



Algemene gegevens	
Nummer	AF-EU-14018
Titel	Biorefine/Innofer
Topsector (A&F of T&U)	A&F
Projectleider (onderzoek)	Peter Kuiman
Contactpersoon overheid	Cor Wever
Status (lopend of afgerond)	lopend
Type onderzoek (F, T of V)	Toegepast onderzoek
Werkelijke startdatum	1-1-2014
Werkelijke einddatum	31-12-2016
Korte omschrijving inhoud	Uitvoering van onderzoek naar de eigenschappen van bodem-organische stof en de mogelijkheden om organische restproducten te gebruiken voor innovatieve (productie van en verwerking tot) organische meststoffen

Highlights
<p>On the efficiency of digestate-enriched clinoptilolite and biochar as nitrogen fertilisers:</p> <ol style="list-style-type: none">1. The liquid fraction of biogas digestate is a fraction and can be directly applied in the field as a fertiliser. However, this may cause practical and environmental problems such as leaching of Nitrate. A solution to this would be to concentrate nutrients onto sorbents, which then can subsequently be used as a fertiliser.2. Het kleimineraal <i>clinoptilolite</i> kan worden gebruikt om nutriënten als ammonium, kalium en ook fosfaat uit verdunde oplossingen te verwijderen, bijvoorbeeld uit de vloeibare fractie van digestaat van vergistingsinstallaties en vervolgens deze N toe te passen als kunstmest. Het restproduct biochar uit pyrolyse kan dit niet of veel minder effectief dan clinoptilolite, en ook niet na een chemische modificatie om de adsorptiecapaciteit in de biochar te verhogen3. On the basis of a laboratory experiment, we concluded that nitrogen from enriched clinoptilolite and biochar could be taken up by the plants, and clinoptilolite performed more effectively than biochar. Initial loading ratio affected the performance of the sorbents when used as a fertiliser.4. Our study highlights the importance of the choice of sorbent material to remove nutrients from the liquid fraction of digestate if the enriched sorbent is to be used as a fertiliser following the removal process. We found that both enriched clinoptilolite and biochar were able to increase biomass yield and N uptake, but clinoptilolite resulted in much higher BR and ANR compared to enriched biochar.5. We also found that initial loading ratio is an important parameter that not only affects the nutrient removal efficiency from the liquid fraction of digestate, but also affects the availability of N and thereby the efficiency of the enriched material when used as a fertiliser. This information is important when selecting a sorbent as a nutrient carrier for the treatment of the liquid fraction of e.g. digestate if the enriched material is to be applied on soil as a fertiliser.

Publicaties:

1. KOL: <http://www.wageningenur.nl/nl/project/BiorefineInnofer.htm>
2. Website met alle informatie zie <http://www.biorefine.eu/>

3. Recycling inorganic chemicals from agro- and bio-industrial waste streams.
http://www.biorefine.eu/sites/default/files/biorefinedownloads/WP2A6_GxABT_20151216_Recovery%20techniques%20-%20Animal%20wastes.pdf
4. Pilot scale explorations & demonstrations of good practice techniques. Production of mineral concentrate.
http://www.biorefine.eu/sites/default/files/biorefinedownloads/Alterra_WP3_A10.pdf
5. Biorefine Final Conference. Presentation of Gerard Velthof: Nutrient (im)balances.
http://www.biorefine.eu/sites/default/files/biorefinedownloads/Problem%20setting_2%20Nutrient%20imbalances_G.%20Velthof.pdf
6. Effect van gebruik mineralenconcentraten (zie <http://www.biorefine.eu/biorefine/downloads/report-effect-van-gebruik-mineralenconcentraat>)
7. Stikstofwerking mineralenconcentraten (zie <http://www.biorefine.eu/biorefine/downloads/report-stikstofwerking-van-mineralenconcentraat-onder-gecontroleerde-omstandigheden>)
8. On P-recovery (zie <http://www.biorefine.eu/sites/default/files/biorefinedownloads/Flyer%20P%20recovery.pdf>)
9. Nazli Pelin Kocaturk, Kor Zwart Sander Bruun, Lars Stoumann Jensen. Nutrient recovery from the liquid fraction of biogas digestate by adsorption to clinoptilolite. Submitted to Chemosphere.
10. R.L.M Schils, R. Postma, D. Rotterdam, K.B. Zwart (2015). Agronomic and environmental consequences of using liquid mineral concentrates on arable farms.
<http://www.wageningenur.nl/nl/Publicatie-details.htm?publicationId=publication-way-343930353937>
11. G.L. Velthof (2015). Mineral concentrate from processed manure as fertiliser. Alterra Wageningen UR. Alterra report 2650, 36pp. Zie <http://www.wageningenur.nl/nl/Publicatie-details.htm?publicationId=publication-way-343930333231>
12. Y. Yong, G.L. Velthof, G.L., O. Oenema (2015). Mitigation of ammonia, nitrous oxide and methane emissions from manure management chains: a meta-analysis and integrated assessment. <http://www.wageningenur.nl/nl/Publicatie-details.htm?publicationId=publication-way-343930353936>
13. Schoumans, O.F., F. Bouraoui, C. Kabbe, O. Oenema, and K.C. van Dijk (2015) Phosphorus management in Europe in a changing world. *Ambio*. 2015 Mar; 44(Suppl 2): 180–192. doi: 10.1007/s13280-014-0613-9

A total of 5 further manuscripts have been prepared and are submitted in 2015 or will be submitted early 2016.

Presentaties en bijeenkomsten

- 15 January 2015. Attendance of Gerard Velthof to Handel in mest, waar ligt de grens? (BE, FR, NL) Ghent, BE http://www.vcm-mestverwerking.be/information/index_nl.phtml?informationtreeid=388
- 16 January 2015. Attendance of Gerard Velthof to Organische meststoffen op de Franse markt – grenzeloze ontmoeting (BE, FR, NL) Ghent, BE http://www.vcm-mestverwerking.be/information/index_nl.phtml?informationtreeid=386
- 9 April 2015. Antwerp (BE) Attendance of René Rietra to “4de Vlaams vergistingsforum”. <http://www.biogas-e.be/4deforum>

- 29 May 2015. Attendance of Gerard Velthof to Toekomst landbouw NL en Duitsland. Oosterbeek NL. <http://duitsland.nlambassade.org/nieuws/2015/05/nld-af.html>
- 26 August 2015. Attendance of Gerard Velthof to Toelichting ammoniak Vlaanderen (Boerenbond, VMM, VLM en ILVO). Aalst, BE
- 17 September 2015. Biogas lesavond - focus Nederland. Ghent, BE
<http://www.biogas-e.be/node/483> *Presentation Gerard Velthof, René Rietra, Phillip Ehlert and Oene Oenema Nut en risico's van covergisting.* <http://www.biogas-e.be/node/483>
- 16 June 2015. Attendance of Gerard Velthof to Emissiesymposium Lucht 2015, Utrecht NL
[http://www.emissieregistratie.nl/erpubliek/documenten/Algemeen%20\(General\)/Emissiesymposium/2015/0.%20Programma%20Emissiesymposium%20Lucht%202015.pdf](http://www.emissieregistratie.nl/erpubliek/documenten/Algemeen%20(General)/Emissiesymposium/2015/0.%20Programma%20Emissiesymposium%20Lucht%202015.pdf)
- 3-4 September 2015, Ghent, BE. Nutrient data monitoring to support decision making. DONUTSS. ESPP – BioRefine workshop in cooperation with the European Commission
<http://phosphorusplatform.eu/platform/2015-09-09-10-54-12/donutss-2> *Presentation Gerard Velthof. What data is available on nitrogen and what is missing for 'nutrient management'?, 3rd September, Ghent*
http://phosphorusplatform.eu/images/download/DONUTSS%20workshop%20presentations/Velthof_DONUTSS_3-9-15.pdf
- 7-10 September 2015, Hamburg DE (with permission of Interreg) RAMIRAN 2015, 16th RAMIRAN Congress <http://ramiran2015.de/>, a presentation by Gerard Velthof, René Rietra, Phillip Ehlert and Oene Oenema *Co-digestion of manure and organic residues in the Netherlands and G.L. Velthof, R.P.J.J. Rietra, P.A.I. Ehlert, O. Oenema (2016) Co-digestion of manure and organic residues in the Netherlands. Full paper RAMIRAN 2015.*
- Yong Hou, Zhaohai Bai, Jan Peter Lesschen, Igor G. Staritsky, Natasa Sikirica, Lin Ma, Gerard L. Velthof, Oene Oenema (2016). Feed use and nitrogen excretion of livestock in EU-27. Submitted to Agriculture, Ecosystems and Environment
- 24-27 August 2015. Attendance Oene Oenema and Poster presentation at Wageningen Soil Conference 2015 (<http://www.wageningenur.nl/en/Research-Results/Projects-and-programmes/Wageningen-Soil-Conference/Programme-and-Excursions-WSC-2015.htm>). P. Yang, G.L. Velthof, A. Reijneveld, E. Hummelink, P. Bolhuis, W. Qin, P. Lerink, O. Oenema. Relating variations in crop yields to soil quality, a case study.
- 4 March 2015. Attendance Schoumans and Poster presentation at Workshop organised by DG Research & Innovation, the European Sustainable Phosphorus Platform and the P-REX project on "Circular approaches to phosphorus: from research to deployment" in Berlin. O.F. Schoumans. ManureValor proposal. Large scale manure processing (<http://bookshop.europa.eu/en/circular-approaches-to-phosphorus-pbKI0115204/>). Case study of a pilot plant.
- 5-6 March 2015. Attendance Schoumans at 2nd European phosphorus Conference in Berlin. O.F. Schoumans (www.phosphorusplatform.eu/ESPC2/).
- 6 May 2015. Attendance Schoumans at Fachgespräch Wirtschaftsdünger – ein wertvoller Rohstoff? At Ministry of food and Agriculture, Bonn, Germany. Presentation O.F. Schoumans "Manure treatment technologies– NL"

Producten:

On Establishing bilateral working groups

Alterra participated to a series of 6 meetings in 2015 and these meeting included our neighbouring countries among the participants and discussed primarily the regional views

on opportunities and barriers on trading (and transport) of manure. Further issues on the calculations on ammonia emissions from organic products were discussed as well as the results of the evaluation of manure digestion in the Netherlands have been discussed at meetings (WP1A3_Alterra_20150917_Biogas e presentation) (In April and September 2015).

On Production of a nitrogen-potassium fertilizer from processed manure using reversed osmosis (RO)

The results of the pilot mineral concentrates have been summarized in a synthesis report (Alterra_2015_Report mineral concentrates) and draft chapters for the NutriCover book (Alterra_2015_Draft Chapter mineral concentrates and Alterra_2015_Draft Chapter mineral concentrates).

On Nitrogen recovery from liquid fraction of animal manure

A presentation about the need for nitrogen data of manure streams in environmental policies and assessments has been given by Alterra at the DONUTSS workshop in September 2015. At the International RAMIRAN workshop in September 2015, Alterra has presented its results from a study on co-digestion and the recovery of N from digestate a paper has been published in the proceedings of this workshop. Results on nitrogen cycling in soil of nitrogen from organic wastes have been presented in draft chapter of the Nutricover book and presented at Wageningen International Soil Conference in august 2015.

On Phosphorus recovery from animal manure

Alterra has attended several meetings related to phosphorus recovery from manure, including a meeting organised by DG Research & Innovation, the European Sustainable Phosphorus Platform and the P-REX project in March 2015, and a meeting with the ministry of agriculture in Germany about manure treatment. The paper of phosphorus management has been published.

IV. GENERAL CONCLUSIONS AND COMMENTS

The project has been executed in close contact with the ministry of Economic Affairs in the Netherlands from the project development stage and onwards. The main collaboration in the Interreg project BioRefine was with partners in Flanders, Germany and UK.

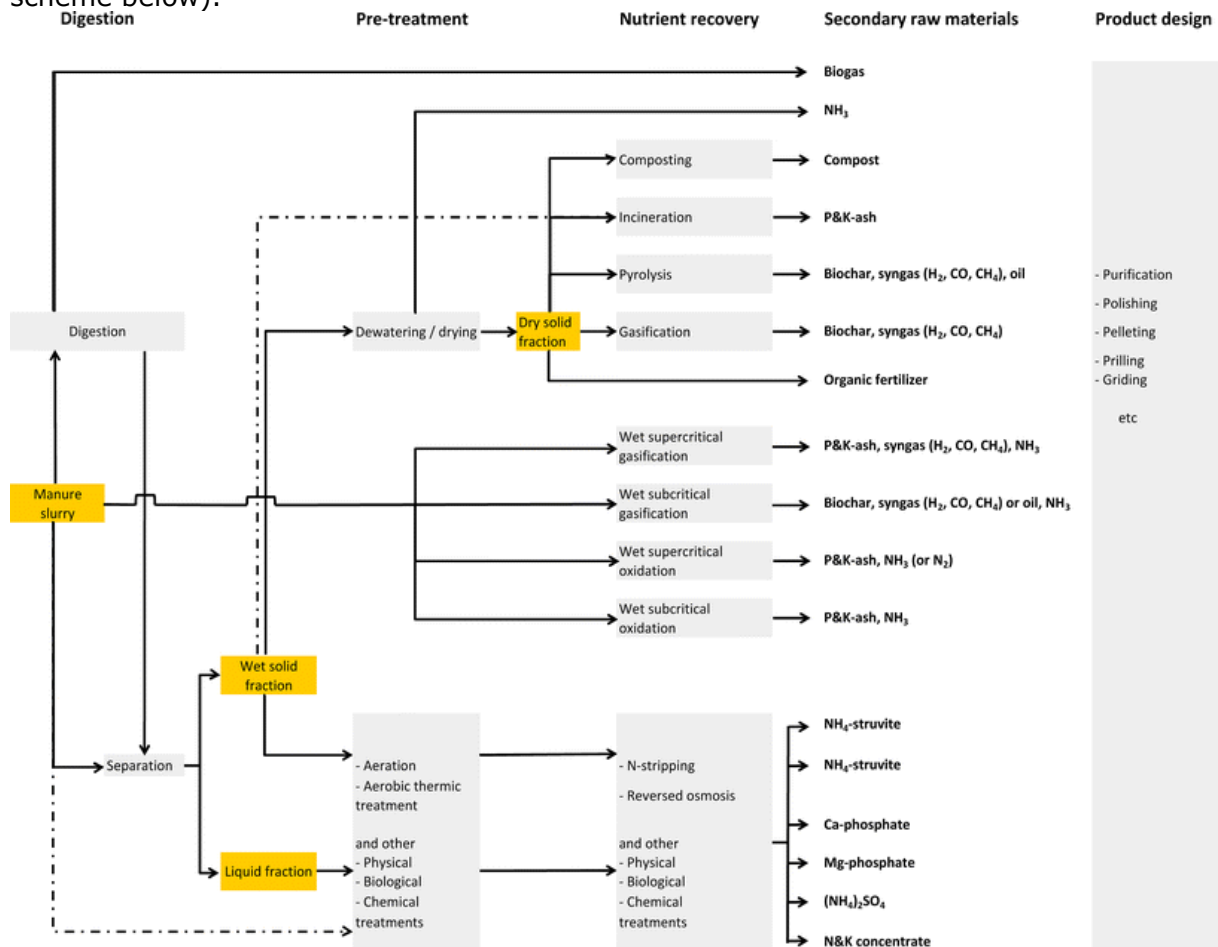
The main achievements and innovation of the projects included respectively:

- Mineral concentrates derived from processed manure have the potential to be used as mineral fertilizers. The nitrogen values as fertilizer from mineral concentrates can be increased if ammonia emission is reduced by incorporation in soil or by acidification.
- A new process for recovery of phosphorus has been developed and applied in a pilot plant which is now running under practical conditions.

Mineral concentrates are produced by reverse osmosis of the liquid fraction of separated livestock slurry. On average, 90% of the nitrogen (N) in mineral concentrate is present as ammonium-N, the other 10% as organic N. Pot experiments showed that the Nitrogen Fertilizer Replacement Value (NFRV) of injected mineral concentrate compared to calcium ammonium nitrate (CAN) was on average 91% and higher than that of injected pig slurry (75%). The average NFRV of injected mineral concentrate compared to CAN ranged in field experiments on arable land from 72 to 84%. The NFRV compared to CAN on grassland increased from 54% in 2009 to 81% in 2014. The reason for the low NFRV in 2009 is not clear. The NFRV compared to liquid ammonium nitrate was higher (79–102%). Laboratory tests showed higher ammonia and nitrous oxide emissions from mineral concentrates than from CAN. Nitrate leaching from applied mineral concentrates was similar or lower than that from CAN and untreated manure. There is scope to increase NFRV of mineral concentrate by use of low NH₃ emission application techniques,

acidification, and reduction of organic N content of the concentrate. Scenario analyses showed that large scale use of mineral concentrate will decrease the need for mineral N and P fertilizers in the Netherlands.

The recovery of phosphorus from manure using different treatment techniques (see scheme below).



Key Publications

Velthof, G.L., 2015. Mineral concentrate from processed manure as fertiliser. Wageningen, Alterra Wageningen UR (University & Research centre), Alterra report 2650. 36 pp.

Schoumans, O.F., F. Bouraoui, C. Kabbe, O. Oenema, and K.C. van Dijk (2015) Phosphorus management in Europe in a changing world. *Ambio*. 2015 Mar; 44(Suppl 2): 180–192. doi: 10.1007/s13280-014-0613-9

Outreach en Outcome and Knowledge transfer:

- The production and use of mineral concentrates at different treatment installations in the Netherlands (Mainly Noord Brabant). The practices have been transferred by presentations, leaflet, reports and meetings with the owners of the plants.
- A manure treatment plant, including phosphorus recovery, has been established in Beltrum, province of Gelderland, the Netherlands. The plant is in a pilot phase, so that the technique can be tested and applied at other plants.
- The results of the pilot mineral concentrates were made available to the ministry of Economic Affairs in the Netherlands and were discussed with the policy makers. The pilot is part of the Dutch Manure Policy and farms that take part in the pilot are indeed allowed to use mineral concentrates as a fertilizer (instead of the requirement to use and account for it as manure).

- The results of the pilots also have been presented at meetings where the European Commission were present (the administrations of the Nitrates Directive and the Fertiliser Regulation).
- Results of the phosphorus recovery have been discussed with the ministry of Economic Affairs in the Netherlands, the Germany ministry of Agriculture and administration of the province of Gelderland in the Netherlands.
- The mineral concentrates pilot has got a lot of attention in Flanders and also Flanders has discussed the use of mineral concentrates as fertilizer with the European Commission. The change on success of using this product as fertilizer is by that increased.
- The phosphorus recovery techniques have been discussed with scientists, policy makers and farmer unions in Flanders and Germany, and this has helped to improve the techniques and to increase the potential of the use of recovery phosphorus as a fertilizer.

International cooperation

- The pilot plants will continue to run and the results will be used by the Netherlands in coming negotiations with the European Commission about the use of mineral concentrates as fertilizers.
- The phosphorus pilot plant is nearly ready for running in practice. It is expected that more treatment plants will be built using similar set of manure treatment techniques.
- The initiative will be continue as part of a new international initiative/project Biorefine EU.