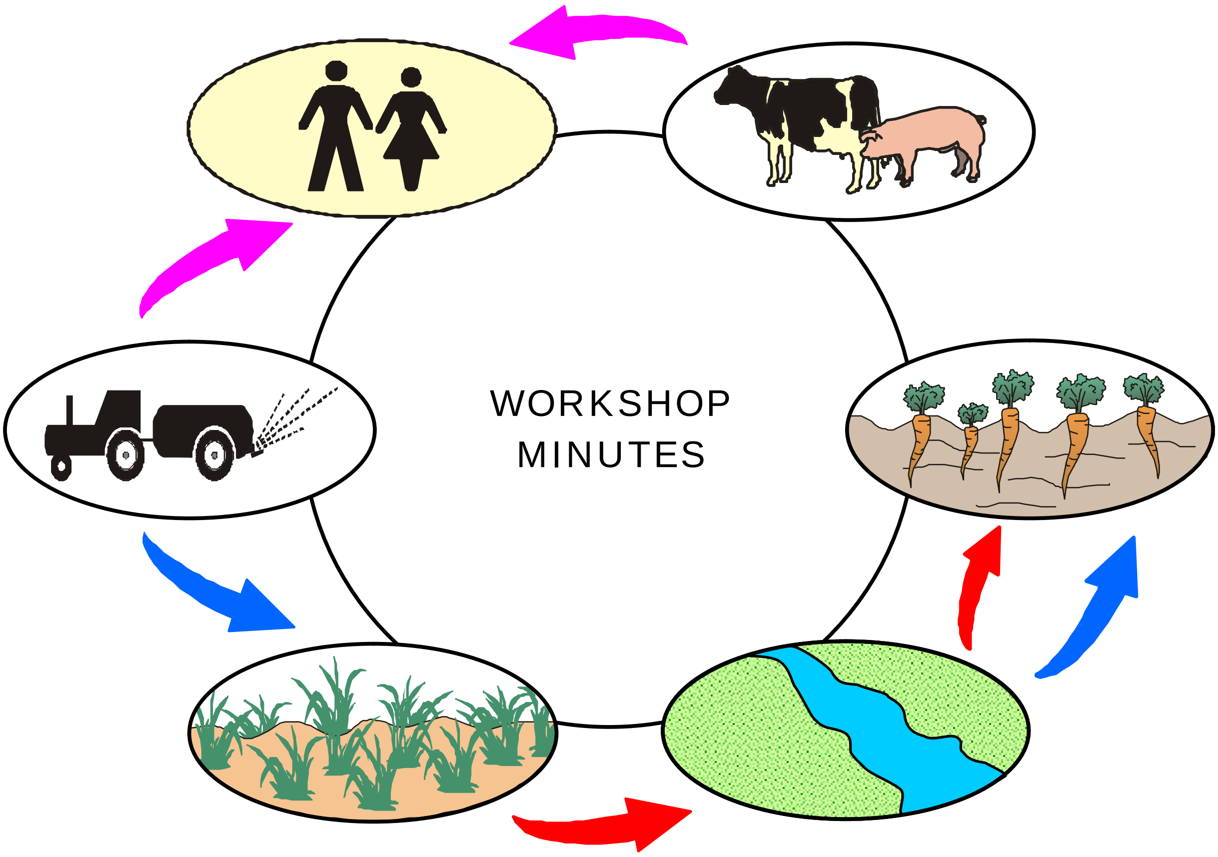
Reconciling environmental and sanitary risks in the management of livestock wastes : a review on the current situation in Europe



Laurence Loyon, Anne-Marie Pourcher, Adele Richmond, Björn Vinnerås and Colin Burton

PARTICIPANTS

Dr	AGUILAR-RAMIREZ	Maite	**MAR**	maguilar@ itgganadero	ITG Ganadero	Spain
Dr	BONMATI-BLASI	August	**ABB**	august.bonmati@ giroct.irta.cat	GIRA Barcelona	Spain
Mr	BOYLE	Mark	**MB**	Mark.Boyle@ gcu.ac.uk	Glasgow Caledonian University	Scotland
Dr	BURTON	Colin	**CB**	colin.burton@ orange.fr	Cemagref Rennes	France
Mr	CUNAULT	Charles	**CC**	charles.cunault@ cemagref.fr	Cemagref Rennes	France
Dr	DABERT	Patrick	**PD**	patrick.dabert@ cemagref.fr	Cemagref Rennes	France
Prof	DALSGAARD	Anders	**AD**	ad@life.ku.dk	University of Copenhagen	Denmark
Dr	ECKEL	Henning	**HE**	h.eckel@ktbl.de	KTBL	Germany
Dr	FRAGOSO	Rita	**RF**	ritafragoso@ gmail.com	ISA Lisboa	Portugal
Prof	HEINONEN-TANSKI	Helvi	**HHT**	heinotan@uku.fi	University of Eastern Finland, Kuopio	Finland
Dr	HERMONIC	Anne	**AM**	anne.hemonic@ ifip.asso.fr	IFIP Le Rheu	France
Dr	HODGSON	Chris	**CH**	chris.hodgson@ bbsrc.ac.uk	Rothampsted - N Wyke	UK
Dr	HOEKSMA	Paul	**PH**	paul.hoeksma@ wur.nl	Wageningen UR	Holland
Prof	HOELZLE	Ludwig	**LH**	Ludwig.Hoelzle@ uni-hohenheim.de	Universität Hohenheim	Germany
Dr	HUNEAU	Adeline	**AH**	Adeline.HUNEA U@anses.fr	ANSES Ploufragon	France
Dr	LALOR	Stan	**SLa**	Stan.Lalor@ teagasc.ie	Teagasc	Ireland
Dr	LEHUGER	Simon	**SLe**	simon.lehuger@ cemagref.fr	Cemagref Rennes	France

Prof	LOGAN	Niall	**NL**	N.A.Logan@gcu.ac.uk	Glasgow Caledonian University	Scotland
Dr	LOYON	Laurence	**LL**	laurence.loyon@cemagref.fr	Cemagref Rennes	France
Dr	MANTOVI	Paolo	**PMa**	p.mantovi@crpa.it	CRPA Reggio Emilia	Italy
Dr	MAROIS	Corrine	**CM**	Corinne.MAROIS@anses.fr	ANSES Ploufragon	France
Dr	MERINO	Pilar	**PMe**	pmerino@neiker.net	NEIKER	Spain
Ms	PEDEMEIRA	Ana	**AP**	ritafragoso@gmail.com	ISA Lisboa	Portugal
Prof	PHILLIP	Werner	**WP**	werner.philipp@uni-hohenheim.de	Universität Hohenheim	Germany
Dr	POURCHER	Anne-Marie	**AMP**	anne-marie.pourcher@cemagref.fr	Cemagref Rennes	France
Dr	PROVOLO	Giorgio	**GP**	giorgio.provolo@unimi.it	University of Milan	Italy
Ms	RICHMOND	Adele	**AR**	adele_richmond@hotmail.com	Cemagref Rennes	France
Dr	RODHE	Lena	**LR**	lena.rodhe@jti.se	JTI Upsala	Sweden
Dr	SOSSIDOU	Eva	**ES**	sossidou@it.teithe.gr	NAGREF - Thessalonika	Greece
Dr	VENGLOVSKY	Jan	**JV**	venglov@uvm.sk	University of Veterinary Medicine, Kosice	Slovakia
Dr	VINNERAS	Bjorn	**BV**	Bjorn.Vinneras@slu.se	Swedish University of Agricultural Sciences	Sweden
Dr	WULF	Sebastian	**SW**	s.wulf@ktbl.de	KTBL	Germany

INTRODUCTION

The following minutes record the presentations and discussion carried out during the 3-day workshop.

The invitation and circulated agenda are given in **Appendix 1**. For presentations including a PowerPoint slide show (indicated), please see corresponding file reproduced in **Appendix 2**. Profiles of participants, including their areas of scientific interest and that of their department, are given in **Appendix 3**. A previously circulated questionnaire is reproduced in **Appendix 4**. The responses of this questionnaire are given in **Appendix 5** with the main summaries set out in tabulated form. **Appendix 6** includes a plan of a report that reviews livestock manure management: "*Reconciling environmental and sanitary risks in the management of livestock wastes : a review on the current situation in Europe*".

For correspondence purposes, please contact **Dr L Loyon** or **Dr A-M Pourcher** of Cemagref (Rennes) : contact details above. A third point of contact with respect to the European network RAMIRAN (http://www.ramiran.net/) is **Dr B Vinneras** of the Swedish University of Agricultural Sciences.

This workshop was carried out as an objective of the **BATFARM project**. Funded by the participants and by the Atlantic Area Transnational Cooperation Programme, 2007 – 2013 of the European Regional Development Fund of the European Union. The project coordinator is **Dr P Merino**. For more information on BATFARM and the partners involved, please visit website, http://www.batfarm.eu/

Special thanks are given to the recording of detailed minutes during the workshop (and the subsequent writing up) by **Ms A Richmond** who also actively participated in the workshop.

DAY ONE: 5th October 2011

***Patrick Dabert* – welcome**

[PowerPoint] Introduction to Cemagref explaining the different departments and their objectives. 'Epure' department is the most relevant to this workshop as they conduct research into manure management and are currently conducting a 10 year project into nitrogen and phosphorus cycles. Special interest has been placed on digestion and mechanisation to decrease nitrogen via reverse osmosis. Brief explanation of Cemagref collaborations to separate enterprises and companies.

***Colin Burton* – opening of workshop**

Personal introduction. Briefing on the itinerary of the workshop including meal schedules and attendance signature sheet. General potential outcomes of this workshop to include i) collaborative review paper summarising the views/decisions of the workshop ii) a revised edition of the MATRESA book iii) a collaborative bid for a research project although this would need a second meeting to confirm. All participants expressed interest in all three agendas.

***Pilar Merino* – presentation of the BATfarm project**

[PowerPoint] Introduction to the BATfarm project. BATfarm is an Inter Atlantic Programme with one contributing research institute from each country. Works in close relation with the IED (formerly IPCC) working on cattle, pigs and poultry. The project looks to reduce livestock pollution with specific relevance to regional differences. The project carries out both literature and monitoring research (min of 36 farms per partner) in order to create a model incorporating the different BAT techniques and evaluating their applicability in relation to animal type and location. They then intend to adapt this model to create a user software to aid farmers and policy makers reduce agricultural emissions including ammonia, methane and nitrous oxide.

Discussion

The software would enable the policy makers and farmers asses each BAT in relation to specific environmental problems in each region and evaluate their efficiencies. The model will incorporate economic data although this information is difficult to acquire due to differences in energy/initial costs and country specific variations. Mention of eutrophication green algae in relation to the recent problems in Brittany and questions as to whether BATfarm was specifically aiming to reduce these problems. The response was that this issue could be reduced but only as a side effect, not a primary objective. Questions regarding manure management discussions as to how there is no universal treatment and therefore no simple solution. Focus must be put on the completion of the nitrogen cycle keeping in mind the costs as well as the hygiene issues. Overall a matrix of solutions is required, specific to each farm to reduce maximum livestock pollution.

***Colin Burton* – Description of the objectives of the workshop**

a) Analysis of the existing techniques looking into manure treatment and spreading, building management etc. in order to evaluate their emission reduction potentials.
b) Assessment as to how well these techniques work. Does pollution swapping occur and to what extent is this impacting the overall reductions?
c) Evaluation of the pathogen load and potential animal and human health risks. Possibilities for re-infection amongst animals? Questions as to food quality.

d) The potential for biogas production and other ways to gain value from agronomic manure. Does treatment add value? Potential for unlocking nitrogen and phosphorus via digestion?
e) How useful is each technique and how practical is wide scale implementation?
f) The need to evaluate air, water and soil contamination and evaluate which is most problematic on a regional scale. There is a need to rationalise which problems need the most important by means of a weighting system.

General potential outcomes of this workshop to include a) collaborative review paper summarising the views/decisions of the workshop b) a revised edition of MATRESA book c) a collaborative bid for a research project although this would imply further separate meetings.

Partner presentations

Helvi Heinonen-Tanski	• Member of the University of Eastern Finland, Kuopio, Department of Environmental Sciences, specifically in the microbiology department. • Predominantly studies indicators of ……… and works in collaboration with Finnish agricultural station on livestock including horses pigs cattle and poultry. • Also collaborates with human waste management projects • At the university also acts as a supervisor for Phd Students as well as bachelors lecturer.
Chris Hodgson **[PowerPoint]**	• Works for Northwyke, Rothamsted Research carrying out i) biotechnological research ii) biological research iii) arable crop research. • It is a multi-million pound facility • Consists of four teams and LDOM if the team carrying out research on faecal indicators such as *E.coli* and intestinal *Entrecocci*. • Particular research is carried out on the management and nutrient deposition on cracking clay soils • North Wyke Farm is separate into three hydrologically isolated farm platforms for water data analysis. • Currently searching for EU collaborators.
Evangelia Sossidou **[PowerPoint]**	• Senior researcher from the Greek research institute NAGREF consisting of three departments: Animal reproduction; Animal health and welfare; and department of hygiene: food technology and toxicology. • Specialises on livestock production systems with emphasis on animal welfare and interactions with the environment and food quality. • Member of the FAO veterinary Public Health Network, ESPA Expert database on Farm Animal Welfare and the European Commission Expert for Organic Farming. • Majority of projects are funded by the European Union
Jan Venglovsky	• University of Veterinary medicine, Kosice. • Studied veterinary medicine and pharmacy. • Works in the department for protection of the environment and the department of animal hygiene. • Worked on the survival of pathogens on animal waste. • Since September has been studying City water treatment plants examining resistant bacteria originating from slaughter houses.

Bjorn Vinneras **[PowerPoint]**	• Associate Professor Env Engineering Swedish University of Agricultrural Sciences National Veterinary Institute. • Focuses on the production of safe fertilisers looking at both human and animal waste in Sweden and low mid income countries. • Studies microbiology of pathogens such as salmonella and E.Coli 0157 as well as viruses to determine their survival rates and carry out risk assessments. • Working on the development of several treatment techniques such as vermin, BSF and thermal composting as well as numerous ammonia treatment techniques.
Anders Dalsgaard **[PowerPoint]**	• Member of the Department of Veterinary Disease Biology, University of Copenhagen (UCPH) working with hygiene and public health aspects of animal manure management. • Studies bacterial, parasitic and viral pathogens within both human and animal waste, examining thier survival, transmission and transport within soils. • Also studies treatment and application of manure to different soils with regards to pathogens. • Focus is placed on source tracking to improve water quality and elimination of vectors for pathogens.
Lena Rodhe **[PowerPoint]**	• Member of the JTI Sweedish institute ofAgricultural Environmental Engineering. • Areas of research include waste sewagw sludge, energy, livestock manure management, especially emissions on abatement techniques with regards to spreading and storage. • Also study biogas production though manure digestion and the possability for mobile biogas plants. • Member of the sister project of BATfarm, BALTIC MANURE which studies the potential techniques availible to reduce livestock pollution within the Baltic Sea region. • One of the projects main objectives is to generate energy from manure.
Stan Lalor **[PowerPoint]**	• Researcher at the institue Teasasc Agriculture and Food Development Authority. It is a nationwise public funded boby studying crops, the enviornment and livestock offerent research, advice and education. • Research projectsconducted at Johnstone castle Centre include soils and the rural environment; manure spreading techniqies; fartiliser and manure management; air and water quality analysis and nutrient efficiency. • Partner in BATfarm • Personally working on nutrient efficiency and advising on the revision of the Gothenburg Protocol.
Pilar Merino **[PowerPoint]**	• From NEIKER, Environmental Quality department. • Conduct research evaluating water treatment techniques • Also works on dairy cattle feeding, Nitrogen fertilisers, nitrous oxide emissions amongst other things. • Project coordinator : BATfarm
Ana Pedemeira	• Member of the team working on BATfarm in for ISA Lisbona.

Rita Fragoso	• Worked with the portugal water efficiencis studying anerobic treatment of watse. • Research into livestock waste management and waste water. • Partner in BATfram
Mark Boyle	• Glasgow Caledonian University • Phd Student working at the Scottish Environmental Protection agency whcih is also a partner in BATfarm. • Studies fecal indicator organisms and pathogen analysis looking into the effects of agricultural pollution
Niall Logan	• Bacteriologist from Glasgow University,working in the department of food and water bacteriology. • Research projects involve bacterial systematics- classification, nomanclature and idendtification of bacteria. • Phd supervisor of Mark Boyle.
Simon Lehuger	• Works at Cemagref for the porject Batfarm. • Is currently carring out his Post Doc in Monitoring and modelling. • Has Phd from INRA on Green House Gas emissons. • Previosuly worked in Zurich for Agroscope producing soil crop models for GHG emissions from grasslands.
Charles Cunault	• Carrying out his Phd at Cemagref researching the potential for heat exchange on effluent as a means of reducing pathogen and manure treatment.
Anne Marie Pourcher **[PowerPoint]**	• Works at Cemagref in the microbiology department studying the treatment of manure and gasseous emissions. • Areas of research include nitrifying/denitrifying bacterial populations; survival of microorganisms of fecal pollution; source tracking and santitary aspects of farm management including monitoring data on 50 farms. Joint supervisor (with Colin Burton) for *Charles Cunault*
August Bonmati-Blasi **[PowerPoint]**	• GIRO - Technological Centre Research scope. • Research topics include anaerobic digestion, composting, process innovation, processes combination, agricultural valorisation as well as mathematical modelling, environmental microbiology, scientific and technical services.
Paolo Mantovi **[PowerPoint]**	• Works for CRPA - Research Centre on Animal Production. • Reconciling Environmental and sanitary risks in the management of livestock wastes. • Nitrates committee of the EC voted in favour of increasing the maximum nitrogen load in fertiliser to 250 kg/N/ha/yr in 4 regions of Italy. • The research projects include solid-liquid separation, biological nutrient removal (SBR technology), anaerobic digestion, ammonia stripping, composting, integrated anaerobic digestion and N-removal systems and digestate drying systems.

Giorgio Provolo **[PowerPoint]**	• Department of Agricultural Engineering at the University of Milan – Italy which has strong connections in research activities encompassing sustainable agriculture, environment protection, food processing, bio-energy and management of agro-food systems. • Research topics include farm and food machinery, agronomy and safety, rural buildings and livestock engineering, landscape planning, agricultural hydraulics and water resources planning, applied physics and energetics, farm information technologies, sensors and automation for biosystems and bioprocesses • Member of the LIFE+ MANEV Project evaluating manure management and treatment technologies for environmental protection and sustainable livestock farming in Europe.
Paul Hoeksma **[PowerPoint]**	• Department Livestock Research Wageningen UR working within the livestock and environmental department. • Research into housing, manure management, energy and nutrient recovery using both laboratory and field experiments. • Measuring and modelling of GHG emissions, odour, ammonia and particulates from livestock housing. • Developing protocols for assigning emission factors to livestock housing systems, used in regulations. • Involved in the development of multipollutant air scrubbers.
Sebastian Wulf **[PowerPoint]**	• Association for Technology and Structures in Agriculture KTBL Darmstadt, Germany which is a non-profit organisation predominantly funded by Federal Ministry of Agriculture, Food and Consumer Protection. • They provide descriptions and evaluations of state of the art technologies, planning data to farms and technical advisory statements to policy and administration. They also initiate and coordination of R&D projects and contributes to national and international regulations. • Partners in the BAT Support project- Best available techniques for intensive livestock farming – support for the implemenation of the IPPC Directive • Evaluate the emissions abatement costs focussing predominantly on ammonia and GHGs including the production of biogas.
Henning Eckel	• Association for Technology and Structures in Agriculture e.V. KTBL Darmstadt in Germany • Joint presentation with Sebastian Wulf
Laurence Loyon	• Cemagref GERE department, Rennes. • Has a PhD in Environmental Chemistry. • Recent research projects include evaluation of anaerobic digestion of livestock waste as a means of treatment as well as a partner in the BATfarm project.

Discussion session 1 - Review of EU regulations influencing manure management.
Led by Colin Burton

Directives

- 8-9 directives exist which either directly or indirectly affect manure management
- E.g. landfill directive indirectly affects manure management as the sewage sludge has a threshold for nitrogen or bacteria.
- All sectors must evaluate the environmental impacts
- Hygiene must also be taken into account in all these directives.

General Questions

- We need to identify areas for further research and areas of importance that have been overlooked.
    - *Animal by-product regulation is often ignored despite the great impact it has and a source for confusion.*
    - *Animal welfare has a great impact.*
    - *National regulations are they needed or should regional/local regulations play a bigger part in legislation. Different rules for different areas e.g. phosphorus levels in Brittany differ to France overall.*
- What help do we need for good management of manure?
- What is missing from the directives? Either National or EU?
- Implementation and national decisions have exceptions, too many loopholes?
    - *Polish manure dumping in landfills? NVZ's are not considered and therefore farmers can dump anywhere according to the nitrates directive?*
- Lack of law enforcement?
- In not within NVZ, there is no EU directive for controlling manure management of Dairy cattle.
- In the UK activity is controlled and it is illegal to dump livestock waste in close proximity to water e.g. 50m to prevent runoff. The water Framework directive controls these issues but is it locally enforced?
- Are there too many inconsistencies within Europe legislation on manure management?
- Should directives control hygiene or nutrient loading primarily? Can they control both consistently? A reduction in chemical pollution would result in a decrease in microbial pollution.
- Should the pathways for microbial spread be controlled?
- Hygiene is not regulated on a farm level and there is no reference farm for comparison (No equivalent to the BREF by IPPC for hygiene)
- In terms of hygiene we need to look at more than just the chemical pollution and consider other vectors such as wild populations.
- Bathing water directives can control microbial populations.
- River water quality can define standards but are they useful for helping reduce pollution form agriculture?
    - *In the UK beaches fail bathing standards due to pathogens and runoff but can we be sure that the pollution is a result of agriculture. Knowing that beaches won't pass standards in the coming years has prompted stricter measures to clean them up.*

- Modelling has begun in the UK, can it help used to identify the source of bacteria. It is the only means of really identifying the source rather than a tracer.
    - *Ambiback, SPG gene. We need a database to differentiate between microorganisms originating from animals or agriculture.*
- Can faecal indicators and specifically source tracking help identify the greatest sources of microorganisms affecting water quality?
- Legislation and management has to be related to biodiversity, it must take into account climate change, animal welfare and regional differences not just country differences.
- There is not upper limit on odours. More research is needed, limits as to the minimum distances between strong odour emitters and residential areas?
- If we were just to evaluate cattle, it is obvious that they emit large amounts of methane and ammonia, should directives look to combat specific animals or control animal density?
- Why are cattle exempt from the IED? No logical reason as they pollute as much is not more than other livestock species.
- Why are pigs considered but not cattle?
    - *Cattle production is viewed as being more harmonious with nature and is low density, manure nutrients are in equilibrium and the balance of nutrients is maintained.*
    - *Not always the case as in winter cattle are housed and therefore at higher density.*
- Per unit of land should one be distinguishing between pig manure or manure concentrations of nitrogen, phosphorus etc per ha. The limit of 170kg does not see a distinction between the animal producing the manure.
- Production systems may be a good way of assessing manure management- free range vs battery etc. and these terms should be more universally agreed upon.
- The type of soil has an impact, clay for example cracks and when saturated presents a water tight barrier preventing leaching but causing increased runoff. Therefore need local restrictions to take soil type into account.
- Topography should also be taken into account in local restrictions, slope angle, whether it is south or north facing impacts microorganism survival.
- Lack of practicality as to when manure should be applied, best times of year to apply environmentally speaking may not be feasible, i.e. June the land is too wet.
- The nitrates directive does not take into consideration chemical fertiliser. Reasonable concession? Or should the 170kg be for all types of fertiliser.
    - *In the Netherlands, farms are only allowed to fertilise up to crop requirements including chemical fertilisers.*
- Nitrates directive doesn't apply to the whole of Europe, should it?
- Organic fertiliser and chemical fertiliser don't have the same nitrogen efficiency. Need to take into account the efficiencies at different times of year of for different spreading techniques as it can lead to higher nitrogen losses.
- Farmers have been known to spread 10% extra to ensure they reach their yield, is this taken into consideration, how to prevent this occurring?
- Manure is a resource but farmers have low confidence, legislation should be encouraging rather than enforcing limitations. They should be provided with a 'real value' for manure.
- The pathogen risks related to different livestock species vary considerably and this needs further research.
- Is feed important to manure nitrogen levels- yes phase feeding, addition of synthetic amino acids and zerolite had been shown to reduce nitrogen outputs from livestock facilities. But is considered as an influencing impact in manure management?
- More research is needed to clarify legislation.
- Byproduct regulation? E.g. 1hr at 70 degrees, is this a useful benchmark?

- Legislations are not fulfilling their predictions in terms of pathogen survival.
    - *Not relevant in Denmark, 130 degrees for 30 mins is the required sanitisation time .*
- How can you be sure that all areas of compost are exposed to the same treatment techniques, surplus of nutrients when trying to move. Drying has the potential to release increased nitrogen into the atmosphere.
- 170kg limit is too crude- seems almost like a random value taken to satisfy every problem but does it. It needs to be dynamic, regionally specific. Regulation needs upgrading.
- Why shouldn't a broad spectrum outcome be defined and then each region provided with a matrix of techniques to reach this target rather than legislation that might not be relevant to the individual farms?
- Habitat directive should influence manure management. There are too many directives influencing one farm, there should be an agricultural directive with a pathogen directive/ standards within.
- Why are we so dependent on directives, farmers should be taught that manure is valuable, yet they still need directives to tell them, how to use their fertiliser?
- Chemical fertiliser is expensive therefore the fact than manure is a cheap source of fertiliser should be seen as a bonus to the farms rather than a nuisance.
- The farmers should be provided with more control, a pull vs push system when it comes to manure management and directives is needed.
- Farmers' need the incentive- best incentive is profit margin therefore should be promoting the rewards of manure as a fertiliser rather than the restrictions.
- Money is an important incentive but a legal framework is still needed to control and more research is needed to ensure the problems associated with manure management are minimised.
- Further education and communication is needed between researchers, policy makers and farmers to show how farms can benefit financially from the legislations. Focus on the savings they make with manure rather than the costs of proper manure management.
- Subsidies?? Should there be more, is this feasible?
    - *For example biogas plants have progressed with the help of subsidies; they help with the acceleration of technologies and treatments.*
- Water framework directive: Phosphorus regulation needs stricter control. It's a key aspect of manure that Dutch farmers view as a benefit.
- Is it possible to place a limit on phosphorus and allow the farmer to use which ever methods are best suited to his specific farm in order to stay within those limits?
- It is country/regionally specific as to which aspects bring about the most problems therefore needs more flexibility in their control.

Discussion session 2 - Description of the environmental, sanitary and economic key issues concerning the use of stored or treated manure.
Led by Colin Burton

List of all the factors influencing manure management that we feel need to be considered when making policies:

- **Odour**- what extent of control does it need, should there be a more standardized way of measuring odour and limits on what is 'acceptable'. Should this apply regionally on a country base? Does this need to be controlled in relation to proximity to residential areas?
- **Cost of technique (investment/running)** Must keep the costs be low enough for the farmers to still make a profit on using manure rather than chemical fertiliser. Improvement of low cost techniques should be researched.

- **Stocking density** Heavily influences the amount and concentrations of manure as well as pathogen concentrations and likelihood of reinfection.
- **Public health and well-being** Affected by pathogens entering drinking or bathing water. Also farm workers becoming infected or suffering respiratory problems due to dust.
- **Animal health and well-being** Manure management must take into account the possibility of animal reinfection and general animal welfare.
- **Dust (particulates)** The limits on these must be met but the technologies for reduction (primarily air scrubbers) are expensive.
- **Acidification** Extent of soil acidification needs to be considered, along with methods of reduction.
- **Eutrophication** Proximity to water bodies needs to be limited. What is considered acceptable?
- **Greenhouse gases** What GHGs are the most problematic, what is considered a reasonable amount for a farm to emit? Is this regionally controllable?
- **Water quality** Both drinking and bathing water considering nutrients and pathogens.
- **Air** quality What is acceptable, does this differ regionally, is this GHGs or other emissions as well and which should be most stringently controlled?
- **Lack of practical technology** Do we ask too much of farmers given that the so much of the abatement/management technologies are too expensive or not cost effective for individual farms.
- **Attitudes** The attitude towards manure- resource or waste? More education and communication required.
- **Energy & water consumption** Do the techniques available consume to much energy and water therefore generating high costs to the farmers as well as other forms of pollution at different stages?
- **Decision support systems** Support for farmers when deciding what treatment is best for their farms.
- **Recovery of nutrients** Should be a priority but is enough being done to ensure this?
- **Land disposal**
- **Energy production** The prospects of biogas plants.
- **Recycle of manure and products.** What ways can manure be reused and how could this influence its initial management.
- **Biodiversity and wildlife** Must avoid impacting natural populations of plants and animals
- **Soil contamination (heavy metals & antibiotics)** What is acceptable and the methods of reduction?
- **Food safety (and quality)** Pathogen control to maintain high standards must be considered.
- **Nitrate/nitrite contamination of food and water**
- **Rural development – sustainability & employment** How will these management techniques impact the farm workers of local residents.
- **Hormones (soil/water routes)** What is acceptable and are hormone levels problematic?
- **Anti-biotic resistance of pathogens** Avoid management strategies which could lead to the increase in resistance. Research into the problems and solutions.
- **Transfer of resistance (to other environmental bacteria)**
- **Phosphorous contamination**
- **Soil compaction** What effects might this have on leaching and runoff and therefore impacts of surface and ground water.
- **Meat production** (importance of...)
- **Organic carbon**
- **Salinisation**

- **Livestock production systems (organic)** Especially important when lime treating manure for pathogens as it can remove all nitrates leaving the manure useless as a fertiliser.
- **Animal diets** Reducing nitrogen in the diet by phase feeding or zeolite can impact manure biochemical properties**.**
- **Definition of manure (as a waste?!)**
- **Legislation** What can be implemented and how standardized should legislation be.
- **Mineral fertilizer prices** Must keep in mind the farmers main objective is profit therefore costs are crucial to different management techniques**.**
- **Marketing issues**
- **Good farm practice techniques** Must be achievable whilst maintaining good farm practice. How far does this go in terms of a technique?
- **Ammonia emissions**
- **Weed management** Are herbicides and pesticides important?
- **Nutrient concentration (variability/volume)**
- **Weather conditions** Different treatments needed in different climates as the effects of temperatures affect the efficiencies.
- **Constraints on agriculture**
- **Ethical issues**
- **Cropping systems** How the manure is spread, over what area?
- **Proximity of feed source to animals**
- **Erosion** Its impacts on runoff and leaching.
- **R&D** New prototype techniques need to be designed with all these factors in mind, not just abatement of emissions. Are the prototypes being followed through, implementation?
- **Enforcement of legislation.**

This list needs to be weighted, the key issues concerning manure management must be identified and from that, a strategy put in place to create "ideal" methods to manage. Rationalisation of this list.

- *But the weighting of this list varies so much between countries and even on an individual farm level, types of animal, density, climate, topography, emissions rates etc. The lost must be rationalized individually but this is impractical.*
- *Should the list be rationalized by categories, Environmental, Economic and Social? Does this leave too much room for cross over as so many factors affect all three categories.*
- *Are all these issues predominantly related to manure or are there other sources which affect them more such as chemical fertilisers or natural populations in terms of pathogens?*
- *Don't try and control issues that cannot be altered, reducing particulates may prevent illness outside the farm building but farm workers and animal health is still at risk.*
- *More focus on reduction at source, low nitrogen feed.*
- *Must assess the actual problem, ammonia isn't a problem in itself, acidification of soils is the problem, focus on the solving the problem or the source.*

Discussion session 3 - Establishing the criteria for selecting the most efficient technologies: reconciling different objectives.
Led by Colin Burton

<u>If we were to come up with the perfect management techniques scientifically speaking what are the most important issues.</u>

- Food – safe, enough, quality
- Sustainability : economically, socially, environmentally
- Eliminate odours
- Reduce NO_3 in groundwater
- Acceptable emission of GHG
- Acceptable emission of NH_3
- Acceptable costs (of manure management)
- Acceptable health risks
- Acc health risk to farm staff (MRSA)?
- Acc emission of dusts
- Acc loss of P : resource conservation
- Recovery of energy
- Prevent and control transmission of emergent animal pathogens (swine fever etc)

    - *What is acceptable, how is this defined for each region? Animal? Pollutant?*
    - *How do we reconcile conflicting factors?*
    - *Need to have a clear plan as to what needs to be achieved with respect to regions. This means more research is needed by each country to asses which factors in the first list are most relevant to their region.*
    - *If we can gain an ideal scenario, could allow the farmers more freedom in how they achieve this outcome with respect to treatment or management techniques.*
    - *Economics cannot be ignored yet not included in an environmental analysis of the ideal situation. The treatments must be cost effective otherwise the farmers will have no incentive to use them.*
    - *Provide a worst case rather than worst case scenario as to what management can bring. This could encourage farmers to use more techniques.*

DAY TWO: 6th October 2011 - Microbiology Subgroup

Led by Bjorn Vinneras and Anne Marie Pourcher

***Bjorn Vinneras* – Outline of the programme and objectives of the day [PowerPoint]**

Need to examine disease transmission

- Within farms
- Between neighbouring farms
- Between animals both agricultural and wild populations
- Between humans
- Into the water system- drinking and bathing.

Topics:

- Acceptable health risks.
- Organisms of concern
- Manure treatment techniques
- Required in DAA -Microbial reduction
  -QRMA
- Should also include transmission routes and exposure.
- Must consider both human and animal health and welfare.
- Must consider source tracking.

***Anne Marie Pourcher* – Literature review on "Sanitary issues of livestock effluents [PowerPoint]**

- Presentation covers the following topics:
  - *Pathogenic microorganisms which may be found in farm effluent.*
  - *Health risks associated with land application of manure.*
  - *Impact of treatment on indicator bacteria and pathogenic bacteria.*
  - *Survival and transfer of bacteria after land application.*
- Literature review shows that prevalence of different bacteria/viruses alters dramatically between studies, types of animal and countries, with poultry having the least diversity in the types of bacteria studied.
- Huge variation between different studies, most studies focus on different fecal indicators, bacteria or viruses so little continuity. Some bacteria are far more heavily investigated than other for example *Salmonella*. Investigations are also not consistent in the monitoring time scale, climate, region and monitoring techniques. This makes it hard to show the effectiveness of different treatments
- High variability in prevalence is a result of factors related to breeding, and the methodologies employed.
- Routes of contamination can either be direct or indirect
  - *Case study of spinach E.coli traced back to cattle manure*.
- Methods of detecting contamination can either be achieved via naturally present populations such as E.Coli and Enterococci or via artificial inoculation of a pathogen such as salmonella or E.coli 0157.
- An investigation carried out by Cemagref in Brittany looking into 47 piggeries in Brittany, evaluating the removal efficiencies of pathogens after anaerobic digestion.

- For Brittany the storage temperate of manure is between 10-15 degrees Celsius, with slight seasonal variation but not very significant. The max temperature is 15 degrees regardless of month.
- QU. Why is there an increase in bacteria from 3-7 months to 12 months?
    - *No idea, all studies show a similar trend yet no obvious explanation.*
- During aerobic treatment the temperature increases to 20 degrees Celsius. In this system heat is not conserved but if it were, i.e. using a cover, the temperature could reach up to 50 degrees Celsius.
- The results for *Enterococci* showed huge variation yet not statistically significant therefore have to be considered as normal data. *Enterococci* data here contains both faecal populations as well as wild populations and there is no easy means of distinction so they must be considered as one. This poses questions as to how reliable *Enterococci* is as a faecal indicator.
    - *Bathing water standards regard both natural and fecal populations so could be falsely identifying livestock waste as the source. E.coli is a much more reliable source*
- Effects of manure storage time were also evaluated, considering both static and dynamic storage. Dynamic storage had a higher CFU/ml than static storage throughout the year.
- Results of the literature review identify thermal treatment i.e. composting as the most effective treatment.
- When evaluating survival of *E.coli* in sandy soils the DRT does not correlate with the total time of detection.
- Survival in clay soil is higher but transfer is lower so the studies don't identify precisely whether they are evaluation transfer or survival.
- The type of application regarding rate and depth were analysed for both *Enterococci* and *E.coli* and results showed that both increased initially (a re-growth within the first 10 days reported by many authors)
- Topography, season, temperature, organic matter, moisture content, pH, and light also influence survival of pathogens.
- There is a need for a multi-factorial analysis of survival as many studies ignore key factors such as humidity/ water content

Discussion session 1 : What is the appropriate target for acceptable microbial risk – are there safe levels? What microorganisms of special concern?
Led by Bjorn Vinnerås

- *Entrococci* - it's in the Water Framework directive but is it a good indicator?
- Must keep in mind chemical/ hormone issues.
- Is there a statistical difference between summer and winter? Should all metrological parameters be examined and not just seasons?
    - *The majority of studies do look into all aspects of weather but for the purpose of the presentation they were simplified to summer and winter.*
- More studies need to include soil parameters, sandy vs clay. All physical parameters should be included.
- Should also include animal based parameters such as feed, welfare, housing, handling etc. What are the worker handling practices and the precautions taken as this can a significant effect on contamination and public health?
- Feed which results in increased ammonia in manure affects pH and therefore survival therefore it is important. All upstream processes affect the biochemical composition of manure and therefore must be examined with regards to pathogen treatment of manure.

- Costs cannot be ignored yet rarely mention in studies.
- Salmonella levels differ between wet and dry soils but the studies don't take into account the handling stages of manure, only the storage and once its applied.
- Upstream managing is very important but the actual manure will always need management to prevent contamination to other farms/ animals/ water bodies etc.
- Looking beyond *Enterococci* and *E.coli* what viruses have been studied and what is their impact.
    - *Many viruses have been analysed and concentrations can be evaluated but not within a manure tank.*
- However there are not many studies on viral indicators as they are hard to study, bacteriophages hard to identify in manure.
- Could use PCR? This technology is available and widely used.
    - *PCR is available but not in all research facilities and traditional techniques are preferred because they are easier and cheaper*
    - *There are problems with the detection limit on PCR and the preparation of the sample is important*.
- *E.coli* is used as a viral indicator but is it accurate. There is also high resistance within the natural populations. Possibly need a different indicator for viral pathogens.
- Pigs manure is host to parvovirus, water virus, influenza, SDRP etc.
- Is the concentration of pathogens and especially needed or is the presence/absence scoring system sufficient for treatment decisions. Will concentrations affect health risks and optimal treatment techniques?
    - *In the case of foot and mouth the consequences of small concentrations means that the presence/absence indicator is enough, the huge fear factor prompted by these types of cases meant that farmers wanted pathogens totally illuminated. But is it really necessary if small concentrations pose no risk.*
    - *In cases such as Hepatitis E, human health is a concern and therefore people require more stringent measures.*
- *Entrococci*, is it all faecal - No and shouldn't be used as a key faecal indicator. Propose a joint paper from all participants to discourage its use as a standardised faecal indicator.
- *Parvovirus*, often originating from pigs takes over 6 hours of heat treatment whilst all other viruses are killed off within thirteen minutes. Is 6 hours of treatment necessary to kill off one virus? The concentrations need to be known as well as the potential risks because the cost of treatment for so long may be too much.
    - *Wary of the risks of over kill in terms of cost effectiveness.*

Helvi Heinonen-Tanski **- Cattle in outdoor during winter [PowerPoint]**

- Cattle in Finland are often kept outdoors even in winter with only light shelter. However they despite having a lot of space and therefore technically being low density, the feeding area has high concentrations of faeces.
- This allows for possible re-infection of animals as well as ground and surface water contamination.
- If these sites will be changed the faecal contamination will spread to larger area. Due to snow and frost the enteric microorganisms will not be destroyed.
- In these cases increasing the land area will have no impact, the only solution is to change the field for cattle grazing or at least for feeding. How often should this are be changed needs investigating.
- The high volumes of melt water in spring result in high risks for contamination yet the phosphorus and nitrogen levels are low so specific treatment options need to be considered.

- Since the animals are free range there is also increased concern about contamination to and from wild animal populations.
- Should the regulation of foodstuff removal be controlled?

***Charles Cunault* – Thermal treatment of manure [PowerPoint]**

- Spores form in the equipment therefore is the treatment aiming to eliminate spores of the pathogen?
    - High temperatures mainly aim to kill the spores and are not capable of killing all bacteria
- When would such intensive treatment be needed?
    - Potentially for epidemics but not primarily. It is only a prototype for a large range treatment. It is a means of managing the risk and defining the indicator.
- What about the solid part of the manure, how would this be treated, could farms afford two separate treatment techniques for different stages of waste?
    - The only reason liquid manure was used in the prototype is because the diameter of the tube was too small to fit solid manure but in a full scale model solid manure could be treated. We can be sure of this because even though the manure was centrifuged, it was not homogeneous and there was significantly larger particles being treated successfully.
- Possible to turn this into a mobile unit which could be used on fields when there is an epidemic.

Discussion session 2 – what is the impact of effluent management/ treatment on the sanitary risk – simple storage, biological treatment, chemical / thermal treatment, animal diets …… combined with Discussion session 3 – what are the prevalence and routes of transmission of most important zoonotic agents relating to animal wastes?
Led by Bjorn Vinneras

- Animal welfare laws state a minimum number of animals per square metre but animals tend to crowd and therefore even if ample space is provided, manure can still be confined to small areas. Also need consider strip grazing? The legislation is not practical for all situations
- There needs to be a better means of determining between agricultural water contamination and wild populations of human impacts.
- Water framework directive doesn't consider microbiology, the only mitigation options to them are physical barriers. Very impractical to avoid cows going close to streams. Sheep often need to cross rivers; it interferes with traditions grazing practices. Also very high costs of fencing off. Aesthetic issues? How far up a river do you need fence off?
    - As shown in the literature review material, a 1m buffer zone has almost the same impact as a 20m buffer zone, therefore no need to use any more. But problems that a 1m zone is too easy to overlap, therefore what should be set as a realistic buffer zone to ensure no manure is actually deposited within one meter of water?
- Is the drinking water at risk? Not in west UK.
- Well contamination is an issue but very few studies look at real seepage, mostly focus on runoff. There needs to be a better evaluation of the transmission routes and the actual health risks associated with different concentrations of pathogen.
- Are some treatments over cautious i.e. parvovirus treatment lasting 6 hours. Is the risk high enough to merit that costs?

- Most well contaminations are a result of runoff and poor well maintenance; it is often not a result of ground water contamination.
- Should manure even be treated??
    - On farm has no directive to advise farmers so re-infection is highly likely.
    - Between farms, manure must be treated to avoid contaminating neighbouring farms but it is often the case that several farms band together and therefore manure "sharing" still occurs within the limits of the joint farm and is not treated.
    - Should we only treat if there is an outbreak? Techniques such as liming remove all nitrogen form the manure leaving it useless as a fertiliser and therefore are very detrimental to organic farmers. Therefore should treatment only be implicated when needed? What level of pathogen is considered an outbreak? i.e. what is "needed"?
    - Problems occur when the storage tank is full when contamination occurs as treatment causes it to overflow and can cause other environmental problems. Would more regular analysis of the manure storage tank be useful?
- Germany has a lot of aerobic digestion at 30 degrees Celsius but why not treat at 55 degrees instead.
    - Too costly. Biogas is common in Germany but biothermic treatment is rare. The retention time is 100 days so not feasible to keep such a large volume at such a high temperature.
- Don't treat! More studies are needed on the natural levels of pathogens in the water/ soil to identify if agriculture is a main source to help establish the level of treatment needed. What about human and wild animal contamination? Source tracking is needed.
- What is an acceptable exposure level because if the natural population of pathogens is quite high then the addition of a small amount from agriculture could pose no additional threat?
- Could concentrations of pathogens within storage tanks be measured?
    - Very difficult as storage tanks aren't homogeneous and if stirrers were added it would affect the aerobic top layer and therefore any values would not be representative of a static storage tank.
- Need to treat poultry manure as salmonella outbreaks in France are relatively common compared to other countries. Many of the other aspects which could result in contamination are controlled and therefore manure is most likely the source.
    - Manure could be a risk but are other factors a bigger risk such as animal handling or manure management within the farm building? Field technology could be a more important factor.
- Poultry also affects food quality directly- egg production so a real threat.

Discussion session 4 - Review of the benefit of current and new technologies. Identify the gaps in current research.

Led by Bjorn Vinnerås

- Storage can be an effective method for preventing pathogen spreading on its own. Static storage however is too costly and therefore not feasible.
- When it comes to manure management we need an objective. Need to combine data for all pathogens, treatment systems etc. and produce a model? But how difficult would this be and would the model have too many variables to be applied practically?
- What is "acceptable"?! Can this be defined as human health risks? Are cows swimming in rivers posing a real threat to human health?
    - Very hard to quantify acceptable, 1 in 1000 cows dies from this pathogen, is this acceptable?
    - This depends on the pathogen, if it causes an epidemic then need to have more stringent controls.

    - Not enough data is currently available.
    - Need to discuss these issues on a farm by farm basis as a farm close to 4 water bodies or several farms will have to have stricter controls than an isolated farm.
    - In tems of human health risk, number of infected people per year is a good reference point but again it depends on the severity of the disease.
    - The scale of the problem is heavily linked the how acceptable the risk is.
    - Risk cannot be quantified as a simple number.
    - In Greece food control levels exist, 1 in 10^{-12} contaminated food items is acceptable.
    - Good farm practice? How could this be implemented to reduce pathogens?
    - Could pathogen specific risks be an acceptable method of evaluating acceptable risks? In this case the exposure risks also need to be assessed such as likelihood of runoff contamination.
    - Must consider specific risks such as swimming- how much water does the average person swallow when swimming and is the concentration of the pathogen in the water high enough to pose a risk?
    - Concentration of the pathogen is important but hard to quantify.
    - A dose response model. i.e. one in three people get sick swimming in this water at a certain concentration but the dose needs to be defined. How many people in 100 getting sick are "acceptable"?
- The potential for in house transmission is far higher than manure contamination. In farm management techniques are negligible compared to manure storage and spreading.
- The time period between animal defecation and storage is vulnerable to contamination for both animals and farm workers.
- In very intensive high density systems such as battery hens this is of major concern. Also need to think of milk contamination, risk of reducing food quality.
- Need to maintain good animal husbandry i.e. cleaning within the animal house to avoid contamination.
- Farm to farm contamination is the highest risk in terms of animal infection and food contamination. So this is the area that needs to be strictly managed.
- If manure is in a tank, the risks of contaminating a different farm or recontamination is minimal therefore storage is a form of prevention.
- World Health Organisation (WHO) has a lot of legislation regarding faecal pathogens from human waste and the same types of management could be applied to manure.
- Need to have a relative weighting of the different risk factors i.e. risk to humans, risk to animals etc.
- How to control recreational/ drinking water. Poor management can allow re-infection of different farms or wild animals further down the water stream.
- Can we quantify how much pathogen is in a slurry tank? Not just per animal. If the slurry tank has low contamination does treatment outweigh the losses in terms of nitrogen concentration of the manure?
- Splash risks need to be considered. Plant contamination?
- Need to assess which stage and which factors of manure management pose the greatest threats; is it spreading, storage, transportation, temperature, distance from water etc.
- More research is needed in upstream processes such as animal handling and feed management.
- Species dependant manure management and their specific livestock production systems need to be considered and different pathogens are prevalent in different manures.
    - However the concept is almost the same regardless of disease. Wild vectors and modes of transmission may differ but not the fact that transmission must be stopped.
- Soller et al. 2010- useful publication referring to these issues for farms in the Unites States> could apply some of the methods to European farms.

Discussion 5: Actions required – summary of main points arising and agreed strategies (targets) and priority themes for research.
Led by Bjorn Vinnerås and Anne Marie Pourcher

1. ***How can vast quantities of contaminated manure be treated whilst remaining cost effective for the farmer?***

- Need to compare different techniques in the same circumstances i.e. same manure type, climate etc. so that the treatment itself can be analysed and not just the factors influencing treatment efficiency.
- 2 months of storage is considered a treatment.
- Chemical treatment
- Thermal treatment
- Alternate systems such as wetlands- this has too high a BOD and could be dangerous.
- Must be cost effective i.e. sustainable.
- Public health need to be considered including the risk to farm workers
- Must also be animal friendly
- Must apply to the specific animal manure and type i.e. liquid or solid.
- Climate, season, temperature, topography and geology of the farm and surrounding area must be included in the parameters for selecting the best treatment.

2. ***Treatment indicators and is Enterococci an effective faecal indicator?***

- *Enterococci* –NO
  - It is used for water standards evaluation but should be advised against for the reasons stated earlier.
- *Total Coliform* - has many of the same problems as Enterococci but not used very often any more.
- *E.coli*- YES
- *CP* –YES
- Viral treatment is very different so need to study bacteriophages.
- Phages can be quantified, they are easy to cultivate using ISO standardised methods.
- Temperature treatment is very easy means of eliminating animal viruses.
- Parvovirus and envelope virus are both of concern and both susceptible to heat. Parvovirus has far higher demands than almost all other viruses in pig manure, needing to be treated for 1hr at 70 degrees Celsius to reduce contamination by two logs.
- Need to be sure the excess heat/ time for one virus is worth the cost. Does the risk justify the costs? Only if the problems associated with the virus as sever.
- Molecular methods are not preferred but often necessary. For example it is needed to distinguish whether salmonella is viable (active or not). But PCR poses problems when it comes to sensitivity.
- MRSE- YES but it is a sensitive issue in the UK and farmers would refuse studies proposing inoculation.
  - The bacteria can be at a high enough concentration to be considered an indicator but its transmitted through the respiratory tract therefore manure may not be the best indicator.

3. ***Source tracking: New technologies for tracking pollution/ evaluation of current tools.***

- Need to evaluate the current tools
- There is a large amount of data available on over 20 different types of bacteria.
- What are the new tools/developments?
- The current situation is that there are many markers for pig manure, less for cattle and even less for poultry.
- Testing (the sensitivity required) is difficult to achieve, possibly need a literature review but hard to gather all the data needed.
- Intestinal ells can be used as a tracer?
- Need to create a "tool box" combining different methods and applying them to the right situations.
- How good is the persistence of the markers in relation to the persistence of *E.coli*? Very difficult to compare.
- Viruses are often host specific. Have viruses been studying specifically at the methods available taking this into account?
- Is genotyping *E.coli* feasible? Yes but not necessarily reliable as it is not homogeneous therefore so it would be hard to build a database.
- USA have commercial source tracking companies, could use some of their techniques in Europe.
- There is a need for a model on pathogen survival.
    - In Copenhagen there is a model for *E.coli* infecting the harbours. The model takes into account the various factors and put different coloured flags stating the risks of bathing in the harbour. This type of model could be applied on a larger scale.
- Could model runoff probability and therefore contamination with regard to weather, topography etc.
- Need to estimate the risk and what measures are appropriate in different situations and modelling could be a very important piece of future work in achieving this.
- QRMA could be helpful.

4. ***What do we find in the manure- biochemical composition and fecal contaminations?***

- This is specific to the type of animal manure being treated.
- Faecal indicator concentrations could be useful if they can be accurately measured.
- Need to establish concentrations/quantities of pathogens within the tank for each type of manure. This requires monitoring data which is currently missing.
- It is possible that these figures have been measured but just never published. Could it be possible to pool all monitoring data with these values and write a report?
- How are homogeneous results achieved from the tank (problems with stirring) Would it be better to study the manure directly after excretion as it will all end up in the storage tank eventually?
- If measurements were taken from 1m depth the manure is 90% homogeneous but is that enough?
- There are also issues of high daily variation. Time frame is difficult to assess.
- These figures of concentration could act as a control for a treatment comparison.
- The techniques for evaluation of bacteria and pathogens are available but expensive. There is limited evaluation technology readily accessible for viruses.
- Should the concentrations refer to a National level, the faecal indicators could be coordinated to the pathogen.

- There is no correlation between salmonella and other *E.coli* because the concentrations depend on the animal level.
- Animal Resistance: Resistances can be controlled between countries i.e. no infected/ resistant chickens from Denmark to France. PCR is available for analysis. Persistence of antibiotics is high through anaerobic treatment. Gene transfer is the main problem, not the antibiotics.
- Could use a model to identify areas where more research is needed. I.e. look at what assumptions are being made and then design investigations to assess these factors.

DAY TWO: 6th October 2011 – Environmental Subgroup

Led by Colin Burton and Laurence Loyon

Discussion session 1 – What are the main pollution threats linked to animal wastes – what is the priority order – what role for legislation and which is the most appropriate?
Led by Colin Burton

- Pollution threats
  1. Ammonia emissions
  2. P – water
  3. Nitrates/nitrites
  4. Ammonia in water
  5. Ammonia deposition
  6. Heavy metals in soil
  7. Methane
  8. Nitrous oxide
  9. Carbon dioxide?
  10. Odours
  11. VOC's : which
  12. Dust emissions
  13. Nitric oxide (NOx)
  14. Potassium (salinity)
  15. Hydrogen sulphide

- Carbon dioxide? – recycled element or new source (from fossil fuel)
  - *soil carbon content*
  - *new carbon release (energy)*
- Negative impacts
  - *Global warming*
  - *Acid rain*
  - *Nutrient surplus problems Eutrophication; Green seaweed; soil enrichment …*
  - *Salinisation (soil)*
  - *Soil toxicity*
  - *Water toxicity*
  - *Organic load in water – oxygen stripping*
  - *Odour nuisance*
  - *Dust (health; deposition near farm)*
  - *Ozone depletion*
- Positive impacts
  - *Fertilizer sources (nutrients + micro-nutrients)*
  - *Remedy deficiencies of Se, … ?*
  - *Better balanced fertiliser … ?*
  - *Organic matter – soil structure, soil improver, water retention .. ?*
  - *Soil carbon storage (re mineral fertiliser)*
  - *Increase value with respect to c fertilisers*
  - *Free and available ?*
  - *Cost benefit + reduced energy for chemical fertiliser (comparison production of 1kg of N-org v N- inorg – better for org (LCA). Terms of comparison? Boundary of the system?*

- Energy production – biogas – incineration – gasification
  - *Biogas – manure helps stabilise plant ? What energy contribution ? Economic? Other benefits (methane emission reduced). Neg energy balance ? (LCA).*
  - *Heat use crucial – possible? Numbers needed! Figures (Holland) give neg energy values. Use of gas crucial for heating.*
  - *Rare to have an economic system without subsidy HE in Germany.*
  - *Surplus heat a problem to use : heat not wanted in summer. Electricity production: 20% of substrate energy as electricity. Other benefits more important? Factory use of biogas.*
  - *Nutrients remain in digestate : improved – mineralised N (by much? 10 to 20% of raw org N – can be achieved by a long term storage!).*
  - *Homogeneity/fluidity : don't know re availability of P and other components.*
  - *Stability of residue organic matter. pH increase.*
- Incineration – especially horse manure (high straw) : volumes significant relating to leisure, small sites – collection? Used for compost. To make energy ? (Not municipal sites). Poultry (several plants in UK/Holland).
- Biochar : net consumer of energy ? Energy source – external? Use half to treat other half – energy balance. To put carbon in soil? How? Soil temperature (solar absorption – GP: ref?) Arguments? Sequestion of C.
- Gasification ? Does it work ? Plant in Germany – dry pig manure, sterling engine – does it work? Motivation – nutrient surplus – destroy nutrients – N to NOx and P to ? No extra NOx from gasifiction (re combustion). Availability of nutrients? Is ash really a good fertiliser?! Land-filled in Germany?
- Dust emission
  - *Health of animals in farm: farm related; nuisance (odour)*
  - *Cooling effect (?)*
  - *Significant? What % of total emissions – nationally (Holland) 5% - check PH*
  - *Dust particles produced from ammonia reactions – urban smog – agricultural contributions – check.*
- Drying option – solid manure (poultry droppings). Ammonia emissions reduced : by inhibiting breakdown of urea – BAT (Ventilation or forced air)
- Drying option (liquid manure)
  - *Esp of solid phase following separation*
  - *Esp of digestate after AD – using waste heat from electricity generation (Germany). Ammonia caught in acid scrubber sometimes.*
  - *Plants in Spain – drying liquid manure using waste heat from electricity generation – nat gas + biogas : requires subsidy. Efficiency compromised of power generation.*
  - *Portugal, Italy : natural evaporation option – ammonia losses ?! Only for the summer? Winter use?*
  - *Bio-drying (heat of composting) – for liquids associated with solids – same problems of ammonia.*
- Ammonia stripping(+Acid trapping)
  - *Pilot plants: Holland (?) , Sweden, Finland, …..*
  - *High energy (heating + compressor).*
  - *Plant in Italy using heat from biogas plant: CaO to produce heat. Production of ammonia sulphate – sold to chemical plant : conc around 8% (w/w) of ammonium sulphate in water.*
  - *May be classified as "organic fertilizer" Residual slurry pH 9.5*
  - *Typically 80% of TAN removed.*

- Struvite precipitation (adding Mg and PO4)
  - *Split-box (Sweden) Biotain : includes ammonia stripping ….*
  - *products : struvite, water, …*
  - *High consumption of Mg and PO4!*
  - *Does it work as an agricultural fertilizer – noting it is not soluble! Slow release fertilizer ……*
- Membrane technologies
  - *Do they work for slurries?*
  - *Pre-separation, flocculation, digestion, clarification then R.O. membranes (60 Bar) Large pilot plants Wageningen. 50-60.000 tonnes year in Holland. Cheaper than transporting manure – 10-15 euro/tonne of raw manure feed. Three end products – solid fraction, liquid to digester and mineral concentrate and water (50% of total volume). Pig farmers paying upto 20 euro/tonne for export (transport costs). Final polishing with ion exchange – discharge to surface water.*
  - *Max tolerable costs lower 3-5 euro/tonne in Spain.*
- Flotation
  - *Chemical + fine bubbles – top layer skimmed off : plants for manure in Holland and Italy. First step as pretreatment- sludge to AD and liquid treated by N/DN. Cost around 2-3 euro/metre3 of manure – total process 6-7 euro/m3 slurry. Objective – removal of organic matter. Also some N and P.*
- Acidification
  - *Used in Denmark – stops ammonia emission and methane. Falling popularity – costly. Teagasc : trials acidification during spreading – method in Gothenburg protocol. Problem of corrosion of machinery and stores. How is the acid added: mixing pit.*
- Aeration
  - *Loss of nitrogen (–ve) especially as N_2O. (Note: substantial losses as N_2O from field following manure application – aeration unlikely to lead to greater overall emissions especially if controlled).*
- Separation: higher emissions of GHG (N_2O) following separation – need to check this claim (based on modeling results from Denmark). Covers of stored liquids needed.

Discussion session 2 -What specific links do you see between land-spreading management/technique and local surface and ground water quality?

Laurence Loyon **–The MAREEF project: the objectives and the main findings** **[PowerPoint]**

Discussion

- Nutrient pathway from waste to environment difficult to identify – run off: many factors (slope, climate, soil condition) – not easy to reconcile.
- Leaching risks (infiltration factor) : leaching or run-off?
- Timescale for evaluation – need to define. Hours, days, months? Dynamic model needed.
- Health risks (being handled by microbiology sub-group)
- Need for decision support tool – best choices for each situation. Weather based system?
- Practical considerations: spreading done when farmers have time!
- Main report from MAREEF project not yet released (workshop minutes available)
- Questions remain on impacts from field heaps and related unprotected storage.

- Questions on land application controls – do they (or can they) work?
- Nutrient balance questions: this must be met first for the whole farm/region – but is it enough? (Local variations).
- Importance to clarify the objective – agronomic (crops) needs are clear but there can remain a risk of pollution even if this constraint is met. Importance of dynamic and seasonal factors.
- Crucial agronomic question – are we actually reducing the consumption of chemical fertiliser as a consequence of better manure management?
- Everything comes back to the true value of the nutrients in the manure – are the applied amounts enough and in the correct proportions? Top up option necessary to ensure crop needs met.
- Again, the same question: what it the goal and hence what is the most appropriate policy? Clearly there is no single solution but multiple strategies are hard to implement.
- Possible future motivation from rising fertiliser prices.
- Causes and consequences – linking poor practice and the resulting pollution – some evidence now available from MAREEF project *e.g*.: falling concentrations of nitrate in Brittany following recent policy implementation.

Discussion session 3: How can we equate different pollution types? What is a fair way to compare options? How can we optimise a farming system to minimise environmental impact?

***Colin Burton* – Whole farm modelling: an example from the BATFARM project** [PowerPoint]

Discussion was partly aimed at the model being developed by the BATFARM project which is intended to be a management tool based on mass balances : the prediction being emissions (air and water) as a function of implemented BAT techniques. (Information provided by MAR). Details of a similar tool being developed by the University of Milan were given by GP with a presentation during the coffee break on Day Three.

Other comments

- How can we compare the impacts from different pollutions associated with manure management? Concept of allocating a value to each type in terms of a universal score – the actual relative weighting could be left to the user depending on the local situation.
- Simplified procedures needed – eg: “traffic light system”
- On the other hand, some situations do require a means of allocating an actual value to enable decisions.
- Any scheme used in a model must be transparent to allow the user to see the reasoning.
- Example of the use of “emission factors” as used for ammonia. A wide range of figures have been published showing the sensitivity to measurement technique and definition of the system.
- Estimating model errors!

Discussion session 4: What are the main pollution risks from manure management for buildings and storage at the farm? What are the best approaches for abatement?

Simon Lehuger **– Measurements of emissions from buildings – the techniques available**
[PowerPoint]

Discussion points

- Measurement of emissions is clearly a large subject area! It's not always clear (a) what emission is being measured nor (b) if that being measured reflects the true emission. There are also (c) the inherent errors of the equipment itself.
  - *Example: the problem of accumulations of emission within the building or manure store with variable release as a function of wind or other local conditions.*
  - *Example: interference of applied tunnels and chambers on the local emission: changing the local conditions.*
  - *Example : representative sampling points – especially for solid manure stores but also poorly defined buildings*
  - *Spatial and temporal variability of the emission – makes for a difficult estimation.*
- Target: maybe it should be the overall emission over a year to enable comparisons and overall impact from farm? This may address problem of "moving the problem" where a local improvement is negated by increased emissions later on (such as during landspreading).
- Special problem of naturally ventilated buildings where flowrates are difficult to measure (possible use of tracers or techniques such as FERM tubes).
- Application of dispersion modelling techniques?
- The choice of the modelling approach runs into the question "Mechanistic" (complicated but scientifically based) or "Empirical" (easier but not usable outside studied area).
- Emission factors country to country – comparing measurement techniques or actual emissions?!
  - *Thus the approach of standardization of technique – however, eliminating operator errors is not so easy even with precise procedures and this is not guarantee of a correct measurement (similar procedures can lead to similar errors!)*
  - *Better approach may be the comparison of systems and options rather than seeking absolute values*
- Observation period for emission estimation crucial : eg: for N2O following land application, the main emission peak may not arrive for several days (or weeks even), often following a rainfall.
- Broad agreement that some simplification of the measurement/evaluation procedure is needed to make this possible.
  - One option might be the establishment of a maximum emission potential (rather like best methane potential or BMP used in biogas calculations) – for ammonia and other gases for a given scenario.
  - Return to the question of standard procedures with the added comment "are we measuring the correct thing (?!) *e.g.:* Emission from a building….. (just the building or associated stores); ……. over what period?; …….. at what places? Again the question returned of what is the question that we are answering?

Discussion session 5: What are the environmental impacts and other negative aspects from manure management options themselves?
Colin Burton **– Literature review on the current technologies available to protect the environment** [PowerPoint]

Conclusions –environmental subgroup - Actions required and agreed strategies

- Need to set much clearer objectives for manure management schemes
- Manure treatment is more a cure of a problem : better to aim at prevention
- 1. Biogas AD – important to look at efficiency and heat use 2. What is being defined as BAT in the new BREF document (due out soon) to see if this can work out in practice.
- Many problems can be solved in efficient nutrient use – low emission stores, timing of application, manure processing may be necessary. Cost efficiency.
- Focus on how to reach a balance between application of manures and crop needs – farm and regional scale.
- Transfer knowledge into suitable and feasible technical solutions – so to use manure as fertilser thus reducing environmental impact.
- Complex problems needs multiple solutions ; balance between land and manure, good management, skilled advisors, precision application, low emissions technology, right timing, crop rotation according soil and regional conditions.
- New technologies only at pilot scale – need to upscale technologies – side effects , LCA .
- Research in treatments aiming to recover / produce new products. Common criterion / methodologies to compare technologies.
- Proper management of nutrients; clearer and integrated legislation.
- Focus on manures as resource and not a waste, highlighting fertilser value, knowledge transfer to the farmers, tools they can use.
- Reach a proper allocation on crops of ecomically viable waste (raw manure) or products after treatment (digestate, composts etc): need to ask before choosing technique – which is most appropriate.
- Fertiliser replacement value : accuracy of nutrient content and availability – regional and situation specific (esp N and P). Try and close the nutrient cycle.
- Manure management: control elements to optimize nutrient cycle at the farm scale. Methodologies – connection between modelling and measuring. Standardized methodology (eg LCA) to harmonise research.

DAY THREE: 7th October 2011

Bjorn Vinnerås **- Summary of main findings and discussion from Microbiology subgroup [PowerPoint]**

- Many different treatments are available, are they sustainable both environmentally and economically.
- There is a need for a review paper comparing the different techniques on a European level.
- Defined manure- What is in it? Pathogen levels need quantification. Also need to look at this on a national level, especially salmonella which is highly variable.
- Faecal indicators could be a good way to quantify this.
- Treatment indicators- Enterococci is not only faecal so why is it an indicator? Proposed a paper on the issues related to *Entrococci*.
- Do we need overkill processes? Parvo55'C takes 6hours but all other viruses denatured by heat treatment within 12 minutes so the risk of this one virus does not justify the cost.
- Source tracking: An evaluation of tools is needed, new and old. Best way to assess source is with a "tool box".
- Modelling of survival: QMRA- How long is survival in manure and what factors influence this? Selection use, application technique, risk of spreading disease…
- Transfer of resistant genes. Microbes can transfer their resistance to non-resistant microbes.
- A model could be used to identify the gaps and assess what assumptions we are making. This would point out the areas which need further research.

Colin Burton **- Summary of main findings and discussion from Environmental subgroup**

- Clearer objectives of manure management are needed. Compiling a desirable list is easy but turning that into policies and legislation is far harder to achieve.
- Need a detailed assessment of the problems associated with manure.
- Biogas: Needs to be very efficient. How applicable is this technology? More case studies are needed to assess how different regions could install this technology.
- Better nutrient use within the cycle- old question but we need to make the most out of what is there to ensure cost effective techniques.
- Has research advanced nutrient balances? Analysis is needed on a farm, field and regional scale to assess whether the balance is working. Are individual farms in balance?
- There is no single solution. Need to have tailor made solutions for individual farms.
- Need to upscale prototypes and bridge technologies to see the larger scale effects of application.
- Need standardise methodologies, i.e. LCA. There is conflicting data and not everyone is approaching the problem in different ways. Need to harmonise research.
- Feed management to reduce nitrogen and phosphorus have been proven and should be a more widely applied management technique.
- Always must consider the animal based parameters

Colin Burton **– workshop actions**

1. ***Review report on livestock waste management*** *(mandatory)*

- Include points from the subgroups.
- Appropriate framework discussed.
- Condition: joined up thinking is required, need a clear plan and objective of this paper.
- There are a huge number of issues and the paper must not trivialise nay but prioritise only. Must identify the areas which require action.
  - *Need to define the problem.*
  - *State the aims of the report.*
  - *Set out options, treatment/ management…*
  - *Set out all the areas which lack data or conflict.*
  - *Identify areas of future research*
  - *Strategies looking at applicability, costs and implementation.*
  - *Conclusions*
  - *Annexes*
- This report is not to be a wish list: it must place a weighting on the different problems in order to identify solutions.
- There could be critical, but positive, evaluation of legislation.
- Must also consider whether manure is the main source for these problems or is chemical fertiliser or human waste?
- A detailed work plan of the required technical report to be circulated shortly after the meeting. This is based on detailed discussions during the meeting: discussion not included here but represented in the draft attached (**Appendix 6**).
- The deadline for all contributions will be **end of November 2011** but it would preferable to have contributions much sooner: some early submissions before the 21st October would be appreciated.
- The target is to release the report for distribution before the end of 2011.

2. ***Scientific review paper*** *(optional)*

- Good way to be cited and will have lasting value.
- Will need to critically evaluate and advise.
- Possibility of turning it into two papers, one focusing on the environmental issues and another on the microbiology issues. This depends on the type of publication. If it were a general publication a paper combining and reviewing both topics would be preferable as it would have a greater impact.
- A lead author is needed and no volunteers as such so must be followed up at a later date.
- Based on above technical report.

3. ***Revision (possible 3rd Edition) of the MATRESA reference book*** *(optional)*

- Colin Burton would love to lead this but is not in a position to do so; he is happy to contribute chapters and offer a lot of support.
- No lead author volunteers as such so must be followed up at a later date.

4. ***Separate Entrococci Paper*** *(optional)*

- Needs a lead author still but had a lot of support in the subgroup on the 6th October

5. ***Collaborative European Projects*** *(optional)* **[PowerPoint]**

- **Project number 1:** rejected
- **Project number 2:** Need a quick decision as the deadline is the 15th November
- **Project number 3:** Looking into downgrading technologies so it can be applied in developing countries with high efficiencies. FAO would partner with us? Would need partners in the developing countries. Advantage is there won't be many bids for this so likely to get it. Possible to get CIRAD. BV and AD keen to provide information but not to coordinate.
- **Project number 4:** Needs European interests
- **Project number 5:** Need partners in India. Many bid for this project so need to be an all or nothing bid. Possible to have a pre-call?
- Possibly lobbying for a project, this was how BAT Support was achieved but is not always an effective strategy.
- Time is running out for bid under 2011 call : possibly in 2012 or think of FP8 (known as "Horizon 2020").

CLOSE OF MEETING

APPENDICES

Appendix 1 Invitation and circulated agenda

Appendix 2 PowerPoint presentations

Appendix 3 Profiles of participants, including their areas of scientific interest and that of their department

Appendix 4 Preparation questionnaire

Appendix 5 The responses of this questionnaire are given in with the main summaries set out in tabulated form

Appendix 6 Plan of the required technical report: *Reconciling environmental and sanitary risks in the management of livestock wastes : a review on the current situation in Europe*".

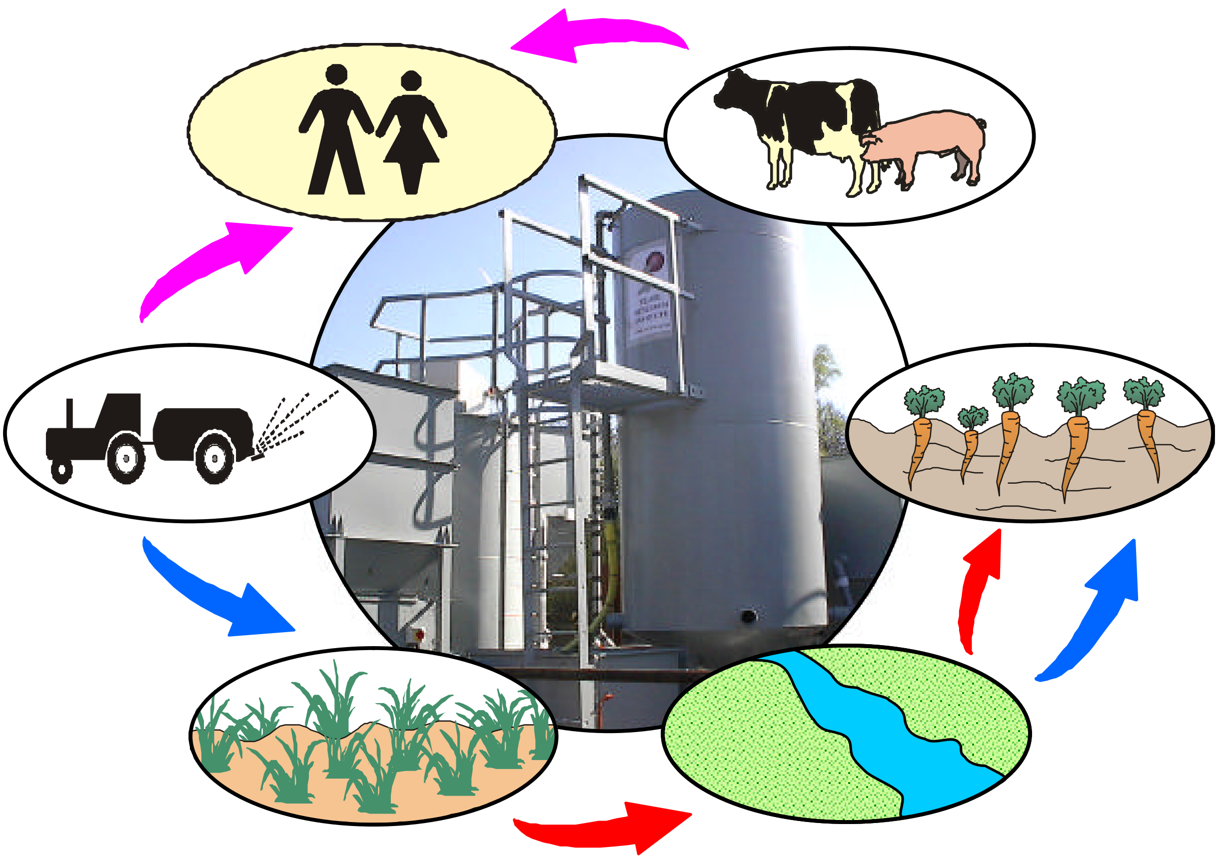
APPENDIX 1

Invitation and circulated agenda

Draft plan: version 27 April 2011

Reconciling environmental and sanitary risks in the management of livestock wastes

European workshop – Rennes, France – 5/7 October 2011



Funded invitation for selected experts

Scientific committee:

Colin Burton[1,2], Anne-Marie Pourcher[1,2] and Björn Vinnerås [3,4]

1 Cemagref, unité GERE , Rennes, France
2 Université Européenne de Bretagne, France
3 Dept of Chemistry, Environment and Feed Hygiene, National Veterinary Institute, Uppsala, Sweden

Objectives

To evaluate new and existing manure management technologies in terms of their actual abatement of associated environmental and health risks. Specifically, we will discuss the :

(i) Reduction of emissions associated with manure handling and use;
(ii) Reduction of water & soil pollution by nutrient excess after manure application;
(iii) Reduction of direct contamination of water and soil by related pathogens
(iv) Reduction of risk presented to food production chain from manure use
(v) Cost implied given as per tonne manure dry solids handled.

As well as looking to quantify technologies in these terms, the likely scientific mechanism will be established to show the viability and durability of each option. Special attention will be given to the conflicts between environmental and hygiene objectives.

Deliverables

- A comprehensive report reviewing manure management technologies across Europe will be published by end-Dec 2011 (*minutes will be produced separately*).
- A joint scientific review paper on the relative benefits of manure management techniques to reduce hygienic risks from manure.
- An agreed structure for a European collaborative project (possibly funded under the next call of FR7). Subject: *the mechanisms relating to applied eco-technologies that determine the persistence of pathogens and the abatement of pollution impacts.*
- *Agreement to the revision of the "MATRESA" reference book on livestock waste* management – 3rd edition targeted for early 2013 subject to funding.

Background

In the face of recurring health and environmental challenges from the management of livestock effluents, there is an increasing reliance on regulation to control the problem such as demonstrated in the progression of the EU IPPC Directive (and related BREF documents) or by the recently revised EU regulations on animal by-products (1069/2009). However, the implementation of environmental measures to reduce pollution and/or health risks can also greatly impede the farming activity whilst not always achieving the intended purpose. Furthermore, legislation to protect food quality by restricting the use of livestock manures on crops may undermine measures for environmental protection by limiting the opportunity to usefully recycle manures safely, thus aggravating the problem of nutrient excess. Clearly there is a need for more research into these conflicting objectives especially if we are to see a significant improvement on the current very limited uptake of abatement technology that can address some of these problems. However, it is not only the lack of research nor of available techniques to deal with manure management which lies at the heart of the problem. For example, the subject was reviewed in depth by the EU Framework 5 project, *MATRESA* which drew on the experience of 30 partners and more than 500 published papers. The shortcoming now is rather an issue of *evaluation and selection strategy*; how to meet multiple targets; how to compare the methods available along with their possible unwanted consequences, some which may have as yet received little consideration.

Structure of the workshop

The workshop will represent the working together of two teams – one comprising environmental engineers/scientists and the other microbiologists and agronomists – together to enable a comprehensive review of the factors that determine good manure management. The meeting will thus be structured as a joint session followed by separate sessions on the second day and a final session to bring together the various finding in a single objective plan.

SESSION 1 (Wed 5 Oct: 10h00 to 13h00) ***Introductions and objectives***

Inevitable, the first part of any workshop requires the introduction of the participants, their background and expertise. As we expect around 30 participants, we propose to limit this to no more than 5 minutes to avoid running on too long : we will ask each person to provide also a brief (half page) resume including contact details which will be included as an appendix in the minutes. We will extend the remit of introductions to include also the perception of each partner of the key issues from their perspective and of their country/region.

SESSION 2 (Wed 5 Oct: 14h00 to 17h00) ***Establishment of keys issues of workshop***

A crucial objective of the first day when all participants will be together will be to set out the common factors that determine the study. These will include the desired purpose and objectives that we must agree to ensure a complimentary approach from the two teams.

- Review of EU regulations influencing manure management
- Description of the environmental, sanitary and economic key issues concerning the use of stored or treated manure.
- Establishing the criteria for selecting the most efficient technologies: reconciling different objectives.

SESSION 3M (Thurs 6 Oct: 09h00 to 13h00) ***State of the art (our current knowledge)***

The objective of this session is to compare the efficiency of methods to reduce the level of pathogens from farms with respect to the intensive rearing of pigs, cows or poultry. We will discuss the way to reduce the health risk associated with manure management practices especially highlighting scientific points that require clarification.
Identification of the microbial risk (what target?)

- Prevalence and routes of transmission of most important zoonotic agent
- Impact of the effluent management on the sanitary risk
- Example of the thermal treatment : a compromise between energy cost and the hygienisation efficiency
- Impact of landpreading management on the water quality

SESSION 3E (Thurs 6 Oct: 09h00 to 13h00) ***What are the real pollution problems?***

This seemingly simple question doesn't lead to an easy answer: for an example, should we be concerned about carbon dioxide emissions from the decay of organic material? Do we want to stop ammonia emissions from buildings or from all farm activities? Then we have the second challenge of deciding between different pollution: 1 kg of ammonia equals how many kg of nitrous oxide?!

- What are the main pollution risks from manure management: buildings, storage, spreading?
- Can we equate different pollution types: if not how can we optimise a farming system to minimise environmental impact?
- What are the environmental impacts from manure management options themselves?
- What is the importance of cost and practicality?
- What is a fair way to compare options?

SESSION 4M (Thurs 6 Oct: 14h00 to 17h00) ***Gaps in the current knowledge***

This session will look to go further than asking “what we don’t know”. It’s important to work out also “what we need to know” and how this can be applied in a research context to enable a better development of methods to address the microbiological concerns relating to manure management. Discussion will be around 12 broad options available for improving the handling of livestock manure :

1. Feed diet control options
2. Air scrubbers and biofilters
3. Storage options (Minimal storage time for manures and covers)
4. Separation and composting systems
5. Anaerobic treatment
6. Aerobic treatment (including nitrification and de-nitrification)
7. Sedimentation options: the use of lime
8. Spreading using injectors or trailing hoses
9. Transporting surpluses out of the region - pipelines
10. Thermal treatment options
11. Manure products (including drying option).
12. Other technologies

- What data do we need to estimate the sanitary aspects of such technologies?
- What is their potential to reduce pathogen in a cost effective way?
- Data acquisition versus modeling the persistence through the treatment
- Quantitative Microbial Risk Assessment methods

SESSION 4E (Thurs 6 Oct: 14h00 to 17h00) ***The technologies available***

Having set out what we expect of the abatement (BAT) technology and how we can reasonably and fairly compare and evaluate the options, we now come to the same list of what is available given above. We will try to include everything that has been shown as possible even if some ideas are not commercially available. For each option or group, we will look at the merits and drawbacks in the context of livestock farming and the set environmental objectives. Health aspects will be considered separately in parallel and during the final session.

SESSION 5 (Fri 7 Oct: 09h00 to 13h00) ***Findings and actions to be taken***

In this final session, we will bring together our separate discussions into a single coherent strategy. From here, the work of the meeting will focus of the development of 2 or 3 bold actions to turn the identified requirement into reality.

- Feedback from separate sessions: presentation of 15 minutes summaries & discussion
- Preparation of a broad statement of research strategie(s).
- The structure and requirements of a review report as a starting point for future projects (workshop minutes will be prepared and distributed separately by the organisers).
- Agreed theme and outline content for a European project. For those participating in this option, a separate meeting will be organised for detailed planning.
- Agreed structure for a joint review paper.

OTHER WORKSHOP ARRANGEMENTS

There will be an optional study tour on the afternoon of Friday 7th October (14h00 to 18h00) which will include farm installations with installed technology to reduce environmental and health impacts from manure management. Arrangements will be put in place for formal evenings for all participants for the Wednesday (in Rennes) and Thursday (in St Malo). Accommodation for all invited experts will be arranged at a local hotel convenient for Cemagref and the city centre.

Contributions required from participants

The success of this consultation will rely on willing contributions from all experts invited. The main elements requested are:

- Preparation of a short talk on previously agreed subject falling into own area of competence (10 minute)
- Verbal contributions during the open discussion sessions of the workshop
- Written contributions following the workshop to support the preparation of the review report on manure treatment technologies (as agreed during the meeting)
- (Optional) : contribution to a joint scientific review paper on the subject.
- (Optional) : contributions to a suitable European project proposal

Subject to agreement and funding, there will also be the option to join the editorial group for a revision of the MATRESA reference book on livestock waste management.

Funding of workshop

Travel and subsistence costs for all invited experts will be covered by funds already secured for this initiative. The main element of the costs the meeting will be met from the BAT-FARM project which is funded by the EU Commission (via regional funds managed by the Atlantic Area Group) and from Cemagref.

Wednesday 5th October 2011

08h30 – 09h00	*Coffee for prompt **09h00** start*	
09h00 – 09h15	Welcome	PD
09h15 – 09h30	Outline of programme for the 3 days	CHB
09h30 – 10h00	Presentation of the BATFARM project	PM
	SESSION 1: Introductions and objectives	
10h00 – 10h30	Objectives, obligations and outputs the workshop	CHB
10h30 – 11h00	*Coffee break*	
11h00 – 12h30	Presentation of partners (5 mins max)	ALL
12h30 – 14h00	*Lunch break*	
14h00 – 15h00	Presentation of partners : continued	ALL
	SESSION 2: Establishment of key issues of workshop	
15h00 – 15h45	Discussion session 1 - Review of EU regulations influencing manure management	CHB
15h45 – 16h15	*Coffee break*	
16h15 – 16h45	Discussion session 2 - Description of the environmental, sanitary and economic key issues concerning the use of stored or treated manure.	CHB
16h45 – 17h30	Discussion session 3 - Establishing the criteria for selecting the most efficient technologies: reconciling different objectives.	CHB
17h30	End of first day	
20h00	*Evening meal at restaurant **La Réserve**, Rennes – meet at the foyer of the Hotel at 20h00*	

Thursday 6th October 2011 - Microbiology sub-group

08h30 – 09h00	*Coffee for prompt **09h00** start*	
	SESSION 3M: State of the art – our current knowledge	
09h00 – 09h15	Outline of programme and objectives	BV
09h15 – 10h00	Literature review 1) Pathogenic microorganisms which may be found in the farm effluents 2) Health risk associated with land application of manure 3) Impact of treatment on indicator bacteria and pathogenic bacteria 4) Survival and transfer of bacteria after land application	AMP
10h00 – 10h30	Discussion session 1 What is the appropriate target for acceptable microbial risk – are there safe levels? What microorganisms of special concern?	BV
10h30 – 11h00	*Coffee break*	
11h00 – 11h15	Identification of the microbial risk from outdoor cultivation of cattle	HHT
11h15 – 11h30	Thermal treatment of manure	CC
11h30 – 12h00	Discussion session 2 – what is the impact of effluent management/treatment on the sanitary risk – simple storage, biological treatment, chemical / thermal treatment, animal diets ……	BV
12h00 – 12h30	Discussion session 3 – what are the prevalence and routes of transmission of most important zoonotic agents relating to animal wastes?	AMP
12h30 – 14h00	*Lunch break*	
	SESSION 4M: Gaps in the current knowledge	
14h00 – 15h30	Discussion session 4 - Review of the benefit of current and new technologies	BV
15h30 – 16h00	*Coffee break*	
16h00 – 17h00	Discussion session 5 – microbiological data What data do we need to estimate the sanitary aspects of such technologies? What is their potential to reduce pathogen in a cost effective way? Data acquisition versus modelling the persistence through the treatment Quantitative Microbial Risk Assessment methods	AMP
17h00 – 17h30	Actions required – summary of main points arising and agreed strategies (targets) and priority themes for research	BV
17h30	End of second day	
17h30	*Visit to St Malo : walking tour and dinner in a local restaurant in the old city* *Coach from Cemagref and return to hotels*	

Thursday 6th October 2011 - Environment sub-group

08h30 – 09h00	*Coffee for prompt **09h00** start*	
	SESSION 3E: What are the real pollution problems?	
09h15 – 09h15	Outline of programme and objectives	CHB
09h15 – 09h45	Discussion session 1 – What are the main pollution threats linked to animal wastes – what is the priority order – what role for legislation and which is the most appropriate?	CHB
09h45 – 10h00	Whole farm modelling – an example from the BATFARM project	CHB
10h00 – 10h30	Discussion session 2 - How can we equate different pollution types? What is a fair way to compare options? How can we optimise a farming system to minimise environmental impact?	CHB
10h30 – 11h00	*Coffee break*	
11h00 – 11h15	The MAREEFproject – the objectives and the main findings	LL
11h15 – 11h30	Discussion session 3 -What specific links do you see between land-spreading management/technique and local surface and ground water quality?	LL
11h30 – 11h45	Measurements of emissions from buildings – techniques available	SL
11h45 – 12h30	Discussion session 4 - What are the main pollution risks from manure management for buildings and storage at the farm,? What are the best approaches for abatement?	CHB
12h30 – 14h00	*Lunch break*	
	SESSION 4E: The technologies available	
14h00 – 14h45	Literature review – current technologies available to protect the environment	CHB
14h45 – 15h30	Discussion session 4 – for each technology : a) What is their performance to reduce polluting gas emissions – which gases, b) Can they reduce N or P surplus – by how much and by what method? c) What benefits (financial or practical) can they bring to the farmer? d) What is the main barrier to uptake?	CHB
15h30 – 16h00	*Coffee break*	
16h00 – 17h00	Discussion session 5 - What are the environmental impacts and other negative aspects from manure management options themselves?	CHB
17h00 – 17h30	Actions required – summary of main points arising and agreed strategies (targets) and priority themes for research	CHB
17h30	End of second day	
17h30	*Visit to St Malo : walking tour and dinner in a local restaurant in the old city* *Coach from Cemagref and return to hotels*	

Friday 7th October 2011

08h00 – 08h30	*Coffee for prompt **8h30** start*	
	SESSION 5: Findings and actions to be taken	
08h30 – 08h45	Outline of programme and objectives	CHB
08h45 – 09h00	Summary of main findings and discussion from **Microbiology subgroup**	BV
09h00 – 09h15	Summary of main findings and discussion from **Environmental subgroup**	LL
09h15 – 10h00	Discussion session 1 – key strategies for future research	CHB
10h00 – 10h30	Current call under FR7 : possible areas for a collaborative bid	CHB
10h30 – 11h00	*Coffee break*	
11h00 – 12h00	Organisation of a state of the art report - setting up an agreed structure. **Proposed title** : manure waste management options to protect the environment and related Sanitary risks (food & water quality, public and animal health). Distribution of tasks amongst partners which each contributing 2-3 pages relating to their own expertise. Compilation to be done by Cemagref team.	CHB
12h00 – 12h30	Discussion session 2 – preparation of a multi-author review paper (based on review report) Nomination of lead author and co-authors; scientific journal; outline of content; allocation of Main tasks (especially literature review). Option of a 3rd edition of the MATRESA reference book	CHB
12h30 – 14h00	*Lunch break*	
14h00 – 15h30	Optional tour of research facilities at Cemagref – Rennes (for those not wishing to participate In the discussion of a European project	CC
14h00 – 15h30	Preparation of an outline bid under the current call for EU proposals Nomination of coordinator for project preparation and lead partner (if not the same) Outline of content and actions needed – agreement of calendar for drafting proposition(s)	CHB
15h30 – 16h00	*Coffee break*	
16h00 – 16h30	Closing session : actions agreed for coming 4-6 weeks Preparation of minutes Final questions	CHB
16h30	End of workshop	
	Optional evening meal – to be discussed	

APPENDIX 2

PowerPoint presentations

APPENDIX 3

Profiles of participants,
including areas of scientific interest and that of their department

PARTNER PROFILES

Dr AGUILAR-RAMIREZ Maite

The ITGG (Technical Institute of Livestock Management of Navarre) is a public company of livestock services that offers technical assistance to the farmers of Navarre. The Department of Innovation and Research of ITGG is the responsible for obtaining and validating technical references to support the technical assistance services to farmers. Our facilites include several experimental farms, but we also performed studies on commercial farms.The general points of ITGG studies are: production systems, conservation of indigenous breeds, quality and food safety, environment, animal welfare, safety and process automation. ITGG collaborates and receives funding for researching both National and International entities.

My own experience: Degree in Agricultural Engineering by the Public University of Navarra (Spain) in 2003/04. Final Year Project based on the study of organic wheat production in semiarid drylands. Participation in a market research for agricultural products in collaboration with the Public University of Navarre. In 2005 start working for the Department of Innovation and Research of ITGG (Technical Institute of Livestock Management of Navarre) until now. The first two years I obtained a grant to study the environmental conditions in the farms in Navarre. Then, my work consisted in supporting farmers in ventilation management in farm buildings and colaborating in the development of a service for GPS location of livestock during grazing. In 2008 I started working in BATs studies. During these years I have participated in several National and European projects: DOMOPEC Project, which consists in the development of a remote management center for several intensive farms by applying new technologies; FERGIR Project, for agronomic valorization of manures and BATFARM Project, for BATs studies. In 2010 I achieved a master's degree in Environmental Agrobiology by the Public University of Navarre and the University of the Basque Country. Nowadays I am a PhD student, my thesis is going to be based on the BATs studies within the BATFARM project.

Dr BONMATI-BLASI August

The GIRO Technological Centre was founded in October 2005. As stated by the acronym GIRO (in Spanish, Integrated Management of Organic Waste), the mission of the Centre is to integrate different areas of knowledge related to the organic waste management in order to decrease its environmental impact and to develop improved strategies to benefit from these materials as a resource, rather than just a waste.

Cooperation with other Centres is a key issue for solving transversal problems. With this respect, GIRO has signed a number of cooperation agreements with different institutions worldwide and nowadays is working with ABP (Denmark), TNO (The Netherlands), CRPA (Italy), EULA (Chile), INTA (Argentina) or ARS-USDA (USA) in different projects, as examples. GIRO was created as a joint research, development and technology transfer centre by the following Catalan institutions, from which the chief directive positions actually belong to the Trustees Board of the GIRO foundation.

- Agrifood Research and Technology Institute (IRTA): is a public research institute from the Government of Catalonia, and belongs to the Department of Agriculture, Livestock, Fisheries, Food, and the Natural Environment.
- The Technical University of Catalonia (UPC): is a public university with a consolidated worldwide reputation and an international vision towards scientific talent and technological innovation.

- Ministry of Territory and Sustainability of the Government of Catalonia: Has the responsibility, among others, on environmental quality and climate change policies, water and waste management, and the promotion of renewable energy. And the Waste Agency of Catalonia (ARC), that belongs to this Ministery.
- City Council of Mollet del Valles, municipality where GIRO is placed.

Since 2007, GIRO is a recognized member of TECNIO, a network devised by the Government of Catalonia with the aim of bringing together leading experts currently working in applied research and technology transfer. TECNIO is a technological partner for firms working side by side on their R+D+i projects, providing technical solutions, grants and project management services. The Mission of TECNIO is to consolidate and enhance the technology transfer model to generate a technology market that offers competitiveness to business, and to provide technology to companies that give added value to their projects in a globalized context. The accreditation process means that GIRO implemented a Quality Management System following UNE-EN ISO 9001 as well as the requirements of the Accreditation System of this network, based on the demostration of excellence on research activities and on the ability to provide services and projects meeting customer requirements.

The GIRO Technological Centre was born with a vocation to encourage that progress in knowledge becomes real applications, contributing to an improvement of the technological offer by private companies, as well as to the setup of optimized management plans by the administration. GIRO provides consultancy services and technical collaboration for R+D projects, in accordance with standard quality parameters, always from an autonomous perspective, confidentiality, and scientific independence.The services offer is:

- Advice on technology, organizational methods, and management plans and programmes
- Evaluation of organic waste and by-products as a potential agricultural and energetic resource
- Evaluation and assessment of new and emerging environmental technology
- Bioremediation of contaminated soils and ground waters
- Contract research and technological development, with evaluation and optimization of treatment processes at laboratory, pilot test and industrial scales
- Laboratory analyses
- Technological Observatory and Documentation Centre
- Specialized training and made-to-measure courses for companies and/or public administration

The current research and development projects are related to the following subjects:

- Anaerobic digestion: methods for overcoming inhibition by LCFA and ammonia, and development of new anaerobic reactor designs and pretreatments for substrates with high solids content.
- Microbial ecology. Characterization and dynamics of microbial populations in biotechnological treatment processes.
- Microbial fuel cells applied to manure and other liquid organic byproducts.
- Process for the recovery (stripping, absoroption, precipitation of struvite) or removal (improved nitrification-denitrification via nitrite, anaerobic ammonia oxidation) of nitrogen.

- Biological gas treatment. Control and treatment of gaseous emissions associated with the processing of organic waste, industrial activities and bioremediation processes.
- Bioremediation. Evaluation of the application of organic waste and/or its transformed products to the soil.
- Methods to assist the decision making process encompassing the use of technology and good management practices.
- Modelling and simulating biological and physicochemical processes.

Mr BOYLE Mark

PhD Student
Dept. Of Engineering and Built Environment
Glasgow Caledonian University
Cowcaddens Road
Glasgow G4 0BA
Scotland

Mark Boyle is currently studying for a PhD in Environmental Microbiology concentrating on the detection and isolation of indicators and microbial pathogens resulting from agricultural activity in the West of Scotland. He is a graduate in Environmental Toxicology and since graduating has worked for the Scottish Environmental Protection Agency in a number of scientific and regulatory roles namely in marine chemistry, ecotoxicology and as a lead water inspector in an environment protection team.

His current research at Glasgow Caledonian University concentrates on the examination of various faecal indicator and other microbial pathogens including *Campylobacter* spp., Salmonellae, *Enterococcus* spp. and *Cryptosporidium* spp. in agricultural run-off and other surface waters. He is also part of the GCU team working on the BATFarm project and conducts analysis and reports on the levels of target organisms in fulfilment of the requirements of the project.

Dr BURTON Colin

Chemical engineer with 30 years of experience - 22 in environmental engineering. He became a project leader in 1989 and has since specialised in the design and operation of treatment processes for agricultural wastes for the abatement of air/water/soil pollution, odour, nutrient use and disease control. He has led national and international research projects and workshops in waste engineering including major reviews of manure management in Europe. He has been invited to give lectures in many countries: publications include scientific papers and reference books on waste management. Switch to environmental engineering in 1989 with appointment as project leader with Silsoe Research Institute (previously, AFRC Engineering) and to Cemagref (Rennes) from 2055 to 2011. Currently independent consultant. Main responsibilities - (a), running research projects (b), consultancy & dissemination work and (c) procurement of new projects. Management duties covered project staff (scientists and technicians) and tutoring PhD students and visiting workers. Other activities reflected the promotion of the institute's work and include scientific publication, lecturing, refereeing and serving as an independent examiner for external projects.

Specialist research areas
The heart of the research work was agricultural & food waste (solid/liquid/gas) treatment processes with the purpose of (i) reducing air, water and soil pollution risks, (ii) nutrient conservation & use, (iii) odour reduction, (iv) disease control and (v) safe disposal. A second theme was the treatment of wastewater to enable re-use. Such processes are often based on biological degradation of an organic substrate, but they can also include physical treatment stages (eg, sedimentation or heat treatments), chemical stages (eg. pH control or flocculation) and mechanical operations(eg, screening or centrifugation). Studies focussed both on the equipment itself and on the performance of the overall treatment package - this work extended to include the engineering, bio-chemical, monitoring and evaluation and agronomic aspects. Practical work included the design and construction of many pilot scale plants varying from a small unit (20 litres/h) set up in a restricted area for virus decontamination work, to large fully automated units to stabilize the wastewater and liquid manure output from a small livestock farm (500 litres/h).

Consultancy work and dissemination
Duties also covered consultancy work with the specific task of developing a technical service for the agricultural and food industries. This led to farm and food factory visits for the purpose of resolving problems related to the management, treatment and safe disposal of organic wastes - the recent IPPC legislation was a major factor in this work. The dissemination of the findings of my various research projects and studies led to lectures at conferences across Europe and in N America. This in turn led to several overseas projects including managing an EU specialist group made up with a team of engineers and scientists from 28 European organisations. The principal output of this last project was my publication of a key reference book for manure management in Europe. Other major overseas assignments included a 3-month secondment to work with partners in France and the development of a World Bank project on manure management with the FAO in SE Asia.

Prof DALSGAARD Anders

Professor (pmso) Food Safety and Environmental Hygiene
Department of Veterinary Disease Biology, Faculty of Life Science
University of Copenhagen,
Stigböjlen 4
DK-1870 Frederksberg C
DENMARK

The DVDB has a broad research and educational expertise within pathogens, hygiene and public as well as animal health taking a One Health approach. Expertise subject areas include bacteriology, parasitology, virology, food safety, environmental hygiene and public health. With direct reference to animal manure management and interactions with environmental and public health the main interest and research areas are: **1) Presence and survival** (bacterial faecal indicators; bacterial, parasite and viral pathogens). This includes detection: culture-based, plaque assays and molecular methods, RT-PCR, etc.; viability (hatch assays of helminth eggs; dye assays (DAPI/PI) of protozoan parasites); and infectivity of bacterial and protozoan pathogens (cell, mouse and chicken infection assays). **2) Transmission – spread**. Here we take a a field to fork perspective and apply different methods (molecular epidemiology, i.e. various types of DNA fingerprinting techniques) as well as epidemiological risk factor analyses to trace the sources of faecal pollution; and vehicles (water, food) – vectors (e.g. insects) of faecal pollution. **3) Transport and survival of pathogens in soil**. Here we study mechanisms and determinants of the transport of pathogens in soil water using both laboratory soil columns; lysimeters and full-scale field experiments. Manure types researched include solid manure, raw slurry, separated liquid and solid slurry fraction applied through both surface and sub-surface (e.g. injection) techniques. Survival of pathogens is also studied during composting, anaerobic digestion, separated (mechanical and chemical) slurry. In addition to animal manure, related research as described above is carried out in relation to irrigation with low quality water (e.g. wastewater) and human excreta (e.g. faecal sludge). The research has a particular international focus on problems faced by less developed countries. DVDB has a broad experience from participating in different types of EU-funded projects, e.g. collaborative projects; Marie Curie training program, and ERA Networks.

Dr ECKEL Henning

Association for Technology and Structures in Agriculture KTBL
Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V.
Darmstadt,
GERMANY

Main focus of the work of the very closely cooperating KTBL teams “system analysis, energy and climate protection” is:

System analysis

- Water protection
- Hygienic aspects of the use of various substrates for biogas production
- Assessment of livestock farming systems (ecological, economic and animal health and welfare)

Energy

- Biogas technology (technical, economic and ecological assessment)
- Energy consumption of farming systems especially livestock farming systems

Climate protection

- Emission inventories
- Ammonia emission abatement costs
- Balancing of costs and emissions in production processes (crop, lifestock, renewable energy) and farm modelling (costs, emissions, mass flows)

Henning Eckel : focus currently on energy consumption of farming systems as well as the evaluation of environmental and economic issues related with livestock farming in the framework of the BAT SUPPORT (www.ktbl.de/index.php?id=604) project and related follow up actions. Furthermore the coordination of the European activities of KTBL is an important focus of my work. This includes conceptual work on projects, writing of proposals, general financial issues and technical contributions to those projects which are within the scope of my work.

Dr FRAGOSO Rita

Rita do Amaral Fragoso
PhD in Agro-industrial engineering at Higher Institute of Agronomy, Technical University of Lisbon (2003). Degree in Technological Chemistry, Faculty of Sciences, University of Lisbon, (1996). Has been involved in several National and European research projects in the environmental field. At the moment is part of Professor Elizabeth Duarte team in an Intereg

Atlantic Area Project on Emissions from livestock farms (BATFARM). She teaches water and wastewater treatment and environmental management to undergraduate and postgraduate students at ISA/UTL. Her field of specialization is wastewater treatment, with special interest on agro-industrial wastewater treatment. Published several scientific papers in national and international magazines, and also pedagogic texts.

Instituto Superior de Agronomia (Higher Institute of Agronomy)
The Instituto Superior de Agronomia (ISA) is the largest and most qualified school of graduate and post-graduate degrees in the Agricultural Sciences, in Portugal, and its know-how is recognized nationally and internationally. With 156 years of experience, adjusting its teaching to technological change and to the reality of the country, focusing both on quality and modernization.

Science and Biosystems Engineering Department (SBED)
Professor Elizabeth Duarte team is part of the SBED and has long experience on agricultural waste engineering and recycling, namely slurries and animal manures. Has been involved with the Portuguese Environment Agency (APA) in the research of gas emissions from pig farms, in order to provide guidelines for both the farmers and policy decision makers for IPPC implementation in Portugal. Has a wide knowledge of the situation of livestock agriculture in Portugal and direct access to the Portuguese ministry of environment, livestock producers and the leading Portuguese research organisations. The department also has background research and comprehensive knowledge of all the main treatment technologies for livestock wastes: anaerobic digestion, aeration, composting, separation, sedimentation, land spreading and chemical treatments.

Prof HEINONEN-TANSKI Helvi

The University of Eastern Finland has been merged from the universities situated in Kuopio and Joensuu – both some 63^{o}N – not far from Russia border. Both of these universities had been established in 1960s. The agriculture in this area is highly milk production. The mantras of University of Kuopio were health and environment and these are still in a high position.

The Department of Environmental Science belongs to the Faculty of Science and Forestry. The total number of workers is some 150 persons – more than half of them paid by different projects started and ending once. Partly the number of temporally paid personnel is high since there are students who make their M. Sc. work or doctoral thesis work. We take annually some 40 young Finnish students to earn their M. Sc in five years + some 10 international students having already B. Sc. to make earn their M. Sc. in two years. The main subject is environmental science. All these students will learn some environmental microbiology.

The research and teaching are the duties in all universities. The research is done in research groups. Most research dealing with manure has been done the research group of environmental microbiology http://www.uef.fi/microbiology. We are now 5 with doctoral degree (2.5 paid by university) and two doctoral students and some M. Sc. students. We have mainly been coworked with Finnish Agrofood Research Centre, Finnish Veterinary Centre and the Finnish Institute of Public Health. Finnish Agrofood Research Centre has local research stations – most close to us is in Maaninka exactly 50 kilometres from our campus. They have some 80 milking cows, which graze in summer time and spend the winters in a new cowhouse and today their manure is going to biogas plant. There is a lysimeter so that together we have studies the effect of grazing.

Besides the Maaninka station we have coworked also with other stations of Agrifood. I have had an honour to supervise also the dissertations of Jaana Uusi-Kämppä from 2010”Effect of Outdoor Production, Slurry Management and Buffer Zones on Phosphorus and Nitrogen

Runoff Losses from Finnish Cattle Farms) MTT Sciences 7: 1- 127. and Kirsi Saarijärvi from 2008. Nitrogen cycling on intensively managed boreal dairy pastures. Agrifood Research Reports 134. http://www.mtt.fi/met/pdf/met134.pdf both dealing with the cattle manure is its fates and effects in soil and the practical work has been done in the fields of Agrifood.

In addition to manure we have also studied the use of municipal waste and wastewater sludge as fertilizers in agriculture.

The cowork with the Veterinary Centre and Public Heath has been mainly cowork where they can analyse different pathogens what we cannot do – due to students. We can determine indicators + salmonella and in projects some others + Clostridium tyrobutyricum.

During the last years we have coworked with the research group of environmental information in order to study economical aspects how far it is idea to transport slurry in order to make biogas – and the hygiene if there is co-treatment with manure and agricultural wastes.

Dr HODGSON Chris

Sustainable Soils and Grassland Systems Department
Rothamsted Research
North Wyke
Okehampton
Devon EX20 2SB
UNITED KINGDOM

I developed my microbiological expertise, during my doctoral research sponsored by the University of Huddersfield. In which I developed laboratory protocols to cultivate and enumerate the coliphage MS2, the bacteriophage of *Enterobacter cloacae* and multiple antibiotic resistant endospores of *bacillus subtilis* var. *niger* (*B. globigii*). These biological tracers were used in multiple tracer experiments to determine the retention time of microbial pollutants, measured as FIOs, in constructed wetlands fitted as tertiary treatment on a sewage treatment works. Whilst at Huddersfield I went on to work on a European Craft funded project (QLK1-CT-2002-70806) to develop novel biocides and biocidal wipes for use in the health care sector. This work lead to a patent application for an Antimicrobial Construction, GB20040011304 20040521; WO2005GB01878 20050518.

In June 2005 I moved to Devon and North Wyke Research, as a post doc on a Rural Economy and Land Use (RELU) project (RES-0224-25-0086), where I investigated the movement of FIOs from various farming systems within the Taw river catchment. At the plot scale I investigated the survival of FIOs in soil to which dairy cattle slurry had been applied by broadcast and shallow injection. At the laboratory scale I developed a method to determine the dispersion kinetics of FIOs from a range of faecal matrices in standard rain water. I have been instrumental in developing the microbiology laboratory here at North Wyke which formerly opened at the end of 2008. I am currently managing a DEFRA funded project (WQ 0118), 'Understanding the behaviour of livestock manure multiple pollutants through contrasting cracking clay soils' the aim of which is to improve our understanding on contrasting cracking clay soils of the *interactions* that occur between livestock manure multiple pollutant (i.e. nitrate-N, ammonium-N, phosphorus, sediment and microbial pathogens) loss processes and pathways to water, and to test practical mitigation methods. In addition I am working on DEFRA funded project (WQ 0111) as part of which I am investigating the survival of FIOS in bovine and porcine farm yard manure heaps.

Rothamsted Research North Wyke is the home of grassland research. Formerly part of the Institute of Grassland and Environmental Research, North Wyke has now become a department of Rothamsted Research (RRes), and so brings together BBSRC research on grassland and arable systems. Rothamsted Research, North Wyke provides unique research capabilities for the UK. These help to address some of agriculture's most pressing challenges, for example mitigating and adapting to climate change, protecting natural resources and sustaining the rural economy in grassland dominated regions such as South West England.

Dr HOEKSMA Paul

Wageningen University and Research Centre
Research group Livestock & Environment
THE NETHERLANDS

The research group Livestock & Environment of Wageningen UR has broad expertise about the effects of livestock on the living environment. The research and knowledge transfer focus on the environmental effects of livestock farming on soil and atmosphere. The research combines expertise about measuring environmental effects (both positive and negative) while understanding the underlying processes. The aim is to promote the ecological sustainability (planet) of livestock and farming systems. Our research translates the demands placed by society on livestock production into sustainable, feasible solutions for livestock farms.

We work actively on the following themes:

- atmosphere (gaseous emissions, particulate matter, low-emission animal housing systems);
- soil (soil quality, water, minerals and fertilisation, pasturing, grassland and feed crops);
- closing mineral cycles (animal-manure-crop cycles, manure technology).

The research focuses on the interactions on the axis: citizen-environment-farm-animal.

Within the sphere of activity, we work together with other research fields at Wageningen UR Livestock Research and with external partners from the Netherlands and abroad.

Dr. Paul Hoeksma : I have a training in environmental science. My expertise is on manure treatment for energy production and nutrient recycling. The key project I'm working on today is about the production of mineral concentrates, containing mainly N and K, with properties comparable to synthetic fertilizer, in terms of fertilizer efficiency and environmental impact.

Prof HOELZLE Ludwig

Institute of Environmental and Animal Hygiene
University Hohenheim, Germany
Garbenstrasse 30
70599 Stuttgart
GERMANY

The Institute of environmental and Animal Hygiene consists of three main working areas, i.e. the division of molecular epidemiology and animal health, the division of infection biology, and the division of environmental hygiene. In the division of animal hygiene the main topic is laid on sanitary aspects of biological wastes and farm fertilizers. This includes studies on the microbiological state of livestock wastes, the environmental and sanitary risks in the management of livestock wastes, and the microbiological and hygienically evaluation of biotechnical processes used for the recycling of livestock and communal waste. In these working areas the institute has a longstanding expertise (over 30 years) which is reflected by the advisory work of the institute both for the national and international administration as well as for companies employed in the recycling of biological waste. People of the institute were and are members of several commissions dealing with the mentioned topics.

Prof HOELZLE Ludwig: Head of the institute since approx. one year; veterinarian microbiologist and specialist for hygiene as well as environmental microbiology; member of the DWA

Dr LALOR Stan

Teagasc,
Crops Environment and Land Use Programme,
Johnstown Castle,
Wexford,
Ireland

Teagasc – the Irish Agriculture and Food Development Authority – is the national body providing integrated research, advisory and training services to the agriculture and food industry and rural communities. The Teagasc research centre at Johnstown Castle is Ireland's leading research centre for soils and the rural environment. The centre conducts research on soils, nutrient efficiency, recovery and losses; air and water quality; the agricultural environment and agro-ecology. The research results generated are used widely by advisory, farmers, scientists and policy makers.

Teagasc has a broad experience of environmental and manure management research. The Environment Research Centre at Johnstown Castle hosts agri-environmental research for Teagasc, and the research programmes include nutrient efficiency, gaseous emissions, soils, agro-ecology and water quality.

Manure management research has contributed centrally to these programmes through projects with both national and European partners, dealing with manure management issues such as nutrient flow pathways following manure application, and gaseous losses from housing and landspreading. Teagasc is currently involved in a range of projects including: evaluation of landspreading technologies; ammonia emissions from housing; decision support systems for sustainable manure and nutrient management; nitrification and urease inhibiting additives; and evaluation of BAT's for manure management. Given that agriculture in Ireland is dominated by grassland based beef and dairy systems, the focus of this research has been on cattle manure management, particularly liquid slurry systems.

Stan Lalor is responsible for the nutrient efficiency research programme and has worked mainly on the area of slurry application methods, and their impact on ammonia emissions and fertilizer replacement value. In particular, he has focussed on the economic impacts of slurry application methods, including cost / benefit analyses. His work has also been highly focussed on extension activities, being heavily involved in research dissemination activities relating to nutrient use efficiency and manure management. He has also been involved in decision support tool development for nutrient management planning and Nitrates Directive Compliance.

Dr LEHUGER Simon

Cemagref - Rennes
17 avenue de Cucillé,
35044 Rennes,
FRANCE

My research focus is about the use and development of agro-ecosystem models and data monitoring to estimate the environmental balance of agricultural systems. I am more specifically interested in **:**

- the prediction and mitigation of greenhouse gas emissions from croplands and grasslands at field and regional scales,
- the estimation of nitrous oxide emission dynamics from soil with models and data monitoring,
- the uncertainty analysis and calibration of process-based models with Bayesian methods,
- the Life Cycle Assessment of agricultural products,
- the environmental assessment of available techniques to decrease air and water pollution in livestock farms.

I obtained an Engineering degree in Agricultural Sciences from the Ecole Supérieure d'Agriculture in Angers (France) in 2005 and a PhD in Agronomy and Environmental Sciences from AgroParisTech (Paris) in 2009. I am currently at CEMAGREF Environmental Management and Biological Treatment of Wastes Research Unit (Rennes, France), for a 2-yr postdoc position (2011-2012) in the BatFarm project. I previously participated in the CarboEurope and NitroEurope projects (EU's Sixth Framework Programme for Research and Technological Development) as a postdoc at Agroscope Research Station, in the Air Pollution/Climate Group in Zurich (Switzerland) in 2010 and as a PhD student at INRA Environment and Arable Crops Research Unit in Grignon (France) from 2006 to 2009.

Prof LOGAN Niall

Professor of Systematic Bacteriology and Biological Safety Adviser
Department of Biological and Biomedical Sciences
Glasgow Caledonian University
Cowcaddens Road
Glasgow G4 0BA
SCOTLAND

Niall Logan is Professor of Systematic Bacteriology, Biological Safety Adviser at Glasgow Caledonian University. He is an expert on the classification and identification of members of the genus *Bacillus* and relatives, a group of spore-forming bacteria that includes agents of food spoilage and food poisoning, the agent of anthrax, insect pathogens, and sources of industrial enzymes. Recent work has concentrated on identification of aerobic endosporeforming bacteria from opportunistic infections, and classification of new species isolated from Antarctica. He is the Chairman of the International Committee on Systematic Bacteriology Subcommittee on the Taxonomy of the Genus *Bacillus* and Related Organisms, and is a member of the International Committee on the Systematics of Prokaryotes, and a member of that committee’s Judicial Commission on Bacterial Nomenclature. He was until recently the Convener of the Systematics and Evolution Group of the Society for General

Microbiology. Other research has included studies microbial diversity in acidified upland lochs, on contact lens contamination and disinfection, and he is currently investigating bacterial pathogens in farm effluents. He has travelled extensively, with working visits to Antarctica, Bangladesh, Brazil, Iceland, Kuwait, USA and various European and Scandinavian countries. He writes for several medical microbiology and systematic bacteriology reference books, including *Topley and Wilson's Microbiology and Microbial Infections*, the ASM *Manual of Clinical Microbiology* and *Bergey's Manual of Systematic Bacteriology*, and has been on the editorial boards of several British microbiology journals. He is also active as a microbiological consultant to industry and has made radio and television appearances. He was elected Fellow of the Society of Biology (formerly the Institute of Biology) in 2009.

Dr MANTOVI Paolo

Research Centre on Animal Production (CRPA) is a research and consulting organisation dealing with the improvement of the livestock sector and the related agro-industry by means of researches, studies, dissemination and technology transfer actions. CRPA has nine research units: forage crops and agronomy, environment & energy, economics, livestock production, software development, machinery and farm buildings, dissemination of research results and communication (hosting an European Carrefour – Carrefour Emilia). CRPA is a member of the CIC - Italian Composting Consortium and of the CIB – Italian Biogas Consortium, with representation in their Technical Committee. It is also a member of ITABIA - Italian Biomass Association and of IWA - International Water Association.

CRPA's main experience on manure treatments concerns:

- Solid-liquid separation
- Biological nutrient removal (SBR Technology);
- Anaerobic digestion
- Ammonia stripping
- Composting
- Integrated anaerobic digestion and N-removal systems
- Digestate drying systems

CRPA's other experiences linked with the workshop topics are:

- Feed strategies to reduce N excretion in pigs
- Fertigation with water + slurry (drip lines or sprinkling)
- Air scrubbers and bio-filters (out of the livestock sector)
- Constructed wetlands to treat dairy wastewaters
- Organisation of manure banks
- Fate of antibiotics in the manure/soil/crop chain
- Clostridium in the anaerobic digestion process

CRPA has undertaken biogas and manure treatment-based projects (studies, monitoring and supervision of pilot and demonstration plants for biogas production and nutrient removal) for the European Union, the Emilia-Romagna Region, ENEA National Agency for New Technologies, Energy and the Environment, CNR National Research Council, ENEL National

Electricity Industry. Concerning the subject of this workshop, a list of the most relevant concerted actions and research projects follows: 1) FAIR3-CT96-1877 – GHG-Biogenic emissions of greenhouse gases caused by arable and animal agriculture, 2) EVK2-CT-2000-00096 – MIDAIR - Greenhouse gas mitigation for organic and conventional dairy production, 3) QLK5-2000-00439 – AD-Nett - Network on anaerobic digestion of waste from industries and agriculture, 4) ALTENER - Preparing the centralised co-digestion of pig manure, poultry excreta and other organic wastes, 5) ALTENER - Biogas implementation study (Herning Municipal Utilities), 6) QLK5-2000-30020 – MATRESA - Processing strategies for farm livestock slurries to minimise pollution and to maximize nutrient utilization, 7) QLRT-1999-30670 – AROMIS - Assessment and reduction of heavy metal input into agro-ecosystems, 8) FP6 – SSPE-CT-2006-44292 – BAT-SUPPORT - Best Available techniques for European Intensive Livestock Farming - Support for the implementation of the IPPC Directive.

In the last 7 years CRPA has coordinated the following LIFE Environment projects: LIFE04 ENV/IT/000454 OptiMa-N - "Optimisation of nitrogen management for groundwater quality improvement and conservation" LIFE06 ENV/IT/000266 Seq-Cure - "Integrated systems to enhance sequestration of carbon, producing energy crops by using organic residues" (Best of the best LIFE project ended in 2010) LIFE09 ENV/IT/000208 AQUA - "Achieving good water quality status in intensive animal production areas".

CRPA is partner of the LIFE 09 ENV/ES/000453 MANEV - "Evaluation of manure management and treatment technology for environmental protection and sustainable livestock farming in Europe"

Dr MERINO Pilar

Research Institute of Agriculture in the Basque Country

P Merino received her PhD in 2000 from the University of the Basque Country on 'Nitrogen oxides from grassland systems'. She become a research scientist in the Department of Environmental Quality in NEIKER, leading projects related to gaseous emissions (ammonia and GHG) from agricultural soils. More recently her research interest has moved on to mitigation of these gases by either feeding modification or the establishment of technologies on farm to decrease the impact of animal pollution.

NEIKER's is the Institute of Agricultural Research in the Basque Country, it supports the knowledge, resources and ability to offer solutions and strategies to restore, preserve and exploit natural resources rationally.

The Environmental Quality Department is made by a team of 23 professionals working on:

- Research and innovation in waste.
- Design of sustainable farming practices.
- Study of climate change.
- Inventories of emissions and removals of greenhouse gases by IPCC.
- Strategies for reducing GHG emissions from agricultural practices and natural ecosystems.
- Strategies for increasing carbon sequestration.
- Development of computer tools for the diagnosis and environmental management.

Prof PHILLIP Werner

Institute of Environmental and Animal Hygiene
University Hohenheim, Germany
Garbenstrasse 30
70599 Stuttgart
GERMANY

The Institute of environmental and Animal Hygiene consists of three main working areas, i.e. the division of molecular epidemiology and animal health, the division of infection biology, and the division of environmental hygiene. In the division of animal hygiene the main topic is laid on sanitary aspects of biological wastes and farm fertilizers. This includes studies on the microbiological state of livestock wastes, the environmental and sanitary risks in the management of livestock wastes, and the microbiological and hygienically evaluation of biotechnical processes used for the recycling of livestock and communal waste. In these working areas the institute has a longstanding expertise (over 30 years) which is reflected by the advisory work of the institute both for the national and international administration as well as for companies employed in the recycling of biological waste. People of the institute were and are members of several commissions dealing with the mentioned topics.

Prof PHILLIP Werner: Veterinarian, agricultural scientist; specialist for hygiene and environmental microbiology; expert in several commissions dealing with sanitary aspects of waste and biotechnical procedures for the recycling of biological waste; since 30 years concerned with questions about recycling manure of the hygienic point of view

Dr PROVOLO Giorgio

Department of Agricultural Engineering
Università degli Studi di Milano
Via Celoria 2 - 20133 Milano (Italy)

The Department of Agricultural Engineering (DIA – Dipartimento di Ingegneria Agraria) is the result of the union of the former Institutes of Agricultural Engineering and Agricultural Hydraulics. DIA operates from January 1st 2009 with a research staff of more than thirty people and a technical and administrative staff of fifteen. The department has a long record of successful research activities, both at the national and international level. One of the DIA main research topics related to the project is the assessment and mitigation techniques of environmental impact of agriculture and especially livestock. The activity relates to the evaluation of nutrient loads from agricultural sources to surface waters in Lombardy. A research area, part of ongoing activities in support of the Lombardy Region, is aimed to develop tools for the management of the records related to the agriculture and assessment of the effect of this activity on the environment, for planning and monitoring purpose. A multicriteria evaluation method has been implemented to classify areas in relation to environmental risk.

The software development expertise of the group has been used to produce software packages to assist administrators and operators for the implementation of environmental regulations. The knowledge of the environmental problems and of the decision support systems has been used to develop models for the management of farm manure and a methodology for the selection of Best Available technologies in relation to local context. This activity has been supported by field experiences of manure management monitoring and by the development of sensors for field evaluation of manure nutrient content. DIA is equipped with sensor for environmental monitoring of air (Temperature, Humidity, light intensity, etc.) and liquids (level, temperature, conductivity, sampling facilities).

DIA has also developed the know-how for the development of sensors for process monitoring. For example a research is aimed to assess the feasibility of simplified optical sensors that could be used for on-line monitoring and controlling fermentation processes.

DIA is also conducting experiments on two-stage fermentation for bio-hydrogen production through biological processes from renewable sources, such as biomass or organic waste.

Furthermore, the need to define the potential amount of agricultural biomass available annually for energy use, has led to the development of an original calculation model and the subsequent implementation of a geographic database of the net exploitable biomass (animal waste, agricultural byproducts, energy crops) produced by the Italian agricultural sector.

DIA is involved in different projects at local, national and international scale related to manure processing technologies and management solutions. The main projects are:

- Evaluation of manure management and treatment technology for environmental protection and sustainable livestock farming in Europe (MANEV) - LIFE +2009 (coordinator SODEMASA - Spain)
- Multi-regional Solutions to improve the Environmental and Economic Sustainability of PIG manure management in the Regions of the Po and Veneto basin (SEES-PIG) - granted by AGER (bank association)
- Development of an expert system for the nitrate issue in lombardian agriculture (VALORE) - granted by Lombardy Region
- Biotechnologies and management technologies for the environmental sustainability of the agricultural system (BIOGESTECA) - granted by Lombardy Region

Dr RODHE Lena

Senior Research Manager,
PhD Swedish Institute of Agricultural and Environmental Engineering
Box 7033, SE-750 07 Uppsala
SWEDEN

JTI - Swedish Institute of Agricultural and Environmental Engineering is an industrial research institute engaged in research, development and information in the areas of agricultural engineering and environmental technology.
JTI has close links with trade and industry. In collaboration with trade and industry we produce results that can be translated directly into real-life practice.
Our work provides companies and authorities with a better basis for decision-making, a powerful competitive edge, less impact on the environment and wiser management of natural resources.

JTI develops and evaluates techniques and methods for functional, economical and environmental friendly animal husbandry. We work with systems solutions to achieve efficient management of animal manure and improved quality of milk and meat. We strive for solutions that create a good environment for animals and humans alike. They also need to be sustained from an environmental point of view and cause minimal impact on land, air and water. We work with agriculture's traditional livestock, but also with horses, which are widely used for recreational purposes nowadays.

Lena Rodhe is a senior research manager at JTI and has a PhD in Agricultural sciences (Agricultural engineering). She has carried out research for c. 30 years mainly focused on manure handling technology and plant nutrient utilisation. Specialisation: 1) The influence of application techniques on plant nutrient utilisation and crop quality; 2) ammonia emissions and greenhouse gases from manure and other organic residues; 3) economical evaluation of manure handling systems. She participates in several international projects, as well as networks and has thereby a good overview of management practice and manure nitrogen utilization in Europe and the influencing factors. For the moment she is running several projects aiming in higher manure N utilization as well as reducing greenhouse gases from manure. She is regularly engaged as lecturer by Swedish authorities, agricultural advisory organizations and farmers' organizations.

Dr SOSSIDOU Eva

Veterinarian-Senior Research Scientist
VETERINARY RESEARCH INSTITUTE
57001 N.AG.RE.F. Campus
P.O. Box 60272
Thermi .Thessaloniki .GREECE

Dr Evangelia N. SOSSIDOU, gained a DVM in Veterinary Medicine (Aristotle University of Thessaloniki, 1986), a PhD in Animal Production and Veterinary Epidemiology (Aristotle University of Thessaloniki, 1993) and a Post-Doctoral Thesis in Farm Animal Welfare (State Scholarship's Foudation in Greece, 2003). She holds the position of a Senior Researcher at NAGREF since 2000. From 1986 up to now, she leads many trials and research projects funded by EU (Cost Actions, Leonardo da Vinci, FP6, FP7, INTERREG, etc), NAGREF, Faculty of Veterinary Medicine of the Aristotle University of Thessaloniki, and Technological Educational Institute of Thessaloniki. This occupation resulted in many publications and scientific presentations in the field of 'livestock production systems, statistical modelling for managing the farm business, veterinary epidemiology, safety and quality of animal products through animal welfare and environmental protection'. She is currently Member of the EFSA Expert Database on 'Farm animal Welfare' and a European Commission Expert for Organic Farming, Member of the WG9 'Welfare and Management' of the WPSA, Chair of the WG11 'Education and Information' of the WPSA and Member of the Steering Committee of the Mediterranean Poultry Network of WPSA. Dr Sossidou teaches and supervises undergraduate, masters, and doctorate students at NAGREF, Aristotle University of Thessaloniki and Technological Educational Institute of Thessaloniki. She is the editor of the Book "Farm Animal Welfare, Environment and Food Quality Interaction Studies", ISBN 978-960-89849-0-5, co-editor of the Book "Basics of Animal Welfare and Product Quality", ISBN 978-963-269-143-5, invited author of the Book "Livestock Production and Society", ISBN-10:90-76998-89-2, ISBN-13:978-90-76998-89-3 and editor/author of many other editions (leaflets, booklets, etc) in the domain of farm animal welfare in different production systems. Dr Sossidou is the scientific coordinator at national level of the on-going project 'SANCO D5/10753/2010-Promoting high quality control posts in the European Union'.

Dr VENGLOVSKY Jan

I graduated as a doctor of veterinary medicine from the University of Veterinary Medicine in Kosice in 1975. For 30 years I was on the staff of the Research Institute of Veterinary Medicine in Kosice as a head of animal hygiene department. From 2002 I joined the staff of the University of Veterinary Medicine and Pharmacy in Kosice, Department of the environment, veterinary legislation and economy as a senior researcher. I was the head of a number of teams working on many Slovak and international research projects. My research activities have focused on (i) hygienisation of wastes from agriculture, particularly from animal production (ii) utilization of secondary raw materials from food and processing industry, (iii) recycling of agricultural and municipal residues in agriculture (iv) production of bioaerosols and antibiotic resistance in the animal environment and treatment of wastes. I collaborated with teams working on international EU projects MATRESA, CHANNEL and WELANIMAL. I am a member of the Extended executive board of ISAH and a country representative at the International Society for Animal Hygiene since 1994. I supervised four PhD students and participate regularly in teaching of undergraduate students at the University of Veterinary Medicine and Pharmacy in Košice, study programmes General veterinary Medicine.

Dr VINERAS Bjorn

Associate Professor
Swedish university of agricultural sciences and the National Veterinary institute.
SLU, box 7032, SE-75007
Uppsala,
SWEDEN.

Our work is focused on production of safe fertilizers with minimal environmental impact and saving the natural resources. The research is focused on manure management, both human and animal, technologies for removing unwanted pathogenic pollutants. Treatment processes that we work upon, is chemical treatment as well as biological treatment and the survival in the environment. The treatment processes that we have our main focus on is ammonia treatment and black soldier fly and vermi-composting. Previously have we been looking closer into lime treatment as well as composting and anaerobic digestion. The ammonia treatment is based on utilizing the toxic effects of ammonia, intrinsic or added, for sanitation of the material. With focus on manure management in developing countries are we evaluating vermi-composting and fly larvae composting where the focus is the end product quality and the possible market for the worms and larvae as animal feed. In all of our studies of treatment technology are we looking into the hygienic quality, the fertilizer value, added values, environmental impacts and microbial risks. The standard set of organisms that we are using in our studies are, *Salmonella, E.Coli O157, Enterococcus faecalis, coliphages, Ascaris suum* and some viruses selected depending on type of project, including enteroviruses, avian flu and parvovirus. During the treatment technology evaluations additional data on green house gas emissions are collected to be included in the environmental comparison of the systems. In addition to the treatment evaluations we do also studies at the veterinary institute focusing on the occurrences of disease in the manure of infected herds and the survival in soil after application of manure in fertilization purposes or during pasturing.

Dr WULF Sebastian

KTBL (see entry under Dr Eckel)

Currently I am coordinating activities concerning climate protection at KTBL. This includes cooperating with other German institutions in calculating the national emission inventories for Greenhouse-Gases and NH_3 and counselling government institutions in questions concerning emission reduction measures and reduction goals. In order to provide decision support tools, we are setting up models for balancing costs and emissions for agricultural production. Apart from this I contributed to the cost analysis and assessment of digestate treatment technologies.

APPENDIX 4

Preparation questionnaire

Reconciling environmental and sanitary risks in the management of livestock wastes

European workshop – Rennes, France – 5/7 October 2011
Scientific committee:

Colin Burton[1,2], Anne-Marie Pourcher[1,2], Laurence Loyon[1,2] and Björn Vinnerås[3,4]

1 Cemagref, unité GERE , Rennes, France
2 Université Européenne de Bretagne, France
3 Dept of Chemistry, Environment and Feed Hygiene, National Veterinary Institute, Uppsala, Sweden

Preparation questionnaire

Please find some time to give your preliminary ideas to help in the targeted preparations for the meeting: all submitted material will be included in the action minutes to follow the meeting.

We would be glad to have your feedback using this questionnaire before the meeting if possible please.

Please send to colin.burton@orange.fr and copy to :
anne-marie.pourcher@cemagref.fr
and laurence.loyon@cemagref.fr

Thank you in advance for your help.

Your expertise

Please tick all areas for which you have some expertise:

- ☐ Measurement and reduction of emissions associated with manure handling and use;
- ☐ National and European legislation for the control and management of food and farm wastes for the protection of the environment and public health;
- ☐ Treatment technologies for the reduction of all water & soil pollutions resulting from nutrient excess after manure application;
- ☐ Abatement and monitoring of direct and indirect contamination of water and soil by manure-related pathogens
- ☐ Reduction of risk presented to food production chain from manure use
- ☐ Economic costs implied for measures used.
- ☐ Resolving conflicts between environmental and hygiene objectives relating to the use of livestock manure and other organic effluents
- ☐ Project management/coordination

Your contributions

Mandatory for those participating in the workshop;

- ☑ Presentation of a short introductory talk including own area of competence (5 minutes/10 slides *maximum*) We will extend the remit of introductions to include also the perception of each partner of the key issues from their perspective and of their country/region
- ☑ Written contributions *following* the workshop to support the preparation of the review report on manure treatment technologies (as agreed during the meeting). These will be used to assemble a comprehensive report reviewing manure management technologies across Europe : first draft by end October; to be published by end-Dec 2011
  NB: minutes will be produced separately by the workshop organisers.

Optional : ***please indicate those you wish to support***

- ☐ A joint scientific review paper on the relative benefits of manure management techniques to reduce hygienic risks from manure.
- ☐ Participation in a European collaborative project (possibly funded under the current call of FR7). Subject: *the mechanisms relating to applied eco-technologies that determine the persistence of pathogens and the abatement of pollution impacts.*
- ☐ *The revision of the "MATRESA" reference book on livestock waste* management – 3^{rd} edition targeted for early 2013 subject to funding.

- ☑ ***All participants: please attach a brief (maximum one page) resume of you, your work and that of your department. Please include your contact details. This will be appended to the minutes***

Your knowledge on livestock waste management

Please supply as much relevant information as you can : we do not expect everyone to answer every question. No answer need exceed 100 words.

1. For which of the following eco-technology options do you have farm-scale experience (not laboratory-based schemes) – please tick all that apply

   - ☐ Feed diet control options
   - ☐ Air scrubbers and bio-filters
   - ☐ Storage options (Minimal storage time for manures and covers)
   - ☐ Separation and composting systems
   - ☐ Anaerobic treatment
   - ☐ Aerobic treatment (including nitrification and de-nitrification)
   - ☐ Sedimentation options: the use of lime
   - ☐ Spreading using injectors or trailing hoses
   - ☐ Transporting surpluses out of the region - pipelines
   - ☐ Thermal treatment options
   - ☐ Manure products (including drying option)
   - ☐ Land application machinery
   - ☐ Land application – controls based on crop nutrient demands
   - ☐ Land application – controls based on local risks
   - ☐ Other technologies (please specify) ________________

For each of the ticked items in the above list ....

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?

c) Can they reduce N surplus – by how much and by what method?

d) Can they reduce P surplus – by how much and by what method?

e) What benefits (financial or practical) can they bring to the farmer?

f) What is the main barrier to uptake?

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region

3. What are the *main* routes of disease transmission from manure to (a) soil, (b) water and (c) crop (food) production? Which are the main pathogens implied?

4. What (if any) are the possible impacts of poor manure management on sanitary risk?

5. What are the main pollution risks from manure management for buildings and storage at the farm,?

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?

7. How can we equate different pollution types? What is a fair way to compare options? If this is not possible, how can we optimise a farming system to minimise environmental impact?

8. What are the environmental impacts from manure management options themselves?

Any other comments ahead of the meeting ?

		Your expertise									Collal
		Measurement and reduction of emissions associated with manure handling and use;	National and European legislation for the control and management of food and farm wastes for the protection of the environment and public health;	Treatment technologies for the reduction of all water & soil pollutions resulting from nutrient excess after manure application;	Abatement and monitoring of direct and indirect contamination of water and soil by manure-related pathogens	Reduction of risk presented to food production chain from manure use	Economic costs implied for measures used.	Resolving conflicts between environmental and hygiene objectives relating to the use of livestock manure and other organic effluents	Project management/coordination		A joint scientific review paper on the relative benefits of manure management techniques to reduce hygienic risks from manure.
Maite	AGUILAR-RAMIREZ	x					x				
August	BONMATI-BLASI			x							x
Mark	BOYLE		x		x	x		x			x
Colin	BURTON	x	x	x				x	x		
Patrick	DABERT										
Anders	DALSGAARD				x	x			x		x
Henning	ECKTEL	x	x	x			x		x		
Rita	FRAGOSO	x		x							
Helvi	HEINONEN-TANSKI	x		x		x			x		x
Anne	HERMONIC										
Chris	HODGSON	x			x	x			x		x
Paul	HOEKSMA	x	x	x					x		
Ludwig	HOELZLE				x	x		x			x
Adeline	HUNEAU										
Stan	LALOR	x	x				x		x		x
Simon	LEHUGER										
Niall	LOGAN		x		x	x		x			x
Laurence	LOYON										
Paolo	MANTOVI	x	x	x		x			x		x
Corrine	MAROIS										
Pilar	MERINO	x	x	x					x		x
Werner	PHILLIP				x	x		x			x
Anne-Marie	POURCHER										
Giorgio	PROVOLO	x	x	x					x		x
Lena	RODHE	x					x				x
Eva	SOSSIDOU		x			x		x	x		x
Jan	VENGLOVSKY		x	x	x	x		x			x
Bjorn	VINERAS				x	x					x
Sebastian	WULF	x	x	x			x		x		
TOTAL		**13**	**12**	**11**	**10**	**13**	**5**	**7**	**12**		**16**

1 Ammonia treatment of liquid manure for removal of salmonella in the slurry tank after the salmonella infection has been d
2 Animal health and welfare assessment methodology (measuring and monitoring animal based parameters)
3 Storage options: Use of addives and inhibitors to slurry (DMPP; Agrotain, commercial additives…)
4 Ammonia stripping technologies

wastes

...boraton projects		Your knowledge on livestock waste management																Other comments (see separate Word file)
Participation in a European collaborative project (possibly funded under the current call of FR7).	The revision of the "MATRESA" reference book on livestock waste management - 3rd edition targeted for early 2013 subject to funding.	Feed diet control options	Air scrubbers and bio-filters	Storage options (Minimal storage time for manures and covers)	Separation and composting systems	Anaerobic treatment	Aerobic treatment (including nitrification and de-nitrification)	Sedimentation options: the use of lime	Spreading using injectors or trailing hoses	Transporting surpluses out of the region - pipelines	Thermal treatment options	Manure products (including drying option)	Land application machinery	Land application - controls based on crop nutrient demands	Land application - controls based on local risks	Other technologies (please specify) listed below	
x			x	x	x									x			x
x	x				x	x	x				x						x
x	x				x	x	x										x
	x		x		x		x	x			x	x					
x																	
x																	
x					x	x		x									x
x	x			x	x		x		x								x
x	x			x					x				x		x		x
x	x		x	x	x		x		x	x		x					x
x			x	x	x	x	x				x	x					
x	x								x				x	x			x
x	x				x	x	x										
x	x	x	x		x	x	x					x	x			x 4	x
x	x	x	x	x	x				x						x	x 3	x
x			x	x	x	x	x				x	x					x
x	x			x		x	x							x			x
x	x		x	x			x		x				x	x			x
x	x	x														x 2	x
x	x		x	x	x		x										x
x	x															x 1	
x																	
21	15	3	9	10	13	8	12	2	6	1	4	5	4	4	2	4	15

...declared to be removed from the animals.

APPENDIX 5

Supplementary information supplied with completed questioinnaires

Reconciling environmental and sanitary risks in the management of livestock wastes

European workshop – Rennes, France – 5/7 October 2011

Preparation questionnaire

Compiled supplementary notes

Maite AGUILAR-RAMIREZ

1. For which of the following eco-technology options do you have farm-scale experience (not laboratory-based schemes)

Air scrubbers and biofilters

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
The measures were carried out in a wet scrubber in a gestating sow building in Navarra (Spain). The concentrations of gas were measured continuously before and after the scrubber using a photo acoustic gas analizer (Innova) during 27 days in October 2009.

- *The average ammonia concentration before and after the scrubber were 18.4 and 4.6 ppm, respectively, representing an average ammonia removal efficiency of 74%.*
- *Higher concentrations of N2O were found in the exhaust air than in the inlet air of the scrubber. On average, an increase of 74% for the concentration of this gas was found. So it seems to indicate that the biological activity in bioscrubbing systems may enhance nitrification and denitrification processes.*
- *It seems that the scrubber did not affect the emission of methane and carbon dioxide. There were no significant differences between the concentration of these gases before and after the scrubber.*

More information: Aguilar, M.; Abaigar, A.; Merino, P.; Estellés, F. and Calvet, S. Effect of a bioscrubber on NH3, N2O, CH4 and CO2 emissions from a pig facility in Spain. International Conference on Agricultural Engineering 2010, Clermont-Ferrand, France.

c) Can they reduce N surplus – by how much and by what method?
No, the water of the scrubber increases the amount of slurry produced and its N content.

e) What benefits (financial or practical) can they bring to the farmer?
Benefits: the scrubbers reduced the NH3, dust and odours emission. The waste water obtained is a solution rich in nitrogen, with a considerable fertilizing potential.

f) What is the main barrier to uptake?
Its costs: we estimated 22 euros per year and sow

Storage options (Minimal storage time for manures and covers)

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?

*We are studying 3 types of covers: Floating cover by means of hexagonal units made of polypropylene***,** *Light expanded clay aggregate (LECA) and a Plastic cover of Polypropylene.*
We haven't measured the emission yet, but ammonia and odours emission reductions are expected and maybe increase in GHG production.

e) What benefits (financial or practical) can they bring to the farmer?
Reduction of ammonia and odours emission. The plastic cover increases the storage capacity because it avoids the rainfall water get into the lagoon.

f) What is the main barrier to uptake?
Costs of the covers. E.g. LECA: 9,55 eur/m2; Hexagonal units: 30 eur/m2; Plastic cover:46 eur/m2.

Separation and composting systems

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many log_{10} units.
Composting: it will depend on the temperature reached and during how much time. When large quantities of material are managed, the temperature can be quite heterogeneous along the piles.

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
Composting: We have done nutrient balances before and after the composting, analizing the materials and estimating the initial and final quantities. We have found in some cases a considerable loss of some nutrients (mainly ammonia nitrogen). The results will depend on the materials used (the selection of appropriate bulking agents with degradable organic-C) and process control (moisture, temperature, aeration/turning and particle size).

c) Can they reduce N surplus – by how much and by what method?
Composting: Important loss of nitrogen can occur.

e) What benefits (financial or practical) can they bring to the farmer?
Composting: elimination of pathogens and weeds, microbial stabilisation, reduction of volume and moisture, removal and control of odours, ease of storage, transport and use, production of good quality fertiliser or substrate.

f) What is the main barrier to uptake?
Composting: cost of installation and management, requirement for a bulking agent, requirement for large areas for storage and operation.

Land application – controls based on crop nutrient demands

e) What benefits (financial or practical) can they bring to the farmer?
Expenditure reduction of chemical fertilizer, improvement of soil structure and its OM content.

f) What is the main barrier to uptake?
Developing and implementation of rapid methods to know the nutrient composition (N content) of manures and slurries before the application. Cost of equipments that improve the application of manures and slurries (minimize emissions, homogeneus distribution…)
Prices of chemical fertilizers. Lack of studies about crop efficiencies using manures and slurries comparing to chemical fertilizers in our region.

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
Nitrates Directive
IPPC Directive
Code of good practices

5. What are the main pollution risks from manure management for buildings and storage at the farm,?
Gas emission (NH3, CH4, N2O and SH2), odours, dust and pathogens. Risk of overflow/breaking of slurry storages. Leaching and drainage of nutrients in open storages of solid manures.

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
Weather conditions during application, type of soil, slope, covered or bare soil, type of machinary used, distance to surface water, control of applications as a function of plant requeriments.

7. How can we equate different pollution types? What is a fair way to compare options? If this is not possible, how can we optimise a farming system to minimise environmental impact?
Dificult to answer... I think that it is important when we are comparing different production systems/farms to consider not only environmental indicators (energy balances, carbon footprint...), but also economical and social indicators.

August BONMATI-BLASI

Separation and Composting

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
Separation → no pathogen removal
Composting → if thermophilic range is reached and Tª above 55ºC is maintained certain time and no recontamination happens, most of the pathogen are killed

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
Risk of CH_4, NH_3 (that can be transformed to N_2O), and COV emission

c) Can they reduce N surplus – by how much and by what method?
Yes, if solid phase or/and compost is transported outside the surplus area (with less transport cost of the manure) Depending efficiency of separator (5-40%) and the losses (of Ammonia) during the composting process

d) Can they reduce P surplus – by how much and by what method?
See previous answer, but phosphorus in the solid phase use to be higher than nitrogen

e) What benefits (financial or practical) can they bring to the farmer?
Improve management of the different fractions of the manure and the production of compost that can be sold

f) What is the main barrier to uptake?
Composting → time expended on the management of composting (at farm scale), Improve efficiency of nutrients (N and P) distribution to solid phase

Anaerobic Digestion.

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ unit
In thermophilic range high pathogen reduction, in mesophilic moderate reduction

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
Avoids uncontrolled CH4 emission in the storage (previous to land application).
Potential increase of NH3 emission in digested storages

c) Can they reduce N surplus – by how much and by what method?
No

d) Can they reduce P surplus – by how much and by what method?
No ; In some case struvite precipitation into the reactor (not desired) can apparently reduce N and P.

e) What benefits (financial or practical) can they bring to the farmer?
Economic benefits selling the biogas or the electricity to the grid

f) What is the main barrier to uptake?
High investment, optimal use of the energy produced (sell of electricity to the electrical grid or biogas to Natural Gas grid), use thermal energy and the requirement of co-substrates to increase biogas production

Aerobic treatment (including nitrification and de-nitrification)

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
Not relevant

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
Risk of N2O emissions

c) Can they reduce N surplus – by how much and by what method?
Yes, transforming organic N to N2 innocuous

d) Can they reduce P surplus – by how much and by what method?
A certain accumulation into the sludge, that can be managed outside the surplus area

e) What benefits (financial or practical) can they bring to the farmer?
Reduction of the required cropland for fertilization, therefore reduction of transport cost

f) What is the main barrier to uptake?
High energy consumed (high cost of operation). Nutrients are not recycled

Thermal treatment options *(drying)*

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
100% of pathogens

d) Can they reduce P surplus – by how much and by what method?
The dry product containing N and P can be exported from the surplus area

e) What benefits (financial or practical) can they bring to the farmer?
High reduction of volume and easy to handle product

f) What is the main barrier to uptake?
High energy consumption (unless waste heat from a CHP engine can be reused).

Please list the *dominant* national and EU regulations that control the management of manure in your country/region

- *Nitrate Directive (91/676/CEE)*
- *IPPC Directive*

Mark BOYLE / Niall LOGAN

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
***Aerobic** – dependant on temp > $\log_{10}$ 4, Aerobic treatment and heat > $\log_{10}$ 4, -pathogenic Enterobacteriaeceae, Campylobacter.*

c) Can they reduce N surplus – by how much and by what method?
***Storage & composting** – reduce N*

f) What is the main barrier to uptake?
*Initial cost, workload, training requirements, lack of understanding/appreciation of environmental benefit***.**

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
PPC, Pepfaa Code, WFD, Nitrate Directive, Bathing Water Directive

3. What are the *main* routes of disease transmission from manure to (a) soil, (b) water and (c) crop (food) production? Which are the main pathogens implied?
Direct application and excretion, run off & poaching, overuse of manure. Pathogenic E. coli, Cryptosporidium, Campylobacter, Salmonella.

4. What are the main pollution risks from manure management for buildings and storage at the farm?
Run off, leachate, direct connection of farm drainage to watercourses

5. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
GW- Pollution thru boreholes, fractures in rock etc.
SW- poor spreading technique and spreading in rain & frost, lack of buffer zones.

6. How can we equate different pollution types? What is a fair way to compare options? If this is not possible, how can we optimise a farming system to minimise environmental impact?
   Examining Carbon footprint & links to Human Health

7. What are the environmental impacts from manure management options themselves?
   Pollution of surface waters, impact of wildlife, eutrophication, gaseous emission, pathogen transferral to water and food, failure to meet regulatory objectives.

Rita FRAGOSO

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
   Decreto-Lei 173/2008 – IPCC transposition, Decreto-Lei 214/2008 – regulates de activity of livestock farms; Portaria 631/2009 – regulates livestock manure management; Portaria 636/2009 – on pig farm characteristics.

Helvi HEINONEN-TANSKI

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
   It is not allowed to spread manure in winter or in late autumn excluding if starting the cultivation of winter cereal.
   The EU environmental regulations limit the amount of N and P per ha if the farmer would like to get EU environmental support (most will get it) and this is followed. There must be at least a small protection strip against surface waters. A more wide protection zone will be better supported (if it is accepted).
   Nitrate directive limits the use of N.

3. What are the *main* routes of disease transmission from manure to (a) soil, (b) water and (c) crop (food) production? Which are the main pathogens implied?
   In Finland the risks of pathogens from manure are rather limited. In rural area also the human faeces is a risk.

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
   The risks from spreading come realistic if there are heavy rains after spreading. By spreading technique the risks can be reduced. There should be possibility to a more wide area to minimize the load to surface waters. Possible some sedimentation ponds?
   In cattle grazing the change or drinking site should be one option.

Chris HODGSON

Storage options (Minimal storage time for manures and covers):

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
   Related to experience with beef cattle FYM and Pig FYM: Minimum storage 3 months with collection of leachate, will reduce FIO loads < 90%. Although I am aware of the 'pathogens' potentially present in animal manures all current UK legislation indexes pathogens as FIOs: The routine enumeration of pathogenic bacteria from environmental

samples is technically demanding, costly and frankly dangerous. Faecal indicator organisms (FIOs) are acknowledged as surrogates of pathogenic bacteria. FIOs are bacteria that derive from the guts of warm blooded animals; the assumption is that if FIOs are present so are faeces a vector for the transport of pathogens. Currently FIOs are defined by (international) legislation as Escherichia coli and Intestinal enterococci and are determined using classic microbiological techniques.

e) What benefits (financial or practical) can they bring to the farmer?
Potential reduction in the reliance on artificial fertilisers, so cost reduction.

f) What is the main barrier to uptake?
Infrastructure costs – leachate collection etc., covered middens vs. field heaps!

Spreading using injectors or trailing hoses:

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
Doesn't reduce pathogen load – potential to increase survival; injection > trailing hose > splash plate (broadcast application). Relevant to FIOs only see above section.

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
Outside my direct area of expertise! But ammonia emissions reduced by injection & trailing shoe compared to broadcast application

f) What is the main barrier to uptake?
Equipment cost

Land application machinery

Relevant to shallow injection, trailing shoe, band spreading and broadcast application of dairy cattle slurries information is same as above:

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
Doesn't reduce pathogen load – potential to increase survival; injection > trailing hose > splash plate (broadcast application). Relevant to FIOs only see above section.

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
Outside my direct area of expertise! But ammonia emissions reduced by injection & trailing shoe compared to broadcast application

Land application – controls based on local risks

This is related to DEFRA project WQ0118 – to improve our understanding on contrasting cracking clay soils of the complex interactions that occur between livestock manure multiple pollutant loss processes and pathways to air (i.e. ammonia and nitrous oxide) and water (i.e. nitrate – N, ammonium – N, phosphorous, sediment and microbial pathogens, as indexed by FIOs).

Relates to Nitrate Vulnerable Zone (NVZ) action programme which introduces a closed period for the application of slurries – 16th October to 16th January, effectively no spreading in winter > storage capacity (mandatory 26 weeks for pig slurry and poultry manure, 22 weeks all other slurries). Limited applications in autumn, best time to spread to minimise compaction of soils. Greater amounts spread through the spring and summer – clay soils can crack wide open!

The processes controlling nutrient losses from drained clay soils are known to be markedly different from structureless sandy soils. On sandy soils, drainage occurs slowly over winter by piston displacement in the unsaturated phase, with wetting fronts moving to depth at rates of a few metres a year depending on drainage volumes and the pore volume of the soil and base rock. On undrained clay and medium loam soils, surface runoff is likely to occur in rapid response to rainfall events, because of the impermeable nature of the soil matrix. Where an effective drainage system is present, much of the water that would otherwise be lost as surface runoff, will move rapidly from the soil surface through macropores that have developed naturally or have been created through the installation of pipe drains, mole drains or subsoiling fissures, with transit times influenced by rainfall volume and intensity. There are in the region of 6.4 million hectares of drained soils in England and Wales, which is equivalent to c.70% of the agricultural land area. The majority of drainage schemes (60%) have been installed on medium and heavy textured soils to correct surface wetness problems, with an estimated c.70% of drainage schemes installed on arable land and c.30% on grassland. Moreover, around 25% of arable and 40% of grassland soils are considered to justify 'intensive' (e.g. pipe and mole channel) drainage schemes.

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region:
   Water Framework directive, revised Bathing Waters Directive, Shell Fisheries Directive, The EC Nitrate Directive, adopted in 1991, (Environmental Permitting (England and Wales) Regulations 2007, SI 3538), which implement the EU Integrated Pollution Prevention

3. What are the *main* routes of disease transmission from manure to (a) soil; *application of slurries and solid manures, direct animal defecation, leaching from storage, slurry tanks, FYM heaps.* (b) water; *application slurry and FYM direct animal defecation, drinking/fording/loafing in streams, rivers*. and (c) crop (food) production; *application of dirty water/contaminated irrigation water from above, potential soil contamination from slurry manure application as fertiliser?* Which are the main pathogens implied, *Faecal Indicators, but are likely to include pathogenic E. coli, Campylobacter, Salmonella, Protozoa, Cryptosporidium, Giardia ?*

4. What (if any) are the possible impacts of poor manure management on sanitary risk?
   Contamination of water courses with the potential to contaminate recreational waters.

5. What are the main pollution risks from manure management for buildings and storage at the farm?
   Limited storage capacity and leaching/leaking to surface drains – the critical source areas (CSAs).

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
   Timing of application, condition of the soil/land specifically the soil moisture deficit, 'knowing the local weather forecast, is heavy rain due?

7. How can we equate different pollution types?
   Pollution swapping what's good for one is not necessarily good for another e.g. reduced ammonia emissions via shallow injection of slurries, potential to increase survival of FIOs/pathogens. What is a fair way to compare options, difficult to compare directly however, by untilising guidelines/limits is one option e.g. bathing water guidelines for FIO concentrations (CFU/100ml) and EC limit for NO_3-N (11.3 mg/l)? If this is not possible, how can we optimise a farming system to minimise environmental impact. Consider the farming system as a whole – an example from FIO work to reduce the risk determine the total E.coli

burden to land, The farm infrastructure, The farmers ability to take action, the connectivity of the land.

8. What are the environmental impacts from manure management options themselves?
   Not sure reduced risk of pollution; air, water and soil?

Paul HOEKSMA

1. For which of the following eco-technology options do you have farm-scale experience (not laboratory-based schemes)

Air scrubbers and bio-filters

Chemical air scrubbers will reduce pathogens (E.coli, Campylobacter, Salmonella) by appox. 1 log unit.
Bio-filters may reduce pathogens but may also increase the number of pathogens.
There is a strong relationship between PM_{10} and pathogens from livestock housing.
Chemical air scrubbing: reduction of ammonia by 70-95%
No reduction of N and P surplus
Air scrubbing and bio-filters are a licence to produce
Only for new pig and poultry housings

Storage options (Minimal storage time for manures and covers)

Minimal slurry storage time for E.coli, Campylobacter, Salmonella is 3 months.
Reduction of ammonia by 70-80%.
No effect on N and P surplus.
Covering slurry storage is obliged.
No barriers for uptake

Separation and composting systems

Composting does effectively reduce entero's.
Separation is a relatively cheap way for dairy farmer to get rid of P surplus.
Benefits for pig farmer strongly depend on regional situation; solid fraction to biogas plant, liquid fraction to land nearby.

Anaerobic treatment

Entero's reduce during anaerobic treatment by ?%.
No effect on N and P surplus
Land spreading of digested slurry may increase ammonia emission because higher content of mineral nitrogen.

Manure products (including drying option)

Production of mineral concentrates will have great benefit for pig farmers in The Netherlands if the product is recognized as a mineral fertilizer according to EU standards. Then a greater amount of nitrogen from animal slurry can be used on land and chemical fertilizer can be saved.

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region

- *Nitrate Directive (EU)*
- *Water Framework Directive (EU)*
- *Manure Legislation (NL)*

Stan LALOR

1. For which of the following eco-technology options do you have farm-scale experience

☑ Spreading using injectors or trailing hoses
☑ Land application machinery
☑ Land application – controls based on crop nutrient demands

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many log_{10} units.
Unsure in all cases.

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
Land application using low emission techniques can significantly reduce ammonia emissions (up to 90%) compared to broadcast spreading.

c) Can they reduce N surplus – by how much and by what method?
Yes, improved land application methods can reduce N surplus by way of decreased ammonia emission replacing chemical N fertilizer. Ammonia-N not volatised is usually assumed to replace chemical fertilizer N on a 100% equivalency.

d) Can they reduce P surplus – by how much and by what method?
No

e) What benefits (financial or practical) can they bring to the farmer?
Economic savings through reduced fertilizer N requirements.

f) What is the main barrier to uptake?
Cost

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
Nitrates Directive.

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
Weather conditions at timing of application (i.e. presence of a transport vector linking nutrient/pathogen source to a receptor)

7. How can we equate different pollution types? What is a fair way to compare options? If this is not possible, how can we optimise a farming system to minimise environmental impact?
Targeting of measures based on regionally specific challenges. For example a measure to reduce N leaching will yield poor results in a region of heavy soils with impeded drainage where nitrate leaching is not a major issue.

8. What are the environmental impacts from manure management options themselves?
Increased energy consumption, Compaction with heavier machinery, Concentration of work on agri-contractors allows less timely application based on optimal weather.

Paolo MANTOVI

1. **For each eco-technology indicated:**
   a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
   b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
   c) Can they reduce N surplus – by how much and by what method?
   d) Can they reduce P surplus – by how much and by what method?
   e) What benefits (financial or practical) can they bring to the farmer?
   f) What is the main barrier to uptake?

Feed diet control options

b) Experimental trials made by CRPA: pigs with low protein (12%) diet: -18 % ammonia emissions from stable, compared with pigs with conventional 14 % protein diet (Fabbri et al., 2008)
c) Experimental trials made by CRPA: pigs with low protein (12%) diet: -17,8 % total N in manure, compared with pigs with 14 % protein diet (Fabbri et al., 2008)
d) yes, if phytase is used (pigs)
e) less the N, P excreted ---> less agricultural area to spread manure
f) farmer's way of thinking, costs for integration with amino acids and phytase

Separation and composting systems

a) CRPA has measured pathogens in composted materials other than manure (such as sewage sludge, animal wastes)
b) reference to Balsari et al. (2008). Ammonia losses from the land application of raw pig slurry and solid and liquid fractions generated from its mechanical separation. Proceedings of the 13th RAMIRAN International Conference
c) Yes. Export of the solid fraction; ammonia emissions during separation and composting.
d) Yes. Export of the solid fraction.
e) liquid fraction to be used as a N fertiliser on growing crops, solid fraction to be exported or used as a P fertiliser. Compost as an amendment to be sold.
f) farmer's way of thinking, costs and time for managing composting

Anaerobic treatment

a) In theory, quite good in termophilic reactors. No direct experience by our Institute
b) reduction of methane emissions, especially if storages are covered. Take care to ammonia emissions at spreading (need to use low emissions techniques).
c) no significant N reduction if only anaerobic treatment
d) no significant P reduction if only anaerobic treatment

e) biogas production and conversion (electrical energy) give economical benefits to Italian farmers. Digestate is more stabilised than raw manure (odours reduction), N in digestate is, potentially, more efficient to crops.
f) administrative burdens, uncertainties on the future subsidies.

Aerobic treatment (including nitrification and de-nitrification)

a) In theory, quite good. No direct experience in our Institute
b) reduction of ammonia emissions. N_2O emissions need to be controlled, quantified and maybe reduced...
c) >95% removal in SBR systems treating pig manure (ref. Piccinini et al., 2006).
d) >95% removal in SBR systems treating pig manure (ref. Piccinini et al., 2006).
e) less N and P in manure ---> less agricultural area to spread manure. Sludge to be used as a P fertilizer on soil with low available P.
f) investment costs, energy consumption. New processes can help (such as partial nitrification).

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region

Nitrate Directive (91/676/EEC)
Implementation of the Nitrates Directive in Italy lies in the competence of the Regional Authorities. However, in order to establish a common ground for implementation, the Ministerial Decree of 7 April 2006 sets out provisions at national level, establishing, for instance, criteria for storage design and volumes, minimum length of closed periods, minimum width of buffer strips along water courses, procedures for establishing nitrogen application, manure N excretion standard coefficients, fertilisation planning, etc.
IPPC (2010/75/UE)
WFD is coming, slowly

5. What are the main pollution risks from manure management for buildings and storage at the farm,?
Air emissions (ammonia+GHG), leaks of slurry

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
Nitrate concentration

Pilar MERINO

1. For which of the following eco-technology options do you have farm-scale experience

   a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.

   Feed diet control options. No effect on pathogen reduction.
   Air scrubbers and bio-filters. Dilution effect
   Storage options (Minimal storage time for manures and covers). Increase anaerobic ones
   Separation and composting systems. Effect of composting, reduction due to high temperatures. 10^5 total microorganisms
   Spreading using injectors or trailing hoses. Effect will depend on surrounding conditions (rainfall, temperature, soil characteristics..) for their survival.
   Land application – controls based on local risks.

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
Feed diet control options. Reduces N content on manure, but gases may be not reduced
Air scrubbers and bio-filters. Reduce ammonia and increase N2O
Storage options (Minimal storage time for manures and covers). Increase methane, no much effect on N_2O. Ammonia may increase or decrease depending on temperature and management (stirring, periodic addition of manure…).
Separation and composting systems. With respect to original slurry, during composting more emissions due to the stirring of material.
Spreading using injectors or trailing hoses. N2O increases and ammonia during the first 48 hours
Land application – controls based on local risks. N2O increases

c) Can they reduce N surplus – by how much and by what method?
Yes: feeding

d) Can they reduce P surplus – by how much and by what method?
Feeding

e) What benefits (financial or practical) can they bring to the farmer?
Feed diet control options. Financial. Less N concentration in manure, thus if fertilisation is done according to crops needs, more manure can be applied.
Air scrubbers and bio-filters. Odour reduction
Storage options (Minimal storage time for manures and covers). Odour reduction
Separation and composting systems. Easier management
Spreading using injectors or trailing hoses. Disposal of a waste may reduce odour if injected.
Land application – controls based on local risks.

f) What is the main barrier to uptake?
Confusion of the benefits as it implies either investment or modify their usual management.

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
Code of good practices
Industrial Emissions Directive 2010/75/UE, 24th November (it includes IPPC, chapter 2).
Nitrates Directive

3. What are the *main* routes of disease transmission from manure to (a) soil, (b) water and (c) crop (food) production? Which are the main pathogens implied?
Mainly E. coli and Campylobacter, other pathogens that can be found in manures are Listeria, clostridium, coxiella. Some serotypes of them are zoonotic and are transmitted by food contaminated with animal excreta.

Werner PHILLIP and Ludwig HOELZLE

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many log_{10} units.

Bio-filters: maximal reduction of one log unit (bacteria, viruses fungal spores)
Manure storage: up to 8 log units for salmonella
Anaerobic treatment, aerobic treatment, thermal treatment:

All methods are more or less capable to inactivate E. coli and salmonella; in some cases also viruses and parasites. However, in all these techniques a validation of the processes is necessary which proofs the inactivation of specified test organisms by at least 5 log_{10} units.

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
   EU-regulations: directive 1774/2002 resp. 1069/2009 and order 142/2001 resp. 749/2011
   National:
   Verordnung des Bundesministeriums für Ernährung, Landwirtschaft und Verbraucherschutz über das Inverkehrbringen und Befördern von Wirtschaftsdünger (Verbringungsverordnung)
   Bioabfallverordnung, Tierische Nebenprodukte-Beseitigungs-Verordnung, Düngemittel-verordnung, Düngeverordnung
   Restrictions of single german federal states

3. What are the *main* routes of disease transmission from manure to (a) soil, (b) water and (c) crop (food) production? Which are the main pathogens implied?
   Soil: overfertilization, marsh soil within water protection areas, slurry containing are contaminated with pathogens, extreme rain
   Water: see soil
   Crop (food) production: output of slurry on grassland, no or short waiting periods after fertilization, insufficient output techniques
   Main pathogens: salmonella, E. coli, MRSA, listeria, Campylobacter, Mycoplasma, mycobacteria, chlamydiae, Coxiella, Clostridium, Yersinia enterocolitica, Pseudomonas aeruginosa, rotaviruses, coronaviruses, ECBO viruses, parvoviruses, cryptosporidia, Ascaris suum.

4. What (if any) are the possible impacts of poor manure management on sanitary risk?
   Latent herd problems (e.g. salmonellosis, paratuberculosis), insufficient and bad feed quality, malnutrition, health problems

5. What are the main pollution risks from manure management for buildings and storage at the farm?
   Leaky slurry storage tanks, uncovered slurry storage tanks
   Emmissions (taste, ammonia)
   Bad ventilation of stable
   Distribution of bioaerosols
   Aerosols containing pathogens

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
   The risk of surface and ground water contamination is limited or improbable if the restrictions on slurry and manure output are adequately observed.
   A reduction of the risk of contamination can be achieved by different treatment procedures.

7. How can we equate different pollution types? What is a fair way to compare options? If this is not possible, how can we optimise a farming system to minimise environmental impact?
   A comparison of different pollution types is rather impossible. Due to prophylaxis slurry transferred between farms should be treated, e.g. pasteurisation. The treatment of slurry and other biological waste in mesophilic or thermophilic biogas plants could be an option. Storage of slurry should be done for at least 4 to 6 months.
   The usage of slurry should be done according to the guide of good agricultural practice. In addition, state of the art techniques should be performed for slurry output.
   Surveillance of the health status of animal herds should be performed.

8. What are the environmental impacts from manure management options themselves?
All types of technical optimisations for storage, treatment and output of slurry and other farm fertilizers are important contributions to avoid contaminations of soil, water and plants, to reduce emissions, to ensure the health of animals and human beings, and to optimise the profitability of the animal production.

Giorgio PROVOLO

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
Referring to E. coli and Salmonella:
Storage has a limited effect due to natural decrease
Anaerobic treatment can reduce the load but can be effective only if the process is thermofilic
Aerobic can reduce the pathogen load. If there are good working condition and with a tertiary stage the pathogen load can be reduced to the accepted limits for discharge in surface water

b) What is their performance to reduce polluting gas emissions – which gases, by how much and by what method?
Storage if covered reduce ammonia emissions
Anaerobic digestion reduce methane emissions. Ammonia emissions depends from the following management
Aerobic treatment if well conducted can reduce ammonia, methane and nitrous oxide

c) Can they reduce N surplus – by how much and by what method?
Storage: no
Anaerobic: no (but can provide energy to do it)
Aerobic: yes up to 75% of the nitrogen produced by the livestock

d) Can they reduce P surplus – by how much and by what method?
P surplus in manure can be transported in other area. Separation can be a practical solution to concentrate P. This is frequently adopted in aerobic and anaerobic plants

e) What benefits (financial or practical) can they bring to the farmer?
Storage: adeguate spreading periods
anaerobic: energy production
aerobic: reduction of N eccess; reduction of manure quantity to spread (only if discharge in surface water)

f) What is the main barrier to uptake?
Cost, legislation

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
EU: Nitrate Directive (91/676/EEC); IPPC (2010/75/UE)
National: Dlgs 152/2006; DM 07/04/2006

3. What are the *main* routes of disease transmission from manure to (a) soil, (b) water and (c) crop (food) production? Which are the main pathogens implied?
There is a limited concern in my area about possible contamination from manure. Most of the issues are related to improper management and direct spreading on crops.

4. What (if any) are the possible impacts of poor manure management on sanitary risk?
See previous answer

5. What are the main pollution risks from manure management for buildings and storage at the farm,?
emissions to air (ammonia, methane, nitrous oxide), leakage and spillage

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
Nitrates concentration in surface and ground water

7. How can we equate different pollution types? What is a fair way to compare options? If this is not possible, how can we optimise a farming system to minimise environmental impact?
I think that is not possible to find a common solution to minimise environmental impact. An integrated and multicriteria approach should be used to take into account different pollution types and different objectives.

8. What are the environmental impacts from manure management options themselves?
I'm not sure to have grasped the question. Of course every option has an environmental impact. I think the approach should be integrated and evaluate the overall impact, eventually using the LCA techniques.

Lena RODHE

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
I have been working with spreading technology and contamination of clostridia and entrobacteria into grass fodder.

e) What benefits (financial or practical) can they bring to the farmer?
Saved N=money

f) What is the main barrier to uptake?
Costly
Lack of knowledge
Lack of technical advisory services.

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
Swedish board of Agriculture has put up regulations, based on nitrate and water directives as well as ceiling levels of NH3 etc. I attach the regulations in English. (Not received: please contact Lena directly should you want to see the document)

3. What are the *main* routes of disease transmission from manure to (a) soil, (b) water and (c) crop (food) production? Which are the main pathogens implied?
I think the transmission is not so well understood. EHEC is discussed a lot.

4. What (if any) are the possible impacts of poor manure management on sanitary risk?
EHEC sickness. Salmonella among animals but not so much among people in Sweden, partly because of strict regulations (animals get slaughtered if Salmonella is detected)

5. What are the main pollution risks from manure management for buildings and storage at the farm?

From buildings I believe rodents and birds may spread the diseases to other animal farms. For outdoor animal production, (in Sweden all cattles are outdoor in summer). Another example is organic farms with outdoor pigs, where are high risks for instance with pathogens from wild pigs, who are increasing in numbers tremendously in Sweden.

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
   I presume the risk that bird and animal spread the pathogens are higher compared to leakage to water. But examples in this winter in a town the north of Sweden, they had problems with contaminated drinking water.

7. How can we equate different pollution types? What is a fair way to compare options?
   If this is not possible, how can we optimise a farming system to minimise environmental impact? It is of great interest to map the route of pathogens from sick animals on farm to ex-farm/in-between farms and of course to water wells etc. making people sick.

8. What are the environmental impacts from manure management options themselves?
   (I don't understand)

Any other comments ahead of the meeting ?

I think the subject is "hot", as we have had both in Europe and in Sweden outbreaks of diseases because of contaminated water or food. Also, children have been sick in EHEC after contact with cattle. It is very important to get a better understanding for the way how pathogens disperse from agriculture to society and in between farms in order to get efficient strategies to prevent it.

Eva SOSSIDOU

1. For which of the following eco-technology options do you have farm-scale experience (not laboratory-based schemes) – please tick all that apply

   ☑ Feed diet control options
   ☑ Other technologies *Animal health and welfare assessment methodology (measuring and monitoring animal based parameters)*

   a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
   By improving digestibility of the diet (lowering the protein content of the diet, selecting feed ingredients that are highly digestible, adding commercially available enzymes, using zeolite, etc).

   c) Can they reduce N surplus – by how much and by what method?
   i.e. 3% reduction of nitrogen in the manure due to pelleting. 8.5% reduction of nitrogen when using synthetic amino acides. Continued research is needed in this area.

   d) Can they reduce P surplus – by how much and by what method?
   i.e. Phosphorus excretion can be reduced 33% when phytase is aadded to a low phosphorus diet (swine and poultry).

   e) What benefits (financial or practical) can they bring to the farmer?
   Product added value, animal welfare, farmer wellbeing

   f) What is the main barrier to uptake?
   The cost

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
EK 1774/2002
Y.A. 239267/2003
Y.A. Y1ß/2000/1995

3. What are the *main* routes of disease transmission from manure to (a) soil, (b) water and (c) crop (food) production? Which are the main pathogens implied?
There are many different organisms in animal manure and each of these has a preference for location. In general terms the limiting factors are exposure to sunlight, extreme temperatures and exposure to oxygen and ammonia.
Main risks from pathogens in manure: E.coli, Listeria, Salmonella, Mycobacterium paratuberculosis, Cryptosporiadia and giardia, foot and mouth disease, coronavirus.

4. What (if any) are the possible impacts of poor manure management on sanitary risk?
Disease transmission to the staff, the farmer's family and the community.
Pathogens enter in the food chain>impacts on food safety and quality and on public health

5. What are the main pollution risks from manure management for buildings and storage at the farm? What specific links do you see between land-spreading management/technique and local surface and ground water quality?
Nutrient runoff from livestock manure

6. How can we equate different pollution types? What is a fair way to compare options? If this is not possible, how can we optimise a farming system to minimise environmental impact?
By modelling the different systems at farm level. Apply risk analysis methodology to measure and communicate with risks.

7. What are the environmental impacts from manure management options themselves?
Air, water and soil pollution, Odour nuisance

Jan VENGLOVSKY

a) What do you consider to be their potential to reduce the pathogen load in the farm waste? Which pathogen groups in particular and by how many $\log_{10}$ units.
The most important factors for decreasing the pathogen load in farm wastes are initial handling of the manure, period of storage (6 months in our country), temperature, treatment possibilities (lime added to pig slurry after separation decreases total count of microorganisms by 4 logs)

c) Can they reduce N surplus – by how much and by what method?
Aerobic treatment (pig farm slurry treatment) reduced N to comply with respective regulations

d) Can they reduce P surplus – by how much and by what method?
Similar as above (for N)

e) What benefits (financial or practical) can they bring to the farmer?
The benefits (treatment costs) are controversial

2. Please list the *dominant* national and EU regulations that control the management of manure in your country/region
   All relevant EU regulations apply in our country (Slovakia)

3. What are the *main* routes of disease transmission from manure to (a) soil, (b) water and (c) crop (food) production? Which are the main pathogens implied?
   Manure to soil and crops. Gastrointestinal infections

6. What specific links do you see between land-spreading management/technique and local surface and ground water quality?
   Surface and ground water protection zones prevent decrease of water quality

7. How can we equate different pollution types? What is a fair way to compare options?
   Good farm and manure management, application of the IPPC system

8. What are the environmental impacts from manure management options themselves?
   It depends considerably on farmers themselves, size and farm management

Any other comments ahead of the meeting ?

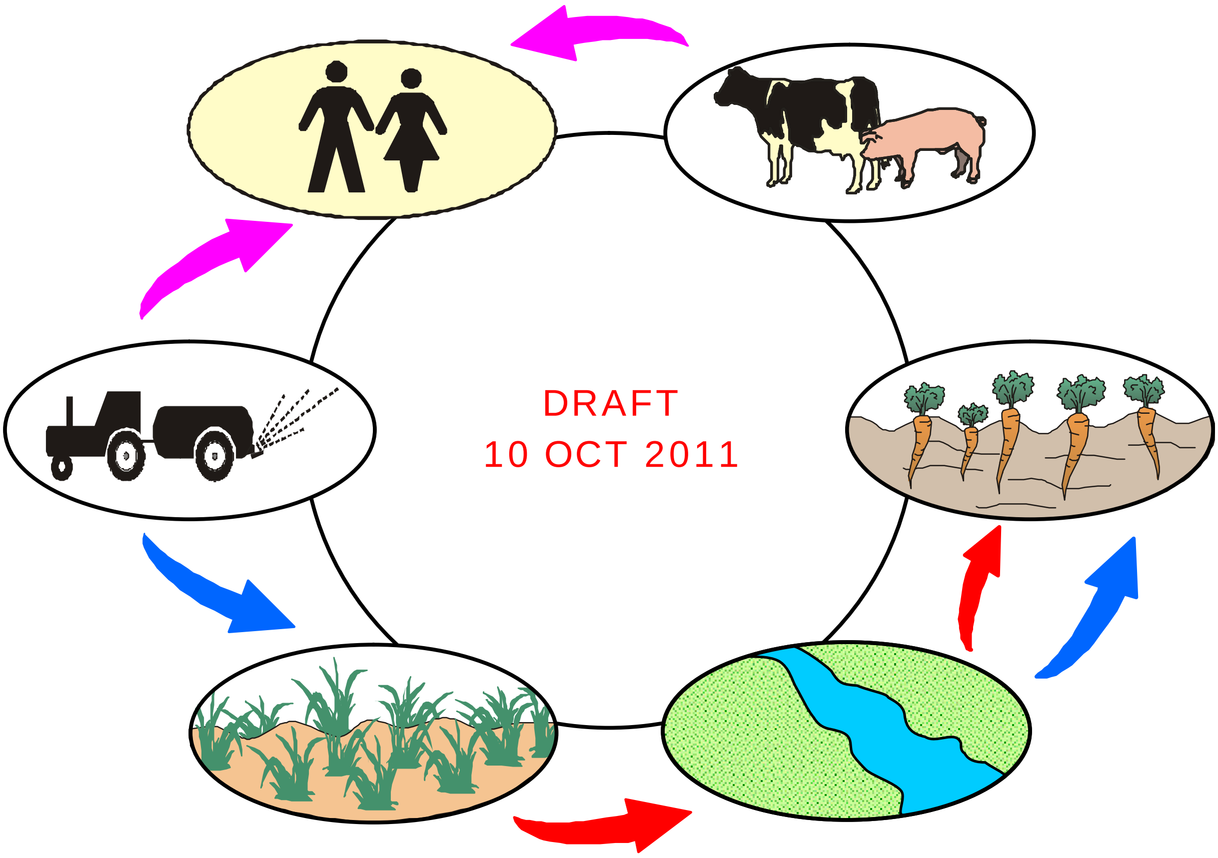
New project: Beta-lactamase genes of enterobacteria in the animal environment and bioaerosols (May 2011- December 2013)

APPENDIX 6

Plan of the required technical report:

“*Reconciling environmental and sanitary risks in the management of livestock wastes : a review on the current situation in Europe*”.

Reconciling environmental and sanitary risks in the management of livestock wastes : a review on the current situation in Europe



Laurence Loyon, Anne-Marie Pourcher, Adele Richmond, Björn Vinnerås and Colin Burton

Based on the findings from a European workshop : *"Reconciling environmental and sanitary risks in the management of livestock wastes"* – Rennes, France – 5/7 October 2011

Scientific committee:

Colin Burton[1,2], Anne-Marie Pourcher[1,2] and Björn Vinnerås [3,4]

1. *Cemagref, unité GERE , Rennes, France*
2. *Université Européenne de Bretagne, France*
3. *Department of Chemistry, Environment and Feed Hygiene, National Veterinary Institute, Swedish University of Agricultural Sciences, Uppsala, Sweden*

Work carried out as an objective of the BATFARM project. Funded by the participants and by the Atlantic Area Transnational Cooperation Programme, 2007 – 2013 of the European Regional Development Fund of the European Union

For more information on BATFARM and the partners involved, please visit website, http://www.batfarm.eu/

Contact persons for this report:

Dr Laurence Loyon : laurence.loyon@cemagref.fr
Dr Anne-Marie Pourcher : anne-marie.pourcher@cemagref.fr

Cemagref
Rennes Regional Centre
17, avenue du Cucillé – CS 64427
F-35044 RENNES cedex
France

Contributors to this report in alphabetical order

Dr	AGUILAR-RAMIREZ	Maite	maguilar@itgganadero.com	ITG Ganadero	Spain
Dr	BONMATI-BLASI	August	august.bonmati@giroct.irta.cat	GIRA Barcelona	Spain
Mr	BOYLE	Mark	Mark.Boyle@gcu.ac.uk	Glasgow Caledonian University	Scotland
Dr	BURTON	Colin	colin.burton@orange.fr	Cemagref Rennes	France
Mr	CUNAULT	Charles	charles.cunault@cemagref.fr	Cemagref Rennes	France
Dr	DABERT	Patrick	patrick.dabert@cemagref.fr	Cemagref Rennes	France
Prof	DALSGAARD	Anders	ad@life.ku.dk	University of Copenhagen	Denmark
Dr	ECKTEL	Henning	h.eckel@ktbl.de	KTBL	Germany
Dr	FRAGOSO	Rita	ritafragoso@gmail.com	ISA Lisboa	Portugal
Prof	HEINONEN-TANSKI	Helvi	heinotan@uku.fi	University of Eastern Finland, Kuopio	Finland
Dr	HERMONIC	Anne	anne.hemonic@ifip.asso.fr	IFIP Le Rheu	France
Dr	HODGSON	Chris	chris.hodgson@bbsrc.ac.uk	Rothampsted - N Wyke	UK
Dr	HOEKSMA	Paul	paul.hoeksma@wur.nl	Wageningen UR	Holland
Prof	HOELZLE	Ludwig	Ludwig.Hoelzle@uni-hohenheim.de	Universität Hohenheim	Germany
Dr	HUNEAU	Adeline	Adeline.HUNEAU@anses.fr	ANSES Ploufragon	France
Dr	LALOR	Stan	Stan.Lalor@teagasc.ie	Teagasc	Ireland
Dr	LEHUGER	Simon	simon.lehuger@cemagref.fr	Cemagref Rennes	France
Prof	LOGAN	Niall	N.A.Logan@gcu.ac.uk	Glasgow Caledonian University	Scotland
Dr	LOYON	Laurence	laurence.loyon@cemagref.fr	Cemagref Rennes	France
Dr	MANTOVI	Paolo	p.mantovi@crpa.it	CRPA Reggio Emilia	Italy
Dr	MAROIS	Corrine	Corinne.MAROIS@anses.fr	ANSES Ploufragon	France
Dr	MERINO	Pilar	pmerino@neiker.net	NEIKER	Spain
Ms	PEDEMEIRA	Ana	ritafragoso@gmail.com	ISA Lisboa	Portugal

Prof	PHILLIP	Werner	werner.philipp@uni-hohenheim.de	Universität Hohenheim	Germany
Dr	POURCHER	Anne-Marie	anne-marie.pourcher@cemagref.fr	Cemagref Rennes	France
Dr	PROVOLO	Giorgio	giorgio.provolo@unimi.it	University of Milan	Italy
Ms	RICHMOND	Adele	adele_richmond@hotmail.com	Cemagref Rennes	France
Dr	RODHE	Lena	lena.rodhe@jti.se	JTI Upsala	Sweden
Dr	SOSSIDOU	Eva	sossidou@it.teithe.gr	NAGREF - Thessalonika	Greece
Dr	VENGLOVSKY	Jan	venglov@uvm.sk	University of Veterinary Medicine, Kosice	Slovakia
Dr	VINERAS	Bjorn	Bjorn.Vinneras@slu.se	Swedish University of Agricultural Sciences	Sweden
Dr	WULF	Sebastian	s.wulf@ktbl.de	KTBL	Germany

CONTENTS

Notes in italics for guidance only and will be removed from final version

1. Define of the problem

This only needs to be a summary as main ideas already well published : some idea of ranking and relative importance may be included

a. Emissions to the air **LL**

Ammonia emissions, nitrous oxide nitric oxide (NOx), methane, carbon dioxide (from energy consumption), hydrogen sulphide, VOC's…….

b. Water contamination from manure sources **PM**

Ammonia (in surface water), nitrates/nitrites, phosphorous, …….

c. Soil and crop contamination from manure sources **??**

Heavy metals in soil, potassium (salinity), ammonia deposition, ……

d. Ensuring the health and well-being of animals and farm staff **??**

Distinguish the various categories of hazard (risk) – notifiable diseases (commercial and public health), direct and indirect health risks.

e. Protecting food and water quality from pathogen contamination **??**

Some explanation of the main issues to mark out the main areas of concern, but detail not needed at this point

f. Offensive odour and other nuisance issues **??**

Include both odours and dust emissions; separate note of health issues related to dusts in above section 1d ? Are dust emissions from livestock significant with respect to other sources? Include figures + references. Other nuisances (noise, visual …) need no more than a very brief note.

g. The consequences of pollution **??**

Again just a resume on a well-reported subject : note difference between pollution emissions and consequences. Global warming, acid rain, nutrient surplus problems, eutrophication, green seaweed; soil enrichment (nitrogen), salinisation (soil), soil toxicity. water toxicity, oxygen stripping (surface water), ozone depletion ……some note on the sequestration of carbon to/from the soil would be useful especially in the context of biochar.

h. Benefits from good manure management **LR?**

To address a rather negative image given by the above list, this final part of section 1 can set out what positive things can be achieved if manure is properly used. Manure as a sources of nutrients and micronutrients; deficiencies of Se, a better balanced fertiliser increasing soil organic matter – (soil structure, soil improver, water retention), increasing soil carbon, financial value (with respect to chemical fertilisers), readily available in the local region ….

2. Set out the specific goals of manure management – the implied strategies

This is a key section : trying to move from a general desire to improve/protect the environment to clear objectives set as target values which will enable scientific research. This is not easy, and we can justifiably make this a research objective in itself.

a. Reduction of gaseous emissions – what are reasonable targets? **??**

b. Management of manure with acceptable health risks: what could be the enforceable standards? **AD**

c. Reducing surface and groundwater contamination by nutrients: what does this mean for manure management **CH**

d. Maximizing the benefits from manure treatments and minimizing the costs: what are the real useful products? **SLA**

3. What are the new and existing manure treatment or management options that are being used to protect the environment

(Details to include : (i) brief description and benefits of technology, (ii) the uptake of the option by the livestock sector in Europe, (iii) practical concerns and the applicability of the method, (iv) installation and running costs, (v) possible drawbacks and (vi) any conflict with other manure management objectives, (vii) references).

a. Animal diet optimization **ES**; linking animal diet to manure management **PMe**

b. A review of new and current manure treatment options *This list can be quite long but information of any one technique should not exceed 2 pages.* *See also notes included at the end of this document.*

- i. Energy production : AD and biogas options **HE/SW**
- ii. Physical separation and sedimentation techniques **??**
- iii. Aeration and composting techniques **??**
- iv. Treatment based on ammonia stripping **PMa**
- v. Drying options – products from liquid and solid manure **??**
- vi. Biochar – what method, what advantage? ??
- vii. Membrane techniques – where do they fit in? ??
- viii. Techniques based on struvite and production **AB**
- ix. Techniques based on algae production **AB**
- **x.** Flotation technologies applied to livestock manure **??**
- **xi.** Acidification of manures **??**
- xii. Other techniques **??**

c. Abatement techniques based on farm building management **GP**

d. Storage and land application of livestock manures **HE/SW/LR**
This is potentially a big subject area – not too much on the agronomy although nutrient use is clearly a key factor

e. Handling, transport and exporting options **??**
This will include the production of manure products and subsequent sale

4. What are the new and existing manure treatments or management options that are being used to reduce hygiene risks to the animal, local people, food production and water quality?

(Details to include : (i) brief description and benefits of technology, (ii) the uptake of the option by the livestock sector in Europe, (iii) practical concerns and the applicability of the method, (iv) installation and running costs, (v) possible drawbacks and (vi) any conflict with other manure management objectives, (vii) references).

a. Options relating to animal diet and feed optimization **ES**

b. A review of new and current manure treatment options
This should only focus on those techniques that can reduce pathogen load. Those methods that are suitable for control during an outbreak should be distinguished from a general abatement of pathogens. Information of any one technique should not exceed 2 pages.

- i. Incineration and other thermal techniques **WP/LH/BV**
- ii. Possible benefits from aeration and other biological treatments **WP/LH/BV**
- iii. The use of sanitizing chemicals **WP/LH/BV**
- iv. Other technologies **??**

c. Storage and land application of livestock manures: the persistence of pathogens in the farming system

- i. Issues related to antibiotic resistance; **JV**
- ii. The impact of soil conditions on survival of bacteria); **AMP**
- iii. Storage as a valid technique for reducing pathogen numbers **WP/LH /LR**

d. What are the options of good farm building management in the reduction of hygienic risk? **??**

e. Health risks associated with transport of manure and manure products **??**

5. The gaps in the current knowledge on manure management and the conflicts of ideas: nine key areas for research

a. The importance of standardized methods for measuring emissions (air, water, soil) arising from manure handling **SLe**

b. Pollution swapping and conflicting effects of applied methods – establishing the current situation **CH**

c. Reliability and extent of acquired data with respect to manure and the related emissions: quality, interpretation, representativeness, relevance: too much and too little? **LR**

d. Understanding the mechanisms that link poor manure management to observed pollution in the environment **??**

e. Getting from the laboratory to the farm : methods to enable a better transfer of knowledge and technology **MA**

f. Linking sources and consequences : reliable methods for tracking manure pollution – microbial tracers and source tracking **AMP**

g. Establishing the availability of nutrients in land applied manure products **Sla**

h. Manure processing: improvement of the processes – are commercial end products really possible? **PH**

i. What are the methods that allow a valid and fair evaluation and comparison of manure management options **GP**

j. Better farm management: development of methods to measure and compare such zoo-technical parameters. [Are there benefits from such policies as reduced stocking density] **ES**

6. Conclusions

What is the most important research actions required? **LL/CB**

This will include key points from the earlier sections identifying the problem and targets for treatment/management. However, special emphasis will be given to the action required now especially section 5 above. Listed targets will be prioritized (based on the collected views of participants) this being given both for the general European level and on a country by country basis, noting regional differences.

Reference list **LL/CB**

Annexes **as submitted**

Codes used for the identification of contributors in alphabetical order (only for the purpose of report preparation – this page and codes to be deleted from final version unless agreed to include specific references throughout the document).

AR	Adele	RICHMOND
AH	Adeline	HUNEAU
AP	Ana	PEDEMEIRA
AD	Anders	DALSGAARD
AM	Anne	HERMONIC
AMP	Anne-Marie	POURCHER
ABB	August	BONMATI-BLASI
BV	Bjorn	VINERAS
CC	Charles	CUNAULT
CH	Chris	HODGSON
CB	Colin	BURTON
CM	Corrine	MAROIS
ES	Eva	SOSSIDOU
GP	Giorgio	PROVOLO
HHT	Helvi	HEINONEN-TANSKI
HE	Henning	ECKTEL
JV	Jan	VENGLOVSKY
LL	Laurence	LOYON
LR	Lena	RODHE
LH	Ludwig	HOELZLE
MAR	Maite	AGUILAR-RAMIREZ
MB	Mark	BOYLE
NL	Niall	LOGAN
PMa	Paolo	MANTOVI
PD	Patrick	DABERT
PH	Paul	HOEKSMA
PMe	Pilar	MERINO
RF	Rita	FRAGOSO
SW	Sebastian	WULF
SLe	Simon	LEHUGER
SLa	Stan	LALOR
WP	Werner	PHILLIP

Supporting information (based on notes taken from the workshop)

For section 3b, "A review of new and current manure treatment options'

Energy production

Biogas – manure helps stabilise co-digestion plant – what does this mean? What is the net energy contribution ? What is the economic evaluation? Other benefits should be noted (eg: potential methane emission reduced). However, possible negative overall energy balances? (also LCA anlaysis). Heat use crucial –is it always possible? Numbers needed! Figures (Holland) give negative energy values in some cases. Use of waste heat or biogas is crucial for heating. Generally, it is rare to have an economically viable system without subsidy: e.g. experience of plants in Germany. Using surplus heat can be a problem: heat not wanted in summer! Electricity production: 20% of potential substrate energy as electricity. Other benefits may be more important? Factory use of biogas (if located nearby). Nutrients remain in digestate : improved – mineralised N (by much? 10 to 20% of raw org N – can equally be achieved by a long term storage!). Claimed advantage of improved homogeneity and fluidity. Some question on availability of P and other nutrient components. Stability of residue organic matter. pH increase is normally observed.

Incineration – example of horse manure schemes (noting high straw content): volumes can be significant especially relating to leisure industry: admittedly relatively small sites implying collection schemes. Manure also used for compost rather than to produce energy ? For poultry litter/manure, there are several energy plants in UK and Holland.

Biochar – surely this process is a net consumer of energy ? Energy source – presumably external? Is it possible to use half of the potential energy in the substrate to treat other half – need to check the energy balance. Objective to put carbon in soil? How? Influence of carbon content on soil temperature (cf : solar absorption – need to check). Catchphrase is often "Sequestration of C".

Gasification – plants in Germany drying pig manure using a *sterling* engine – does it work? What is the motivation – nutrient surplus? – destroying nutrients – removing N as NOx ? What about the fate of the phosphorous? Possible reduction of NOx from gasifiction (re combustion). What is the availability of nutrients? Is the ash really a good fertiliser: it is often land-filled in Germany!

Drying option (poultry droppings) – overall ammonia emissions reduced by inhibiting breakdown of urea – given as BAT technique. Commonly used in laying plants : basis of circulation of ventilation (or forced) ambient air within the building.

Drying option (liquid manure) – more easily established for of sludge and solid phases following separation. Special interest for the digestate followingr AD – often using waste heat from electricity generation (Germany). Ammonia driven off can be removed by acid scrubbers. Plants in northern Spain dry liquid manure using waste heat from parallel electricity generation – (natural gas + biogas) : the scheme still requires subsidy. Efficiency of system possibly compromised by the need for power generation. In Portugal and Italy there are schemes based on the natural evaporation / drying of liquid manure. Presumably large ammonia losses ?! Most appropriate for the summer. Bio-drying (heat of composting) – for liquids associated with solids – same problems of ammonia.

Ammonia stripping – (usually followed by acid trapping). Pilot plants in Holland (?), Sweden, Finland, ….. High energy consumption (heating + compressor). Plant in Italy using heat from biogas plant: CaO added to produce heat and alkalinity. Production of ammonia sulphate (when using sulphuric acid) – sold to chemical plant at a concentration of around 8% (w/w) of ammonium sulphate in water. May be classified as "organic fertilizer" – check. Residual slurry pH 9.5 Typically 80% of TAN removed.

Struvite precipitation (by adding Mg and PO_4) – process also known as 'Biotain Split-box" (Sweden - check) includes ammonia stripping ….products : struvite, water, … However, there is a high consumption of Mg and phosphate. Key question is "does it work as an agricultural fertilizer – noting that struvite is not very soluble! What is its value as a slow release fertilizer …how slow?

Membrane technologies – are they applicable for livestock slurries? Important to include first, pre-separation, flocculation, digestion, clarification…..only then R.O. membranes (60 Bar operating pressure). Large pilot plants in Wageningen: 50 to 60.000 tonnes year (Holland). Still cheaper than transporting manure – cost given as 10-15 euro/tonne of raw manure feed. Three end products ot the membrane process – a solid fraction, a liquid concentrate (to digester) and water (representing 50% of total volume). Pig farmers in Holland already payi up to 20 euro/tonne for exporting surpluses (transport costs). Final polishing of permeate from membranes (using ion exchange) enables the safe discharge to surface water. Costs still seem high ; eg ; maximum tolerable costs are much lower at 3-5 euro/tonne in Spain.

Flotation treatment – based on the addition of flocculating chemicals and the aeration by a stream of fine bubbles – this produces a concentrate in the top layer which is skimmed off. Such plants for manure exist in Holland and Italy. Often used as a first pretreatment step : the sludge going to AD and liquid separately treated by N/DN. Cost given as around 2-3 euro/metre cube of manure for flotation: for the total process, nearer 6-7 euro/m^3 raw slurry. Objective of flotation – removal of organic matter. Effect on N and P?

Acidification of manure – currently only used extensively in Denmark – clear purpose is to stop ammonia emission: also reduces emission of methane. After a promising start in late 90's, falling popularity – costly and possibly handling problems. Teagasc carried out trials applying acidification during spreading – method cited in Gothenburg protocol. Expected problems of corrosion of machinery and stores. How is the acid added: mixing pit; during application……..

Aeration processes – many processes (including composting for solid manures). Operated to achieve also a loss of nitrogen especially as N_2 but unwanted emissions of N_2O as well. NB: similar emissions of N_2O and other gases following the application of untreated manure will also occur : the quantities may be greater. Aeration is a very effective way to remove reactive organic matter and associated odours : it does incur an operation costs (for the aerator).

Separation processes – higher emissions of GHG gases (especially N_2O) following separation – need to check! Information source: modeling results from Denmark. Covers of stored liquids needed.