

## Abstracts of Oral Presentations on the ORBIT 2014 Scientific Conference

### Table of Contents

|  |    |
|--|----|
| Plenary session:.....  | 7  |
| Biowaste management in the context of Zero Waste strategies<br>Enzo Favoino, Chair, Scientific Committee, Zero Waste Europe, Scuola Agraria del Parco di Monza .....   | 7  |
| 1.1. Agronomical-pastoral composting system in developing countries<br>(Convenors: Dr. Mamadou Amadou Seck, Mariana Cerca).....  | 8  |
| Enzymatic activity and humic acids correlation during maturity of grape pomace composting process<br>Martinez M. M., Ortega R., Janssens M. (Advanced Center for Agricultural Technologies, Universidad Federico Santa Maria, Chile) .....   | 8  |
| Evaluation of composting as pig manure management strategy at farm level in the region of Murcia (Spain)<br>Tovar J. A. S., Bernal Calderón M. P., Clemente R. (CEBAS-CSIC) .....  | 8  |
| Development of composting industry in China<br>Ji L. (China Agricultural University) .....   | 8  |
| Agronomical valorisation of bovine slaughterhouse waste by aerobic composting: effects of the compost obtained on tomato ( <i>Solanum Lycopersicum</i> ) germination and growth, variety of mongol-hybrid F1, in vegetation pots<br>Seck A. M. (University Cheikh Anta Diop) ..... | 9  |
| Urban Forest Waste Management in Small Municipalities of São Paulo State, Brazil<br>Cerca M., Nolasco M. A. (University of São Paulo).....   | 9  |
| Solar Energy - as a Renewable Energy Source – for Improving the Protection Cultivation Systems on Sweet Pepper Production under plastic tunnels<br>El Aidy F. (Kafrelsheikh university) .....  | 9  |
| 1.2. Organic waste management as part of Nationally Appropriate (Climate) Mitigation Actions (NAMAs)<br>(Convenors: Dr. Konrad Soyecz, Dr. Johannes Paul) .....  | 11 |
| Delineation of greenhouse gas emission reduction targets from Philippine waste sector legislation to support Nationally Appropriate Mitigation Actions (NAMA)<br>Soyecz K., Paul J. (University of Potsdam) .....  | 11 |
| The NAMA Facility – Providing support for the implementation of NAMAs<br>Hendrikje R. (TSU NAMA Facility) .....  | 11 |
| NAMAs – Introduction of a new instrument for climate protection and its relevance for the waste sector<br>Wolf J. (Federal Environment Agency (Germany)) .....   | 12 |
| Monitoring, Reporting & Verification (MRV) – How environmental sciences can contribute to improving waste management practices in terms of climate protection and sustainability<br>Gerstmayer B., Krist (FHAM University of Applied Management).....                              | 12 |
| Potentialities of Nationally Appropriate Mitigation Actions (NAMAs) project for Brazilian National Policy on Solid Waste and National Policy on Climate Change implementation<br>Souza K., Ramalho T. (Institute of Social Sciences – Lisbon University - CAPES scholarship).....  | 12 |

|   |    |
|---|----|
| Decentralized Composting in Low Income Countries - Urban Land Price and Compost Value as Key Factor<br>Giavini M., Enayetullah I. (ARS ambiente) .....  | 13 |
| Climate change mitigation through solid waste management<br>Pfaff-Simonate W., Nassour A., Nelles M. (Kreditanstalt fuer Wiederaufbau, Frankfurt Main, Germany) .....   | 13 |
| 1.3. /A. Waste prevention - Waste reduction - Seperate collection<br>(Convenors: Dr. Katia Lasaridi, Dr. Antonis Zorpas) .....  | 15 |
| Development of Governmental Prevention Strategy. The case study of Cyprus<br>Zorpas A. , Voukkali I. (Cyprus Open University) .....   | 15 |
| Development of a web-based support tool for waste prevention at local authority level .....   | 15 |
| Lasaridi K., Abeliotis K., Hatzi O., Batistatos G., Chroni C., Kalogeropoulos N., Chatzieleftheriou C., Gargoulas N.,<br>Mavropoulos A., Zorpas A.A., Nikolaidou M., Anagnostopoulos D. (Harokopio University) .....  | 15 |
| Environmental assessment of waste prevention activities<br>(Abeliotis K., Chroni C., Zorpas A. A., Lasaridi K. (Harokopio University) .....   | 15 |
| Estimating household food waste in Denmark: case study of single family households<br>(Essonanawe M. E., Petersen C., Scheutz C., Astrup T. (Technical University of Denmark, Department of<br>Environmental Engineering) .....                                     | 16 |
| Biological waste strategies in Poland<br>Spodziewa A. ....  | 16 |
| Planning, starting, optimising separate collection of organics: approaches and results (including city centres)<br>Enzo Favoino, Chair, Scientific Committee, Zero Waste Europe, Scuola Agraria del Parco di Monza .....  | 16 |
| 1.3. /B. Waste prevention - Waste reduction - Seperate collection (Convenors: Dr. Katia Lasaridi, Christian Garaffa).....   | 18 |
| Monitoring and Evaluation of waste prevention activities in Selected Groups<br>Zorpas A., Lasaridi K., Voukkali I., Loizia P., Chroni C., Georgiou A., Phanou K., Goumenou P., Pirilly D. (Cyprus Open<br>University) .....   | 18 |
| Household food waste in Greece - estimation through a self-reported food waste diary<br>Abeliotis K., Chroni C., Kyriacou A., Boikou K., Zorpas A.A., Lasaridi K. (Harokopio University) .....  | 18 |
| The separate collection of residential organic waste in the city of Milan (Italy)<br>Petrone P., Vismara D. (Amsa S.p.A.) .....   | 18 |
| The Role of Source Separated Food Waste in the New Waste Management Plan in Lombardy, Italy<br>Giavini M., Zerbinati P., Confalonieri E. (ARS ambiente).....  | 19 |
| Towards a circular bio-economy : challenges for the biowaste management<br>Braekevelt A. (Public Waste Agency of Flanders) .....  | 19 |
| 1.4. The competition for biowaste: energy production versus high quality soil improvers (Convenors: Dr. Arjen<br>Brinkmann, Dr.-Ing. Wolfgang Müller) .....   | 20 |
| Ecological and economic benefits of compost and digestate products<br>Vandaele E., Vandenbroek K., Auweele V. W., Vandenbroucke I., Boogaerts C. (Vlaco vzw) .....  | 20 |
| Bioresource utilization chains – Efficiency of substantial and energetic utilization options on the example of food<br>residues and grass cuttings in a district of Hamburg<br>Körner I., Hertel S. (Hamburg University of Technology).....                         | 20 |
| Development of indicators to evaluate manure processing technologies. Anaerobic digestion and composting<br>of cow manure plant as case study<br>Bonmatí A., Burgos L., Tey L., Noguerol J., Flotats X., Palatsi J. (IRTA) .....                                    | 20 |
| SYNECO - synergy of high quality green compost and green energy<br>Boogaerts C. (Vlaco) .....   | 21 |
| Greenhouse gas balances in biowaste treatment concepts with focus on compost and energy production<br>Wolfgang M., Ortner M., Bockreis A. (Unit of Environmental Engineering, Section of Waste Treatment and Resource<br>Management, University of Innsbruck) ..... | 21 |
| CO <sub>2</sub> calculation tool for sustainable green waste management<br>Brinkmann A. (BVOR - Dutch Association of Biowaste Processors) .....   | 22 |

|   |    |
|---|----|
| 2.1. Biological Industrial Treatment of Organic Waste (Convenors: Ricardo Arribas).....   | 23 |
| Handling of Excessive Process Water (EPW) from Mechanical Biological Treatment (MBT) of Municipal Waste<br>Stopp P., Dr.-Ing., Weichgrebe D., Voss E. (ISAH, Leibniz Universität Hannover, Germany) .....   | 23 |
| Characterization of three industrial digestates and composts of digestates: Impacts of the composting step on the innocuousness of digestates<br>Orvain M., Houot S., Colin M., Lecarpentier A. Covez R., Chevallier M., Ochoa J., Bacheley H. (Veolia Environnement Recherche et Innovation, VERI) ..... | 23 |
| Improved method for recovery of organic solids from diluted swine manure in 3rd generation treatment system<br>Vanotti M., Hunt P., Airton K., Rice M. (United States Department of Agriculture (USDA), Agricultural Research service (ARS)).....   | 24 |
| The investigation of respiration after mechanical biological treatment of municipal solid waste<br>Gulyás M., Béres A., Aleksza L., Dér S. (Department of Water and Waste Management, Institute of Environmental Sciences, Szent István University, Gödöllő) .....  | 24 |
| 2.2./A. Bioprocessing: aerobic and anaerobic degradation (Convenor: Dr. Ljudmilla Bokányi) .....  | 25 |
| Effect of biochar amendment during composting and compost storage on compost quality, N losses and P availability<br>Vandecasteele B., Mondini C., D’Hose T., Russo S., Sinicco T., Quero A. A. (Institute for Agricultural and Fisheries Research (ILVO)).....   | 25 |
| Temporal and spatial distribution of organic waste physical properties along composting process<br>Druilhe C., Huet, Tremier, Debenest (Irstea).....  | 25 |
| Optimizing the composting parameters as a post-treatment of digestates of organic fraction of municipal solid waste<br>Yang Z., Dabert P., De Guardia A., Tremier A. (Irstea) .....   | 25 |
| Effects of the proportion of cotton gin as a bulking agent in the co-composting of the solid fraction of pig slurry<br>Santos M.A., Bustamante R., Moral, Bernal M.P. (CEBAS-CSIC).....   | 26 |
| Composting of manure using olive mill wastewater for moisture control<br>Fenia G., Fountoulakis M., Niarhos A., Fletcher L., Stentiford E., Nikolaidis N., Manios T. (Department of Agricultural Technology, Technological Educational Institute of Crete, Heraklion, Greece) .....                       | 26 |
| In-situ co-composting in a bedded-pack dairy barn<br>Szántó G., Aarnink A.J.A., Dooren H.J.van, Boer H.C .de, Galama P.J. (Wageningen University) .....   | 27 |
| 2.2./B. Bioprocessing: aerobic and anaerobic degradation (Convenor: Dr. Ljudmilla Bokányi).....   | 28 |
| Valorisation Alternatives for Cheese Whey and Permeate in the Basque Country (Spain)<br>Cebrián M., Orive M., Gutierrez M., Rentería M. (AZTI-TECNALIA).....  | 28 |
| Investigation into the microbial potential of digestion towers, using no co-substrates in their input material, to prospectively increase biogas yields at sewage treatment plants<br>Walter A., Probst M., Aichinger P., Ebner C., Insam H. (University of Innsbruck, Institute for Microbiology) .....  | 28 |
| Study on biodegradability of wood residues<br>Menert A., Kriipsalu M., Anderson K., Pihlap E., Orupõld K., Kulli S. S. (University of Tartu).....   | 29 |
| Mechano-chemical treatment of amaranth waste to enhance anaerobic digestion<br>Varga T., Bokányi L. (University of Miskolc, Institute of Raw Material Preparation and Environmental Processing).....  | 29 |
| Effect of paper fraction on the mesophilic anaerobic digestion of ofmsw. biogas and digestate evaluation<br>Mata-Alvarez J., Fonoll X., Dosta J., Astals S. (University of Barcelona).....  | 29 |
| Energy-based optimization of dry-state, sequential anaerobic digestion – aerobic composting of sewage sludge<br>Rózsáné Sz. B., Simon M., Szántó G. L., Füleky Gy. (Szent István University) .....  | 30 |
| 2.3. Advanced Waste Process Controlling (Convenors: Prof. Dr. János Tamás, Dr. Mézes Lili).....   | 31 |
| The artefacts map for waste treatment plants - working optimization for laboratories with fermentation units<br>Weitze L. (Bauhaus-Universität Weimar).....   | 31 |
| Surface temperature analyses of sewage sludge based open air composting<br>Hunyadi G., Juhász Cs., János T. (University of Debrecen).....   | 31 |
| Optimisation of the starting up of swine manure methanisation at low temperature<br>Dabert P., Morizur J., Jaziri K., Lendormi T., Buffet J., Le Roux S., Barrington S., Beline F. (IRSTEA).....  | 31 |

|   |    |
|---|----|
| Biogas controlling system testing with poultry feather recycling<br>Mézés L., János T. (University of Debrecen) .....   | 32 |
| Preliminary evaluation of nutrient indices to estimate compost maturity<br>Ortega R., Martinez M.M. (Universidad Tecnica Federico Santa Maria) .....  | 32 |
| 2.4. Energy from biomass (Convenor: Prof. Dr. Marco de Bertoldi) .....  | 34 |
| 4- bio system (bioethanol-methane-compost-algae)<br>Bertoldi M. de, Schnappinger U. (University of Udine) .....   | 34 |
| Biogas from blackwater, lawn cuttings and grease trap residues in a district of Hamburg<br>Hertel S., Deegener S., Körner I. (Hamburg University of Technology, Institute of Wastewater Management and<br>Water Protection, Bioconversion and Emission Control Group).....  | 35 |
| Catch crops rotation as a strategy to minimize nitrogen leaching and optimize manure anaerobic digestion<br>performance<br>Riau V., Burgos L., Camps F., Anton A., Bonmatí A. (IRTA) .....  | 35 |
| Methane potential from paper industry wastes and investigation of the methanogens involved<br>Franke-Whittle I., Silberberger S., Walter A., Insam H. (University of Innsbruck, Institute for Microbiology).....  | 35 |
| Pilot-Scale anaerobic co-digestion of sewage sludge and olive mill wastewater for increased biogas production<br>Maragkaki A., Fountoulakis M., Lasaridi K., Manios T. (Laboratory of Solid Waste & Wastewater Management,<br>Department of Agricultural Technology, Technological Educational Institute of Crete) .....                | 36 |
| Conceptual design and implementation of an integrated system for organic solid waste treatment and by-products<br>recovery – pMethan<br>Borges A. C., Assis Temponi Cabral Dias A. de, Ferreira O. B., Luis Felipe de Dornfeld Braga Colturato, Carlos Augusto<br>de Lemos Chernicharo (Federal University of Minas Gerais (UFMG) ..... | 36 |
| 2.5. Emissions and immissions of biological waste treatment (Convenor: Thomas Terpetschnig, Yael Laor) .....  | 38 |
| The challenge of sampling and assessing odor emission from open-air composting windrows<br>Laor Y. (Agricultural Research Organization, Institute of Soil, Water and Environmental Sciences, Neve Ya'ar Research<br>Center).....  | 38 |
| Comparison of the odour immissions from GORE® Cover systems and tunnel composting systems<br>Wittemeier T. (Barth & Bitter GmbH) .....  | 38 |
| Comparison of the odour emissions and immissions from GORE® Cover systems and tunnel composting systems<br>subject to the Federal Republic of Germany regulation<br>Barth S. (Barth & Bitter Gutachter im Arbeits- und Umweltschutz GmbH . Wunstorf . Federal Republic of Germany) .....  | 38 |
| Defects and efforts approach in the use of biofilter for waste gas purification<br>Huebner R. (Braunschweiger Umwelt-Biotechnologie GmbH (BUB)) .....   | 39 |
| Greenhouse gases from composting and anaerobic digestion of biowaste in Germany<br>Cuhls C. (gewitra GmbH) .....  | 39 |
| 3.1./A. Compost and digestate in agricultural practice (Convenor: Dr. Péter Simándi).....   | 40 |
| Bioremediation of soils contaminated with Bonny light crude oil using Horse manure<br>Nwankwo C., Stentiford E.I. (University of Leeds) .....   | 40 |
| Effect of sewage sludge compost application on the potential toxic elements of soil and plant in 2009-2012<br>Tomócsik A., Makádi M., Orosz V., Mészáros J., Füleky Gy. (University of Debrecen CAS Research Institute of<br>Nyíregyháza).....  | 40 |
| Digestates origin and post-treatment influence their biological stability, potential nitrogen availability for plants and<br>reactive nitrogen gas emissions<br>Askri A., Laville P., Guiziou F., Beline F., Hout S. ( INRA-EGC Grignon, France).....   | 40 |
| Improving barley utilization of n and p nutrients from soil amended with bio-digested cattle manure<br>Hao X., Hill B., Caffyn P., AAFC, Nelson V., ARD, Li X. (Agriculture and Agri-Food Canada).....  | 41 |
| Quality of liquid digestate as fertilizer – challenges for analytical procedures and regulations<br>Sørheim R., Harladsen K. T., Govasmark E. (Bioforsk).....   | 41 |
| 3.1./B. session: Biochar in agricultural practice (Convenor: Imre Czinkota) .....   | 42 |
| Biochar and Compost usage in Farmland for Carbon Sequestration with Mitigating GHG Emission<br>Yoshizawa S., Tanaka S. (Meisei University).....   | 42 |

|   |    |
|---|----|
| Examination of zinc adsorption capacity of soils treated with different pyrolysis products<br>Rétháti G., Vejzer A., Gál A., Simon B., Füleky Gy. (Szent István Egyetem, Inst. of Environmental Sci.) .....   | 42 |
| Influence of biochar and digestate on pesticide decontamination<br>Mukherjee S., Tappe W., Weihermüller L., Vereecken H., Burauel P. (Helmholtz Association Agrosphere Institute).....  | 42 |
| Elution experiment on biochar-soil and biochar-compost systems to investigate the leaching dynamics of nutrients and possible toxic components<br>Üveges Zs. (Wessling Hungary Kft.) .....  | 43 |
| Analysis of organic matter and heavy metal extraction kinetics of different pyrolyzed waste fractions<br>Czinkota I., Keresztes, Simándi, Rácz, Rétháti, Gulyás, Tolner (Department of Soil Science and Agricultural Chemistry, Institute of Environmental Sciences, SZIE, Gödöllő) .....   | 43 |
| 3.2. Fate of organic matter (OM) in the composts and digestates and in the treated soils (Convenors: Dr. Marianna Makádi) .....   | 44 |
| A new organic matter fractionation methodology applied on a large panel of organic wastes: accessibility characterization for bioaccessibility prediction and process modelling improvement<br>Jimenez J., Aemig Q., Feurgard I., Houot S., Steyer J-P., Patureau D. (INRA Narbonne France).....  | 44 |
| Organic matter transformation drives the fate of organic micropollutants during anaerobic digestion and composting of sludge<br>Aemig Q., Cheron C., Delgenes N., Bergheaud V., Dumeny V., Hout S., Patureau D. (INRA LBE).....   | 44 |
| Digestate and Compost qualities focus on nitrogen and organic matter respective brings to crops and to cultivated soils<br>Jean Luc M., Allain M. (Suez Environnement) .....  | 45 |
| Increasing the organic matter content of sandy soils using sewage sludge compost<br>Makádi M., Tomócsik A., Aranyos T., Demeter I., Szegi T., Boros N., Fehér B. (Research Institute of Nyíregyháza, CAS, University of Debrecen).....  | 45 |
| 3.3./A. The use of alternative organic nutrients in agriculture and horticulture (Convenors: Dr. Louise Fletcher, Prof. Dr. Ed Stentiford).....   | 46 |
| Effect of Intensity and Time of Aeration on Agrochemical Properties of Extracts from Vermicompost<br>Hanc A., Boucek J., Svehla P., Tlustos P. (Czech University of Life Sciences Prague, Prague, Czech Republic) .....   | 46 |
| Effects of different biochars and combined biochar and anaerobic digestate utilization on rye-grass and soil properties in laboratory model experiment<br>Gulyás M., Fuchs M., Holes A., Szegi T., Kocsis I., Füleky Gy. (Department of Soil Science and Agricultural Chemistry, Institute of Environmental Sciences, SZIE, Gödöllő)..... | 46 |
| Effect of compost source and soil type on canola yield and nutrient uptake from calcareous and acid soils under greenhouse conditions<br>Hao X., Chunli L., Yang L. (Agriculture and Agri-Food Canada) .....  | 47 |
| Vegetable crop residues as feedstock for composting and silage: collection efficiency and product quality<br>Vandecasteele B., Viaene J., Agneessens L., Van De Sande T., Dekeyser D., De Neve S. (Institute for Agricultural and Fisheries Research (ILVO)) .....  | 47 |
| Estimation of biologically available heavy metal content of composts by various extraction methods and ICP-OES multielemental detection<br>Heltai Gy., Aleksza L., Horváth M., Kovács K., Takács A. (Institute of Environmental Sciences, Szent István University) ....   | 47 |
| Pelletized compost can be a superior alternative to phosphate fertilizer compared to bulk compost<br>Arakawa Y. (NARO Kyushu Okinawa Agricultural Research Center).....   | 48 |
| 3.3./B. The use of alternative organic nutrients in agriculture and horticulture (Convenors: Dr. Louise Fletcher, Prof. Dr. Ed Stentiford).....   | 49 |
| Effect of compost treatments on the growth of the strain field area of apple trees, and on the number of fruits per tree<br>Szabo A., Balla-Kovács A., Kátai J., Vágó I. (University of Debrecen, Institute of Agricultural Chemistry and Soil Science) .....   | 49 |
| Use of compost from grape pomace as organic amendment for recovering a decayed pear ( <i>Pyrus communis</i> cv Packam's Triumph) ORCHARD<br>Poblete H., Martinez M.M, Ortega R. (La Rosa Sofruco, Chile).....   | 49 |

|   |    |
|---|----|
| Crop response to alternative organic treatments<br>Mortimer N., Fletcher L., Velis K. (University of Leeds) .....   | 49 |
| Sensitivity analysis of a dynamic soil-plant model for simulations of fate of pollutants after repeated applications of amendment on agricultural soils<br>Revallier A., Serre J., Cambier P., Trapp S. (Veolia Environnement Recherche & Innovation) ..... | 50 |
| 3.4./A. Waste-to-Product (Convenors: Dr. Antoni Sánchez, Teresa Gea) .....  | 51 |
| When product status is not enough – the development of a UK Renewable Fertilizer Matrix<br>Tompkins D., McManus W. , Chambers B., Taylor M. (WRAP) .....  | 51 |
| Define waste criteria for the production of high quality compost<br>Zorpas A., Lasaridi K., Voukkali I. (Cyprus Open University) .....  | 51 |
| Development of sustainable potting soil based on green compost and other organic recycled materials<br>Hoekstra B. (Vlaco vzw) .....  | 51 |
| Wood ash improves composting processes and end products<br>Fernández-Delgado Juárez M., Prähauser B., Franke-Whittle I., Insam H. (University of Innsbruck, Institute for Microbiology).....  | 52 |
| Digestates main characteristics and residual biodegradability: influence of waste origin and management of the digestion plant<br>Trémier A., Buffet J., Daumoin M., Picard S., Saint-Cast P. (Irstea, UR GERE, Rennes, France) .....                       | 52 |
| 3.4./B. Waste-to-Product (Convenors: Dr. Antoni Sánchez, Teresa Gea).....   | 53 |
| GLOCAL – An ecosystem-based business model<br>Gea T., Bautista R., Domen T., Knowles H., Sánchez A., Theeuwes E., Wahl D., Warrington A. (Universitat Autònoma de Barcelona) .....  | 53 |
| Protease production from organic residues by SSF and their potential uses<br>Abraham J., Gea T., Sanchez A. (GICOM-Universitat Autònoma de Barcelona).....  | 53 |
| Recovery of nutrients from Organic Fraction of Municipal Sólid Waste (OFMSW) in the Ecoparc 2 of Montcada i Reixac, Barcelona: alternatives to the current process<br>Mena M.J., Bonmatí A., Pujolà M., Tarraga J., Comas J. (IRTA) .....                   | 53 |
| Design and validation of an Action Plan to produce animal feed vegetable flour from food waste<br>Martin D. San, Zufia J. (AZTI-Tecnalia) .....   | 54 |
| 3.5. Pathogen (plant and animal) Survival/Sanitary Assurance of Final Compost (Convenor: Dr. Daryl McCartney) ....  | 55 |
| Quality Assurance of compost and digestate products in Flanders, a safeguard for product quality<br>Auweele V.W. (Vlaco).....   | 55 |
| Examining the VBNC induction and regrowth in E.coli and Salmonella exposed to a simulated thermophilic condition of a composting pile<br>Isobaev P., McCartney D., Neumann N. (University of Alberta).....  | 55 |
| Mapping composting bioaerosol dispersal using pine needles<br>Jean Jacques G., Galès A., Wéry N., Latrille E., Steyer P.J. (INRA) .....   | 55 |
| Assessment of home composting through stability indices and pathogen inactivation<br>Lasaridi K.-E., Kyriacou A., Chatzipavlidis I., Abeliotis K., Zorpas A.A., Chroni C., Koufopoulos M., Miniadis M. Sgoubopoulou A. (Harokopio University).....          | 56 |

***Biowaste management in the context of Zero Waste strategies***

*Enzo Favoino, Chair, Scientific Committee, Zero Waste Europe, Scuola Agraria del Parco di Monza*

**Text:** A Zero Waste (ZW) vision is getting increasingly emphasised both at the level of policy-making and in local practice in waste management. Remarkably, the EU Communication on Circular Economy, which includes proposals for renewing EU waste policy (with specific regard to key Directives: the Waste Framework Directive, the Landfill Directive and the Packaging Directive) recently leaked from the EC offices, is sub-titled “A Zero Waste programme for Europe”.

The ZW vision is being propelled by a few concurrent factors:

- The global resource scarcity crisis, which will particularly affect those economies poor in primary raw materials, hence Europe, and calls for an ever-increasing capacity to recycle in order to secure supplies of raw materials to the local economy
- The need to ensure a more sustainable approach to use of resources and management of discards
- The positive occupational implications of waste management strategies focussed on recycling and reuse (up to 2 million green jobs in the EU have been estimated as the potential effect of increased kerbside programmes, and related recycling/reusing/composting strategies)

The Zero Waste vision and practice has been consolidated in the ZWIA (Zero Waste International Alliance) hierarchy, a codified and peer-reviewed document which lists options that belong to a ZW vision in order of preference.

In the ZW vision and practice, a pivotal role is assigned to proper management of organic discards (food scraps, garden waste, discards from large producers as canteens, greengroceries, food shops and markets, etc.) on account of multiple reasons:

1. from a quantitative point of view, separate collection of organics makes it possible to achieve highest material recovery rates
2. from an operational point of view, minimising percentages of organics in residual waste, makes it possible to reduce its frequency of collection, which in turn
  - a. represents one of the main factors for cost-optimisation of schemes for separate collection
  - b. and, remarkably, it exerts a “boosting effect” also on the increase of separate collection of other materials (first and foremost, packaging waste)
3. from a qualitative point of view, a residual waste with a minimised percentage of organics, is less “dirty”, more “workable” and may be suitable for further material recovery, so that the total recycling rates be maximised

The presentation will provide an overview of the Zero Waste vision and approach in the current global, and operational context, and the way it may fulfil drivers coming from the political and regulatory framework. Then, it will focus on the key role of strategies to manage organics, and ways to optimise them.

## 1.1. AGRONOMICAL-PASTORAL COMPOSTING SYSTEM IN DEVELOPING COUNTRIES (CONVENORS: DR. MAMADOU AMADOU SECK, MARIANA CERCA)

### *Enzymatic activity and humic acids correlation during maturity of grape pomace composting process*

*Martinez M. M., Ortega R., Janssens M. (Advanced Center for Agricultural Technologies, Universidad Federico Santa Maria, Chile)*

**Text:** To determine the correlation between enzymatic activity and humic and fulvic acids content, as maturity indicators, in a grape pomace composting process, the evolution of enzymatic activities  $\beta$ -glucosidase, urease, acid and alkaline phosphatase, humic (Ha) and fulvic (Fa) acid contents C/N, Ha/Fa, and N-NH<sub>4</sub>/N-NO<sub>3</sub> ratios and were evaluated, during a 180-day period. Properties were standardized using a Z score before analysis. The C/N ratio was between 10-17,6 including the compost in type A according to Compost Council USA, EU and Chilean National Standard (humic acids~fulvic acids>acid phosphatase. Urease increase could be explained as result of proteases activity; with positive correlation between urease and N-NH<sub>4</sub> and negative with N-NO<sub>3</sub>. The time of increase of the humic acids, coincided with the stabilization of  $\beta$ - glucosidase and Acid phosphatases. However, only acid phosphatase negatively related with Ha content. Results suggest that besides C/N ratio or Ha content, enzymatic activity could be used as more simple and sensitive indicators for monitoring compost maturity. Keywords: compost, enzymatic activity, humic acids, maturity, indicators

### *Evaluation of composting as pig manure management strategy at farm level in the region of Murcia (Spain)*

*Tovar J. A. S., Bernal Calderón M. P., Clemente R. (CEBAS-CSIC)*

**Text:** Intensification of the livestock sector has improved the production efficiency and reduced economic costs, but it has also introduced a major environmental risk derived from the generation of vast amounts of animal waste and slurries in relatively small areas (Bernal et al., 2009). The Region of Murcia (Spain) is one of the zones with the highest concentration of pig farms in Spain. This leads to an excess of pig slurry production for given the reduced land available for its agricultural use. This fact suggests both the need of a deep evaluation of the amount of pig slurry which can be used in vulnerable areas (170 kg N ha<sup>-1</sup>) in Murcia and the assessment of the excess of pig slurry which may need alternatives for treatment and recycling. The aim of this work focused on the viability of composting as an alternative for recycling pig manure at the farm level. To achieve this goal, two composting trials using the solid phase of pig slurry and two different bulking agents were set up in a farm located near Lorca, which is the highest slurry production area within Region of Murcia. The results obtained have shown that the characteristics of the bulking agent play an important role both in the evolution of the composting process and in the quality of the compost. Therefore, composting of the solid phase of pig manure can be an efficient way to manage this waste obtaining a useful and valuable product.

### *Development of composting industry in China*

*Ji L. (China Agricultural University)*

**Text:** This paper introduced the development of composting industry in China in last 20 years. It covered major composting fields in this largest organic waste producing country, as history of compost making, spatial and temporal trend of generation of organic solid wastes, current situation of treatment of agricultural wastes, municipal solid wastes, sewage sludge and food wastes. screening of microbial strains and development of inoculants, rapid composting and bio-composting, main practiced composting processes and facilities, governmental regulation on the wastes treatment, establishment of compost standards and development of new products(organic fertilizer, biological organic fertilizer, compound organic-inorganic fertilizer, functional compost, et.al. ), long-term field effects of compost use and prospects on the composting industry in the future. It also introduced main research institutes and major events in the composting industry in the country.



## ***Agronomical valorisation of bovine slaughterhouse waste by aerobic composting: effects of the compost obtained on tomato (*Solanum Lycopersicum*) germination and growth, variety of mongol-hybrid F1, in vegetation pots***

*Seck A. M. (University Cheikh Anta Diop)*

**Text:** Compost originating in the mixture of household waste, chicken droppings and fish flour organic residues was used as an organic improvement in a tomato culture. The experimental device included 10 plots of 15 m<sup>2</sup> each with 5 test plots and 5 check plots. All plots had received 30 kg of horse manure and the same amount of fish flour; only the test plots had received 7 tons of compost per hectare and had not been the object of phytosanitary treatment unlike the check plots that had been treated against nematodes and fungi. The results agronomically achieved showed that fusariosis infestation was more marked on the tomato feet and leaves in check zones. Thus 14 % of the plants attacked were observed in the check plots in 30 days of vegetal development against only 4 % in test sites for the same period, resistance to alternariose was within similar proportions for the test plants. The same trend was observed on test grounds, as far as resistance to phytoparasite nematodes was concerned, especially the *Meloidogyne* kind, particularly devastating for the tomato crops in the Niayes market-gardening area. Thus, it was possible to count 18,000 *Meloidogyne* sp in the check plots against 4,000 in the test plots for one ( 1 ) gram of root taken off from the soil. Secondary biomass (tomato fruit) production perfectly reflected the vegetative development state as it was clearly more significant in the test plots with nearly 65 % of the output obtained. This preliminary research work will be continued to better master the dynamics of nematode populations and reduce the negative effect of fungi on market-gardening crops and to participate in the fight against ill-nutrition and poverty in the rural areas of Senegal. Keywords: compost, alternariose, fusariosis, nematodes

## ***Urban Forest Waste Management in Small Municipalities of São Paulo State, Brazil***

*Cerca M., Nolasco M. A. (University of São Paulo)*

**Text:** The waste management of urban trees is related to one of the main challenges of urban centers: the proper disposal of solid waste, in compliance with the Solid Waste National Policy. Under the current circumstances in Brazil, the mismanagement has resulted in high costs for municipalities, affecting large areas for disposal, pollution and degradation of the environment. Entails also the residues materials that have potential for the manufacture of various products such as well as compost. Thus, was designed a model for urban forest waste management for small municipalities that have special technical, administrative and economic conditions that often prevent an appropriate disposal of such waste. The cities analyzed are those with less than 35,000 inhabitants in the state of São Paulo and the results show a lack of planning of urban forest, a large municipal responsibility regarding pruning, removal and disposal of these waste; as well as the lack of data on costs and quantifying the amount of waste generated. Not many municipalities have a proper disposal or recovery, and there is a great tendency for specific actions for recovery, such as composting, as solution used by municipalities, demonstrating the great importance for the development of management plans of urban forest waste and validation of these through municipal legislation. The developed model plan was evaluated by the municipalities, obtaining a high degree of receptibility and approval, although the lack of human and financial resources and political will are often precludes the implementation.

## ***Solar Energy - as a Renewable Energy Source – for Improving the Protection Cultivation Systems on Sweet Pepper Production under plastic tunnels***

*El Aidy F. (Kafrelsheikh university)*

**Text:** ABSTRACT This study was carried out at the Experimental Farm of Faculty of Agriculture, Kafrelsheikh University, Egypt during the two seasons of 2011/2012 and 2012/2013 under walk-in plastic tunnels on bell pepper hybrids (*Capsicum annum*, L.) and Strawberry plants. The aim of this study is to evaluate bell pep-

per plant and strawberry growth, fruits yield and quality under semi-controlled (heating & cooling) tunnel , comparing with the uncontrolled tunnel by using the Solar Energy as the source of energy. The following, the main items were done during the period of the project: - Preparing 2 walk-in plastic tunnels 6m width X 30m length X 2.3 m height. - Erecting the cell system (2 kw), solar heater, heating and cooling systems. - Planting the pepper plants for 2 seasons and strawberry plants in the second season. - Measuring and recording all possible data and analysis these data . Results: Solar energy system for electricity: The project used Off-Grid System, which including the battery bank for 24 h energy supply, as an example for any agricultural project far from the electricity source. The data indicated that the real efficiency of a panel was 13.2% at the rate of 938 watt/m<sup>2</sup> of solar radiation , 37 oC air temperature and 51 oC module temperature. And wind speed 0.3 m/sec. The charger efficiency was 85% and the inverter 95%. Heating system: The data indicate that there were around 1.5 °C differences between the heated and Unheated soil, also the better distribution of the heat through the soil of the tunnel. Cooling system: The efficiency of the system was 77% at the outside air humidity 50%. The result was about 7 °C decrease in the inside air temperature with average about 25 oC, and about 32 oC outside temperature. Pepper crop: The data show an increment on the total yield –controlled tunnel produced , the semi520 kg and 490 kg compare with 370 and 340 kg under control during the two seasons with Cabia variety. Strawberry crop: Data recorded indicated that the increase in the total yield under the semi-controlled tunnel during April by 124% than the uncontrolled tunnel. The most important result was the marketable fruits which reached 77% under the semi-controlled tunnel while this ratio was 60% under the uncontrolled tunnel.

## 1.2. ORGANIC WASTE MANAGEMENT AS PART OF NATIONALLY APPROPRIATE (CLIMATE) MITIGATION ACTIONS (NAMAS)

(CONVENORS: DR. KONRAD SOYEZ, DR. JOHANNES PAUL)

### *Delineation of greenhouse gas emission reduction targets from Philippine waste sector legislation to support Nationally Appropriate Mitigation Actions (NAMA)*

*Soyez K., Paul J. (University of Potsdam)*

**Text:** Abstract The mitigation of Greenhouse Gas (GHG) emissions from waste management can contribute to combat climate change where national and local governments play major roles. The adoption of Nationally Appropriate Mitigation Actions (NAMA) as anchor program may stimulate the development of relevant action plans. In the Philippines, as in other developing countries, many municipalities struggle to upgrade their solid waste management (SWM) system due to limited budgets and lack of expertise in operating efficient technologies. Uncontrolled or poorly managed dumpsites remain as the primary means of waste disposal, whereas segregation, recovery and processing of materials out of the waste stream remain low especially for organic waste. With mixed waste disposal sites as a primary source of methane emissions, the waste sector has a huge potential to reduce GHG emissions considering the inevitable future increase in waste generation from urbanization. A NAMA system is thus being considered to facilitate capacity building, technology transfer and innovative financing measures to re-vitalize sectoral initiatives. The Philippines has not agreed upon voluntary mitigation targets so far, but it is anticipated that the country's national contributions will emanate from a collective analysis of the priorities of each sector. The authors propose to delineate "proxy"-mitigation targets based on the legal prescriptions of the waste management sector and as a basis to develop a sectoral NAMA. The paper presents approaches on how to translate sectoral objectives and related national development goals into GHG mitigation targets based on existing legal prescriptions. The results of this study may be useful in the Philippines but could also serve as an input for the development of waste related NAMAs in other developing countries.

### *The NAMA Facility – Providing support for the implementation of NAMAs*

*Hendrikje R. (TSU NAMA Facility)*

**Text:** As announced during the climate negotiations 2012 in Doha, Qatar, the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the Department of Energy and Climate Change (DECC) of the United Kingdom (UK) jointly established the NAMA Facility and contributed jointly 120 million euro of funding to support developing countries and emerging economies that show leadership on tackling climate change and that want to implement ambitious climate protection measures (NAMAs). In previous years, developing countries have prepared a multitude of ambitious climate protection measures. However, accessing finance for implementation through existing commercial and public channels has proven difficult, particularly for the most innovative parts of NAMAs. The NAMA Facility offers tailor-made climate finance by funding the implementation of ambitious country-led NAMAs, thus delivering concrete greenhouse gas reductions on the ground. The presentation will provide a general introduction to the NAMA Facility, its means of support, its selection criteria as well as up-to date information on the second call for projects. In addition, lessons learned during the first call for projects and the early implementation stage of the selected NAMA Support Projects will be shared with the audience. For further information on the Facility, the 2nd call and the so far selected projects: [www.nama-facility.org](http://www.nama-facility.org)

## ***NAMAs – Introduction of a new instrument for climate protection and its relevance for the waste sector***

*Wolf J. (Federal Environment Agency (Germany))*

**Text:** Nationally appropriate mitigation actions (NAMAs) are an emerging international climate mitigation instrument. It is supposed to be used by developing countries to make progress in reducing their domestic greenhouse gas emissions, supported and enabled by technology, financing and capacity building in a measurable, reportable and verifiable (MRV) manner. So far the definition from the Bali Action Plan – but what exactly is a NAMA? Even though the term already emerged in 2007 at the 13th Conference of the Parties, the concept is not yet precisely defined and there are no clear guidelines on what a NAMA should look like. Yet, there is an increasing international discussion on this promising concept, the UNFCCC NAMA Facility has been launched and actors around the world take the chance to press ahead with it themselves by nonetheless starting to develop NAMA activities. NAMA development takes place in developing countries in all economic sectors, including the waste sector. The waste sector is particularly interesting for NAMAs as it offers a significant potential for GHG emission reductions: sustainable waste management practices can lead to emission reductions of up to 15-20% of the national GHG emissions in developing countries. A special focus lies on organic waste management as this fraction causes high methane emissions if not treated properly. The aim of this presentation is to give an introduction to NAMAs, their background, the current situation and some prospects for the future. Moreover it will show general possibilities that NAMAs offer for the waste management sector.

## ***Monitoring, Reporting & Verification (MRV) – How environmental sciences can contribute to improving waste management practices in terms of climate protection and sustainability***

*Gerstmayr B., Krist (FHAM University of Applied Management)*

**Text:** Despite its seemingly technical nature, MRV is yet one of the most important and contentious issues in any international arrangement on climate protection. The term encompasses all measures to collect performance data and to compile this information in reports and inventories, and to subject these to some form of review. While initial discussions around MRV of NAMAs have centered on greenhouse gas (GHG) emissions reductions, many developing countries and international stakeholders view the sustainable development outcomes as the primary policy driver and main selling point to national stakeholders. But which metrics would allow policy makers to track and highlight the effects of any NAMA on development goals such as, for example, catalyzing economic growth and public health, poverty and unemployment reduction as well as environmental conservation? But also, of course, how can composting and methanisation of organic residues as well as recycling of plastics, paper and other materials lead to reduction of GHG emissions directly in a certain host country and, indirectly, in global production processes and supply chains? The presentation will bring light into the issue of MRV in general and will point to certain challenges in measuring and appraising the impacts of programs and actions in the waste management sector designed to meet the requirements of national appropriateness.

## ***Potentialities of Nationally Appropriate Mitigation Actions (NAMAs) project for Brazilian National Policy on Solid Waste and National Policy on Climate Change implementation***

*Souza K., Ramalho T. (Institute of Social Sciences – Lisbon University - CAPES scholarship)*

**Text:** Climate change (CC) and municipal solid waste (MSW) management have common demands to mitigate greenhouse gas (GHG) emissions. The MSW disposal represent more than 20% of anthropogenic methane (CH<sub>4</sub>) (IPCC, 2005). The estimated contribution of this sector in anthropogenic GHG emissions is 3-5% (UNEP, 2010), and has great potential for reducing fuel and energy consumption in collection and treatment of CH<sub>4</sub> avoided emissions in landfills by biodegradable municipal waste (BMW) diversion to biodigestion and composting, and fix carbon in soils by compost or biofertilizers produced application, and reduce natural resources extraction by multi-material recycling. In Brazil, the National Policy on Solid Waste - PNRS, is being

implemented with goals of close open dumps, selective collection and reverse logistics with socio-productive inclusion of waste pickers (BRAZIL, 2010). 51.4% from the MSW generated is biodegradable matter. In 2012, 57.98% of the waste disposed of adequately, while 42.02% were inappropriate target (ABRELPE, 2012). The Brazil recycles 2% of MSW, only 0.8% of the BMW. 98% by the work of about 800,000 waste pickers. Although the National Policy on Climate Change - PNMC, set goals for the CH<sub>4</sub> recovery from MSW treatment facilities and recycling expansion to 20% until 2015, the sector was not covered by the national strategy. Considering a NAMA an opportunity for financial and technological support from community international to Brazil forward in reducing their domestic emissions, this work aims to demonstrate the potential of the waste sector, and valuation of BMW as a compliance strategy to PNRS and PNMC.

## ***Decentralized Composting in Low Income Countries - Urban Land Price and Compost Value as Key Factor***

*Giavini M., Enayetullah I. (ARS ambiente)*

### **Abstract**

**Text:** Urban population is steadily increasing across the world; most recent estimates show that by 2050, 70% of the world's population will be urban.

As in low and middle income countries the organic fraction plays a major role in MSW, the feasibility of its collection and treatment in megacities across the world will become more and more an issue to be investigated. Currently there are a few case studies in which biowaste collection and composting have been implemented on a quite relevant scale; one of those is the experience of Dhaka, Bangladesh, in which Waste Concern, a Social Business Enterprise, have set up a combined model including both a community - based decentralized composting (< 3,000 tpy) inside urban areas, and a large scale composting plant (40,000 tpy).

These two main models in place in Dhaka allow for some comparisons to be made in order to evaluate with which boundary conditions the decentralized composting solution is feasible in urban areas. We will present how two main factors, namely urban land price and the market value of the compost produced with the small scale facilities, can affect the choice between these two options, showing that the decentralized option may prove to be feasible in many megacities.

## ***Climate change mitigation through solid waste management***

*Pfaff-Simonate W., Nassour A., Nelles M. (Kreditanstalt fuer Wiederaufbau, Frankfurt Main, Germany)*

**Text:** Introduction The vast majority of solid waste management (SWM) projects implemented in developing, emerging and transition countries (DETC) envisage the disposal of residual waste on a sanitary landfill. Mostly this leads to an increase of greenhouse gas emissions compared to the given situation. With the implementation of advanced SWM systems DETC could lower their national greenhouse gas balance by 10 – 15%. The paper discusses the possibilities how financial sustainability of advanced SWM systems could be safeguarded in DETC. It is part of a doctoral thesis recently finalized at the University of Rostock / Germany. Methods and Data Based on experiences of international development cooperation, model calculations on cost and potential revenues have been carried out. Material, energy and greenhouse gas balances have been calculated for 16 different - more or less – advanced SWM concepts, taking eight standardized waste compositions and properties as a basis. The waste types were derived from typical waste characteristics of different regions, categorized and related to the GDP. Due to missing experience in DETC notional cost calculations for different advanced SWM technologies were conducted. Based on cost structure analyses the influences of local frame conditions were assessed and the 'theoretical' full cost calculated. Results Around 70 – 80% of the total costs are operating cost. Hence the provision of low-interest credits or even grants alone can not secure financial sustainability of advanced SWM systems in DETC. Financial sustainability requires steady and reliable revenues. Charging full cost covering user fees, faces serious restrictions in DETC. Revenues for recyclable materials or energy-from-waste could cover between 20 – 30% of the total system costs, depending on waste composition and recycling market conditions, whereas financial compensations for greenhouse gas reduction effects of advanced SWM could – depending on SWM concept and frame conditions – cover between 30% and 50% of the total system cost. Thus the appropriate remuneration of the greenhouse gas

reduction efforts turns out as the crucial question for guaranteeing financial sustainability of advanced SWM in DETC. Conclusions and Findings To the extent industrialized countries meet their commitments given in the Framework Convention on Climate Change, the Kyoto-Protocol and other international agreements on climate change, DETC with a GDP of about more than 2.000 €/cap/year could afford advanced SWM systems. Besides that DETC have to be supported in a holistic approach with technology transfer, capacity building and the development of conducive framework conditions in order to develop their own technological competence in the long run.

### 1.3. /A. WASTE PREVENTION - WASTE REDUCTION - SEPERATE COLLECTION (CONVENORS: DR. KATIA LASARIDI, DR. ANTONIS ZORPAS)

#### *Development of Governmental Prevention Strategy. The case study of Cyprus*

*Zorpas A. , Voukkali I. (Cyprus Open University)*

**Text:** The annual per capita production of waste in Cyprus is estimated at 468 Kg for residential areas and 670 Kg for tourist areas, while the total waste is estimated at the end of 2012 up to 630000t according to the official statistics. The Waste Prevention Strategy for Cyprus suggests that local authorities and policy makers should now put more emphasis on waste prevention and re-use, in order to achieve a reduction of disposal costs, CO2 emissions and a decrease in the demand for natural resources. The waste prevention activities and the waste prevention actions as designed are in relation to specific waste prevention target and indicators per selected group like Public and Local Authorities, Educational Centre, Tourist Activities, Shopping centres, Constructions. The prevention activities focuses on public awareness program using social media, newspaper, radio spots, tv spots, mails, door by door informative, live links, seminars, conferences, advertising of waste prevention as well as through telephone lines. Also the activities promote home composting on which yard and green waste can be composted easily (those waste in some regions especially the tourist areas consist the 25% of the total waste v/v). Through this Strategic specific emphasis is given to Food waste reduction. The proposed Governmental strategy covers the state of the art, the compositional analysis, the waste prevention activities, the waste prevention actions, waste prevention target and indicators, the methodology for determine the waste prevention. This Waste Prevention Plan supports the overarching Waste Management Strategy for Cyprus from 2014-2020.

#### *Development of a web-based support tool for waste prevention at local authority level*

*Lasaridi K., Abeliotis K., Hatzi O., Batistatos G., Chroni C., Kalogeropoulos N., Chatzieleftheriou C., Gargoulas N., Mavropoulos A., Zorpas A.A., Nikolaidou M., Anagnostopoulos D. (Harokopio University)*

**Text:** The paper reports on the development of a novel web-based Decision Support Tool, the WASP Tool (acronym of the words Waste Prevention), that enables LAs to select and implement the optimum waste prevention programme for their local circumstances and prepare their Waste Prevention Plans. The tool has been developed in the context of the LIFE+ project “WASP Tool - Development and Demonstration of a Waste Prevention Tool for Local Authorities” – LIFE10 ENV/GR/622”) and specialises in the geographical area of Greece and Cyprus, with high potential to better reflect need of the Mediterranean space. A wide range of the waste prevention activities that have been already implemented worldwide has been studied and evaluated regarding their diversion potential, cost of implementation, level of behavioural change required and environmental benefits. Moreover, analysis has been conducted of the waste production characteristics and the existing waste management systems in the study areas of Greece and Cyprus. The WASP-Tool utilises the information and conclusions from the aforementioned evaluation and field results. More specifically, the WASP-Tool is implemented as a knowledge-based decision-support system, which extracts characteristics and features of the waste prevention strategies, models them, and applies multi-criteria evaluation techniques in order to facilitate decision making. The output of the system includes a ranking of the appropriate waste prevention activities, as well as estimated results for each activity, taking into account local demographics and waste parameters.

#### *Environmental assessment of waste prevention activities*

*(Abeliotis K., Chroni C., Zorpas A. A., Lasaridi K. (Harokopio University)*

**Text:** Waste prevention measures do not just aim at the reduction of waste; they also prevent the environmental impacts associated with the utilisation of resources during their entire life cycle. Thus, a key issue in waste prevention is its environmental assessment. Review of international literature reveals that the use of life cycle assessment is an established way for carrying out this kind of environmental assessments. The aim of this paper is presentation of the results of different case studies dealing with the preliminary environmen-

tal assessment of waste prevention activities in households in Greece. The first deals with the assessment of home composting while the second examines the environmental impacts of the prevention of printed advertising material. Relevant scenarios are built and assumptions are introduced for study of the life cycle environmental impacts of those prevention activities. Two case studies based on the current situation in Greece have been analysed utilising life cycle assessment. The results of the first study indicate that home composting is environmentally preferable over the current organic waste management situation in Greece, while the second case study shows that the prevention of waste advertising material has clear environmental benefits. More research is required in order to quantify the environmental benefits of preventing other waste streams via the use of LCA.

### ***Estimating household food waste in Denmark: case study of single family households***

*(Essonanawe M. E., Petersen C., Scheutz C., Astrup T. (Technical University of Denmark, Department of Environmental Engineering))*

**Text:** Food waste prevention remains the first priority in the European Waste Framework Directive, which aimed to halve the amount of food wasted within the EU Member States by 2025. Thus, reliable data on food waste composition and quantity are crucial for assessing the current food waste situation and determine potential improvements. In Denmark, although many sorting campaigns involving household waste has been conducted, little attention has been placed on food waste. Comparison of recent studies made for examples in Austria, and the UK suggests that quantity and material composition of food waste vary significantly among the studies and differ from one country to another. Here, we provide a consistent methodology for characterization of household food waste, so that data comparability and source information are ensured. In this study, residual household waste was sampled and manually sorted from more than 211 single-family houses in Denmark. The residual waste from each household was collected and sorted separately to obtain a representative variation of the quantity and composition of food waste among households. The main fractions contributing to the household food waste were avoidable vegetable food waste and non-avoidable vegetable food waste. Furthermore, avoidable vegetable and animal food waste were the primary source of household food waste. Statistical analysis found a positive linear relationship between household size and the amount of the household food waste suggesting the amount of household food waste increases with the number of occupants per household.

### ***Biological waste strategies in Poland***

*Spodzieja A.*

**Text:** In Poland there are living about 38,54 mln people. 135,2 mln tons of waste was produced in Poland in 2012, where 9% (12,1 mln tons) went for communal waste (2013). This result ranks Poland at 6<sup>th</sup> place among European countries in terms of the generated waste amount.

Nowadays in Poland the law has already been change to be in line with EU directive. At present regarding biodegradable land generated from MSW it's directed to stabilizing process and after word achieved output in landfill.

According to kitchen waste and green waste which is very often collected separately there are no specific regulation due to technology but plant which do care about this kind of waste should do biological treatment. Biological treatment when we talk about water supply plant is also a big issue this days. From 01.01.2016 obligatory in Poland will be treating of sludge by thermal stabilize or composting.

### ***Planning, starting, optimising separate collection of organics: approaches and results (including city centres)***

*Enzo Favoino, Chair, Scientific Committee, Zero Waste Europe, Scuola Agraria del Parco di Monza*

**Text:** Separate collection of organics is a key part of schemes to achieve highest rates of recovery of materials. Also, it allows recovery of clean organic resources, which are then suitable for application onto farmlands, thereby causing multiple beneficial effects as

- locking C in soils (which helps tackling climate change)



- fighting desertification and erosion
- reducing use of mineral fertilisers (and eutrophication that may occur in sensitive areas and wetlands)
- preventing pathogens thanks to the suppressive power (which reduces use of pesticides), etc.

On account of its multiple beneficial implications, separate collection of organics has been tabled in many local and international regulatory provisions, with drivers in the form of mandatory separate collection programmes (e.g. in the Netherlands and Austria) or bans on landfilling (fairly common in North America) or targets (specific targets for biowaste, as e.g. in Sweden, or general separate collection targets that also boost separate collection of organics, as e.g. in the UK and Italy).

Typically, separate collection of garden waste is considered a comparatively easy scheme to be implemented (by means of bring systems or dedicated collection rounds) while separate collection of food scraps is regarded as an option showing multiple challenging operational implications, on account of the putrescible nature of materials that are targeted. Hence, in the common perception of waste contractors and local planners / decision-makers, separate collection of food scraps is deemed to be suitable for sparsely populated areas only (villages and small Municipalities, residential outskirts in cities) not for the densely populated city centres and high-rise buildings (notably, separate collection of biowaste will become mandatory everywhere from 2015 in Germany, which is propelling interest in solutions to tackle also the city centres).

However, operational experience has been gained and consolidated in last 20+ years, which provides plenty of evidence and information on the following:

- kerbside schemes collecting also organics (and notably, food scraps) may work everywhere, including South Europe: wide implementation is e.g. currently detected in Spain (Catalonia and Basque Country) while 34 million people (60% of the population) are currently covered by separate collection of food scraps in Italy
- many schemes, and notably those from Southern Europe, are showing the possibility to tackle separate collection of food waste also in the densely populated city centres: Milan (1.4 M people) is already covering 100% of its population with more than satisfactory results both in terms of quantity and quality
- the need to make the system user-friendly is key: maximised participation and capture, besides boosting recycling rates, may also minimise percentages of organics in residual waste, thereby making it possible a reduction of collection rounds for residual waste, which is a key factor for cost-optimisation of schemes
- customer satisfaction analyses tell us that well designed schemes gain wide support by households and large producers.

The presentation will dwell on operational expertise of the presenter, who took part in the design and roll out of many ground-breaking schemes, and will provide such evidence, elaborating on key issues to be considered when designing and rolling out a separate collection scheme; particular emphasis will be given to schemes tackling food scraps and related results, so that the new challenges posed by the ongoing revision of the EU Waste Policy be tackled with confidence, and successful results be achieved.

### **1.3. /B. WASTE PREVENTION - WASTE REDUCTION - SEPERATE COLLECTION (CONVENORS: DR. KATIA LASARIDI, CHRISTIAN GARAFFA)**

#### ***Monitoring and Evaluation of waste prevention activities in Selected Groups***

*Zorpas A., Lasaridi K., Voukkali I., Loizia P., Chroni C., Georgiou A., Phanou K., Goumenou P., Pirilly D. (Cyprus Open University)*

**Text:** According to Waste Framework Directive (directive 2008/98/EC), waste prevention are the measures taken before a substance, material or product has become waste, that reduce the quantity of waste, the adverse impacts of the generated waste on environmental and human health or the content of harmful substances. The European framework directive on waste requires national waste prevention programmes to be drawn up. Additionally, according to Zorpas and Lasaridi, (2013), waste prevention is a very personal behaviour, which often goes undetectable (e.g. when shopping) or out of the sight of others (at home), so that there is no descriptive social norm to support it. Waste prevention is performed in the privacy of our own home and is personal as it is driven by deeply held beliefs and attitudes rather than social norms. However monitoring and evaluation of waste prevention activities is critical, as is the main reason to enable policy makers, local authorities and experts to build their strategic plans, as they can measure and ensure that waste prevention initiatives are being effective and delivering behavior change. This paper examined the behaviour of waste prevention regarding several streams like food waste, waste that can be composted, re use of plastic bottles in several targets groups in Municipality of Paralimni which took part in a LIFE+ project (WASP TOOL).

#### ***Household food waste in Greece - estimation through a self-reported food waste diary***

*Abeliotis K., Chroni C., Kyriacou A., Boikou K., Zorpas A.A., Lasaridi K. (Harokopio University)*

**Text:** According to a study for food waste in the EU-27, households produces approximately 42% of the total amount of food waste. Even though the generation of household food waste is only one part of the whole picture, there is growing evidence that their contribution to the problem is particularly significant. However, there is a complete lack of quantitative data on the food waste generation in Greece. Thus, the aim of the present research was to fill the lack of information on the attitudes and behaviours of Greek households towards food waste generation and prevention. A structured questionnaire was utilized in order to identify the attitudes of the respondents in addition to certain behavioural good practices that can prevent food waste generation. In order to quantify food wastage, a 15-day food waste diary was filled by 120 participants representing respective households, during the second half of 2013. The results were then extrapolated for a whole year. In addition to the food wasted, sociodemographic characteristics were also recorded. The diaries were completed in the cities of Athens, Heraklio and Chania. The research indicates that people in Greece have positive attitudes towards food waste prevention and their habits are close to the good practices suggested by the literature for reducing waste. Regarding the type of the household, household behaviour towards food waste prevention is affected by the family structure and the behaviour of the person who is mainly responsible for food shopping and cooking. The research was partially funded by the LIFE+10 ENV/GR/622 project "WASP Tool".

#### ***The separate collection of residential organic waste in the city of Milan (Italy)***

*Petrone P., Vismara D. (Amsa S.p.A.)*

The challenge of collecting the separate fractions of urban waste is at its highest when doing so from areas of high population densities with high levels of multi-occupancy housing. The City of Milan is one such area with a population density of 7000/km<sup>2</sup> and over 80% of housing classified as multi-occupancy. In this respect it is similar to other European cities like Barcelona, Berlin and Vienna but unlike these cities, since 2012 Milan has been collecting food waste using the intensive door to door system widely adopted in less dense territories. Households are provided with vented kitchen containers, compostable bags and larger outdoor bins which are used by multiple families. The collection equipment has been accompanied by a high profile communication campaign and the performance is under constant surveillance. This ongoing collection of collection data alongside organic and residual waste analyses have shown that the City of Milan has a diver-

sion of food waste of 90 kg / inhab.\*y equating to a capture rate of over 86% with an average contamination level of 4.27% which is well within the acceptable tolerances set by the Consortium of Italian Composters. A comparative analysis with six similar European cities shows that the approach taken in Milan is by far the highest performing with respect to organic waste collection.

### ***The Role of Source Separated Food Waste in the New Waste Management Plan in Lombardy, Italy***

*Giavini M., Zerbinati P., Confalonieri E. (ARS ambiente)*

**Text:** Lombardy is a Region in northern Italy, with a population of 10,000,000 people and 1546 municipalities. Recently it drafted the new regional waste management plan, setting a new target in terms of recycling rate (65% for each municipality, to be achieved by 2020). In order to achieve this high target, the Region recognizes the key role of food waste as the first fraction to be separated by citizens. In Lombardy, currently more than 600 Municipalities have already implemented the kerbside collection scheme based on biodegradable and compostable bags for the collection of food waste only, without garden waste. This scheme have proven to be comfortable for citizens, economically viable and also environmentally friendly as a detailed LCA study shows. Thus, it has been identified by the regional plan as a general model to be spread. According to the new plan, by 2020, each municipality have to set up food waste collection, including smaller municipalities. The big city of Milan (1,300,000 people) already implemented it on almost the whole part.

### ***Towards a circular bio-economy : challenges for the biowaste management***

*Braekevelt A. (Public Waste Agency of Flanders)*

**Text:** Due to the fact that the availability of agricultural area in Flanders is rather limited, the supply of raw materials is often linked to the recovery and recycling of valuable products from biomass waste fractions and side streams of existing industrial food, wood processes,... A lot of challenges are waiting due to European or local measures for e.g. the anaerobic digestion plants in Flanders because of the increasing costs for biowaste with biogas potential and the phosphate restrictions for using digestate on land. Depending on the price of artificial fertilizer at the moment, new opportunities for recycled nutrients are waiting in the future. The composting plants for biowaste are looking for predigestion of the biowaste in order to combine the production of energy and good compost quality. Next to investing in pilot and full scale plants, a lot of research is done in universities, ... for the biorefinery of more difficult biomass streams, like lignocellulos e crops and biomass waste to develop biochemicals. It's a challenge for them all to contribute to the sustainable growth on a cost effective way. At the end of June 2014 tips and tricks will be presented and illustrated to tend to a circular bio economy, based on the biowaste management plan 2015-2020 for the Flemish region in preparation.

## 1.4. THE COMPETITION FOR BIOWASTE: ENERGY PRODUCTION VERSUS HIGH QUALITY SOIL IMPROVERS (CONVENORS: DR. ARJEN BRINKMANN, DR.-ING. WOLFGANG MÜLLER)

### *Ecological and economic benefits of compost and digestate products*

*Vandaele E., Vandenbroek K., Auweele V. W., Vandenbroucke I., Boogaerts C. (Vlaco vzw)*

**Text:** European soils are systematically degrading. The European Soil Strategy urges more attention to the need for organic matter in soil: 45% of the soils in Europe show a lack of organic matter. This is also a problem in Flanders: almost 50% of the soils are below the target of organic matter. A range of measures is necessary for restoring the organic matter content: green manures, crop residues, organic fertilizer and soil improvers will all be needed. It is therefore of great importance that in the future sufficiently high amounts of quality composts and digestate products are produced, because these have shown to be excellent sources of stable organic matter and/or contribute to the soil fertility and food supply. The benefits of compost and digestate are numerous: • High quantity of stable organic carbon • (Slow release) nutrients • Improves soil structure • Improves water management of the soil • Reduces soil erosion • Reduces the emission of greenhouse gases • Stimulates soil life (plant protection against diseases) Although the benefits of compost and digestate have been proved, the prices for compost and digestate are rather low. Vlaco calculated the economic value (intrinsic value) of compost and digestate (e.g. 55 euro/ton green compost or 130,98 euro/ton dried digestate). Beside this economic value Vlaco calculated also the possible reduction of greenhouse gases by using compost and digestate products instead of mineral fertilizers or non-renewable raw materials. This calculation gives important data to be used in life cycle assessment to compare sustainability of different fertilizing strategies.

### *Bioresource utilization chains – Efficiency of substantial and energetic utilization options on the example of food residues and grass cuttings in a district of Hamburg*

*Körner I., Hertel S. (Hamburg University of Technology)*

**Text:** During the chain from an agricultural bioresource to a food product, by-products and residues are generated. The majority of the residues are handled within urban waste and waste water management structures; the contained valuables regarding the energetic content and nutrients such as N and P are actually inefficiently or not utilized. The mass flows from primary agricultural bioresources to food consumption and the whereabouts of the residues will be analyzed. Similarly the green waste sector is studied on the example of lawn cuttings. The chain analysis is done for a common scenario with source-separated biowaste collection by bins and waste water disposal into the sewage system. It will be compared with innovative scenarios. In all scenarios substantial and energetic products are generated, but with strongly varying efficiency. The scenarios are based on data of Hamburg's district of Wandsbek. One of the scenarios is actually under implementation. Visionary a region can be considered as a "civilization biorefinery" if the majority of bioresources are utilized most efficiently for generation of substantial and energetic products. Wandsbek city quarter "Jenfelder Au" demonstrates the combination of waste water, waste and energy management including advanced utilization of some secondary and tertiary bioresource fractions. The return of valuables into agriculture (nutrients, organics) is also aspired. In such systems energetic and substantial utilization are not on completion, but have synergetic effects.

### *Development of indicators to evaluate manure processing technologies. Anaerobic digestion and composting of cow manure plant as case study*

*Bonmatí A., Burgos L., Tey L., Noguerol J., Flotats X., Palatsi J. (IRTA)*

**Text:** Intensive livestock production has experienced a rapid growth in the last few decades, especially concentrating in certain geographical areas. The improper management of livestock manure causes severe environmental impacts related to eutrophication, acidification, release of greenhouse gases, pollution due to

toxic chemicals (heavy metals, antibiotics, hormones, etc.), among others (Laureni et al., 2013). Nevertheless, in the current framework of resources and energy scarcity, organic wastes arise as an attractive resource that, if processed properly, can reduce the environment impacts associated to their management. The LIFE+ Manev project (LIFE+09 ENV/ES/453) aims to develop a Common Protocol to evaluate the technical, environmental and economical performances of the existing processing technologies. This common protocol will be tested by assessing 13 treatment technologies and manure management systems located in 8 regions along Europe. The Common Protocol developed includes different indicators for each of the considered criteria: Environment, Energy, Economy, Social, Livestock density, Agronomic, Animal and Humane Health and Legal Framework criteria. In this paper, the case study of an anaerobic digestion and composting plant processing the manure produced by a cow farm located in St Esteve de Guialbes (Girona, Catalonia) will be presented. Two years survey of the efficiency of the plant, energy production, compost productions, etc., has been performed. Special attention has been paid to gaseous emissions. The plant has been treating an average of 29.596 tonnes/year of manure with a biogas production of 1.438.471 m<sup>3</sup>Biogas/year equivalent to 2.738.916 kWh/year. CH<sub>4</sub>, NH<sub>3</sub> and N<sub>2</sub>O were detected in both the inflow and digestate storage.

### ***SYNECO - synergy of high quality green compost and green energy***

*Boogaerts C. (Vlaco)*

**Text:** Central question SYNECO How can the compost industry optimally apply the available biomass resources for producing green energy and high quality soil improvers? What innovations in composting (adapted process in case of lower amounts of bulky material) are feasible, and what are the possibilities for anaerobic digestion of the fine fraction of green waste? Can we set standardized quality requirements for both end products (both compost and biomass streams)? Does the production of both high quality soil improver and biomass for green energy allow an economic optimization for the compost sector? Approach By means of an inventory of the input and by calculating mass balances SYNECO searches for an optimal distribution of input streams for green energy or materials recycling. By analyzing end products (compost versus biomass) of referential and experimental compost piles and critical process factors we will equally search for the necessary adaptations of the composting process in case of a changed input composition. Also a general decision support-tool for maximizing the net cash flow of compost companies is constructed. Intermediary results Occasionally the experimental composts yield fairly low levels of organic matter. Evidence suggests that biomass for energy can be filtered out before and/or after the composting process – displaying similar quality for burning. Intensifying the composting process, and filtering out only specific biomass-fractions, possibly abstaining from taking out biomass in certain periods of the year, seem advisable and may be further necessarily complemented by windshifting the biomass.,

### ***Greenhouse gas balances in biowaste treatment concepts with focus on compost and energy production***

*Wolfgang M., Ortner M., Bockreis A. (Unit of Environmental Engineering, Section of Waste Treatment and Resource Management, University of Innsbruck)*

**Text:** The greenhouse (GHG) gas and energy performance of bio-waste treatment plants was investigated for characteristic bio-waste treatment concepts: composting, biological drying for the production of biomass fuel fractions, and anaerobic digestion. In contrast to other Life-Cycle Assessment (LCA) studies the focus was put on the direct comparison of the latest process concepts and state of the art emission control measures. In addition the value of compost as a soil improver was included in the evaluation. The study is based on data from operational facilities which are combined with literature data. To ensure a direct comparability the same quantity of waste (25,000 t bio-waste and 5,000 t green waste input per year) and composition have been modeled for all concepts concerned. The results show that all concepts contribute to a reduction of GHG emissions and show a positive balance for CED. Compared to other studies the advantage of anaerobic digestion compared to composting is smaller as a result of accounting the soil improving properties of compost. Still anaerobic digestion is the environmentally superior solution, due to the high energy conversion efficiency of biogas to electricity and heat.

## ***CO<sub>2</sub> calculation tool for sustainable green waste management***

*Brinkmann A. (BVOR - Dutch Association of Biowaste Processors)*

**Text:** CO<sub>2</sub> calculation tool for sustainable green waste management This presentation will outline key features of an innovative and practical CO<sub>2</sub> calculation tool, which allows to quantify CO<sub>2</sub>-effects of green waste processing and of application of derived products. Unique about the tool is that it does not only calculate CO<sub>2</sub>-effects of energy applications (e.g. use of wood chips as fuel or), but also accounts for CO<sub>2</sub>-effects of material re-use, most notably compost products. Optionally, the tool can take into account CO<sub>2</sub>-effects of innovative, biobased products from green waste. Tool formulas en data have been based on scientific studies, including Life Cycle Assessment (LCA) studies, while the design of the tool allows practical usage in daily operations. The tool allows to objectively quantify and compare carbon effects of different treatment options for green waste and biomass management, thus facilitating market players and other stakeholders in decision making. It is envisaged that the tool will play a role in public tender procedures for green waste management in the Netherlands. Development of the tool was commissioned by BVOR, the Dutch Association of Biowaste Processors. The tool was developed by IVAM, part of the University of Amsterdam, in 2013. The presentation will outline the set up of the tool and highlight potential applications of the tool in the biowaste sector.

## 2.1. BIOLOGICAL INDUSTRIAL TREATMENT OF ORGANIC WASTE (CONVENORS: RICARDO ARRIBAS)

### *Handling of Excessive Process Water (EPW) from Mechanical Biological Treatment (MBT) of Municipal Waste*

*Stopp P., Dr.-Ing., Weichgrebe D., Voss E. (ISAH, Leibniz Universität Hannover, Germany)*

**Text:** The Mechanical Biological Treatment (MBT) of municipal waste is well established in many European countries. Depending on the water content of the input, excessive process water (EPW) is generated, which cannot be reused in the MBT process and must be disposed as liquid waste. With respect to the kinetics of the AD reactor, EPW of MBT plants is heavily loaded in particular with SS, COD, BOD, TN, TP etc. EPW is listed in the European Waste List under 190604, digestate from anaerobic treatment of municipal waste. The disposal via aerobic sewage treatment plants is energy and cost-intensive, moreover an additional carbon source is required, due to a C/N ratio of ca. 3. However, with adjusted handling, EPW can be also seen as potential substrate for a co-fermentation plant or crude material for fertilizer production. For this research, digestate was taken and analyzed from a VALORGA-plant with an input of ca. 95,000 t per year and a specific biogas production of 160 m<sup>3</sup>/tOS of input. According to the digestate characteristics, three alternative treatment pathways were investigated as a case study with a focus on energy efficiency and nutrients recovery: Firstly: using high ammonia adapted sludge and inoculum from a co-digestion plant to gain biogas and recover the nutrients with the digestate. Secondly: using an evaporation process with heat of the Combined Heat and Power station (CHP) at the MBT facility. Thirdly: Treatment with standalone or integrated membrane technology.

### *Characterization of three industrial digestates and composts of digestates: Impacts of the composting step on the innocuousness of digestates*

*Orvain M., Houot S., Colin M., Lecarpentier A. Covez R., Chevallier M., Ochoa J., Bacheley H. (Veolia Environnement Recherche et Innovation, VERI)*

**Text:** The use of treatment methods involving Anaerobic-Digestion (AD) is expanding rapidly for a wide range of organic waste in France/Europe. In addition to biogas, AD generates digestate, a partially stabilized/sanitized product. In the majority of cases digestate is recycled for agricultural use, whether in composted form or not. However, little is known about its effect and impact on soils and the agro-system. In this context DIVAGRO study was initiated in partnership (ADEME/INRA/VERI) with the aim to study three digestates and Composts of Digestates (CD). Digestates studied were issued of the treatment of residual municipal solid-waste (biowastes), co-digestion (food processing wastes) and sludge (wastewater treatment). For Raw Digestates (RD) it appears that the agronomic characteristics are closely to raw-wastes put into AD (preservation of nutrients from raw-wastes), as well as to the process of AD implemented (HRT, thermo/mesophilic...). RD show a fertilizing value through the conservation of macro/micronutrients and nitrogen mineralization during AD. CD present almost similar agronomic characteristics to composts produced from other raw-wastes. Concerning the innocuousness of digestates and CD, heavy metals, organic compound and inert contents fulfill the French regulatory criteria (NFU44-051 or NFU44-095 for composts). Their spreading shouldn't have any negative environmental impacts at short-term. Microbiological results show that a stabilization step by composting allows a reduction of salmonella. Finally, phytotoxicity tests show the phytotoxic character of one digestate and the absence of phytotoxicity of all the composts. Beneficial effects on germination and development of aerial parts of barley and watercress were even observed using CD.

## ***Improved method for recovery of organic solids from diluted swine manure in 3rd generation treatment system***

*Vanotti M., Hunt P., Airton K., Rice M. (United States Department of Agriculture (USDA), Agricultural Research service (ARS))*

**Text:** Solid-liquid separation of the raw manure increases the capacity of decision making and opportunities for treatment. The high-rate separation up-front using flocculants allows recovery of most of the organic compounds, which can be used for manufacture of high-quality compost materials. However, the use of flocculants and dewatering equipment is costly on high-volume, diluted wastewater. This project evaluated and demonstrated the viability of a third generation manure treatment technology for swine manure in the USA. The technology first separated solids and liquids in the flushed manure with the aid of settling and polymer flocculants; subsequently, the ammonia nitrogen was treated with nitrifying bacteria adapted to high-strength wastewater and cold temperatures; and lastly, the soluble phosphorus was separated via calcium phosphate precipitation. The harvested manure solids were composted in a centralized facility and converted into value added commercial products. The third generation was designed to further reduce cost of manure treatment through pre-concentration of diluted manure using a decanting tank before polymer application. The technology was demonstrated full-scale on a farrow-to-finish farm that produced 30,450 finishing swine per year. The combination of treatments substantially eliminated the release into the environment of odors, pathogens, ammonia, phosphorus and heavy metals, which are environmental standards required for new swine operations in North Carolina. The pre-concentration strategy increased polymer use efficiency 5.4 times (from 52 to 279 g/g), and reduced the total manure volume processed by the solid separator press by 98,000 liters per day. This lower volume is one of the major advances of the third generation project: It increased solid separator press capacity and lowered operating expenses when adapted to flushing systems, while meeting the five environmental standards for new swine operations.

## ***The investigation of respiration after mechanical biological treatment of municipal solid waste***

*Gulyás M., Béres A., Aleksza L., Dér S. (Department of Water and Waste Management, Institute of Environmental Sciences, Szent István University, Gödöllő)*

**Text:** The mechanical biological treatment (MBT) systems treat and process the mixed municipal solid waste and the residual of other waste treatment processes (e.g.: selective waste collection and sorting). The enrichment and assortment processes are conflated with biological treatments as composting in MBT. The primary aim of these treatments is to reduce the environmental hazards, volume, and mass of wastes, to stabilize the organic residues, and the retrieval of the recyclable waste materials (metals, refuse derived fuel-RDF). One of the largest amount of material originated from the waste treatment is a compost-like material, that may be used to cover the landfill depend on the quality. These type of stabilized biowastes have to meet the legal requirements and have to be stable before utilization. The aim of our studies was to determine the 4 days respiration index (AT<sub>4</sub>) of municipal solid waste after MBT with OxiTop Control B6M-2,5 device. Respiration index was determined and followed during the time of stabilization. Preparation of samples and determination of respiration index were made based on different European standards.



## 2.2./A. BIOPROCESSING: AEROBIC AND ANAEROBIC DEGRADATION (CONVENOR: DR. LJUDMILLA BOKÁNYI)

### *Effect of biochar amendment during composting and compost storage on compost quality, N losses and P availability*

*Vandecasteele B., Mondini C., D'Hose T., Russo S., Sinicco T., Quero A. A. (Institute for Agricultural and Fisheries Research (ILVO))*

**Text:** We tested the effect of adding 10% biochar (on a dry weight base) in a mixture of green waste and the organic fraction of municipal solid waste before processing in a composting plant. Composting was executed in lanes with automated mechanical turning and forced aeration. Both the compost and the biochar-blended compost were characterised chemically and physically in order to quantify the effect of biochar on compost quality and nutrient losses during the process. Temperature in the reference treatment was significantly higher than in the biochar-blended compost throughout the whole bio-oxidative phase (1-27 days). Mixing biochar in the compost feedstock clearly affected the process and compost characteristics, i.e. the oxygen uptake rate (OUR) and nutrient availability during this phase. A higher organic matter decomposition and dry matter content and lower P and NH<sub>4</sub><sup>+</sup>-N concentrations were observed for the fraction.

### *Temporal and spatial distribution of organic waste physical properties along composting process*

*Druilhe C., Huet, Tremier, Debenest (Irstea)*

**Text:** As an aerobic biological treatment, the composting process is influenced by the physical properties of organic waste. On one hand, material settlement, air permeability and free air space affect the aeration efficiency and the composting performance. On the other hand, the organic matter biodegradation during the process leads to a variation of material physical properties. The aim of this study was to investigate the time variation and the spatial distribution of the physical properties of a sludge and bulking agent mixture during its composting treatment. Composting was carried out in 300L pilot-scale reactors with forced aeration. In order to follow the spatial distribution in each reactor, the material was divided in three layers. Reactors were respectively stopped after 1.5, 3, 7, 14 and 31 composting days, and each material layer was characterized for moisture content, bulk density, free air space (FAS) and air permeability (K). The results showed that the changes in material properties were different according to the considered layer. The deepest layer, impacted by the air inlet in the reactor, had the highest decrease of moisture content and bulk density, a steady K and the highest FAS increase, whereas the surface layer, impacted by a condensate dropout, showed a slight increase of moisture content, steady density and FAS, and a very strong increase of K. Then, a physical structural reorganization of material occurred during the process. In the future, the obtained results could help to improve composting models, taking into account the temporal and spatial distribution of physical properties in the porous media.

### *Optimizing the composting parameters as a post-treatment of digestates of organic fraction of municipal solid waste*

*Yang Z., Dabert P., De Guardia A., Tremier A. (Irstea)*

**Text:** There are increasing concerns about the management of digestates since the application of anaerobic digestion has grown spectacularly in recent years. Despite their good fertilizing properties, the digestates are often incompletely stabilized and concentrated in ammonium. Moreover, some pathogens can survive anaerobic digestion and complicate digestates valorization. Considering the drawbacks of direct utilization of digestates in agriculture, we studied the composting as a post-treatment of a typical digestate, the digestate of organic fraction of municipal solid waste. Our work was based on an experimental design of the composting practical parameters including the aeration rate, the type and size of bulking agent, the mixing ratio of bulking agent with digestates and the recycling of mature compost and used bulking agent. We evaluated the stabilization of the compost produced, the ammonia and nitrous oxide emissions during composting and

the self-heating ability of composting pile in function of these parameters. We showed that changing from an inert bulking agent (plastic pall ring) to an active one (wood chips) helped to stabilize the digestates and reduced by 70-fold and four-fold ammonia and nitrous oxide emissions, respectively. Increasing the mixing ratio from two to four doubled the oxygen consumption of the compost and reduced 50-fold nitrous oxide emissions. The recycling of mature compost reduced ammonia emissions from 0.25 to 0.08 g nitrogen per kg organic matter but increased nitrous oxide emissions from 2 to 5 g nitrogen per kg organic matter. This work discusses the mechanisms of our observations and proposes optimized parameters for the composting of digestates.

### ***Effects of the proportion of cotton gin as a bulking agent in the co-composting of the solid fraction of pig slurry***

*Santos M.A., Bustamante R., Moral, Bernal M.P. (CEBAS-CSIC)*

**Text:** Composting can be a feasible technology for managing the pig slurry in surplus areas, producing a stabilized final product with good agricultural properties. The aim of this study is to assess the influence of the proportion of the bulking agent in the development of the composting process and in the quality of the compost obtained. For that, two static piles of about 2000 kg were built, using solid fraction of pig slurry (SPS) and cotton gin, in two proportions (SPS:bulking, v/v): 4:3(A) and 3:4(B). The Rutgers static composting system was used. Internal and external temperatures were registered and the physico-chemical characteristics of the materials were determined during the composting process, and after maturation. Both piles showed similar evolution for all the parameters studied and high temperature developed in the thermophilic phase, with a decrease of the most labile forms of carbon and nitrogen, indicating a strong microbial activity during the process. Total organic carbon decreased by 15 and 24%, while total nitrogen increased by 80 and 22% in A and B, respectively. Also, CHA was higher in A than in B (8670 and 7468 mg.kg<sup>-1</sup> DM, respectively), indicating a greater humification of the OM in the former. The composts obtained showed good maturity, with a germination index >80%, C/N ratio 67 cmol.kg<sup>-1</sup> OM. Increased cotton gin proportion prolonged the thermophilic phase, extending the required composting time, producing a compost with lower C, N and CHA concentrations. Therefore, using 4:3 proportion (SPS:bulking) is adequate for composting the SPS.

### ***Composting of manure using olive mill wastewater for moisture control***

*Fenia G., Fountoulakis M., Niarhos A., Fletcher L., Stentiford E., Nikolaidis N., Manios T. (Department of Agricultural Technology, Technological Educational Institute of Crete, Heraklion, Greece)*

**Text:** Composting has been widely used for converting organic wastes into relatively stable products for use as fertiliser or soil additives. Moisture has been referred to as a critical factor in optimising composting systems because the decomposition of organic matters depends on the presence of water to support microbial activity. Olive mill wastewater may be a potential source of water for moisture control during composting. In addition, OMW contains about 1,0 g / L of Nitrogen, 0.4 g / L of phosphorus and 5.0 g / L of potassium so it is possible to increase the nitrogen, phosphorus and potassium concentrations of final product. During this study, three different types of manure were used, pig, cow and poultry manure, each one at about 10m<sup>3</sup>, mixing with chopped green garden wastes as bulking agent, at the same volume (1:1, v/v), in an effort to improve the composting procedure. During this three month procedure, quantities of OMW were added in order to correct moisture, when necessary and add nutrients as P and K. **ACKNOWLEDGMENTS** This research was funded by EU (LIFE10 ENV/GR/00596)

## ***In-situ co-composting in a bedded-pack dairy barn***

*Szántó G., Aarnink A.J.A., Dooren H.J.van, Boer H.C.de, Galama P.J. (Wageningen University)*

**Text:** The currently developed Dutch bedded-pack barn is an integrated housing method for dairy cows. In this system, animal welfare, waste management and nutrient recovery considerations are merged for economic and ecological sustainability. The core design features the use of organic bedding and the application of an in-situ, co-composting process. During the co-composting of the manure-bedding mixture, the process needs to be optimized for moisture removal (to keep the bedding dry for the kept animals) and the production of an emission-poor compost product for agricultural reuse. This implies that the co-composting process is designed to achieve the 'slowest optimal' degradation rate where a dominantly aerobic stabilization is achieved without extensive ammonia (NH<sub>3</sub>) and greenhouse gas (CH<sub>4</sub> and N<sub>2</sub>O) emissions. The current paper details the preliminary research results regarding relevance of potential bedding materials (wooden by-products and municipal composts) for this process, and the effectiveness of different co-composting regimes. The assessed composting methods include passive aeration (using daily agitation only), and two forced aeration methods (utilizing blowing- and suction-type ventilation). Next to the quality assessment of the bedding materials and composting regimes, the experimental results are also used for the validation of a newly developed, bedded-pack composting model. This model is developed to quantify moisture removal, degradation rate and ammonia losses during the co-composting process in the bedded-pack barn.

## 2.2./B. BIOPROCESSING: AEROBIC AND ANAEROBIC DEGRADATION (CONVENOR: DR. LJUDMILLA BOKÁNYI)

### *Valorisation Alternatives for Cheese Whey and Permeate in the Basque Country (Spain)*

*Cebrián M., Orive M., Gutierrez M., Rentería M. (AZTI-TECNALIA)*

**Text:** Cheese whey is one of the most important pollutant generated by the dairy industry (more than 100 Million m<sup>3</sup> /year in the EU). In the Basque Country (Spain) the small size and the geographical dispersion of the cheesemakers make difficult its effective management for energetic uses and other added-value applications. The aim of the Life+ VALORLACT project (Life 11 ENV/ES/639) is to demonstrate the technical, environmental and economic feasibility of different technologies such as membrane filtration and biogas production from cheese whey. Protein and whey concentrates have been used for the development of 4 new food prototypes (cheese slices, cheese sauce, flavored whey powder and drinks). Biogas production tests have been also performed with raw whey and permeate in a two-stage system. 1 and 10 L Continuous Stirred Tank Reactors (CSTR) have been used for acidogenesis and methanogenesis stages respectively. For raw cheese whey the average maximum Specific Biogas Productions (SBP) was 0.900 NL•g VS-1•day (57 % methane) at Hydraulic Retention Time (HRT) of 13 days and Organic Load Rate (ORL) of 3.46 g VS•L-1•day-1. The maximum SBP reached with permeate was 0.688 NL•g VS-1 (55 % methane) with HRT of 15 days and ORL of 3.67 g VS•L-1•day-1. A pilot scale plant has been also started-up in a medium size cheese factory to demonstrate the feasibility of combining ultrafiltration and biogas processes.

### *Investigation into the microbial potential of digestion towers, using no co-substrates in their input material, to prospectively increase biogas yields at sewage treatment plants*

*Walter A., Probst M., Aichinger P., Ebner C., Insam H. (University of Innsbruck, Institute for Microbiology)*

**Text:** In sewage treatment plants (STPs), the anaerobic fermentation of sludge primarily aims at hygienic stabilization and reduction of mass. Recently however, a great potential has been seen regarding the addition of co-substrates in anaerobic treatment plants to increase biogas yields. The aim of this project was to compare the biotic and abiotic characteristics of STPs using or not using co-substrates in their digestion towers. Fermenter sludges from different reactors were sampled and physico-chemically analysed. Denaturing gradient gel electrophoresis (DGGE) was conducted to obtain an initial impression of differences in the bacterial and methanogenic community composition. Finally, the adaption velocity of the microbial community and the quantitative methane potential of three different reactors were tested with an Automatic Methane Potential Test System (AMPTS) device, by using paracrystalline cellulose and a mixture of primary and surplus sludge as reference co-substrates. All reactors were operating stably. Co-substrate had a strong impact on bacterial community composition. The two reactors that received biowaste clustered separately from the other reactors. Their methanogenic communities were similar, with only 11% differences in community composition. AMPTS data revealed equal methane potentials in all reactor sludges. The adaption velocity was independent of whether or not the STP processed co-substrates. According to these results, microbial communities in STPs can easily and very quickly accommodate the introduction of co-substrates in a reactor, even if they have not been adapted to such an environment.

### *Study on biodegradability of wood residues*

*Menert A., Kriipsalu M., Anderson K., Pihlap E., Orupõld K., Kulli S. S. (University of Tartu)*

**Text:** Bark and timber residues (waste wood) mingled with soil, dirt and stones have so far been landfilled without any alternative use. The aim of this study was to propose a technology for biological treatment of this waste, enabling to produce quality compost. Lignine-rich material is poorly degradable, therefore its decay was boosted with various inocula. Tests were performed in lab, pilot and field scale. For biodegradability tests of wood carbon, inocula with bacterial communities similar to those of wood in various decomposition stages (species from phyla Actinobacteria) were selected. In lab scale, the content of organic matter and 16S rDNA-based community profiling were explored over time. In pilot scale experiments in 200 L drum reactors degradability and availability of carbon was studied. Based on the results of pilot experiments, the inoculum for field tests was chosen (compost from park waste, food waste, and category III animal by-products). Temperature, content of evolved gases, dry matter and organic matter content of solid sample and respiratory activity were measured. In aqueous extracts pH, conductivity, dry matter and organic matter content and dissolved organic carbon (DOC) were measured. In field tests with external temperatures down to -15°C composting was most active in center layers but temperature drop caused a sharp decline in the composting activity. Windrow leachate was biologically hardly decomposable, though none of the measured indicators showed extensive pollution. Waste wood has a good composting potential as the requirements for input material are low and the recyclable waste is free of harmful impurities.

### *Mechano-chemical treatment of amaranth waste to enhance anaerobic digestion*

*Varga T., Bokányi L. (University of Miskolc, Institute of Raw Material Preparation and Environmental Processing)*

**Text:** Biogas production has a great importance in the energetic utilization of bio wastes. The seeds of the amaranth plant are utilized widely, but after removing the seeds, the leaves and stems appear as bio waste. In the meantime, because of the cellulosic structure, this waste is difficult to degrade both by aerobic and anaerobic degradation. The aim of the study was to investigate the effect of an activation process using stirred media mill reactor on the anaerobic biodegradation process. The influence of the wet activation at different retention time was studied through chemical analysis (COD), FTIR and HPLC analysis, as well as the biogas experiments were also carried out using a laboratory static installation. The results indicate that the activation in stirred media mill reactor was not only mechanical, but also chemical one. Furthermore, this mechano-chemical activation positively influences the biogas production of cellulosic amaranth waste. Although, the improved biogas yield is still relatively low comparing with other substrates, and the energy investment due to mechanical treatment is high, the results are extremely useful and important for many cellulosic biomass recycling techniques in the future.

### *Effect of paper fraction on the mesophilic anaerobic digestion of ofmsw. biogas and digestate evaluation*

*Mata-Alvarez J., Fonoll X., Dosta J., Astals S. (University of Barcelona)*

**Text:** The effect of the percentage of paper fraction on the anaerobic digestion of Organic Fraction of Municipal Solid Waste (OFMSW) was evaluated in terms of biogas production and digestate stability. To reach this objective, the municipal waste from an anaerobic digestion plant was manually divided into 3 fractions: organic, paper and inert fraction. Two lab-scale semi-continuous anaerobic digesters were tested under mesophilic conditions and maintaining an HRT of 15 days: one reactor was fed only with organic fraction as a reference reactor (R1) and the other one (R2) was operated with 15 and 30% of paper in a wet weight basis. The feedstock of each reactor was grinded and mixed with the liquid fraction from the effluent of the anaerobic digestion plant to achieve a concentration of 5% TS. The digestate stability was evaluated with two different methods: The 5-day biochemical oxygen demand (BOD<sub>5d</sub>), done following the 5210D standard method procedure, and a batch anaerobic activity test. The results showed that the behavior of both digesters were the same with the addition of paper except when the feedstock had a 30% of paper on it. In that case the specific methane production decreased a 15%, in comparison with the reference reactor. However, the digestate

stability was better because the R1 digestate kept having more biodegradability potential than R2 digestate. The DBO<sub>5d</sub> were 2.0 and 1.5 gO<sub>2</sub> L<sup>-1</sup> and the production during the batch anaerobic activity tests were 196 and 163 mlCH<sub>4</sub>/gSV<sub>fed</sub>-1 for R1 and R2 respectively.

### ***Energy-based optimization of dry-state, sequential anaerobic digestion – aerobic composting of sewage sludge***

*Rózsáné Sz. B., Simon M., Szántó G. L., Füleky Gy. (Szent István University)*

**Text:** Sequential anaerobic digestion - aerobic composting processes are crucial for low carbon footprint utilization of sewage sludge. Treatment plants with sludge drying may benefit from such methods, provided that the two degradation processes are harmonized. A laboratory-scale trial was executed focusing on the energy relations of the two processes. Data was analyzed with an adjusted composting model of Haug (1993). The outcome implies that drying depends primarily on the initial total solids (TS) content of the compostable sludge and only to a smaller degree on the anaerobic conversion. Considering a 25% anaerobic degradation and scenarios of 5 and 20 °C external temperatures, the minimum required TS content in the starting substrates was 30 and 25 %TS, respectively. Above these values, anaerobic conversion did not limit the aerobic thermophilic stage. The amendment and volumetric requirements for composting were also quantified. The described methodology supports economic designing of biological sewage sludge treatment.

## 2.3. Advanced Waste Process Controlling (Convenors: Prof. Dr. János Tamás, Dr. Mézes Lili)

### *The artefacts map for waste treatment plants - working optimization for laboratories with fermentation units*

*Weitze L. (Bauhaus-Universität Weimar)*

**Text:** The optimization of workflows ensures efficiency of processes. Especially in waste treatment for the warranty of same boundary conditions coordinated work processes are required. This includes the use of measurement technology, the use of evaluation methods and the exchange of knowledge between stakeholders. The artifacts map documented object-specific information of individual objects, connecting foot-path and interaction patterns on the job. Therefore, different test people and their handling with artifacts should be observed in their everyday work. The map shows the optimization potential in terms of location and interaction of the artifacts in the case study of a laboratory fermentation unit. For this purpose photos of objects and a glossary is required. Moreover, the interaction is documented by a participant observation. This approach provides the basis for an advanced waste process control in terms of the integration of empirical knowledge. They can be transferred to other processes which includes artifacts and their interaction with stakeholder. The artifact map is a contribution to knowledge management in the field of resources management.

### *Surface temperature analyses of sewage sludge based open air composting*

*Hunyadi G., Juhász Cs., János T. (University of Debrecen)*

**Text:** The economical growth of the EU is followed by the growth of the amount of wastes which indicates needless cost, energy consumption, environmental damages, health problems and decreases life quality. The main goal of the EU is to transform the community to a “recycling society” through the decrease of these negative effects. One of the first steps is the utilization of produced sewage sludge. The sewage sludge is a very good raw material of composting because its advantageous characteristics do not change during the degradation process. To increase the effectiveness of composting sewage sludge has to be mixed with bulking agents – such as wood clipping, straw, etc. Commonly, the used method to follow and control the degradation process is the temperature measurement during retention time. In most cases only the inner temperature is examined and the surface temperature is not taken into consideration. During our research we examined sewage based compost prisms. Two prisms were examined where wood clipping or straw was used as bulking agent. To determine the surface temperature PYROLATER 12 thermocamera was used. Samples were collected from points where the temperature was higher and where the temperature characterized the surface averagely. The samples were taken in the fourth week of the degradation when the temperature is stable. The aim of this paper is to determine the reasons of the different surface temperature and to analyse the differences of surface temperature and temperature distribution of compost prisms that were set with various raw materials.

### *Optimisation of the starting up of swine manure methanisation at low temperature*

*Dabert P., Morizur J., Jaziri K., Lendormi T., Buffet J., Le Roux S., Barrington S., Beline F. (IRSTEA)*

**Text:** All over the world there is a need for simple, robust and cheap methanisation processes to produce energy from animal waste. One solution is psychrophilic methanisation but it is limited by the long time required for microbial community adaptation at low temperature, which may last up to one year. We tested three different strategies to optimise the start-up of such processes on swine manure: (i) Impact of temperature and inoculation. 12 outdoor storage tanks of 120 L were started without or with inoculation of either a mesophilic swine manure digestate or stored swine manure. Fresh manure was added weekly to simulate the filling of a real storage tank from May to November 2013. Methane production was strongly linked to ambient temperature

fluctuations. (ii) Selection of an inoculum. Five different manures (fresh or stored swine manures, fresh cow manure, mesophilic swine manure digestate) were tested separately as inoculum for methanisation of swine manure at 13°C in 2L bottles for 8 months. Methane production ranged from 0 to 42L CH<sub>4</sub>/kg VS substrate/day depending on the inoculum. (iii) Understanding microbial community changes. The digestate from the best acclimated bottle from (ii) was used for BMP tests on fresh swine manure incubated at 4 different temperatures: 35, 25, 15 and 5°C for 8 months. This acclimated inoculum showed faster and higher biogas production at 15°C and 25°C than a mesophilic standard inoculum. Dynamics of the archaea community, determined by molecular fingerprints of both ribosomal RNA and DNA, showed that a group of archaea kept its activity with decreasing temperature.

### ***Biogas controlling system testing with poultry feather recycling***

*Mézes L., János T. (University of Debrecen)*

**Text:** Feather is produced in large amounts as a waste in poultry slaughterhouses. Only 60-70% of the poultry slaughterhouse products are edible for human being. The high protein content of poultry feather - dried feather contains 91% proteins (Salminen and Rintala, 2002) - makes it an excellent raw material for biogas production. The keratin-content of feather can be difficultly digested, so physical, chemical and/or biological pre-treatment are needed in practice, which have to be set according to the utilization method. Feather was enzymatic degraded, and then digested in anaerobic bioreactors in different ratio (0.5, 7.5 and 10.0%). Cattle slurry, corn silage and mesophilic digestate was the control without feather. The bioreactor system (4 digesters with 6 litre volumes) was controlled by an ACE SCADA software which granted pre-programmed measurement (pH, temperature, CH<sub>4</sub>, CO<sub>2</sub>, etc.). The produced biogas flows were filtered. Following this the produced biogas was switched (doubled valve-system). The content of the gas mixture was monitored continuously with custom created and periodically with MX42A gas-analyser (H<sub>2</sub>S, NH<sub>3</sub>). Our main objectives were testing the new biogas controlling system, to determine the methane potential of feather waste and the most effective treatment ratios. In case of reproduction test variance analysis with Tukey's test was applied to examine differences between the control and different treatments. The effect of treatments was expressed in the percentage of the controls. Feather waste - this difficultly disintegrating material produced in large amount - recycling with anaerobic digestion provides an environmentally friendly way of utilization.

### ***Preliminary evaluation of nutrient indices to estimate compost maturity***

*Ortega R., Martinez M.M. (Universidad Tecnica Federico Santa Maria)*

**Text:** One of the key compost maturity indicators is the C/N ratio. However, other ratios could be also used to estimate compost maturity and discriminate among compost types. Several nutritional indices are available within the plant nutrition literature. The most well-known is the Diagnosis and Recommendation Integrated System (DRIS) developed by Beaufils (1973). The DRIS involves the analysis of the results of plant analysis of a large number of samples of a specific crop. Samples coming from high yielding populations are considered as standards over which ratios of nutrient concentrations are developed and their coefficients of variation (CV) recorded. For a given sample, nutrient ratios are calculated and combined with those of the standard to determine DRIS Indices. The sum of all the nutrient indices, in absolute value, corresponds to the nutritional balance index (NBI). The larger the NBI the greater the imbalance. To evaluate the DRIS approach in compost, known mature compost samples (n=25) were used as standard. Samples were analyzed for total C, N, P, S, K, Ca, and, Mg, using standard procedures, and their ratios calculated along with the coefficient of variation for each ratio. Then, a set of 21 compost samples of different degree of maturity (4, 12, 19, 31, 41, 50 and 60 days of composting) were used to test the ability of the DRIS method. Nutrient ratios and DRIS indices were calculated for each sample. The DRIS-C/DRIS-N ratio was also estimated. Analysis of variance and regression were performed to evaluate the effects of compost maturity on each nutrient index as well as on NBI. Results indicated that DRIS indices for all nutrients, except N and P, significantly differed among compost ages; however, only DRIS C and N indices significantly decreased with maturity time, while DRIS K increased. On the other hand, NBI also tended to decrease with maturity and significantly differed among compost ages. The DRIS C index positively correlated with C/N and DRIS-C/DRIS-N ratios, DRIS N, DRIS P, and negatively with DRIS K. The DRIS indices as well as DRIS-C/DRIS-N ratio showed more sensitivity than C/N



ratio as they showed a larger coefficient of variation. There is a good potential for nutritional indices such as DRIS to be used to better estimate compost maturity, however, more work has to be done in terms of establishing maturity standards as well as DRIS indices critical levels.

## 2.4. Energy from biomass (Convenor: Prof. Dr. Marco de Bertoldi)

### 4- bio system (bioethanol-methane-compost-algae)

Bertoldi M. de, Schnappinger U. (University of Udine)

**Text:** The aim of this project is to perform and validate a new integrated system of 4 biological processes transforming biomass into: bioethanol, methane (thermal and electric energy), compost and algal biomass. The integrated biological system proposed in this process includes four different industrial microbial processes: 1. fermentation (bioethanol production), 2. anaerobic respiration (methane production), 3. aerobic respiration (compost production), 4. photosynthesis (algae production –biodiesel and proteins). A computerized system will connect the 4 industrial system in order to control in real time all the processes, starting material, transformation pathway and by products, giving the quantity and the quality of these parameters. All the parameters that affect the rate of the process and the quality of the end-products will be controlled and optimized by the same computer program.

The starting material for these process can be cellulose, starch and sugar crops or by-products. Cellulose crops are firstly enzymatically hydrolyzed to sugar; starch also by  $\alpha$ -amylase is converted to sugar. The fermentation of glucose to ethanol is operated by selected strains of *Saccharomyces cerevisiae* in a single stage continuously stirred reactor, with simple Monod kinetics, using a plot of steady-state concentration. The main parameters to be controlled are: flow rate, temperature, yeast concentration, nutrient concentration, catabolite concentration, recycling operation, pH, oxygen level, C/N ratio. A computer simulation for the ethanol fermentation with cell recycling is used. Ethanol is then extracted from the medium by fractional distillation at atmospheric pressure. Further purification of ethanol requires a dehydration step to reach 99.99% purity.

The by-products from bioethanol production (exhausted pulps, stillage, lingo-cellulosic residues, etc.) are used to feed Anaerobic Digestion process. This process is carried out in thermophilic conditions, in two separate reactors: in the first hydrolysis and acidification occur with a retention time of about 17 days; in the second the methanogenesis occurs with a retention time of 7 days.

The methane produced undergoes to a treatment of purification to remove  $H_2S$ , water and  $CO_2$ . The purified biogas will feed a turbine system to produce electric and thermal energy. Thermal energy is completely recycled inside the plant to dry the starting material, for fermentation and distillation and for thermophilic anaerobic digestion. Electric energy is recycled inside the plant only 20-25%. The remaining energy is sold. Sludge from anaerobic digestion mixed with other agricultural residues is composted in order to produce an organic fertilizer suppressive to plant pathogens, to be used in the fields where the crops for starting material are produced.

The composting process is carried out inside an industrial building with a continuous air change. The aspirated air from the building is purified by passing through a water basin with algae. The composting process is performed in horizontal reactors (channels) periodically turned with an automatic mechanical system and ventilated from the bottom. Air coming from ventilation is also purified by algae. Parameters like temperature, oxygen level in the mass and moisture are continuously monitored and the values transmitted to a computer which manages the feed back control of the process. After 30 day retention time, the material is automatically removed and proceeded to the final refinery process by screening: the smaller parts are mature compost and the bigger will be recycled in a new composting process.

All exhausted air coming from the three processes (bioethanol, methane and compost) is treated biologically by algae avoiding any  $CO_2$  emission in atmosphere.

This integrated plant producing bioethanol, methane and compost, is completely self-sufficient both for thermal and electric energy, because they are produced in a huge quantity by itself. It produces bioethanol, energy and compost from renewable sources with sustainable process, in accord with Kyoto protocol, reducing the emission of  $CO_2$  (carbon credits). No waste production: 100% of the raw materials and by-products of the processed are recycled and converted in energy. No air, water and soil pollution. The cost of bioethanol production is lower than with other processes owing to the huge quantity of energy recovered. It preserves the biological fertility of the soils where the crops for starting materials are produced; moreover, compost utilization reduces the use of chemical fertilizers and pesticides, both products that are produced with petrol energy.

## ***Biogas from blackwater, lawn cuttings and grease trap residues in a district of Hamburg*** *Hertel S., Deegener S., Körner I. (Hamburg University of Technology, Institute of Wastewater Management and Water Protection, Bioconversion and Emission Control Group)*

**Text:** The research project KREIS focuses on the combination of renewable energy generation, with innovative waste and wastewater management systems. The new system, developed by HAMBURG WASSER is called the “Hamburg Water Cycle®” (HWC) and is actually realized in the Hamburg city quarter “Jenfelder Au”. HWC contains a separate treatment of greywater and blackwater. Vacuum toilets are used to concentrate the blackwater. Biogas will be produced from the blackwater by an anaerobic digestion. The daily amount of blackwater will be about 12 m<sup>3</sup> (DM: 0.6%; oDM: 63% DM; N: 1.5g/l; P: 0.2g/l). To increase the amount of biogas for energetic utilization co-substrates will be added. Grease trap residues from restaurants and canteens (DM: 5%; oDM: 90% DM; N: 0.1% DM; P: 0.1% DM) are available in large amounts in Hamburg. An inventory study showed, lawn cuttings (DM: 37%; oDM: 78% DM; N: 2.5% DM; P: 0.3% DM) are even available in a sufficient quantity within a 5 km radius around the biogas facility. The lawn cuttings must be pre-treated for wet fermentation firstly. Two options were investigated: preparation of a press juice and maceration into a suspension. Experiments were carried out with various fresh lawn cuttings and silage. Lawn cuttings were collected at several times over the year and the change in composition was investigated. To study the effect of pre-treatment and storage of silage on biogas yields, batch-tests were carried out. The effects of different substrate mixtures, consisting on blackwater, grease trap residues and lawn cuttings of the various types, on biogas yield, retention time and process stability have been studied in continuously operated reactors. The experiments have shown that a stable process (biogas production 800 l/kg oDM) is possible with a mixture of blackwater, lawn cuttings and grease trap residues in a volume ratio of 1:1:1.

## ***Catch crops rotation as a strategy to minimize nitrogen leaching and optimize manure anaerobic digestion performance***

*Riau V., Burgos L., Camps F., Anton A., Bonmatí A. (IRTA)*

**Text:** Catch crops are grown as secondary crops after harvest of the main crop with the primary objective of binding nutrients in the soil. Additionally, the grown biomass can potentially be used as a feedstock source for bioenergy production, without interfering with food and fodder crops production. The main objective of this research was to assess the use of catch crops as an alternative to the common co-substrates used in manure-based biogas plants while maximizing biogas production. Six different catch crop species grown in the climatic conditions of the north-east of Catalonia (Spain) were chosen; three ensilage crops: Sorghum bicolor, maize and ryegrass, and three fresh crops: Festuca arundinacea, Panicum virgatum and Phalaris aquatic. Once the species were characterized, biodegradability tests were carried out. It appears that ensiling favors the hydrolysis process increasing the biodegradability by more than 90%. Then, ensilage species showed highest biodegradability than fresh crops. Continuous anaerobic co-digestion assays were carried out with sorghum and ryegrass. In the first period, the reactor operated with only cow manure as substrate. In the second period, the reactor was fed with a mixture of cow manure and ryegrass (10% w/w), and in the third period with a mixture of cow manure and Sorghum (10% w/w). The second period, corresponding to cow manure and ryegrass, showed the best results in terms of organic matter removal (67% and 72% for COD and VS, respectively) and methane production (0.71 m<sup>3</sup> CH<sub>4</sub>•m<sup>-3</sup>•d) which triplicates the methane production obtained in the period fed with cow manure.

## ***Methane potential from paper industry wastes and investigation of the methanogens involved***

*Franke-Whittle I., Silberberger S., Walter A., Insam H. (University of Innsbruck, Institute for Microbiology)*

**Text:** The anaerobic digestion of organic wastes is a sustainable waste management strategy that is gaining significance due to the increasing costs of fossil fuels and the urgent need to mitigate anthropogenic global warming. Wastes generated by the paper industry are potential substrates for anaerobic digestion and bioenergy production. In this study we used an automatic methane potential test system (AMPTS) to investigate the biogas production potential from lignocellulosic and cellulosic paper industry wastes. The materials were

subjected to both mesophilic and thermophilic treatment for 23 days, and various chemical (1% NaOH), mechanical (autoclave and ultrasonic) and enzymatic (ligninase, xylanase, cellulase mixture) pre-treatments of wastes were investigated. The methanogenic communities were investigated using DGGE and the ANAERO-CHIP microarray.

Highest methane levels were produced under thermophilic conditions. Results indicated that a combination of enzymatic with ultrasonic treatment of the cellulosic pulp and lignocellulosic sediment wastes resulted in the highest methane production at mesophilic temperatures (407.5 and 221.7 ml CH<sub>4</sub> g<sup>-1</sup> VS, respectively). DGGE revealed that the temperature used in anaerobic digestion exerted the greatest influence on methanogenic community composition, and that the methanogenic communities present after anaerobic digestion did not vary significantly, despite different pre-treatments being applied. Microarray analysis also revealed similar communities in the samples, which were dominated by *Methanoculleus* and *Methanosarcina* but also included *Methanobrevibacter*, *Methanospaera* and an uncultured methanogen. Results indicate some potential for use of these paper industry wastes in biogas production.

### ***Pilot-Scale anaerobic co-digestion of sewage sludge and olive mill wastewater for increased biogas production***

*Maragkaki A., Fountoulakis M., Lasaridi K., Manios T. (Laboratory of Solid Waste & Wastewater Management, Department of Agricultural Technology, Technological Educational Institute of Crete)*

**Text:** Olive mill wastewater (OMW) is a highly polluting wastewater, caused by a high organic load and phenol content. These characteristics suggest that it may be suitable for increased biogas production in anaerobic treatment. In an attempt to improve biogas production co-digestion of sewage sludge and OMW was studied. The effect of OMW in biogas production was investigated using a 220 L pilot-scale (140L active volume) digester under mesophilic conditions (35°C) with a total feeding volume of 7.5L daily, at a 24 days hydraulic retention time. The initial feed was sewage sludge and the bioreactor was operated using this feed for 55 days. OMW was then added to the feed so that the reactor was fed continuously with 95% sewage sludge and 5% OMW. The reactor treating the sewage sludge produced 14.72 ± 6.85 L/d biogas before the addition of OMW and 46.92 ± 15.06 L/d biogas after the addition of OMW (375 ml daily, 5% v/v in the feed). This work suggests that methane can be produced very efficiently by co-digesting sewage sludge and OMW. **ACKNOWLEDGEMENTS** This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program “Education and Lifelong Learning” of the National Strategic Reference Framework (NSRF) - Research Funding Program: ARCHIMEDES III. Investing in knowledge society through the European Social Fund (Acronym: EXISTING).

### ***Conceptual design and implementation of an integrated system for organic solid waste treatment and by-products recovery – pMethan***

*Borges A. C., Assis Temponi Cabral Dias A. de, Ferreira O. B., Luis Felipe de Dornfeld Braga Colturato, Carlos Augusto de Lemos Chernicharo (Federal University of Minas Gerais (UFMG))*

**Text:** This paper addresses the conceptual design and implementation of a decentralized system for the proper management of organic solid waste from small generators, reducing the dependence on fossil fuels and the emission of GHG. The system, named pMethan, consists of a double-stage anaerobic system (a 20-m<sup>3</sup> CSTR followed by a 0.9-m<sup>3</sup> UASB reactor), a heat and power cogeneration unit (engine adapted to run on biogas), a solid-liquid separation device (adapted draining bags) and a thermal dryer that takes up the heat from the exhaustion gases of the cogeneration engine. Altogether, these units allow the generation of three valuable byproducts - biogas, bio-solids and reuse water – and zero waste, since all these products are used in benefit of the proper system. The pMethan is located at the Federal University of Minas Gerais, Brazil, and is now treating the whole amount (around 500 kg.d<sup>-1</sup>) of food waste generated at the university restaurant. After sorting, crushing and dilution, the food waste is initially pumped to the first- and then to the second-stage anaerobic reactor. The effluent from the second-stage reactor is directed to the solid-liquid separation unit; the drained liquid is used for irrigation and the solid portion to feed the thermal dryer. After this step,

bio-solids are produced and are also used in the green areas around the plant. The plant is now in its initial stage of operation, but the results show to be very promising. The project is fully integrated and takes up the concepts of "waste-to-energy" and "zero waste".

## 2.5. Emissions and immissions of biological waste treatment (Convenor: Thomas Terpetschnig, Yael Laor)

### *The challenge of sampling and assessing odor emission from open-air composting windrows*

*Laor Y. (Agricultural Research Organization, Institute of Soil, Water and Environmental Sciences, Newe Ya'ar Research Center)*

**Text:** Odor has long been recognized as a critical issue for open-air windrow composting. Environmental regulations worldwide require the assessment of odor impact by means of dispersion models based on odor flux measurements; yet, collecting air emissions from compost piles, as well as from other area sources, is far from being standardized. Passive area sources with a liquid-gas or solid-gas interface present particular difficulties in sampling because - unlike active sources - there is usually no well-defined airflow rate associated with them. These emissions are usually governed by evaporation and diffusion, whereby a concentration gradient provides the driving force for the transfer of odorants from solid or liquid surfaces to the air. Compared to classical *passive* or *active* emission sources, open-air composting windrows are highly complex: Active emissions occur in the initial stages of the composting process, during pile turnings and under thermophilic conditions due to natural convective buoyant airflow, whereas passive emissions occur in the pile under stable mesophilic conditions. The sensitivity of the composting process to operational variables creates additional challenge and may require multiple odor measurements. Presently, there is a need to develop a full-cycle sampling strategy for flux measurements of odor emitted from open-air composting windrows. To well represent a full composting cycle, the completed strategy should address sampling devices that are most appropriate, sampling locations (top pile/sides), density and frequency.

### *Comparison of the odour immissions from GORE® Cover systems and tunnel composting systems*

*Wittemeier T. (Barth & Bitter GmbH)*

**Text:** In a comparative study, the odour immissions from three types of GORE® Cover systems were compared to those of a typical tunnel composting system with enclosed curing. The emissions were estimated based on own measurements as well as data from literature. Odour immissions were then calculated making use of the US regulatory dispersion model AERMOD. Whilst the immissions of all GORE® Cover systems are all at a similar level, the performance of the tunnel composting system is heavily dependent on biofilter performance. Assuming an average odour concentration of 300 OU/m<sup>3</sup>, for the biofilters, the odour immissions from the tunnel composting system are comparable to those of the GORE® Cover systems. Consequently, higher biofilter emissions will leave the tunnel composting systems behind the GORE® Cover systems. On the other hand, a study conducted by the State Environment Authority North Rhine-Westphalia (Both & Schilling, 1997) showed that odours from fully functional biofilters, as required by odour regulation in Germany, are usually not perceived at a distance of more than 100 m. As can be shown by a dispersion calculation assuming zero emissions from the biofilters, in this case the odour immissions of a tunnel composting system are lower than those of the GORE® Cover systems. However, this assumption is only valid if a proper function of the biofilter is guaranteed, especially concerning the perception of odours from the original odour source, as opposed to typical biofilter odours.

### *Comparison of the odour emissions and immissions from GORE® Cover systems and tunnel composting systems subject to the Federal Republic of Germany regulation*

*Barth S. (Barth & Bitter Gutachter im Arbeits- und Umweltschutz GmbH . Wunstorf . Federal Republic of Germany)*

**Text:** Own measurements of odour according to the GORE® Cover system and other conventional composting systems as well as data from literature have shown, that, as a function of technical configuration of the conventional composting system, the GORE® Cover system is able to give comparable or slightly better results related to the odour immissions in the environment of the plant. In this context it should be described what the relevant differences in both composting systems are. Two model installation sare compared: one model installation is a typical tunnel composting system with a relatively marginal complexity. The other

model installation is the GORE® Cover system. Emission scenarios are defined which lead to input parameters for the odour calculations making use of the German dispersion model AUSTAL2000, a particle dispersion model. The results are evaluated with the German TA Luft (Technical Instructions on Air Quality Control) and Geruchsimmissions-Richtlinie (Guideline on odour in ambient air). Assuming the emission scenarios defined above, it can be shown that for equal input material, the GORE® Cover system is in advantage to the tunnel composting system. In a second step further emission predictions and dispersion calculations will be done. The results show that it is possible to improve the tunnel composting system with further technical input to generate comparable results. It will be the decision of the operating company to choose the right system for themselves.

### ***Defects and efforts approach in the use of biofilter for waste gas purification***

*Huebner R. (Braunschweiger Umwelt-Biotechnologie GmbH (BUB))*

**Text:** According to the IED and the so-called Brefs the exhaust of reactors and aerated rotting windrows from composting plants must be sent to an exhaust air treatment. A Biofilter is the most used method for the waste gas purification. Biofilters are reactors which are filled with a support media, for example an organic material like wood bark or chopped wood. The air contents are metabolized by microorganisms. To ensure that on the pure-gas side the required 500 OU/m<sup>3</sup> are abided, a lot defaults for the planning, dimensioning and the operation are needed. Practice examples show the effects of planning deficiencies and of the defects during the operation of Biofilters. The purification capacity of Biofilters can be reduced clearly by wrong dimensioning, absence of a humidifier and structural faults during the construction time. Also the inhomogen air flow, the compression of the surfaces, the differential subsidence of the biofilter-media and also wall effects can be the reasons for the emission of raw air. Thereby it can also enter a clearly higher odour-emission on the pure-gas side, not only the Biofilter-specific odour with 300-500 OU/m<sup>3</sup>. In comparison with other cleaning methods are the operating and monitoring expenses of the Biofilters relatively small, but not too negligible. To ensure the process stability and the perfect treatment performance; it required daily visual and sensory checks, regular cleanings of the humidifier and also a refilling or replacing of the Biofilter media.

### ***Greenhouse gases from composting and anaerobic digestion of biowaste in Germany***

*Cuhls C. (gewitra GmbH)*

**Text:** Greenhouse gas (GHG) emissions from 12 to 120 kgCO<sub>2</sub>äq/Mg from composting and anaerobic digestion of biowaste are important for environmental impacts and results in Life Cycle Assessment (LCA). Poor operation can cause even higher emissions up to 400 kgCO<sub>2</sub>äq/Mg. The amount of CH<sub>4</sub> and primary N<sub>2</sub>O differ in a range of factor 10 between different plants and is a result of variation in substrate (feedstock) and basic process parameters like: porosity, density, temperature, moisture, C:N ratio, O<sub>2</sub> and pH-value. Emission control and GHG mitigation must be preventive procedures and process integrated. Biofilters as end-of-pipe technology are not able to reduce CH<sub>4</sub> and N<sub>2</sub>O. Acid scrubbers are effective against NH<sub>3</sub> emissions. Nitrification of NH<sub>4</sub><sup>+</sup> in biofilters generates and releases secondary N<sub>2</sub>O. For preventive it is useful to learn not only from measuring temperature in composting windrows but also measuring pore gases O<sub>2</sub>, CO<sub>2</sub> and CH<sub>4</sub> in order to join in the process and act the right conditions for low emissions.

### 3.1./A. Compost and digestate in agricultural practice (Convenor: Dr. Péter Simándi)

#### ***Bioremediation of soils contaminated with Bonny light crude oil using Horse manure***

*Nwankwo C., Stentiford E.I. (University of Leeds)*

**Text:** Horse manure has appreciable nitrogen content. This made it attractive to be used as organic amendment for tomatoes (*Solanum lycopersicum*) grown in soils contaminated initially with Bonny light crude oil at 5, 7.5 and 10% (w/w). Tomato seeds grown in nursery trays were supplemented with horse manure at the rate of 25 and 50% (w/w) thus reducing the initial oil concentration to 3.75, 5.6 and 7.5% at soil/compost ratio of 3:1 and 2.5, 3.75 and 5% oil level at soil/compost mix ratio of 1:1 respectively. There was variation in the physico-chemical characteristics (pH and electrical conductivity) of the different mixtures over 35 day's experimental period. The results at initial 5% oil level, show that the percentage germination after 14 days of planting was 50 and 75% at 2.5 and 3.75% diluted oil content respectively. At initial 7.5% oil level, the percentage germination was 69 and 63% at 3.75 and 5.6% diluted oil content respectively. However, growth was highly compromised at 10% initial oil level. The study shows that applying horse manure to the contaminated soil improved yield. Keywords: Contaminated soil, Bonny Light Nigerian crude oil, tomatoes, horse manure, biomass yield, oil spillage.

#### ***Effect of sewage sludge compost application on the potential toxic elements of soil and plant in 2009-2012***

*Tomócsik A., Makádi M., Orosz V., Mészáros J., Füleky Gy. (University of Debrecen CAS Research Institute of Nyíregyháza)*

**Text:** In the spring of 2003 we established a small plot experiment with sewage sludge compost that contains 40% sewage sludge, 25% straw, 30% rhyolite and 5% bentonite. In 2006, 2009 and 2012 the experiment was re-treated. We ploughed into the soil 0, 9, 18 and 27 t ha<sup>-1</sup> sewage sludge compost in five repetitions. We used spring crops and autumn cereals as corn, pea and triticale in crop rotation. Now we present some potential toxic elements (Co, Cu, Ni and Pb) content of soil samples collected from the 0-30 cm soil layer after harvesting, in 2009-2012. We have not found any increase of these of these elements' concentration in plants - even though pea accumulated metals in its root – and the values were in the concentration range of crops growing on unpolluted sites. When we treated soil with this sewage sludge compost, we can found any or a very little increase of toxic elements content, and these results of metal content stayed under the threshold limit (50/2001 (IV.3.) Government Statue). We concluded that any significant effect of sewage sludge compost treatments was not found on Co, Cu, Ni and Pb content of the soil. For the future, we would like to maintain this unique long-term experiment and prove that sewage sludge compost is a relevant nutrient and organic matter source applying it similar to the farmyard manure in every third year.

#### ***Digestates origin and post-treatment influence their biological stability, potential nitrogen availability for plants and reactive nitrogen gas emissions***

*Askri A., Laville P., Guiziou F., Beline F., Hout S. (INRA-EGC Grignon, France)*

**Text:** The objective was to evaluate how digested wastes and post-digestion process determine the interest of digestates as organic amendments, source of nitrogen for plants and their potential environmental impacts through NH<sub>3</sub> and N<sub>2</sub>O emissions. Digestates of different origins were sampled at various process steps: raw effluent, solid and liquid phases from phase separation, composted or dried solid phases and concentrates from membrane operation. All experiments were done in laboratory controlled conditions: potential nitrogen availability and organic matter stability during incubation of soil-digestate mixtures, NH<sub>3</sub> emission using a modified wind-tunnel method and N<sub>2</sub>O emission using soil-digestate incubation during three months. Digestates could be used as substitute of mineral fertilizer and organic amendment. All solid digestates were highly stabilized with 56 to 76% of stable organic carbon and to 83% after additional composting thus interesting as soil organic amendment. The nitrogen availability for plants was mainly related to initial mineral nitrogen present in the digestates with the largest concentration in the untreated digestates and the liquid phases. The stabilization of organic matter during anaerobic digestion led to a slow mineralization of organic



nitrogen. The NH<sub>3</sub> volatilization influenced the nitrogen availability for plants, it ranged from less than 5% to more than 80% of total ammonium, depending on ammonium concentration and other characteristics as pH and dry matter. The lowest emissions were observed with the solid phases. N<sub>2</sub>O emissions accounted for 0.14% to 2.7% of total nitrogen input. Phase separation reduced N<sub>2</sub>O emissions and the potential environmental impacts after digestates application on soils.

### ***Improving barley utilization of n and p nutrients from soil amended with bio-digested cattle manure***

*Hao X., Hill B., Caffyn P., AAFC, Nelson V., ARD, Li X. (Agriculture and Agri-Food Canada)*

**Text:** Anaerobic digestion (AD) of animal manure has become an environmentally attractive technology to meet the world's increasing demand for energy. Anaerobically digested manure (ADM) is a nitrogen-rich material and its application increases crop yields. We investigate barley response to the application of ADM. Two field sites located in Alberta Canada were used, Lethbridge (Southern) and St. Albert (Central). There were five treatments: (1) control: no amendment (CK), (2) fresh manure (M), (3) ADM, (4) liquid removed from ADM to produce separated solids (SS), and (5) SS processed into pellets (PE). All amendments were applied at 100 and 200 kg N ha<sup>-1</sup> yr<sup>-1</sup> for Lethbridge and 135 and 270 kg N ha<sup>-1</sup>yr<sup>-1</sup> for St. Albert. Barley was grown and harvested at the soft dough stage as forage for making silage feed. Barley yield and N and P uptake varied significantly over the years, affected by weather and seeding dates. The yield and N uptakes from ADM liquid were higher than , from SS were similar to and from pellets were lower than the fresh cattle feedlot manure. The responses of barley forage reflected the nutrient levels and availability of the amendment applied. The availability of nutrients was further reduced by pelletization of the separated solids (SS). Thus, mineral fertilizer supplementation is required in order to sustain or increase barley forage yield. Similar yields suggest separated solids have similar agronomic value as fresh manure. Thus, feedlot manure management strategies developed over the years are also applicable to managing digestate separated solids.

### ***Quality of liquid digestate as fertilizer – challenges for analytical procedures and regulations***

*Sørheim R., Harladsen K. T., Govasmark E. (Bioforsk)*

**Text:** During anaerobic digestion (AD), methane and CO<sub>2</sub> are released during decomposition of organic matter. Consequently, the concentration of heavy metals and other possible harmful substances will increase on dry matter basis (DM). The concentrations of plant nutrients in the digestate will also increase. The quality of the feedstock is therefore important. Traditionally quality of organic waste products intended for soil amendment are classified according to their heavy metal concentrations on DM basis. However, anaerobic digestates from digestion of source separated organic household waste or food industry by-products, represent materials with very low content of contaminants and heavy metals. Liquid anaerobic digestate from such materials are well-documented nitrogen fertilizers, and supply crops with sufficient amounts of other plant nutrients. When AD gives high methane yield, the remaining organic matter in the digestate will be low. Consequently, such digestates will be of poorer quality due to higher contaminant : DM ratio. The lower DM content (typically 1-2 % (w/w)) combined with difficulties in obtaining a representative cause the DM measurements to be less accurate. This uncertainty in DM content is likely to influence the classification of digestate. Furthermore, a high proportion of dissolved gases and NH<sub>4</sub>-N are found in digestates. These compounds evaporates during DM determination. This presentation shows a comparison of heavy metals loads by using compost and anaerobic digestate of source separated organic household waste. The study showed that by supplying the same amount of nitrogen per hectare, far less heavy metals is supplied by digestate than by compost.

### 3.1/B. session: Biochar in agricultural practice (Convenor: Imre Czinkota)

#### ***Biochar and Compost usage in Farmland for Carbon Sequestration with Mitigating GHG Emission***

*Yoshizawa S., Tanaka S. (Meisei University)*

**Text:** By using biochar carbonized with biomass materials such as waste wood, bamboo and agricultural materials in farmland, carbon sequestration in the land soil for long period is expected. The analytical method of estimation of undegradable carbon (UDC) amount as follows: The total carbon amount (TOC) and the inorganic carbon (IOC) amount derived from carbonate in the soil of the farmland were measured with the solid sample combustion method. The organic carbon amount (TOC) was measured with the Tyulin method (the titration method). The UDC amount was estimated by deducting the TIC amount and the TOC amount from the T-C amount. The T-C, TOC and UDC amounts in the soil used with the biochar and the compost remain larger than those in the soil with the compost. Green house gases (GHGs) from the soil in the farmland were collected with a closed chamber method and analyzed with gas chromatography. Just after using compost in the farmland, CO<sub>2</sub> and N<sub>2</sub>O emission were observed in a short time. CH<sub>4</sub> emission amount from the soil with biochar-compost was smaller than that from the soil with compost. It was concluded that the addition of the biochar is effective in making the soil aerobic state.

#### ***Examination of zinc adsorption capacity of soils treated with different pyrolysis products***

*Rétháti G., Vejzer A., Gál A., Simon B., Füleky Gy. (Szent István Egyetem, Inst. of Environmental Sci.)*

**Text:** During pyrolysis the high organic matter content materials (biomass originated organic matter) are heated in oxygen free (or limited amount of oxygen) environment. As a result, the solid phase that remains after eliminating the gases and liquid phase, is more stable compared to the original product, it cannot be mineralized easily and its utilization is more beneficial in terms of climatic aspects. Furthermore, it can improve the soil structure, it can retain soil moisture and cations in the topsoil for long periods of time that are very important for plants. In our experiment, the effects of biochar and bone char were examined on soils by zinc adsorption experiments. Based on our experiments, we concluded that the pyrolysis products can have significant Zn adsorption capacity compared to the soil. Bone ash can adsorb more Zn than the charcoal product. The Zn adsorption capacity of soils treated by pyrolysis products can be described by Langmuir adsorption isotherms. However, based on the amount of pyrolysis product, one or two term Langmuir isotherm fits well on the experiment data, which depends on the time that the pyrolysis product spent in the soil.

#### ***Influence of biochar and digestate on pesticide decontamination***

*Mukherjee S., Tappe W., Weihermüller L., Vereecken H., Burauel P. (Helmholtz Association Agrosphere Institute)*

**Text:** Influence of biochar and digestate on pesticide decontamination S. Mukherjee\*, W. Tappe, L. Weihermüller, H. Vereecken, and P. Burauel Agrosphere Institute (IBG-3) Forschungszentrum Jülich GmbH, Jülich, Germany. \*E-mail : s.mukherjee@fz-juelich.de Abstract: To overcome the problem of on farm point pollution originated from cleaning pesticide spraying equipment, easy and cheap on farm biopurification systems are under development. To optimize such systems the combination of soil amended with biochar and/or digestate will be tested. Therefore, a sophisticated screening procedure based on respiration, degradation, sorption/desorption, and leaching studies will be performed to identify the most appropriate mixture with respect to different pesticide classes (herbicides, fungicides, and mixtures). In this presentation, we will mainly focus on the first screening step performed (respiration), which will already provide information about the microbial activity within the different soil/amendment mixtures and degradation of the pesticides studied so far (Bentazone and Pyrimethanil) . Key words: Char, Digestate, Pesticides, Sorption-desorption, Retardation, Degradation and Biofilter.

## ***Elution experiment on biochar-soil and biochar-compost systems to investigate the leaching dynamics of nutrients and possible toxic components***

*Üveges Zs. (Wessling Hungary Kft.)*

**Text:** Nowadays there is no doubt about the negative impact of the fertilizers and chemicals used in agriculture, and it is more and more urgent to increase sustainability by reducing the use of these agrochemicals. It can happen by recycling, reusing organic waste, food industrial by-products and farm organic residues as compost and biochar products. After transformation (pyrolysis and composting) of waste materials we can apply these compost and biochar products as fertilizers or soil improvers. However before agricultural applying we have to make sure of the environmental safety of these products. To investigate that I got biochar samples from Terra Humana Kft. and Pyreg GmbH, and compost samples from Profikomp Kft. to do the right analytical measurements to know their content of nutrients and toxic components (heavy metals, PAHs and PCBs). In this way a huge analytical database was set up but it is important to know in what extent nutrients and toxic components can be mobilized in the soil. It is also has a significance if the additives can change soil properties or leaching properties. To studying these leaching tests were carried out. In the experiment perform 4 kind of soils with different origin, 3 kind of elution solvents at different pHs and 4 kind of amendments. In the performance I would like to present the elution test, the results and the conclusions.

## ***Analysis of organic matter and heavy metal extraction kinetics of different pyrolyzed waste fractions***

*Czinkota I., Keresztes, Simándi, Rácz, Rétháti, Gulyás, Tolner (Department of Soil Science and Agricultural Chemistry, Institute of Environmental Sciences, SZIE, Gödöllő)*

**Text:** The solid pirolysis products contains almost all mineral components of original waste fractions, but a part of organic components are removed by liquid or gaseous fraction, during the thermodegradation. Heavy metal and organic contents of waste fractions or solid pirolysis product are leached in the environment. To modeling the dissolving process, we investigated the samples by Hot Water Percolation (HWP) method. Five times 100 cm<sup>3</sup> extract samples were collected from six waste fractions, in original and 500 and 350 °C pirolyzed forms. We measured the heavy metal concentration of all samples by ICP and UV-VIS spectra by spectrofotometer.

Analyzing the extraction of heavy metal, and humic like organic matter, the concentration results we calculated first order kinetic equation. Analizing the spectra of extracted fraction, the leaching effect higher at shorter wavelength, it means the smaller organic molecules can dissolved easier than greater, longer wavelength absorbing, organic compounds.

## 3.2. Fate of organic matter (OM) in the composts and digestates and in the treated soils (Convenors: Dr. Marianna Makádi)

### *A new organic matter fractionation methodology applied on a large panel of organic wastes: accessibility characterization for bioaccessibility prediction and process modelling improvement*

*Jimenez J., Aemig Q., Feurgard I., Houot S., Steyer J-P., Patureau D. (INRA Narbonne France)*

**Text:** The huge amount of organic wastes can be treated through biological processes such as anaerobic digestion or composting for their energetic and agricultural valorization. In order to predict the fate of the organic matter in these processes, knowledge on biodegradability and bioaccessibility is crucial. However, in the literature there is a lack of protocol to assess organic matter bioaccessibility. Recently, a methodology based on chemical sequential extractions combined with fluorescence spectroscopy has been developed for sewage sludge. A successful correlation with bioaccessibility was shown (Jimenez et al., 2014). However, this technique was based on alkaline extractions which target proteins and humic acids and was not sufficient for the carbohydrates or lignocellulosic substrates characterization. These wastes were traditionally characterized by the Van Soest protocol based on acid extractions targeting fibers. In this paper, a new protocol is proposed, based on the combination of the two ones previously mentioned. It was tested and validated on 3 organic wastes of different nature (digested sludge, green waste and digested sludge mixture and this mixture after composting). Results showed that the organic matter extraction yield was about 92% for all the wastes. The fractions before and after composting reflects the usual transformations of organic matter during the process. Moreover, the less accessible fraction is the most complex one (showed by fluorescence) underlying the relevance of the methodology. Then, 10 organic wastes of different biochemical composition have been fractionated to show its applicability to a large panel of wastes and build a bioaccessibility prediction model. Jimenez, J., (2014) Prediction of anaerobic biodegradability and bioaccessibility of municipal sludge by coupling sequential extractions with fluorescence spectroscopy: towards ADM1 implementation. *Water Research* (50) pp359–372.

### *Organic matter transformation drives the fate of organic micropollutants during anaerobic digestion and composting of sludge*

*Aemig Q., Cheron C., Delgenes N., Bergeaud V., Dumény V., Hout S., Patureau D. (INRA LBE)*

**Text:** In France, sewage sludge is very often recycled on cropped soils as fertilizer substitute. To avoid impacts related to organic micropollutant input in soil, it is necessary to ensure their dissipation from the sludge during the stabilization processes like anaerobic digestion and composting. The behaviour of organic micropollutants (13 polycyclic aromatic hydrocarbons, nonylphenols, 2 antibiotics (sulfamethoxazole and ciprofloxacin), 1 hormone ( $\beta$ -estradiol) and 1 anti-inflammatory drug (ibuprofen)) was experimentally studied during lab-scale anaerobic digestion followed by composting. At the same time, the fate of organic matter was studied during the treatments. To go further on the comprehension of organic micropollutants dissipation mechanisms, the organic matter was chemically fractionated according to its accessibility. For each extracted fraction, organic carbon, total proteins, total sugars and chemical oxygen demand are measured to characterize organic matter. 3D fluorimetry is also used to complete the organic matter characterization. After each step of fractionation, organic micropollutants concentration is determined in the residual solid phases in order to get their partition in the compartments and finally to link this partition either to the fraction characteristics or to the dissipation mechanisms. The evolution of organic matter fractions and partition of organic micropollutants allow us to better understand their dissipation pathways and to improve their removal during anaerobic digestion and composting. In addition, experiments with  $^{14}\text{C}$ -labelled molecules (fluoranthene, sulfamethoxazole and nonylphenol) have allowed us to better characterize the dissipation mechanisms during both treatments.

## ***Digestate and Compost qualities focus on nitrogen and organic matter respective brings to crops and to cultivated soils***

*Jean Luc M., Allain M. (Suez Environnement)*

**Text:** Digestate and Compost qualities : focus on nitrogen and organic matter respective brings to crops and to cultivated soils Martel Jean-Luc and Allain Monique, CIRSEE SUEZ ENVIRONNEMENT, Le Pecq, FR Jean-luc.martel@suez-env.com CIRSEE team contributes for Suez Environnement and in collaboration with different public and private partners to the collaborative R&D program DIVA that is partially financed by ANR and that is dedicated to the characterization and agricultural recovery of different digestates produced in France. CIRSEE participates to the task “agronomic characterization” that is led by INRA and realizes different laboratory and “on land” tests in order to precise and compare the agronomic value of different organic products : raw digestates, composted digestates as Methacompost or simple composts produced from domestic or agricultural waste. This paper will compare the agronomic quality of 2 composted digestates, one produced from domestic biowaste and the other produced from municipal solid waste (MSW) to a raw digestate and a compost produced from MSW. The different studied products and their respective origins (different stages of treatment or process applied) will be shortly described. Then, the protocol of characterization (chemical and physical composition, self-heating test, biochemical composition of organic matter, nitrogen bioavailability test through a Chaminade test applied to ray grass growing in pots, Carbon and Nitrogen mineralization in soil) will be given. In the following part, main results of different analyses and tests – including the first results of a 2 years field trial -applied to the 4 products will be given and discussed. In conclusion, the little nitrogen bring of compost and composted digestate and the important effect of anaerobic digestion on organic matter stabilisation will be emphasized. . References [1] OPTIMISATION OF THE AEROBIC MATURATION PROCESS OF THE MSW DIGESTATE ON MONTPELLIER AMETYST PLANT by jl Martel, O Garone, A Sommain and O Greze in ORBIT 2012 [2] CONTRIBUTION TO THE AGRONOMIC CHARACTERIZATION OF THE NEW METHACOMPOST PRODUCED IN 2012 ON AMETYST PLANT by jl Martel& M Allain in RAMIRAN 2013

## ***Increasing the organic matter content of sandy soils using sewage sludge compost***

*Makádi M., Tomócsik A., Aranyos T., Demeter I., Szegi T., Boros N., Fehér B. (Research Institute of Nyíregyháza, CAS, University of Debrecen)*

**Text:** The growing quantity of wastes increases the need for environmentally sound treatment and utilization of these materials. Sewage sludge is a continuously formed organic waste. Its treatment and utilization depend on the quality of the sludge. If it contains high quantity of nutrients and the organic and inorganic toxic materials and elements are present in low quantity, the sewage sludge could be composted and utilized in the agriculture. In our long-term sewage sludge compost experiment 0, 9, 18 and 27 t ha<sup>-1</sup> compost is added to the soil in every third year. Compost is made from sewage sludge, straw, rhyolite and bentonite therefore it is suitable for improving the acidic sandy soil in the Nyírség region of Hungary. After 10 years of sewage sludge compost treatment, the loss on ignition were 1.5-2-times higher in treated samples comparing to the control one. The humus content was 0.875% in the control while 1.075% in the 27 t ha<sup>-1</sup> treatment and we found similar increase in the total carbon content, also. On the other hand, the value of E4/E6 ratio was decreased with the increasing compost doses. Connecting to the organic matter, the rate of soil respiration and the activity of invertase enzyme were also increased in the compost treated soil samples. Our results proved the positive effect of regular application of sewage sludge compost on the organic matter status and therefore, the fertility of acidic sandy soil.

### 3.3./A. The use of alternative organic nutrients in agriculture and horticulture (Convenors: Dr. Louise Fletcher, Prof. Dr. Ed Stentiford)

#### *Effect of Intensity and Time of Aeration on Agrochemical Properties of Extracts from Vermicompost*

*Hanc A., Boucek J., Svehla P., Tlustos P. (Czech University of Life Sciences Prague, Prague, Czech Republic)*

**Text:** Vermicomposting is a completely environmentally friendly technology which converts biowaste to a value-added product. Extracts from vermicompost can be applied to plant surfaces and soils in ways not possible or economically feasible with solid vermicompost. The aim of this work was to determine the influence of aeration intensity and time of extraction on the agrochemical properties of aqueous extracts from two types of vermicomposts. Vermicomposts were made from horse manure (M) and apple pomace (P) waste. There were 2 treatments: stirring (750 rates/min) without aeration (S), and stirring (750 rates/min) with aeration (6 L/min) (A). Samples were taken after 1, 6, 12, 24, and 48 hours of leaching. Aeration significantly increased the levels of the monitored agrochemical parameters found in the extracts. Under the experimental conditions utilized in this study, the highest increase within any parameter was found for chemical oxygen demand (COD) - (between 1 and 6 hours), which reflects the quick release of organic substances into solution. This resulted in a gradual decrease in the level of dissolved oxygen. The electrical conductivity (EC) and content of macro-elements in the extracts increased proportionally with time. The contents decreased in the following order: MA > MS > PA > PS. After 48 hours, the highest release of macro-elements into the extract was found in the case of MA. It contained 53%, 55%, 8%, and 14% of the total contents (measured by the XRF method) of P, K, Ca, and Mg, in vermicompost, respectively.

#### *Effects of different biochars and combined biochar and anaerobic digestate utilization on rye-grass and soil properties in laboratory model experiment*

*Gulyás M., Fuchs M., Holes A., Szegi T., Kocsis I., Füleky Gy. (Department of Soil Science and Agricultural Chemistry, Institute of Environmental Sciences, SZIE, Gödöllő)*

**Text:** Recycling of organic wastes and preparation of added value products such as biochar or anaerobic digestate are challenges for a sustainable agriculture. Utilization of biochars to improve soil fertility and to mitigate global climate change is a popular research area. Residual of anaerobic digestion can be used as soil amendment as well, since it contains high amount of different macro-, and micronutrients mainly in water soluble form. Combination of digestate and biochars can cause various interactions, between digestate-biochar and soil system. Harmonization and adaptation of archive and new data from different climatic regions and soil types are necessary in both topics. In our experiments the compilation of the biochar treatments was depended on volume ratio as the following: (1) control, (2) 1% (10g biochar), (3) 2,5% (25g biochar), (4) 5% (50g biochar) and 10% (100g biochar to soil). During the application of the biochar 150 cm<sup>3</sup> kg<sup>-1</sup> water/digestate (60% of the soil's plasticity) was used. These treatments were carried out in 4 replications, and 2 grams of rye-grass (*Lolium perenne*) were seeded in each pot. The experiment pots were watered to weight and the average plant height was measured after germination. Our results show that neither negative nor positive effect of the combined pyrolysis solid and digestate application can be determined clearly, thus further and long term investigations are needed.

## ***Effect of compost source and soil type on canola yield and nutrient uptake from calcareous and acid soils under greenhouse conditions***

*Hao X., Chunli L., Yang L. (Agriculture and Agri-Food Canada)*

**Text:** Composting is an alternative manure management strategy with lower transportation cost than fresh manure. This study investigates the effect of compost applications on canola yield and nutrient uptake under controlled greenhouse conditions. Composts  $DG_c$  and  $DG_w$  were obtained from a research feedlot produced with manure from cattle on 40% corn DDGS and 60% wheat DDGS diets, respectively. Two other composts, one horticulture grade produced from cattle manure (HORT) and the other from 70% paunch and 30% construction & demolition waste (PAU), were obtained from a commercial cattle feedlot operations. A synthetic fertilizer (FER) and unamend CK were included for comparison. Both composts and synthetic fertilizer were applied at rates of 0, 50, 150 and 450 mg P kg<sup>-1</sup> soil. There were six cycles of seeding and harvesting with each cycle 7 to 8 weeks long. Canola was grown in rotation with pea in both calcareous and acid soils. Canola yield and N and P uptake from compost-amended soils were higher than ( $P < 0.05$ ) or similar to ( $P > 0.05$ ) FER, except for a lower ( $P < 0.05$ ) P uptake from  $DG_c$  and HORT at 150 mg P kg<sup>-1</sup> rate in calcareous soil and from  $DG_w$  at 450 mg P kg<sup>-1</sup> rate in acid soil. Canola yield and N and P uptake from synthetic fertilizer and compost amended treatments were higher ( $P < 0.05$ ) than un-amended CK. Our results suggest that application of compost amendments could enhance canola yield, N and P uptake.

## ***Vegetable crop residues as feedstock for composting and silage: collection efficiency and product quality***

*Vandecasteele B., Viaene J., Agneessens L., Van De Sande T., Dekeyser D., De Neve S. (Institute for Agricultural and Fisheries Research (ILVO))*

**Text:** The crop residues of vegetables are important for nutrient and organic matter cycling. However, these residues often may lead to nitrogen leaching risks. This study investigates the feasibility of removing crop residues, followed by composting or ensiling as a means to reduce N leaching losses. Ensilage conserves the nutrients for reuse on the field after the winter or for other applications (e.g., anaerobic digestion), while composting results in stabilisation of the organic matter before application in the field. Crop residues of cabbage were mechanically harvested with common available equipment at two different moments: the end of summer and the end of fall. The residue collection efficiency was low as the collected material had high soil particle load. For composting, residues of white cabbage or leek were mixed with wood chips and bark, straw and corn stover for a good compost composition. For silage, crop residues of white cabbage, celery, cauliflower or leek were mixed in a 50/50 volume ratio with chopped corn stover. Feedstock materials, composts and silage were analysed for (bio)chemical characterisation. Silage quality was optimal for the mixtures with leek and celery, and less optimal for the other mixtures. This was related to higher NH<sub>4</sub><sup>+</sup>-N concentrations and lower compressibility of the mixtures with cauliflower and white cabbage. Composting was suboptimal due to the high soil particle load of the crop residues and the corn stover. New silage and compost experiments are run in 2014.

## ***Estimation of biologically available heavy metal content of composts by various extraction methods and ICP-OES multielemental detection***

*Heltai Gy., Aleksza L., Horváth M., Kovács K., Takács A. (Institute of Environmental Sciences, Szent István University)*

**Text:** The different fractionation protocols may offer different chemical information on biologically available element content of compost, however, only to the BCR sequential extraction scheme is available a sediment type certificated reference material for validation the fractionation procedure. For soils, composts CRM samples are available only for single step extraction or digestion procedures. In our preliminary studies application of different fractionation methods was widely used for sediment, soil and other solid environmental samples (e.g. red mud). The aim of our recent study is the preparation of compost reference material for total and releasable heavy metal analysis. For this aim a green compost sample was selected and about 50 kg was homogenized. An inter-laboratory comparison will be organized for determination of total soluble and biologically available heavy metal content. In our laboratory for multielemental analysis ICP-OES method will be

applied using different extraction protocols for fractionation. (Lakanen Erviö, BCR, Hungarian Standard: MSZ-21470-50:1998) This research was supported by projects: Hungarian Science Research Fund (OTKA 108558)

### ***Pelletized compost can be a superior alternative to phosphate fertilizer compared to bulk compost***

*Arakawa Y. (NARO Kyushu Okinawa Agricultural Research Center)*

**Text:** Manure is used as fertilizer and for soil amendment if handled appropriately, although it is the leading source of agricultural pollution if mismanaged. Because of the high water content, long-range haulage is uneconomical. Therefore, manure is mostly applied at high dose, close to the source, thereby diminishing its potential in soil amendment. Composting and pelletization facilitate manure exports, including storage, handling, and transport, for off-farm use and field application. We showed that compost pelletization produces increased phosphorus (P)-use efficiency (Arakawa, 2012); however, further investigations are needed. Greenhouse pot experiments were conducted to assess pelletization effect on P-use efficiency by using various compost types—food waste, swine manure, cattle manure compost incorporated with poultry litter biochar, poultry litter, and cattle manure compost incorporated with poultry litter. Both bulk and pellet forms were used as fertilizer, as the sole source of P, in sequential cultivation of komatsuna (*Brassica campestris* L.) and buckwheat (*Fagopyrum esculentum* Moench). Pots with no P fertilizer and pots in which single superphosphate fertilizer was applied were used as negative and positive controls, respectively. In general, the plants took up significantly high amounts of P from the pelletized compost. Overall, the P-use efficiency did not differ significantly among the composts. The overall P recovery rate (difference between P taken up from the fertilized pots and that in the control pots) was 25.6% when using pelletized compost, which was comparable to that in the positive control; however, the rate was 13.4% when using bulk compost.



### 3.3./B. The use of alternative organic nutrients in agriculture and horticulture (Convenors: Dr. Louise Fletcher, Prof. Dr. Ed Stentiford)

#### ***Effect of compost treatments on the growth of the strain field area of apple trees, and on the number of fruits per tree***

*Szabo A., Balla-Kovács A., Kátai J., Vágó I. (University of Debrecen, Institute of Agricultural Chemistry and Soil Science)*

**Text:** The effect of different compost doses on the nutrient contents of the soil (in depth of 0-30) were measured in an apple orchards (organic and integrated). Growth of the strain field area of different apple species (Golden Delicious and Pinova) and the number of fruits per tree were determined (2010-2012). At the start of the experiment the strain field area of the marked control and treated trees did not differ from each other, therefore their strength could be considered statistically uniform. In 2010 no composting effect could be effect observed (the first application was performed after the crop binding). In 2011, there were no apples on the trees. The reason of the crop failure was the early spring frost, which caused damage during the period of flowering. In 2012, a significant increase was observed in the number of apples in parallel with the increase of the compost doses (primarily in the organic). During the three years of the field experiment we concluded that, all the compost doses justifiably increased the strain field area – the complex index of vegetative performance of the trees – in case of both apple varieties in the organic cultivation (where mineral fertilization is excluded). It was demonstrated that the compost doses and the bigger nutrient source together could favourably offset the decreasing effect of spring frost on fruit binding in the integrated culture This research was supported by the European Union and the State of Hungary, co-financed by the European Social Fund in the framework of TÁMOP-4.2.4.A/2-11/1-2012-0001 ‘National Excellence Program’.

#### ***Use of compost from grape pomace as organic amendment for recovering a decayed pear (*Pyrus communis* cv Packam’s Triumph) ORCHARD***

*Poblete H., Martinez M.M, Ortega R. (La Rosa Sofruco, Chile)*

During two growing seasons, an experiment was performed to evaluate the effects of mature compost from grape pomace on the recovery of a pear (*Pyrus communis* L.) orchard. Two treatments (T1: control, T2: Integrated plant nutrition, IPN) were compared. The IPN consisted on the application of 20 ton/ha of compost, together with chemical fertilization of 70 kg N/ha, 20 kg P<sub>2</sub>O<sub>5</sub>/ha and 66 kg K<sub>2</sub>O/ha; the control treatment included only chemical fertilization.

Applied compost had, C/N ratio 11:1, pH 7.82, EC 0.86 dS/m, N-NH<sub>4</sub>/N-NO<sub>3</sub> ratio 0.81, Olsen-P 448 ppm, extractable K 43.20 cmol/Kg, *Salmonella* sp., and *E. coli* < L.D. and a low content of trace elements, with the exemption of Cu. Compost was applied in band, in winter time, while chemical fertilization was applied during the growing season. Evaluations included: total shoot growth, root density, pruning weight, enzymatic activity in soil, nutrient leaf contents, physical and chemical soil properties, Normalized Difference Vegetation Index (NDVI), and SPAD readings. Nutrient indices were calculated by multiplying NDVI by total nutrient content.

Results showed significant differences (p<0.05) between treatments for root density, pruning weight, enzymatic activity in soil, NDVI, SPAD, Na, Zn, Cu leaf contents and nutrient indices for N, K, Ca, Mg, Cu and Zn, soil bulk density, porosity organic matter content, and for Olsen-P, extractable K, Mn, and B in soil, which were larger for IPN.

Integrated plant nutrition seems to be the way to recover decayed orchards through the inclusion of good quality organic matter within the management program.

Key words: grape pomace compost, integrated plant nutrition, pear orchard

#### ***Crop response to alternative organic treatments***

*Mortimer N., Fletcher L., Velis K. (University of Leeds)*

**Text:** The aim of the research is to assess the effects of novel wastes, composts and biochar on commercial arable and horticultural crops, and the impact on soil quality. The research will focus on determining the ben-

efits of replacing inorganic fertilisers with novel wastes and compost (such as chicken manure and olive mill waste (OMW)) along with the carbon sequestering properties of biochar. The field trials in 2013 were carried out on two crops; oilseed rape (OSR) and winter wheat (WW) within a commercially sown field. There were 5 treatments applied to the crops with six replicates of each, each single plot being 24m<sup>2</sup>. Measurements taken included chlorophyll within the leaves on a weekly basis for 5 months, soil properties and at the end of the season a yield (kg/m<sup>2</sup>) from each plot. The quality of the OSR crop was assessed by measuring the glucisinolates present within the seeds. During the field trials of 2013 the differences in the yield and quality of the crops between treatments suggests that the alternative fertilisers to the standard inorganic fertiliser can perform favourably. The yield for best and worst treatments in the OSR had a difference of 0.9 tonnes/ha (between 3.2 and 4.1 tonnes/ha); for WW the difference was 1.3 tonnes/ha (between 11.8 and 13.2 tonnes/ha). The trials are being repeated on the same plots in 2014 following the commercial farm's crop rotation; in 2014 the crops are WW and potatoes. In 2014 horticultural trials with strawberries will be completed in polytunnels.

### ***Sensitivity analysis of a dynamic soil-plant model for simulations of fate of pollutants after repeated applications of amendment on agricultural soils***

*Revallier A., Serre J., Cambier P., Trapp S. (Veolia Environnement Recherche & Innovation)*

**Text:** In 2009, Veolia Environnement Research and Innovation, the Institut National de la Recherche Agronomique and the Technical University of Denmark have started a large research cooperation to develop a mathematical model dedicated to the assessment of the fate of organic substances and metals in agricultural soils, after repeated applications of Residual Organic Products (ROP, e.g : sludge, composts). This dynamic model predicts the concentrations of substances in different compartments of the agricultural ecosystem and fluxes in groundwater over time, as a function of approximately a hundred input (physicochemical properties and concentration of substances, environmental conditions, crop characteristics). A validation by comparison with experimental data was performed and was mostly satisfying (Legind et al. 2012). Then a sensitivity analysis was achieved in 2013, with the implication of Ecomatters, scientific consultant from Netherlands, in order to identify the key parameters and their influence on the results. The model was evaluated using Monte Carlo simulations, and 10 000 iterations were tested. Rank correlation coefficients were calculated from the results to assess the influence of each input. Some inputs are systematically influent while some other inputs are only influent for some substances. For instance, concentrations of pollutants in plants are systematically sensitive to the water content of plants. In some cases outputs are sensitive to the choice of the variables associated to the scenario (e.g : concentrations in ROP). Overall, this analysis confirms the good functioning of the model. Further research is recommended to refine the variation ranges, and to realise an uncertainty analysis.

### 3.4./A. Waste-to-Product (Convenors: Dr. Antoni Sánchez, Teresa Gea)

#### *When product status is not enough – the development of a UK Renewable Fertilizer*

##### **Matrix**

*Tompkins D., McManus W., Chambers B., Taylor M. (WRAP)*

**Text:** The UK standardised its approaches to ‘end of waste’ for compost in 2007, and digestate in 2009. Both are now well-established, covering around 50% of the UK’s 3.5 million tonnes of compost and 20% of the 1.4 million tonnes of digestate that were produced in 2012.

These end of waste approaches require that materials are independently certified to a baseline quality specification (Publically Available Specification (PAS) 100 for compost, PAS 110 for digestate), which includes thresholds on parameters such as potentially toxic elements, physical contaminants and indicator pathogens. However, despite the availability of these specifications – and their endorsement by the UK’s environmental regulators – the UK food chain has expressed a number of reservations around the quality and safety of compost and digestate. In some cases, this has led to compost and digestate use being restricted by farm assurance schemes.

Working with these assurance schemes, as well as food safety authorities and retail representatives, WRAP has supported the development of an evidence-based Renewable Fertiliser Matrix. It incorporates specific harvest and cropping intervals for compost and digestate against a range of standardised cropping categories, which align with categories used by the extremely influential Red Tractor Farm Assurance scheme.

This presentation will outline the wide range of concerns expressed by the UK food chain, the evidence gathered to counter them, and the future of the Renewable Fertiliser Matrix.

#### *Define waste criteria for the production of high quality compost*

*Zorpas A., Lasaridi K., Voukkali I. (Cyprus Open University)*

**Text:** The Waste Framework Directive 2000/98 (WFD) contains specific provisions to define end-of-waste criteria (EWC). The objective of EWC is to remove the administrative loads of waste legislation for safe and high-quality waste materials, thereby facilitating recycling. The objective is achieved by requiring high material quality of recyclables, promoting product standardisation and quality assurance, and improving harmonisation and legal certainty in the recyclable material markets. Composting is one of a number of alternative treatment options for biodegradable wastes (Bernal et al., 2009; Zorpas, 2012). However composts should cease to be waste only if they are placed on the market for a purpose for which adequate rules on the use of compost apply. Establishing EWC for compost offers environmental and economic benefits as this improves harmonisation and legal certainty, promotes the production of compost with high and reliable quality and facilitates its use, by avoiding unnecessary regulatory burden. The first technical working group meeting on EWC criteria for compost and digestate of the European Commission took place at the Joint Research Centre “Institute for Prospective Technological Studies (JRC-IPTS)” on the 2 March 2011 in Seville (ECN, 2011). Based on the JRC report (JRC, 2008; ECN, 2011), in which the methodology for determining EWC for different waste streams (metals, aggregates, compost) was developed, the EU Commission has assigned the JRC to work out a proposal for end-of-waste criteria for compost and digestate too. The paper focuses in the determination of EWC for the production of high quality compost for several applications.

#### *Development of sustainable potting soil based on green compost and other organic recycled materials*

*Hoekstra B. (Vlaco vzw)*

**Text:** Although peat is a major component of potting soil, its use is questioned due to ecological constraints. In addition, there is a need for better valorization of green waste compost in Belgium and an increasing consumer awareness of sustainable garden products. Therefore, experiments were set up to develop a sustainable high-quality all-purpose potting soil for the consumer market. Our aim was to replace the primary resource peat as much as possible without loss of quality of the potting soil. Therefore, we identified, char-

acterized and evaluated (for use in universal potting soil) 20 different organic recycled materials that can be combined with green compost, known as a qualitative sustainable recycled material for potting soil. Selected raw materials were combined in different ratios. Mixtures were characterized and those complying to the Federal Legislation (pH-range from 4.5 to 7.0  $\pm$ 0.3 and EC below 750  $\mu$ S/cm) were selected to undergo chemical characterization, phytotoxicity measurements and a sequence of greenhouse experiments with potted plants. The effect of the mixtures on plant quality was assessed. The end result was a selection of the five most qualitative and sustainable potting soils. In addition, their financial feasibility and introduction on the consumer market was explored. Finally, based on experimental experience, we developed a scheme with minimum physical and chemical requirements for organic recycled materials. This research is funded by MIP Flanders.

### ***Wood ash improves composting processes and end products***

*Fernández-Delgado Juárez M., Prähauser B., Franke-Whittle I., Insam H. (University of Innsbruck, Institute for Microbiology)*

**Text:** The use of biomass as a renewable energy source results in the production of ashes that are often land-filled. This is a waste of nutrients like P, Ca, Mg, K, and a number of micronutrients. It is known that wood ash can be used as fertilizer or lime replacement, as well as an additive in composting. This is owed to its ability to buffer pH and reduce compost malodours. Nevertheless, the Austrian Compost Ordinance allows a maximum admixture of 2% ash. This study investigated the effects of ash amendments of 0, 6% and 12% on the physical/chemical and microbial properties of a compost made from a mixture of communal biowaste and green waste. Various parameters were measured during a 9 week composting process and after a 24-week curing. Chemical and physical analyses showed that the composts with wood ash amendment more rapidly matured than composts without amendment. Community Level Physiological Profiling showed a clustering of maturing phase composts, while composts at the end of the curing phase grouped separately, depending on whether they had been amended with ash or not. Microbiological investigation of composts using the COMPOCHIP microarray and DGGE showed that wood ash affected the microbial diversity more in initial composting stages, while more mature composts exhibited similar microbial communities. Plant growth was best with the 6% ash compost. In conclusion results indicate that ash additions of 6 and 12 percent are positive for the process and end product, thus a revision of the compost ordinance should be considered.

### ***Digestates main characteristics and residual biodegradability: influence of waste origin and management of the digestion plant***

*Trémier A., Buffet J., Daumoin M., Picard S., Saint-Cast P. (Irrstea, UR GERE, Rennes, France)*

**Text:** Digestates have to be properly valorized as soil improvers or organic fertilisers in order to ensure good environmental and economic performance of the whole anaerobic digestion treatment scheme. Nevertheless, determinants of the digestates quality and digestates residual biodegradability have raised little interest even as they determine their conditions of storage, use or post-processing. The aim of the present study was thus to propose determinants of digestates quality and to assess their residual biodegradability and its impact in terms of further storage or post-treatment. Five digestion plants were studied: 2 farm plants, 1 agro-waste centralized plant and 2 plants treating mainly urban biowaste. Digestates were sampled 5 times along the year: raw digestate (exit of the digester or post-digester), solid and liquid digestates (after phase separation). Samples were analyzed for chemical and biochemical parameters (C, N, BMP, OUR, etc.) and statistical analysis was performed to find correlation with waste origins, digestion process management, type of phase separation process, etc. Results showed that raw digestates quality is mainly influenced by the origin of the treated waste and by the way to manage the digestion process (dry or liquid) while solid and liquid digestates quality is largely influenced by the phase separation process performance. Residual biodegradability was generally low and depended from the digestion process efficiency. But it could be sufficient for further aerobic post-treatment. Interesting links between biodegradability and characterization of soluble organic matter biochemical fractions have also been proposed through this study.

### 3.4./B. Waste-to-Product (Convenors: Dr. Antoni Sánchez, Teresa Gea)

#### *GLOCAL – An ecosystem-based business model*

*Gea T., Bautista R., Domen T., Knowles H., Sánchez A., Theeuwes E., Wahl D., Warrington A. (Universitat Autònoma de Barcelona)*

**Text:** A potentially game-changing business model is currently being trialled on the island of Mallorca. Ecover, Forum for the Future, GICOM, Daniel Wahl, the University of the Balearic Islands, the local industry Clusters and several local entrepreneurs are working together to pilot a distributed manufacturing model that: • produces locally but draws on the global R&D knowledge held by Ecover • uses local bio-based resources that would otherwise be considered as waste The GLOCAL project is: • Exploring the potential of using local resources and manufacturing capacity together with Ecover expertise. • Understanding the possible business models for open innovation and distributed manufacture that would ensure local agents and Ecover benefit appropriately. • Understanding the conditions for success for GLOCAL in terms of relationships, resources, formulation and infrastructure required. • Using the learning from the prototype to identify next steps in scaling GLOCAL to use as a model for other regions. As part of the ORBIT 2014 conference we would like to share our experience of understanding the waste streams available through local investigations and satellite mapping, and then transforming these ‘wastes’ into ingredients for Ecover quality products to be made on Mallorca for the Mallorcan market.

#### *Protease production from organic residues by SSF and their potential uses*

*Abraham J., Gea T., Sanchez A. (GICOM-Universitat Autònoma de Barcelona)*

**Text:** An environmental-friendly process is proposed in this work to reduce the negative impact of the increasing agro industrial residues due to the faster growth of the world population. It consists on the valorization of nitrogen-rich local residues, such as soya fiber, hair waste and coffee husk, by solid-state fermentation (SSF) to obtain proteases. SSF experiments were undertaken in 0.5, 4.5, 10 and 55 L reactors throughout 1, 2 and 3 weeks. It was not necessary to sterilize the materials and no inoculation of pure microorganisms was needed for the development of the process. Besides, aeration was provided to ensure the prevalence of aerobic conditions during the assay. Alkaline proteases were produced as a consequence of the degradation of these materials, formerly considered residues. The highest activity of the alkaline proteases in crude extracts was determined at 3, 7 or 14 days of the process according to the nature of the resources assayed. The yields obtained are higher than reported values in literature. Biochemical characterization of the crude extracts was also carried out. The final organic product obtained in the SSF presented a stability degree similar to that of compost, meaning low rate of oxygen consumption. Potential application of the extracted proteases has been successfully studied on dehairing cow hides, representing a significant advantage over the chemical process. Also, a preliminary study on kinetically controlled synthesis of peptides has been performed. In conclusion, the use of SSF with organic residues avoids consuming natural resources to produce enzymes of high value.

#### *Recovery of nutrients from Organic Fraction of Municipal Sólid Waste (OFMSW) in the Ecoparc 2 of Montcada i Reixac, Barcelona: alternatives to the current process*

*Mena M.J., Bonmatí A., Pujolà M., Tarraga J., Comas J. (IRTA)*

**Text:** Recovery of nutrients from the OFMSW is a relevant topic as evidenced by the European initiative ‘End of Waste’. Following this guideline, the Ecoparc 2 of Montcada i Reixac, belonging to the Metropolitan Area of Barcelona, submits the OFMSW to anaerobic digestion and then the digestate is separated mechanically, first by pressing and then by centrifugation. The solid of press (Sp) and the solid of centrifugation (Sc) are composted together (CSp+Sc) and used as organic fertilizer. There are alternatives to the current treatment of the OFMSW as: (1) direct use of Sc as fertilizer, (2) composting of Sc (CSc) and (3) composting of Sp (CSp). This paper focuses on analyzing the recovery of nutrients. During the treatment of the OFMSW an important proportion of nutrients is lost in the impurities that are sent to landfill, another part is lost in the leachate that are sent to the wastewater treatment plant. In the composting of the Sc the carbon losses were very

low compared to the current process, this suggests a high degree of stability of the Sc. The average nutrients recovery in the Sc was 17% higher than the current process. Due to the content of heavy metals in the products studied these are classified in category B of fertilizers according to the Royal Decree 824/2005. The results suggest that the direct use of Sc could decrease time, energy and costs of treatment of the OFMSW compared to the current process.

### ***Design and validation of an Action Plan to produce animal feed vegetable flour from food waste***

*Martin D. San, Zufia J. (AZTI-Tecnalia)*

**Text:** Almost three quarters of vegetable by-products generated from food industry and retail trade end up in dumps. However, they can be valued as raw material for animal feed, if they are managed under appropriate conditions. The Clean-Feed project ([www.cleanfeed.org](http://www.cleanfeed.org)) is funded by European LIFE+ program and Basque Government. The aim of this study is to reduce up to 70% of vegetable wastes generated in the Basque Country. The first stage was to determine the feasibility of using vegetable waste for animal feed. Food retailing, cider, wine, potato, bread, coffee and vegetable transformation sectors produce about 25,000 tons / year. These vegetable by-products were nutritionally and sanitarly appropriated based on analytical results. Once these targets were guaranteed, a drying methodology was developed to adequate them to animal feed market. The technologies tested were Pulse Combustion Drying, Oven and Microwave. Three flour prototypes were obtained and all of them fulfilled all requirements of animal feed market. Then, a theoretical Action Plan was defined in agreement with stakeholders. This plan was validated in a real scale demonstration trial. Finally, technical, economic and environmental feasibility was performed. This study demonstrated that vegetable byproducts can be used for animal feed due to the favorable quantities and characterization results. However, a suitable Action Plan is a key factor to make profitable this option for animal feed companies.

### 3.5. Pathogen (plant and animal) Survival/Sanitary Assurance of Final Compost (Convenor: Dr. Daryl McCartney)

#### *Quality Assurance of compost and digestate products in Flanders, a safeguard for product quality*

*Auweele V.W. (Vlaco)*

**Text:** The biological treatment of biowaste through composting and anaerobic digestion in the Flemish Region, is subject to the Flemish Regulation on Sustainable Materials Management and Waste, setting out the criteria for different waste streams to obtain the status of a product. For organic fertilizers or soil improvers, the waste treatment plants must obtain a quality certificate, based on a system of independent quality assurance and certification. For this purpose, Vlaco (the Flemish Compost and Biogas Quality Association) has set up a Quality Assurance Scheme (QAS) that is composed of 4 essential elements: (a) input materials and acceptance protocol, (b) operational quality (e.g. monitoring of critical process parameters, hygienisation), (c) end product control (limit values for contaminants and agricultural value) and (d) sustainable use of the end products. Moreover, quality assurance forms the basis of solid markets for compost and digestate. Transparency and assessed quality management throughout the entire production chain results in high quality fertilisers/soil improvers that are safe for use. This is also a key element in the End of Waste study carried out by the JRC of the European Commission. As Europe aims at resource efficiency, a high quality recycling economy for organic fertilisers and soil improvers must be supported. The presentation will focus on the beneficial elements of quality assurance in order to meet the criteria for end of waste, for compost, digestate and products derived from digestate post-treatment, and hereby supporting sustainable markets.

#### *Examining the VBNC induction and regrowth in E.coli and Salmonella exposed to a simulated thermophilic condition of a composting pile*

*Isobaev P., McCartney D., Neumann N. (University of Alberta)*

**Text:** The survival and regrowth of pathogenic microorganisms in low numbers during thermophilic composting has been reported. The microbial viable but not culturable (VBNC) state has been viewed as the possible cause. Pathogens in VBNC can overcome heat stresses during composting and revert to normal when optimum conditions are regained. The objectives of this study were to investigate if and how soon the indigenous to compost matrix *E. coli* sp. and *Salmonella* sp. would induce the VBNC state upon exposure to thermophilic conditions; and whether the VBNC state in these organisms could be reverted. Samples were prepared by isolating *E. coli* and *Salmonella* from the biosolids compost matrix, enriching them in TSB and individually seeding into 30 micro-centrifuge tubes. All samples were exposed to a simulated composting temperature inside a programmable incubator and withdrawn at pre-set intervals. The culturability was tested using XLD agar and IDEXX QuantiTray™ 200. To quantitatively assay VBNC cells, samples were treated with propidium monoazide and analysed using real-time PCR. For resuscitation analysis samples were individually seeded into Luria-Bertani broth and incubated at 36°C. Both *E. coli* and *Salmonella* lost their culturability upon exposure to  $\geq 52^{\circ}\text{C}$  due to VBNC induction. The VBNC state helped both *E. coli* and *Salmonella* survive at appreciable concentration. The VBNC at the early state in *E. coli* and *Salmonella* was reversible but not after 22 days. It needs to be examined if the failure to resuscitate was due to irreparable cell damages or failure to provide more specific conditions.

#### *Mapping composting bioaerosol dispersal using pine needles*

*Jean Jacques G., Galès A., Wéry N., Latrille E., Steyer P.J. (INRA)*

**Text:** Surface of leaves represent the largest surface on earth and contain one of the most abundance microbial communities. But leaf surfaces can also be considered as landing zone for microbes travelling by air. Based on the landing hypothesis, this work tries to draw a boundary around the composting site impacted by an emission punctual source of bioaerosols. *Pinus halepensis* needles were used as collection surface of bioaerosols released by a composting plant located in the South of France. We quantified the microbial indicator *Saccharopolyspora retivirgula*. Samples were collected at distances ranging from 100 m to 4000 m

around the composting plant. 16S rDNA abundance from *S. retivirgula* and the total bacteria were measured by qPCR to indicate the impact of composting plant bioaerosol. The abundance of 16S rDNA of *S. retivirgula* varies from 102 to 104 copies by g of *P. halepensis* needles. The abundance of *S. retivirgula* on pine needles was negatively correlated with distance to the point source. Topography and prevalent wind direction had an influence on the dispersion pattern. The abundance of indicator has reached the background level at distances ranging from 2 km to more than 5.4 km from the composting plant. This study confirms the ability of microbes to land on leaves and the ability of leaves to keep a memory of airborne microbial pollution. This cumulative data free of meteorological conditions can usefully replace the challenging instantaneous collecting of air samples to determine impacted zone from a composting plant.

### ***Assessment of home composting through stability indices and pathogen inactivation***

*Lasaridi K.-E., Kyriacou A., Chatzipavlidis I., Abeliotis K., Zorpas A.A., Chroni C., Koufopoulos M., Miniadis M. Sgoubopoulou A. (Harokopio University)*

**Text:** Home composting can be considered as one of the most feasible options for bio-waste avoidance, granted that its end-product (the compost) fulfills certain quality criteria. In order to assess home composting process and compost quality, the integrated application of independent methodologies is needed. The present study reports on assessing compost quality through the evaluation of the stability levels and pathogen inactivation during home composting. A mixture of food waste (no meat, fish, lipids and oils were included) and garden clippings was monitored, in triplicate, from raw material to mature compost, with regard to abiotic factors (temperature, moisture, volatile solids, pH and conductivity), respiration activity (using the Specific Oxygen Uptake Rate test and an electrolytic respirometer) and microbial counts of total bacteria, total coliforms and *Escherichia coli*, clostridia and *Salmonella*. The composting process went through typical changes in temperature and microbial properties for this type of composting. Total coliforms and *Escherichia coli* were detected for over 90 days of processing, mainly due to the marginal achievement and short duration of the thermophilic stage (up to 46°C for two days). Although the initial mixture constituted only of vegetable waste (garden and kitchen), *Salmonella* was detected in it but was practically destroyed in the process. The respiration activity reflected well the process evolution. The results of this study will contribute to the improvement of our understanding of the stabilisation process, the potent risks and their reduction for home composting. The research was partially funded by the LIFE+10 ENV/GR/622 project “WASP Tool”.