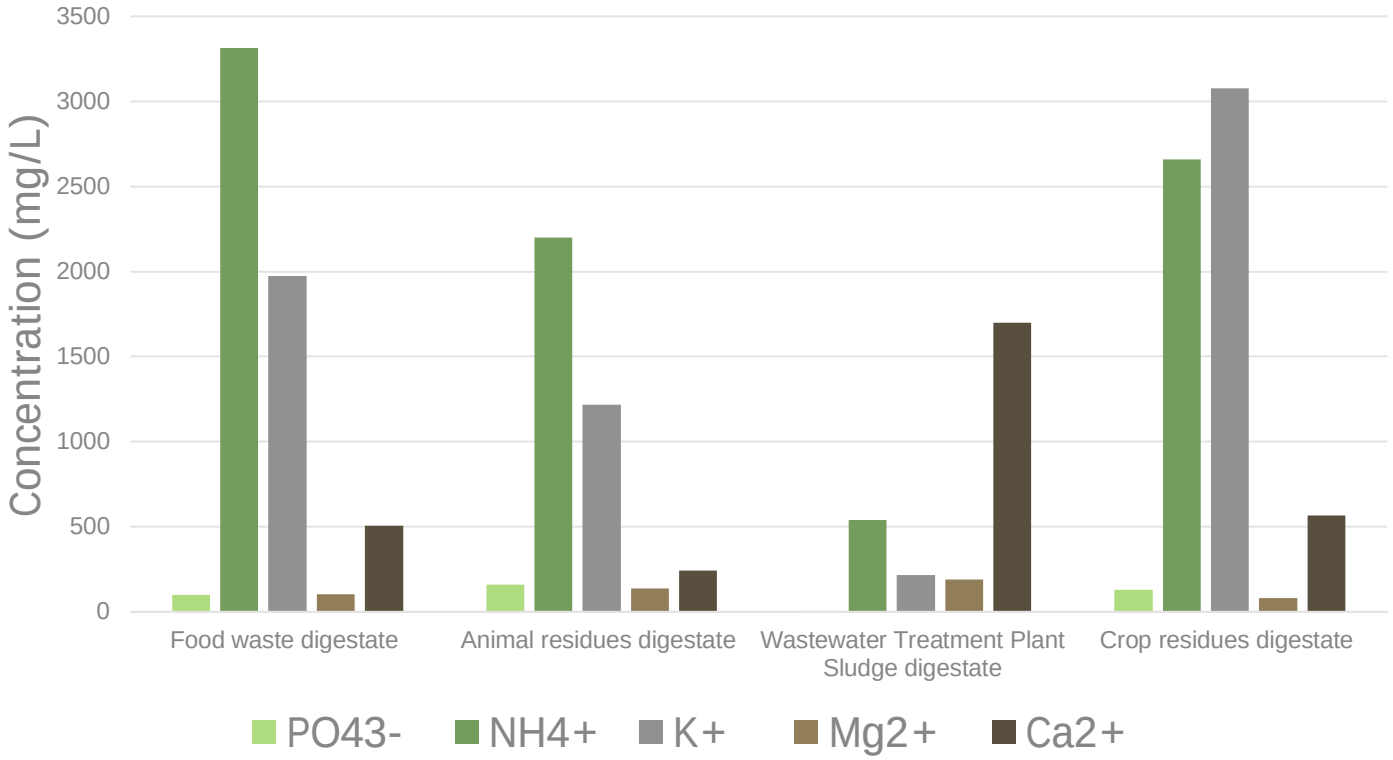
WWT Sludge



Digestate characterization

Digestate	pH -	TN gN / kg DM	TNK gNH_4 / kg DM	TP gPO_4 / kg DM	K g / kg DM	COD g / kg DM	DM %
Food waste digestate	8.8	145	145	11	113	1425	5.7
Animal residues digestate	8.1	125	125	27	102	1075	3.4
Wastewater Treatment Plant Sludge digestate	7.6	51	51	17	18	918	4.0
Crop residues digestate	8.0	117	116	8	118	774	7.9

Nutrient ions' availability



Key assumptions

- Percentage of water loss during pasteurization (2%).
- Moisture content of recovered solids (70%).
- Percentage of ammonium loss during pasteurization (43%).
- 100 % recovery of nutrient ions during SED.
- 50% water recovery during UF – RO systems.

Products recovery

Digestate	Recovered wet fibre (kg)	Total Nitrogen in the wet fibre (%)	Nutrients recovery with SED					Water recovery (%)
			PO_4^{3-} (kg)	NH_4^+ (kg)	K^+ (kg)	Ca^{2+} (kg)	Mg^{2+} (kg)	
Animal residues digestate	1000	123	0.27	0.04	0.99	0.81	0.22	0.11	42.9
Food waste digestate	1000	164	0.27	0.05	2.28	1.46	0.07	1.46	36.4
Urban wastewater Sludges digestate	1000	128	0.22	0.007	0.35	0.15	0.25	0.15	39.7
Crop residues digestate	1000	263	1.4	0.07	1.36	2.48	0.17	0.02	35.9

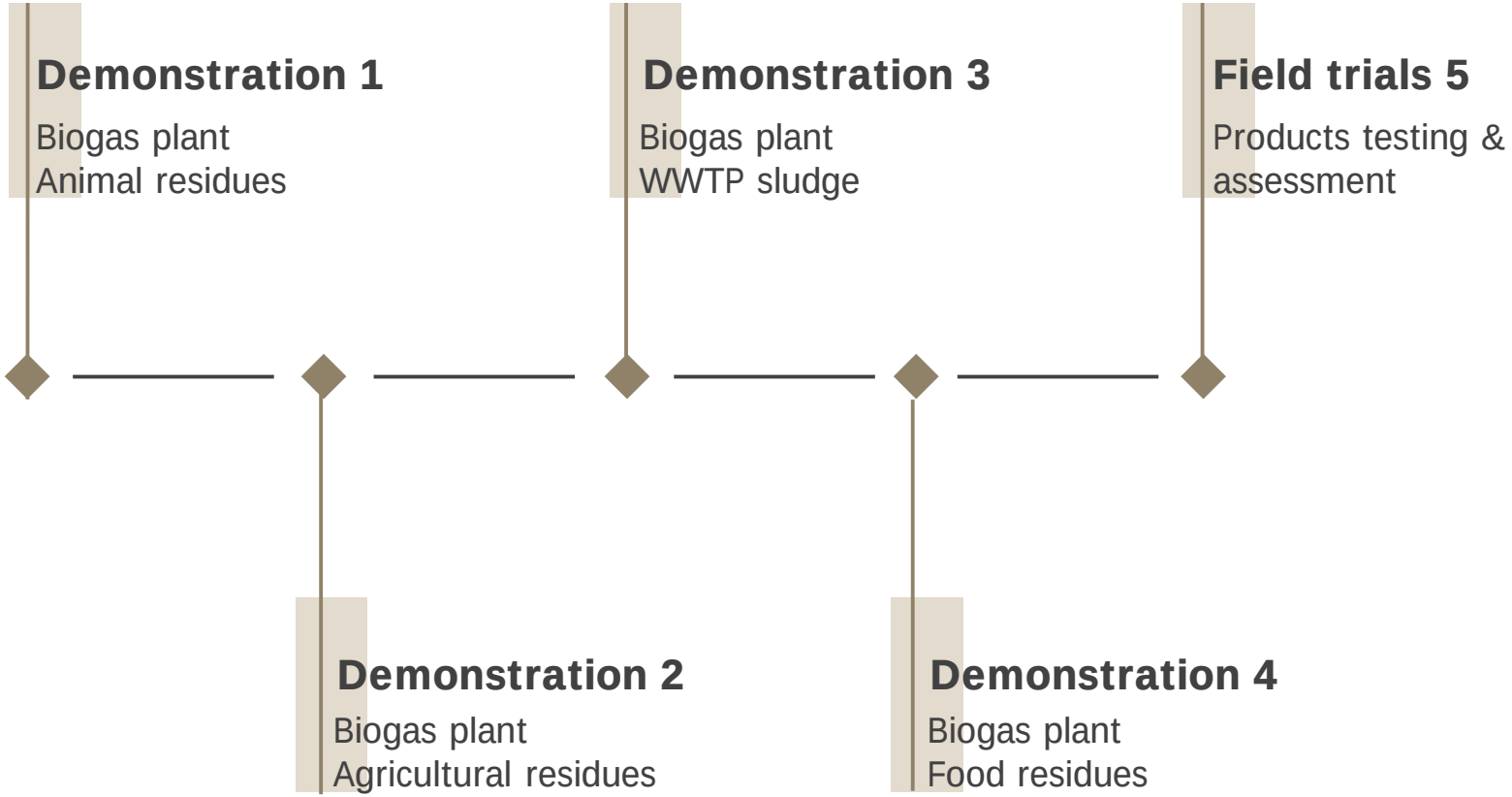
Results

- **Higher solid recovery** was achieved in the case of digestate with **agricultural residues** origin.
- **Lower solid recovery** in the case of **animal residues** digestate.
- Solid fraction from **agricultural waste** digestate has **higher nitrogen content**.
- **Higher NH_4^+ recovery** with SED treatment in the case of **food waste digestate**.
- **Phosphorus** is predominant mostly in the **solid fraction** indicating its recovery in the liquid fraction would be lower than the other ions.
- **Potassium recovery** is higher in the case of **agricultural residues** digestate.

Results

- The proposed technology seems very promising in terms of **treating diverse digestate and producing a variation of valuable products.**
- Every fraction of digestate is processed and utilized with respect to circular economy and environmentally friendly manner, through the **enhancement of circular resource management and of sustainable agricultural practices**.
- Key for **reducing the overall cost, complexity and footprint of small biogas plants**, reducing the risks and challenges associated with digestate, creating new revenue streams and improving their economic viability.

Future work


Demonstration 1
Biogas plant
Animal residues
Demonstration 2
Biogas plant
Agricultural residues
Demonstration 3
Biogas plant
WWTP sludge
Demonstration 4
Biogas plant
Food residues
Field trials 5
Products testing &
assessment

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THANK YOU

Does anyone have any questions?

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