Valorisation of livestock manure into a range of stabilised soil improving materials for environmental and economic sustainability

Berlin, March 4rd 2015







Dr. Jennifer Bilbao

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB





Introduction

Potential of animal manure as phosphorus resource

- ~1800 million tonnes of manure
- P2O5 recovery potential:
 18 million tonnes
- P2O5 consumption in Europe:
 3.1 million tonnes
- Manure management practices
 - Storage, transport and application to soil
 - Treatment: Solid-liquid separation, anaerobic digestion



Livestock density, Source: Eurostat



Introduction

- Limitation of manure use as nutrient source
 - Nutrient ratio (N:P:K) not balanced for optimal plant use
 - Large agricultural areas needed
 - Excess nutrients and metals in soil (e.g. eutrophication, air pollution)



Source: Burton, C.H. and C. Turner Manure management : Treatment strategies for sustainable agriculture. 2003 (modified)



The BioEcoSIM concept



- Development of a technology to enable farmers to produce sustainable soil improving products that can be easily handled, transported, and applied.
- Stabilized organic soil amendment
- Mineral fertilizers
- Syngas
- Reclaimed water



Biochar

P-salts

N-salts

- High performance fertilizers on demand for precision farming
- Demonstrate the economic, technological environmental, and social feasibility



BioEcoSIM Consortium and Business Model

- 15 partners from 4 countries
- Project costs:5.2 M Euro
- EC contribution: 3.8 M Euro
- Start: October 2012
- End: September 2016



www.bioecosim.eu





The BioEcoSIM concept



- 1. Solid-liquid separation and pre-treatment
- 2. Phosphorous precipitation from the liquid fraction
- 3. Drying of the solid fraction with superheated steam (SHS) and biochar production via pyrolysis
- 4. Nitrogen recovery as ammonium sulfate





The BioEcoSIM concept



Potential improvements, impacts and outcomes

- Reduce the pressure on primary raw materials
- Reduce negative environmental impacts in intensive livestock regions (eutrophication, NH₃ and N₂O emissions)
- Mitigate EU's dependency for P-fertilizers
- Increase water efficiency use in agriculture
- Support European strategies and directives
- Economic benefits for farmers through sales of fertilizer products and less costs for manure disposal





Results

Nutrient balance of conventional pig manure







Nutrient distribution in the liquid fraction after separation



- P, Ca and Mg remains mainly in the solid fraction
- To increase concentration in liquid fraction → acidification



Results



Increase in the nutrient concentration in the liquid fraction by acidification of pig manure



Most of the macronutrients available in the liquid fraction



Phosphorus Precipitation Unit



Solid-Liquid-Separation & P-Salts Recovery

Separation of solids from the liquid fraction to enable a P-recovery as a valuable product salt

Composition of the P-salt mixture [w.%]					
P_{gesamt}	N_{gesamt}	Mg	ĸ	Ca	Na
9,2	2,1	6,1	1,2	5,7	0,9



particle-free solution



P-salts



High Value Products

P-Salts are excellent fertilizers, even better than mineral fertilizers





- Heavy metal content was beyond all critical values
- Bioassays with P-salts and biochar
 - No inhibiting effects on germination
 - → No negative effects on early plant growth
 - No effects on earthworm mortality



Outlook



- Commissioning and demonstration of pilot-scale (flow 100 kg/h raw manure)
 - Solid-liquid separation & pre-treatment
 - P-precipitation from liquid fraction
 - Solid fraction: SHSD dryer & pyrolysis
 - N-Recovery via membrane modules



- Economic, Environmental and Social Impact assessment
- Verification of field trials of the BioEcoSIM products



Acknowledgement

Project BioEcoSIM receives funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 308637

www.bioecosim.eu



Contact

Dr. Jennifer Bilbao

Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB

Department of Physical Process Technology Group Manager Nutrients Management Nobelstrasse 12, 70569 Stuttgart, Germany Phone +49 711 970-3646 | Fax +49 711 970-3997 jennifer.bilbao@igb.fraunhofer.de www.igb.fraunhofer.de



