European Commission

J R C T E C H N I C A L R E P O R T S

Kick-off meeting of the technical working group for the EMAS sectoral reference document on best environmental management practices for the agriculture - crop and animal production sector

Minutes of the meeting

Paolo Canfora – European Commission, JRC
Marco Dri – European Commission, JRC
Ioannis Sofoklis Antonopoulos - European Commission, JRC

David Styles - Bangor University
Julie Williamson - Bangor University

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European Commission
Joint Research Centre
Institute for Prospective Technological Studies

Contact information
Address: European Commission, Joint Research Centre, IPTS, Edificio Expo, c/ Inca Garcilaso 3, E-41092 Seville, Spain
E-mail: jrc-ipts-emas@ec.europa.eu
Tel.: +34 9544 88318
Fax: +34 9544 88300

http://ipts.jrc.ec.europa.eu/
http://www.jrc.ec.europa.eu/

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1 INTRODUCTION

The European Commission's Joint Research Centre (JRC) is developing a sectoral reference document on best environmental management practice in the agriculture – crop and animal production sector. The document will describe best environmental practices that farmers can implement to minimise the environmental impact of agriculture.

The elaboration of this sectoral reference document is part of the European Commission's work to implement the EU Eco-Management and Audit Scheme (EMAS) Regulation. EMAS is a voluntary framework for companies and other organisations to evaluate, report and improve their environmental performance. Within this framework, the EU decided in 2009 to develop Sectoral Reference Documents (SRDs) on Best Environmental Management Practice for different sectors. These are documents that EMAS registered organisations must take into account when assessing their environmental performance, but can also be used by others looking for guidance on how to improve their environmental performance. The agricultural sector is one of the priority sectors for which these documents are developed. Further information on this background is available on the following website: http://susproc.jrc.ec.europa.eu/activities/emas.

For the development of the agriculture SRD, the JRC established a European technical working group (TWG), comprising of experts in different aspects of environment and agriculture, to assist the European Commission in identifying these best practices and then validate the final findings. The kick-off meeting of the TWG was held in Brussels on 14-15 October 2013. The goal of this workshop was to establish the information exchange between the members of the TWG and to begin steering the development of the document, discussing its scope and the preliminary best environmental management practices identified. To this end, Bangor University was contracted by the JRC to prepare a background document to be used as a basis for the development of the sectoral reference document and a draft version of this background report was sent to the TWG members prior to the workshop.

2 OPENING OF THE WORKSHOP

The JRC opened the session and welcomed the participants. After a brief explanation of the meeting procedure, an introduction to the workshop and overall exercise was given. The meeting agenda (attached in Annex 1) was presented and agreed by the participants. The TWG members introduced themselves and summarised their experience in environment and agriculture (the list of participants is attached in Annex 2). It was agreed to use first names to refer to the different TWG members and the same convention is adopted in these meeting minutes.

3 INTRODUCTION TO THE EMAS SECTORAL REFERENCE DOCUMENTS AND PURPOSE AND GOALS OF THE MEETING

The JRC presented the framework of the EMAS Regulation. According to its article 46, the European Commission must develop, in consultation with stakeholders and member states, sectoral reference documents comprising best environmental management practices, environmental performance indicators and benchmarks of excellence. The aim of the documents is to describe with concrete measures what organizations of a given sector can do to improve their environmental performance and minimise their environmental impact.
It was also explained that the documents go beyond EMAS, offering support and being a source of information for all organisations willing to improve their environmental performance.

After this introduction, the JRC presented the goal of the TWG kick off meeting, which is essentially to ensure that the TWG members contribute as much as possible to the development of the sectoral reference document.

4 LESSONS LEARNT

The JRC presented how the previous sectoral reference documents were developed as well as their structure. The approach and general structure will be the same for the agriculture document. Most of the presentation focused on the meaning of environmental performance indicators and benchmarks of excellence with useful examples from previous documents. The approach used to identify best environmental management practises by analysing the measures implemented by frontrunners was also presented.

5 OVERVIEW OF THE AGRICULTURE SECTOR AND SCOPE OF THE SECTORAL REFERENCE DOCUMENT

Bangor University gave an introduction to the agriculture sector reporting data on employment, economics and structural profile. The presentation covered also a proposal for the scope of the document elaborated by JRC and Bangor University based on a list of NACE codes as well as the foreseen target actors and data sources for the document. Finally, the proposed structure of the sectoral reference document was presented.

Discussion: there were concerns about using NACE codes for defining the scope of the document. Some TWG members suggested that there are other potentially more suitable statistical classifications. **The JRC will circulate among the TWG members a new proposal for the scope open for comments.**
The structure of the document was also discussed. The opportunity to include a chapter dedicated to biodiversity should be explored (biodiversity is a cross cutting issue but would gain more attention with its own chapter). It was agreed that the document would contain a table including all types of farming systems and links to the relevant best environmental management practices presented in the document. **Karl** mentioned a database he developed containing measures farms and farms advisors can take. He **will send the link**. The proposed document structure was considered generally appropriate but **Urs will provide a proposal to improve it**.

6 ENVIRONMENTAL ASPECTS OF THE AGRICULTURE SECTOR

Bangor University gave a presentation on the environmental issues in Europe related to agriculture (CO_2 and NH_3 emissions, N and P leached in water, land use, soil erosion, water use), the global increasing demand for food and recent crop yield trends. Massive use of fertilizers since 1950s and expanding the agricultural land area allowed meeting the increasing demand for food but with high costs to the environment.

Discussion. The use of antibiotics for animal rearing and the contamination of soils with heavy metals should also be considered in the chapter on the environmental aspects. The environmental performance indicators should be revised carefully assessing where it is more appropriate expressing the environmental pressure per hectare or per unit of yield. The difference between land sparing and land sharing is not well formulated. Historical data on crop production yields need to be updated with figures from the latest years (2012, 2013), and differentiated for a wider range of crops (e.g. include corn). **Arnaud will provide information on wheat yields**.

After this session, the meeting analysed and discussed the proposed best environmental management practices (BEMPs) one by one, following chapter by chapter the draft background report. The numbering of BEMPs and chapters follows the numbering in the attached presentation (see Annex 3) as well as in the draft background document that was circulated to the TWG members ahead of the meeting. This will change in future versions of the document.

7 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – SOIL FERTILITY

Soil testing for nutrient management plan (NMP) (BEMP 5.1)
Discussion: soil testing alone does not reduce the environmental impact of agriculture; it should be related to other measures of nutrient budgeting. Information on economics of soil testing should be also presented. **Arnaud will come back with data**.
It is necessary to reconsider this BEMP and associate it with measures for improving soil.

Sustainable organic matter and nutrient amendments (BEMP 5.2)
Discussion: The aspect of quality of organic matter needs to be considered and **Urs will provide a proposal**. Cover crops are also crucial for the organic matter of the soil. However, employing cover crops can be problematic in some countries, because of climatic reasons.
Karl will send papers on cost of putting in a cover crop. The trade-off between slurry/sewage sludge application and heavy metal accumulation should be addressed.

Maintain soil drainage (BEMP 5.3)
Discussion: Economic benefits vs environmental benefits of soil drainage is a concern and **Karl will provide information** on this. Crucially, soil drainage can also lead to negative environmental effects, so the content of this BEMP should be reconsidered.

Slurry separation (BEMP 5.4)
Discussion: the main suggestion from the TWG was to expand this BEMP into manure management, presenting also how and which products could be obtained. **Karl will provide a link** with more details on best practices for manure management.

Precision application of fertilisers and manures (BEMP 5.5)
Discussion: to reduce the amount of fertiliser used, the direct placement of fertiliser close to seeds is sometimes practised but it depends on the crop. Therefore in the document there should be more information on the crops considered for this technique. **Claude will provide information** on some cases of application of fertilisers directly to the seeds.

Select lower impacts fertilisers (BEMP 5.6)
Discussion: polymer coated fertilisers are expensive. Calculation of carbon footprinting for fertilisers does not have a standard methodology. Care will be taken to ensure that the document includes robust indicators for green procurement of fertilisers.

8 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – GRASS AND GRAZING

Maximize grazing grass uptake (BEMP 6.1)
Discussion: The BEMP should not focus only on grass but also on other feeds, therefore it is necessary to reconsider the title and the BEMP. Grazing can lead to lower nutrient recovery from excreta (depending on how indoor excreta is managed), but improves animal welfare. Mowing grass can lead to more efficient use of grass, and should be mentioned. Mob grazing should not be considered best practise. Permanent grazing systems can be rich in biodiversity, and should be considered in the BEMP (**Urs will provide material** on them).

Manage grazing for water quality (BEMP 6.2)
Discussion: For large grazing areas, it is uneconomic to prevent cattle to reach rivers with fences and buffer strips may not be effective. However, buffer strips are good for biodiversity and **Katarina will provide data** on cattle density related to the opportunity and effectiveness of having buffer strips.

Grass-clover swards and sward renovation (BEMP 6.3)
Discussion: the TWG required reconsidering this BEMP to clearly distinguish between best practice for permanent pasture and for leys when discussing sward renovation.

Efficient silage production (BEMP 6.4)
Discussion: It is needed to expand this BEMP to other forms of forage systems, not focusing only on silage (which usually is only 10% of the diet of cattle). In light of this **Urs will provide literature** on combining grass that is cut at different times in order to improve the quality of the feed. Moreover, **Katarina will provide info** on a German group who developed a model to estimate when to mow the grass. There should also be diversification between high/low intensity grazing systems (north/south of Europe). The main outcome of the discussion was to amend this BEMP with new information provided.

Efficient application of slurry to grassland (BEMP 6.5)
Discussion: there are case studies of efficient application of slurry on grassland; however, it is also necessary to add emphasis to the timing of application, the potential infection of the soil (e.g. bacteria) and the temperature/moisture conditions.

Nitrification Inhibitors (BEMP 6.6)
Discussion: the main concern on this BEMP was that the use of inhibitors should be avoided with a correct manure management plan, which prevents having excess of manure in the farm. It is therefore necessary to reorientate this BEMP to emphasise their primary environmental benefit of mitigating N2O.

9 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – ANIMAL HUSBANDRY

Breed selection (BEMP 7.1)
Discussion: More clarity will be offered on the species considered and differentiation made (at least between ruminants and non-ruminants). Local breeds are not always the most productive; the appropriateness and adaptability of breeds to local conditions is the important factor. This BEMP will be reconsidered, with one option being a differentiation of best practice for extensive farms (local breeds) and high productivity farms (efficient breeds).

Nutrient budgeting on livestock farms (BEMP 7.2)
Discussion: This BEMP was in principle fine with the TWG.

Dietary reduction of N excretion (BEMP 7.3)
Discussion: Good diet also improves the quality of the product, though this can be difficult to provide indicators for. Urinary N in milk is a good indicator of excess N in diet. This BEMP could be merged with the following one.

Dietary reduction of enteric fermentation (BEMP 7.4)
Discussion: There is contention over the best approach to minimise methane emissions per unit of output, and whether less digestible feed can sometimes reduce methane through inhibition of methanogenesis. **Urs will send an analysis** on the effectiveness of various feeds. Moreover, there may be some health issues for the cattle and **Juern will send some material** on this.

Green procurement of feed (BEMP 7.5)
Discussion: This BEMP was in principle fine with the TWG.

Maintain animal health (BEMP 7.6)
Discussion: Veterinary inspections at the farm can be seen in different ways: preventive visits or last resort visits; the number of veterinary inspections are thus not a good indicator. Longevity could be considered as a good indicator for animal health. Having a health management plan and applying it could also be a good indicator. Responsible use of antibiotics is an important aspect that should be considered.

Optimize animal profile (BEMP 7.7)
Discussion: It is necessary to be species specific. An indicator on calving rate will also be considered.

10 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – MANURE MANAGEMENT

Manure management in housing (BEMP 8.1)
Discussion: Manure management in housing best practice must be compliant with animal welfare legislation.

Anaerobic digestion of manure (BEMP 8.2)
Discussion: It may be necessary to consider other systems for manure management (e.g. composting, which can also be used to stabilise residues after anaerobic digestion). This will be assessed based on an analysis of emissions from different types of manure management systems across Europe – slurry systems are a known hotspot for emissions with considerable improvement potential. Anaerobic digestion can be considered best practice only if it is economically viable; it will therefore be important to mention this in the applicability section of the BEMP description.

Appropriate manure storage (BEMP 8.3)
Discussion: The TWG suggested adding indicators about residence time of manure before anaerobic digestion, and the number of months storage capacity for slurry. Finally, it was stressed that there is a need to ensure that the BEMP described goes beyond current legislation (even Nitrate Vulnerable Zones regulation), probably through a recommendation for capped storage.

11 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – TILLAGE

It was suggested by the TWG that this chapter could follow the chapter on soil and nutrient management (Chapter 5), and that the name could be changed to “soil preparation”.

Restrict tillage to appropriate soils (BEMP 9.1)
Discussion: The TWG mentioned that in this BEMP there is too much emphasis on peat soil and therefore it is necessary to reconsider this aspect. In addition, tillage techniques must be related to the appropriate soil type. Crop and livestock choice should be moved to a new BEMP. Therefore it is necessary to reconsider/restructure this BEMP.

Nutrient management planning on arable lands (BEMP 9.2)
Discussion: This BEMP needs to be integrated with the implementation of a nutrient management plan at field level rather than at farm level. Moreover, an indicator on soil carbon and nitrogen should be added. The TWG suggested to combine or cross-reference this BEMP with BEMP 9.3.

Optimised crop rotation (BEMP 9.3)
Discussion: Crop rotation has many benefits (e.g. reducing pesticides and herbicides, reducing erosion and sequester carbon). In this BEMP it is important to consider also the economic viability at different timescales. Moreover, the TWG suggested mentioning the agro-environment programmes in the economic section. Finally, resilience to climate change and biodiversity opportunity of new crops also need to be considered.

Efficient application of slurry to arable land (BEMP 9.4)
Discussion: This BEMP needs to be expanded to include other organic applications and needs to be linked with Chapter 5 (management of nutrients and soils). Manure testing should also be considered.

Low-impact tillage options (BEMP 9.5)
Discussion: This BEMP may be linked to a new BEMP on avoiding soil compaction/maintaining soil structure in the soils chapter (**Birgit to provide literature** from university of Kiel). There are several low-impact tillage techniques and **Henk will provide material.** A new BEMP will be added regarding "tillage minimization/avoidance", which includes direct drilling, etc.: **Urs will provide publications**. The indicators presented may not be realistic for farmers (e.g. soil colour); instead practice-related indicators could be more meaningful. Water holding capacity could be a good indicator and **Tania and Katarina will provide information** on this. Soil erosion is reduced by low-impact tillage and **John will provide literature** on simple assessment of soil erosion by farmers. Buffer strips do not prevent erosion but contain it within the field. Applicability is also an issue because this BEMP may not be feasible for some soil types and **Jaroslav will provide information.**

Establish cover crops (BEMP 9.6)
Discussion: The cost for establishing cover crops is an issue and **Karl will provide literature** on this. Cover crops can be used to suppress weeds and **Urs will provide literature** on biofumigation. An indicator considering tonnes per hectare of biomass should be included. JRC has already published some reports on this and **Tania will send the link**.

During the final remarks of this session the TWG mentioned the need to consider the issue of herbicide use in no tillage systems and the importance of tillage in mixed farms (livestock+arable). It was also emphasised that important issues such as prevention of soil compaction, soil crusting and prevention of soil erosion should be considered – these will be now addressed in earlier soils chapters. The whole chapter needs to distinguish between major soil types common across European countries and it may be appropriate to change the chapter name to "soil preparation".

12 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – IRRIGATION

Minimise irrigation demand (BEMP 10.1)
Discussion: This chapter awaits development. Local (farm based) water storage, use of alternative sources of water (treated wastewater, rainwater, recycling of drainage water) as well as salinity control measures could be added in the BEMPs. Connection between inefficient irrigation and soil erosion should also be considered. Irrigation should also be linked to soil management. The availability of drought tolerant and/or salt tolerant crops could be investigated. **Alberto will provide material** on cropping techniques while **Miguel will provide information** on control deficit irrigation.

Efficient irrigation (BEMP 10.2)
Discussion: This BEMP should distinguish field crops from horticulture and it should be linked to Chapter 12 (horticulture). In irrigation a broader/regional approach to water management is very important. Moreover, drought observatories are very useful and the JRC has established one. This BEMP could also include links to national weather services such as the Irish weather service, which provides data for soil moisture and **Karl will send information** on this.

13 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – AGROCHEMICAL MANAGEMENT

Integrated pest management (IPM) (BEMP 11.1)
Discussion: The TWG recommended to reconsider the title (minimisation/avoidance of plant protection products) and the indicators, using for example annual treatment frequency or kg active ingredient per hectare. Precision application should be considered and biological treatments should also be included. This BEMP s needs to distinguish between organic and conventional agriculture because different products are used. **Urs suggested an article published in Science** about organic vs. IPM. In the BEMP the correct IPM wording needs to be used according to the definition in the sustainable use directive. It is important to make sure that this BEMP goes beyond regulatory requirements as IPM is going to be mandatory from Jan 2014 (Regulation (EC) 1107/2009, Art. 55). **Tania will provide examples** of IPM while **Philippe will provide on-line sources** on guidelines for IPM.

Select lower-impact active ingredients (BEMP 11.2)
Discussion: The risk vs. hazard approach should be deleted or just mentioned as part of EU regulation because this is applicable to the regulatory authorisation of plant protection programs (PPPs) but not to the use of PPPs at farm level. The definition for "lower-impact" should be clear, linked to specific indicators, and this BEMP (select lower-impact active ingredients) could have a different title (e.g. with the word "health"). Indicators should be reconsidered and the different labels mentioned should be classified according to how strong the requirements are (however if labels are mentioned in this BEMP they should be mentioned also in others). The BEMP should carefully consider products and the relation between quantity needed and environmental impact.

14 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – HORTICULTURE

The first issue raised was to change the chapter title into protected horticulture because horticulture is a much wider sector including also field crops.

Waste heat and renewable energy (BEMP 12.1)
Discussion: This technique is only relevant for Northern Europe and this should be mentioned. **Henk will send material** from The Netherlands where there are cases of storing heat in ground water during summer and reusing it during winter. Lighting in greenhouses could also be included. The use of natural refrigerants is relevant only for port harvest storage and can be considered outside the scope of this document.

Water management (BEMP 12.2)
Discussion: Parts of this BEMP could be duplicated from what is reported in the introduction of the document (or this section could also be moved there) and there should be a link to the WFD to consider sustainable use of water (recharge area). Among the best practices considered are water metering, covering on-farm dams to reduce evaporation in Southern EU, and optimization of various irrigation methods (not just drip irrigation). Recirculation of water may not be applicable in some southern parts of the EU because of salt content of ground water. An

indicator about the quality of underlying ground water should be added. The first indicator listed should be transformed into productivity: kg produced per m^3 of water.

Waste management (BEMP 12.3)
Discussion: This BEMP should include composting of plant residues removed from greenhouses or other forms of reuse (e.g. biochar). **Miguel can provide references on this**.
Use of bio-plastic could also be mentioned and **Alberto can provide data**. The issue of waste management should be addressed for the whole agriculture sector including all on-farm waste.

Final remarks for this section were that horticulture is not limited to greenhouses, there are also field crops (e.g. fruit trees, wine, olives, almonds) for which best practices to minimise soil erosion and N leaching should be proposed. **Urs will provide material**.
A new BEMP including the use of beneficial insects and bugs in greenhouses/horticulture could be added. **Richard and Urs can send literature.** Finally also peat-free growing media may be investigated.

15 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – CROSS-CUTTING FOR POLICY MAKERS

Encourage responsible consumption (BEMP 3.1)
Discussion: The main recommendation of the TWG was to redraft this BEMP from the point of view of the farmers (e.g. for sustainable nutrition, they can interact with schools). The whole chapter should change name and be targeted at farmers. **Alberto will provide some studies** on environmental benefits from direct/local selling from farmers and vegetable boxes schemes.
This BEMP includes reducing food waste across the chain and encouraging diet change (mentioning balanced diet). If this is to be kept, other indicators should be considered: excess proteins, saturated fats, how much fruit and vegetables are eaten. Food waste on the farm is also another issue (e.g. products not meeting the quality/appearance standards).

Landscape management (BEMP 3.2)
Discussion: The TWG recommended also for this BEMP to focus on the point of view of the farmer. The terminology "allocate areas" should be avoided. Farmers can build for example wildlife/green corridors. This BEMP will be restructured.

Agri-environmental schemes (BEMP 3.3)
Discussion: This BEMP should also be amended to be from the farmer perspective, and should include mapping of environmental resources across the farm, and long term environmental planning/habitat creation. The policy perspective should be moved to the introduction and it should be considered that consistent funding is still available under pillar 1 of CAP.

Final remarks for this session were to consider adding biodiversity targets, links to the water framework directive and links to PEF (product environmental footprinting) starting in 2014 for agriculture, food and drinks. Moreover, the TWG suggested adding an explanation on why certain aspects were chosen and which are the target groups. The importance of cooperation among farmers should also be stressed and acknowledgement made of challenges such as low farming uptake by younger generations.
The parts of this chapter addressing policy makers will be moved to the introduction chapter to set the context of best practice in farm management.

16 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN AGRICULTURE – CROSS-CUTTING FOR FAMERS

Good housekeeping (BEMP 4.1)
Discussion: This BEMP should mention organic certification and also the advantages achieved from introducing an environmental management system. The title should be changed (e.g. "best environmental management")

Planted buffer strips (BEMP 4.2)
Discussion: This BEMP could be restructured as measures to prevent soil erosion. Planted buffer strips may not be always effective and many different measures are required to prevent soil erosion. **John will provide literature on this**. It may be possible to merge this BEMP with BEMP 3.2 (land scape management).

Conservation and habitat management (BEMP 4.3)
Discussion: This BEMP may be merged into landscape management and Natura 2000 could be helpful in identifying indicators.

Constructed wetlands (BEMP 4.4)
Discussion: This BEMP may be merged into BEMP 3.2 (landscape management).

Final general remarks for this session were to merge Chapters 3 (cross-cutting for policy makers) and 4 (cross-cutting for farmers) of the document creating only one chapter of cross-cutting BEMPs for farmer. A BEMP on resource efficiency as well as on strategic plans for farmers (5-10 years plans), on the advantages of having an environmental management system (ISO 14001 and especially EMAS, **Esther will provide info**) should be added. **Richard will provide information** on energy management on farms. Biodiversity measures should also be taken into account and **Katarina will provide information** on this while **Tania will send links** for functional agro-biodiversity. Private certifications should not be promoted; they could however be considered for integration into an EMS. Finally, **Urs promised to share a dropbox folder** with many papers and **Esther will provide guidelines** from the Minister of Environment in Germany.

17 CONCLUSIONS

The meeting was closed skipping the session on gaps and missing techniques (which had been partially covered during the previous discussions). The JRC presented all the discussions and main agreements reached during the meeting for the TWG members to comment on. Participants were invited to send suggestions/comments on other gaps and missing techniques by email, after receiving the minutes of the meeting.
It was agreed that for all further communication and to provide their contributions, TWG members could send their e-mails jointly to the JRC and Bangor University (e-mail should be sent to both d.styles@bangor.ac.uk and paolo.canfora@ec.europa.eu).
Bangor University will integrate all the feedback received during the kick-off meeting in the background document, which will be used for the development of the sectoral reference document for the agriculture sector. To this end, Bangor University will contact bilaterally members of the TWG for obtaining further inputs/clarification/feedbacks.

ANNEX 1: AGENDA

14 October 2013 – Venue: Albert Borschette Conference Centre, Room AB-1B		
Arrival and registration of participants		10:00 – 10:15
Opening and welcome		10:15 – 10:30
Introduction of experts		10:30 - 11:00
Purpose and goals of the meeting		11:00 - 11:15
Introduction of the sectoral reference documents on best environmental management practise (BEMP) and lessons learnt so far		11:15 - 12:00
Overview of the Agriculture - Crop and Animal production sector and definition of the scope of the sectoral reference document		12:00 - 12:45
Lunch Break		12:45 - 14:00
Environmental aspects of the Agriculture - Crop and Animal production sector		14:00 - 14:45
Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Soil fertility and grass and grazing management BEMPs		14:45 - 15:45
Coffee Break		15:45 - 16:15
Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Animal husbandry and manure management BEMPs		16:15 - 17:15
Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Tillage and irrigation		17:15 - 18:15
Wrap-up and close of the day		18:15 - 18:30

15 October 2013 – Venue: DG Taxation and Custom Union (TAXUD), Room 1/01		
Arrival and registration of participants		08:45 - 09:00
Opening of the day		09:00 - 09:15
Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Agro-chemical management BEMPs		09:15 - 09:45
Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Horticulture BEMPs		09:45 - 10:15
Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Cross-cutting and farm management planning BEMPs		10:15 - 11:15
Coffee Break		11:15 - 11:45

Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: gaps/missing techniques		11:45 - 12:15
Environmental Indicators and Benchmarks of Excellence		12:15 - 12:45
Conclusions, way forward and information gathering		12:45 - 13:15
Wrap-up and close of workshop		13:15 - 13:30

ANNEX 2: LIST OF PARTICIPANTS

Name	Organisation
Audrey Moulierac	Agriculture and Horticulture Development Board
Xavier Poux	ASCA - European Forum on Nature Conservation and Pastoralism
David Styles	Bangor University
Julie Williamson	Bangor University
Laure Le Quéré	FARRE
Tanja Runge	Copa-Cogeca
Arnaud Petit	Copa-Cogeca
Christian Pallier	EFA
John Boardman	Environmental Change Institute - University of Oxford
Bram Moeskops	IFOAM
Urs Niggli	FIBL
Philippe C. NICOT	INRA
Jaroslav Prazan	Institute of agricultural economics and information
Claude Bourguignon	Laboratoire Analyses Microbiologiques Sols
Caroline Drummond	LEAF
Karin Stein-Bachinger	Leipniz-Zentrum fuer Agralandschaftsforschung
Richard Riester	LEL - State institute for development of agriculture and rural areas
Henk Westhoek	PBL Netherlands - Environmental Assessment Agency
Euan Brierley	Soil Association
Karl Richards	Teagasc
Juern Sanders	Thunen Institute
Esther Zippel	UGA – German EMAS Advisory Board
Rodney Thompson	Universidad de Almeria
Miguel Quemada	Universidad Politécnica de Madrid
Katarina Hedlund	University of Lund
Carlo Leifert	University of Newcastle
Alberto Pardossi	University of Pisa
Birgit Wilhelm	WWF
Frank Brentrup	Yara International Fertilisers
Olivier Diana	European Commission - DG AGRI
Angelo Innamorati	European Commission - DG AGRI
Gilles Vincent	European Commission - DG ENV
Rolf-Jan Hoeve	European Commission - DG ENV
Victor Palacios	European Commission - DG ENV
Karin Nienstedt	European Commission - DG SANCO
Marco Dri	European Commission - JRC
Ioannis Antonopolus	European Commission - JRC
Paolo Canfora	European Commission - JRC
Harald Schoenberger	European Commission - JRC
Franz Weiss	European Commission - JRC

ANNEX 3: PRESENTATIONS

Crop and Animal Production:

Sector overview and scope of the SRD background report

Presentation Structure

1. Brief overview of sector
2. Scope of SRD background report
3. Selective *best* practice, techniques, measures, indicators
4. Structure of SRD background report

1. Economics

- GVA 144 billion EUR in EU27(2010)
- Agricultural c.6% of trade in the EU27
- Underpins much greater GVA and trade
  - food and drink processing, distribution, retailing…
- Landscape management (water provisioning, tourism…)
- Fundamental role in *real* economy undervalued in recent decades? On the up?
- Supports rural areas

1. Employment in EU27

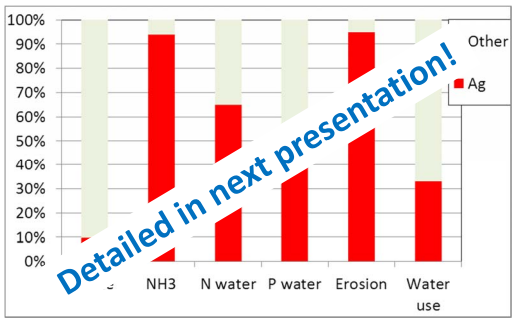
- 4.5 million holdings employ 10.5 million people directly
- Agriculture and food: 17 million jobs (7.6% of all employment)
  - 27 million people when family labour included
- Lower paid jobs, but in rural areas

1. Structural profile

Type of Farming	No. of holdings (FADN field of observation)	UAA (ha)	AWU	FNV added (Average result per holding, 1000 EUR)
Field crops	1 498 467	42.93	1.50	19.99
Horticulture	164 547	5.20	3.36	62.34
Wine	231 378	13.94	1.79	38.16
Permanent crops	853 086	9.28	1.35	17.05
Milk	500 383	39.87	1.86	30.28
Grazing livestock (excl. milk)	611 024	54.41	1.65	23.72
Pigs and / or poultry	137 741	20.64	1.93	51.12
Mixed (crops + livestock)	951 804	30.08	1.68	14.33
Source: DG AGRI (2012)				

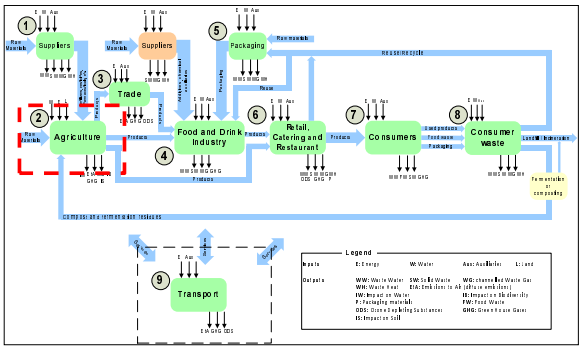
- Large number of SMES
  - high improvement potential
  - difficult to reach
  - flavour of document (what's best for most, or for highly specialised farms?

1. Environmental burdens

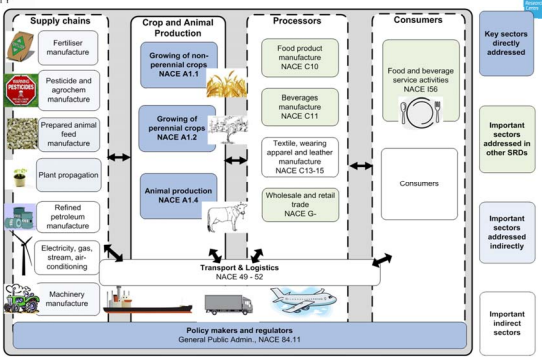


- Large contributions to some burdens/environmental loadings
- 50% EU land area: Critical to ecosystem services delivery

2. Scope flow diagram



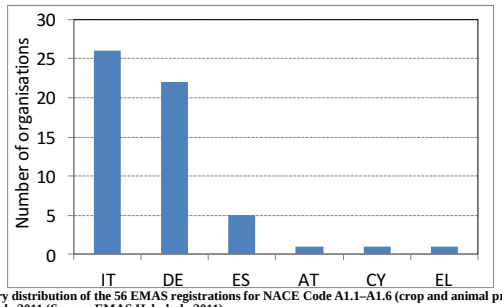
2. Scope: summary



2. Scope: NACE codes

NACE Code	Agricultural Production	NACE Code	Agricultural Production
A	**Agriculture, forestry and fishing**	**A1.3**	**Plant propagation**
A1	**Crop and animal production, hunting and related service activities**	A1.3.0	Plant propagation
A1.1	**Growing of non-perennial crops**	**A1.4**	**Animal production**
A1.1.1	Growing of cereals (except rice), leguminous crops and oil seeds	A1.4.1	Raising of dairy cattle
A1.1.2	Growing of rice	A1.4.2	Raising of other cattle and buffaloes
A1.1.3	Growing of vegetables and melons, roots and tubers	A1.4.3	Raising of horses and other equines
A1.1.4	Growing of sugar cane	A1.4.4	Raising of camels and camelids
A1.1.5	Growing of tobacco	A1.4.5	Raising of sheep and goats
A1.1.6	Growing of fibre crops	A1.4.6	Raising of swine/pigs
A1.1.9	Growing of other non-perennial crops	A1.4.7	Raising of poultry
A1.2	**Growing of perennial crops**	A1.4.9	Raising of other animals
A1.2.1	Growing of grapes	**A1.5**	**Mixed farming**
A1.2.2	Growing of tropical and subtropical fruits	A1.5.0	Mixed farming
A1.2.3	Growing of citrus fruits	**A1.6**	**Support activities to agriculture and post-harvest crop activities**
A1.2.4	Growing of pome fruits and stone fruits	A1.6.1	Support activities for crop production
A1.2.5	Growing of other tree and bush fruits and nuts	A1.6.2	Support activities for animal production
A1.2.6	Growing of oleaginous fruits	A1.6.3	Post-harvest crop activities
A1.2.7	Growing of beverage crops	A1.6.4	Seed processing for propagation
A1.2.8	Growing of spices, aromatic, drug and pharmaceutical crops	**A1.7**	**Hunting, trapping and related service activities**
A1.2.9	Growing of other perennial crops	A1.7.0	Hunting, trapping and related service activities

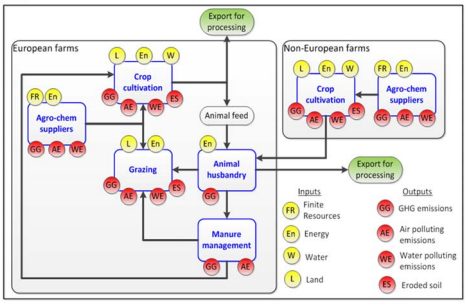
2. Target actors



Country distribution of the 56 EMAS registrations for NACE Code A1.1–A1.6 (crop and animal production) as of July 2011 (*Source:* EMAS Helpdesk, 2011).

- **The SRD will target *any* stakeholder interested in resource efficiency and/or environmental improvement**

2. Systems perspective



- Consider indirect effects (within farmer influence)
  - e.g. fertiliser manufacture via type/CF requirements

2. Core target actors

- **Farmers and farm advisors** (dissemination and implementation of farm BEMP)
  - Livestock (dairy and beef cattle, sheep, pigs, poultry)
  - Arable (cereals, root crops and vegetables)
  - Horticulture (grapes, apples, oranges, tomatoes…)
- **Policy makers** (demand management, waste reduction, landscape management, regulatory development)

2. Other (indirect) target actors

- **Control points:**
  - Food processors (SRD in prep)
  - Retailers (1st SRD)
  - Voluntary improvement groups (SAI, etc)
  - Consumers
- **Suppliers**
  - Fertiliser manufacturers
  - Pesticide manufacturers
  - Machinery/equipment suppliers (e.g. irrigation, manure app. equipment)
  - Non-European crop-based feed producers
  - Other feed producers
  - Plant breeders
  - Transporters
- **Others**
  - Waste disposal (food waste to AD, compost, sewage sludge…)

3. Where to focus?

- Hundreds of crops…
- Multiple livestock types…
- Hundreds of regions…
- Some aspects heavily regulated…
  - Regulatory gaps?
  - Scope for improvement and quantitative *voluntary* targets?
- Some high impact processes have low improvement potential
- Farm size and management determine what is economically achievable…

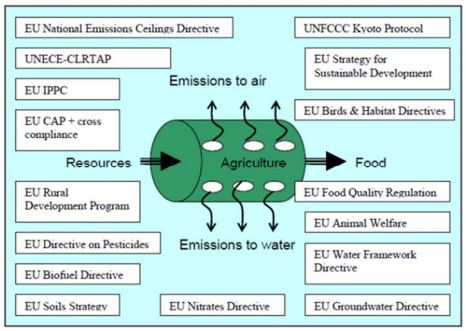
3. Where to focus?

- Hotspot *processes* within sector and food chains
- *Actors x regions* with greatest environmental improvement potential (across EU)
  - E.g. irrigation of cereals in southern Europe, dairying in northern Europe

Informed by quantitative overview of EU burdens and life cycle approach (see next presentation)

- Actors and processes less well covered by regulation
  - (or where voluntary measures can go significantly beyond regulation)

3. Regulatory drivers



Source: Eurostat (2011). 1977-0375. *Farm data needed for agri-environmental reporting.*

CAP: Cross-compliance, Lower and Higher Level Stewardship schemes

3. Related BREFs

- **Intensive rearing of poultry and pigs**
  - SRD will provide more guidance for optimised manure management and spreading (including AD)
  - Go beyond BREF for direct aspects?
- **(Large volume inorganic chemicals)** (ammonia, acids and fertilisers industries)
  - SRD will guide on Green procurement of fertiliser with lowest embodied energy, GHG and NO_x emissions
- **(Manufacture of organic fine chemicals)**
  - SRD will guide on avoidance and GP to reduce toxicity (focussed on use stage)

3. Added value of SRD

- Minimum regulatory standards ≠ best practice
  - But, poor compliance in some areas > examples of effective implementation relevant as BEMP?
- Higher Level Stewardship, NVZ regs, etc ≈ best practice?
- Best practice in relation to majority of farmers
  - may exclude some high tech. and specialist applications (already closer to optimisation???)

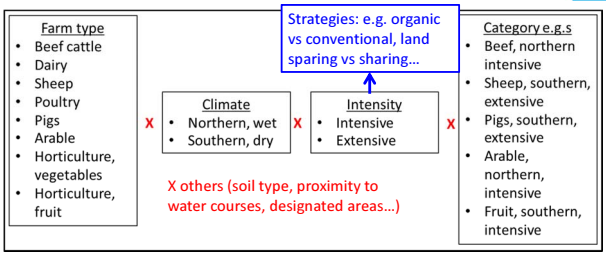
3. Data sources

- Indicators, (benchmarks), technical information, guidance manuals, case studies
- Large number of good and "best" practice guides, reports, tools…
  - Applicability across regions?
  - Processes level? Farm scale?
  - **Best???**
- Emissions mitigation reports (e.g. Task Force on Reactive Nitrogen)
- Data from experimental farms
  - Few data from commercial farms
  - Best practice = start measuring? Proxies?
- **TWG expert knowledge, guidance on all the above, contacts …**

4. Document structure

- No ideal solution…
- According to actors and processes (*not* environmental themes)
  - √ Improved usability for practitioners
  - X but not for policy makers)
  - √ Reflects multiple environmental burdens of many processes
  - X Some repetition and cross-referencing

4. BEMP specificity?



- Lots of permutations! Some processes and BEMP applicable within and across categories, others differ…
- Impossible to systematically address all permutations
  - Specificity/resolution of SRD in context of time constraints
- How to ***prioritise***? How to ***arrange***?

4. BEMP specificity?

- Process level BEMP widely (universally) applicable for discreet industrial processes
  - More complex for agriculture
- Background report prioritises widely applicable BEMP techniques
  - Range of "measures" within BEMPs to differentiate across e.g. livestock type
- Further differentiation may be required
- Some BEMPs mutually exclusive (e.g. high/low intensity systems)
  - Addressed in "Applicability" sections
- No one size fits all: expert guidance from TWG, BEMP by BEMP…
  - **Aim: target maximum environmental improvement potential with available resources (context for your expert input)**

4. Example: Dietary reduction N excretion (BEMP 7.3)

Description: Dietary reduction of N excretion

M Analysis of harvested forage nutrient content

M Produce a feed plan to match crude protein in feed with animal production requirements

Mixed farms only

All livestock farms

Proposed Indicators

E Feed crude protein contents (kg/kg DM)

E N retention/excretion (kg N/kg live weight)

E kg crude protein / LU/y

E kg CP / kg meat(1000 L milk) output

E Feed conversion efficiency

E N surplus (kg/1000 L milk, kg/ha)

E NH_3 losses from housing and slurry storage (kg/yr)

Indicators apply to all livestock types; values (benchmarks) differ >> One BEMP; differentiated benchmarks and technical specificities under "operational data"

p.267-271

4. BEMP sequence

BEMP	Target actors
Cross cutting for policy makers	Policy makers
Farm planning	All farmers, advisors
Soil fertility management	All farmers, advisors
Grass and grazing	Pasture based famers, advisors
Animal husbandry (cross-ref BREF for intensive pig and poultry)	Livestock farmers, advisors
Manure management (cross-ref BREF)	Livestock farmers, advisors, receiving tillage farmers
Tillage	Tillage farmers, advisors
Irrigation	Tillage and horticulture farmers, advisors
Agro-chemical management	Tillage, horticulture
Horticulture	Horticultural farmers, advisors

Over-arching: addressed at end of this meeting

David Styles
Email: d.styles@bangor.ac.uk
Tel: +44 (0)1248 382502

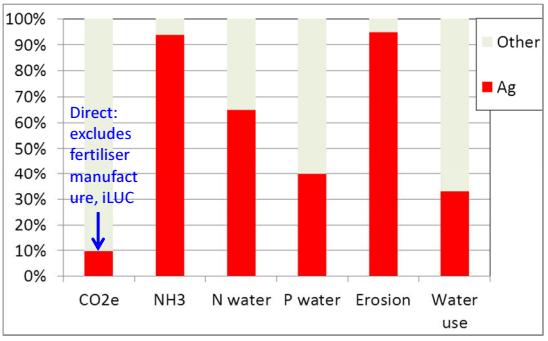
Julie Williamson
Email: j.c.williamson@bangor.ac.uk
Tel: +44 (0)1248 383232

Crop and Animal Production: Environmental aspects

Presentation Structure

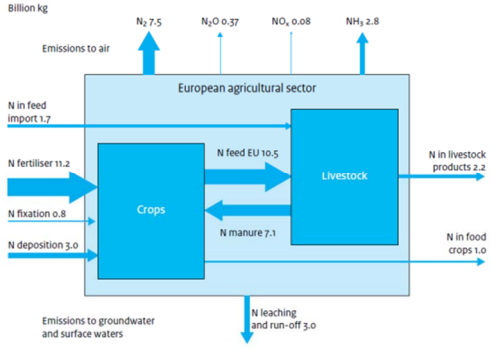
1. European burdens
2. The demand challenge
3. Environmental aspects: sectoral overview
4. Environmental aspects: production (life cycle) perspective

1. Environmental burdens



- Large contributions to some burdens/environmental loadings
- 50% EU land area: Critical to ecosystem services delivery

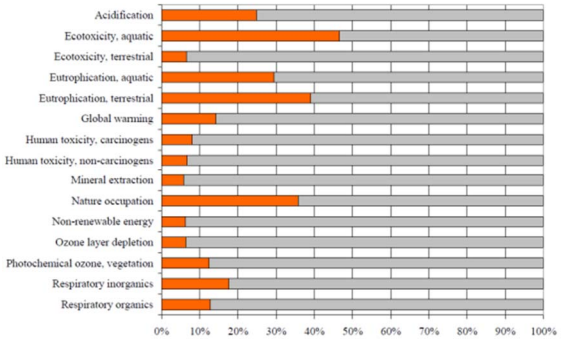
1. The N cycle



Source: PBL (2011).

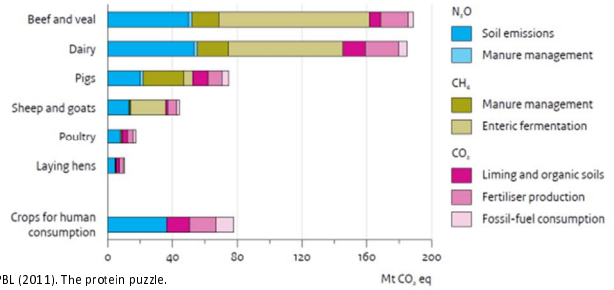
N use efficiency in EU ag = 19%! Climate change, eutrophication, acidification, resource depletion

1. Livestock agriculture



Contribution of meat and dairy products to the environmental burdens of final consumption in the EU27 (Source: JRC, 2008)

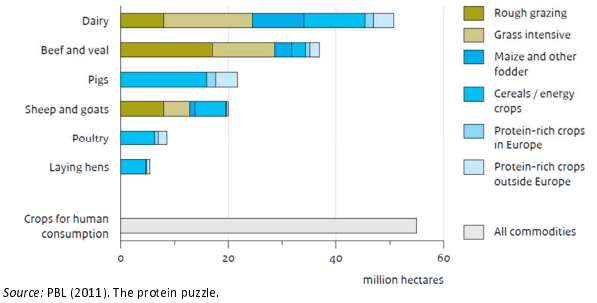
1. GHG emissions



Source: PBL (2011). The protein puzzle.

- N_2O from cultivation of soy beans in South America included (4 Mt CO_2 eq./yr).
- Emissions caused by deforestation and conversion of pasture/scrubland for soy beans not included: could amount to 134 Mt CO_2 eq. (FAO 2010)!
- 10% EU GHG emissions from livestock agriculture

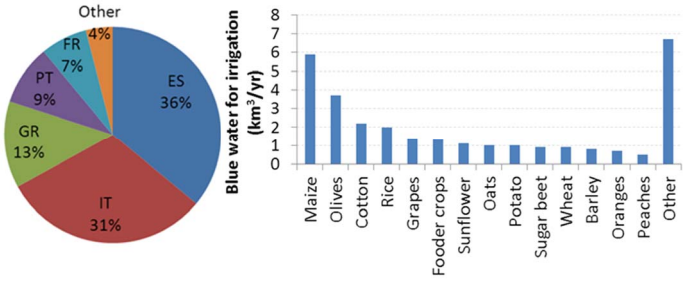
1. Land use EU27



Source: PBL (2011). The protein puzzle.

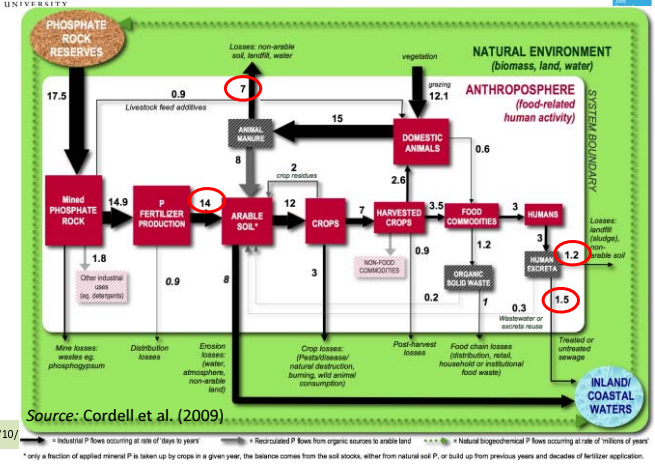
- Biodiversity loss: e.g. bird species declines
- However, benefits of extensive grassland systems
- Exponential decline with N app: sparing vs sharing (policy level land planning…)

1. Water abstraction



Blue water withdrawal for irrigation across the EU28 by country and crop (Source: Vanham and Bidolglio, 2013).

1. Phosphorus (global)



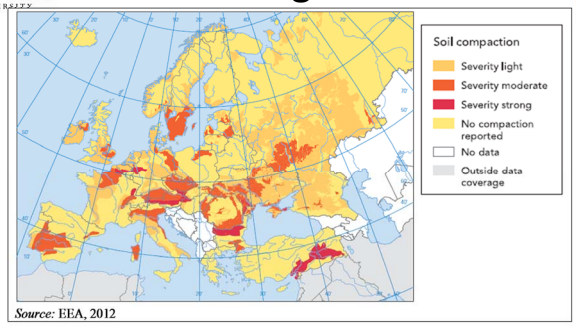
Source: Cordell et al. (2009)

1. Soil erosion

Verheijen et al. (2009) (Earth-Science Reviews 94: 23–38) reported for Europe:

- Soil formation rate 0.3-1.4 t/ha/yr (mostly weathering of parent material, also deposition)
- Average erosion rates:
  - Overall agricultural land: 3.2 - 19.8 t/ha/yr
  - Tillage land: 4.5 – 38.8 t/ha/yr (3-40 times > formation rate!)
- Main removal mechanisms: crop harvesting, tillage, rill and sheet erosion, wind erosion
- Gullies and slope engineering can lead to high soil losses where employed
- Also results in nutrient and carbon losses and represents long-term sustainability problem
- Oldeman (1991) estimated 160 M ha land in Europe affected by erosion c.75% by water, 25% by wind

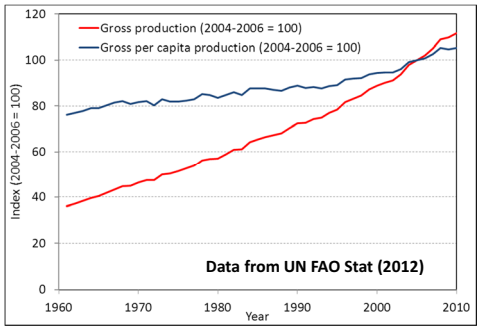
1. Soil degradation



Source: EEA, 2012

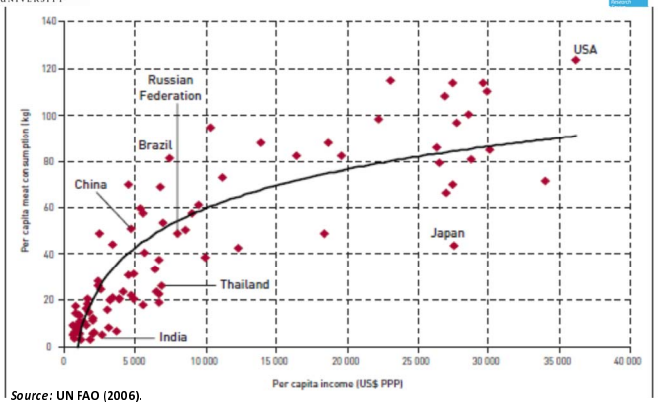
- Declining SOC an indicator of degradation
  - UK 1978-2003, average annual decline in SOC of 0.6%
  - 45% European soils very low SOC (<2%); 45% medium SOC (2-6%) (JRC, 2012)

2. The demand challenge



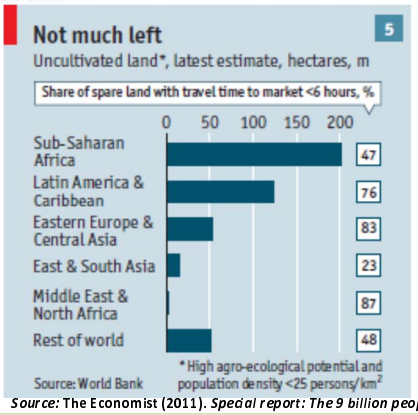
- Demand projected to increase a further 70% by 2050
  - ➢ Focus on "sustainable intensification"! Land sharing vs sparing…

2. An inevitable trend?



Source: UN FAO (2006).

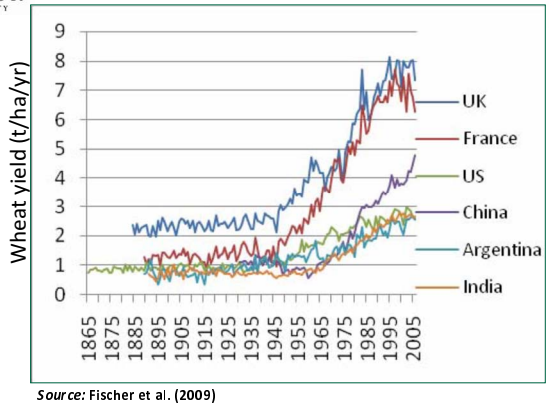
2. Global land constraints



One third of global land area already used to support livestock, c.50% global land area appropriated by agriculture

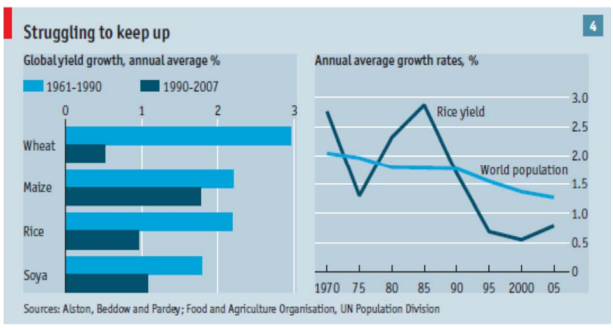
Source: The Economist (2011). *Special report: The 9 billion people question*

2. Yield trends



Source: Fischer et al. (2009)

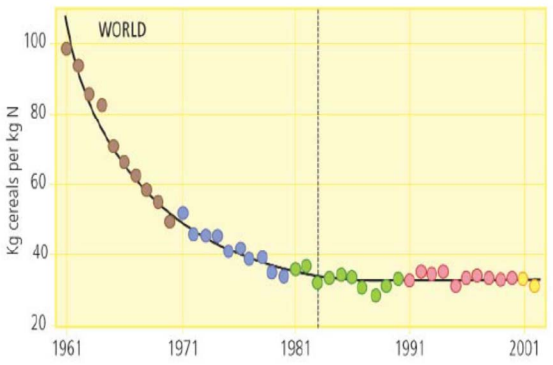
2. Yield trends



Source: The Economist (2011). Special report: *The 9 billion people question.*

- Climate change effects on yields may be positive or negative, depending on region and particular year (extreme events) (IPCC, 2007)

2. NUE trends



Source: IFA (2007)

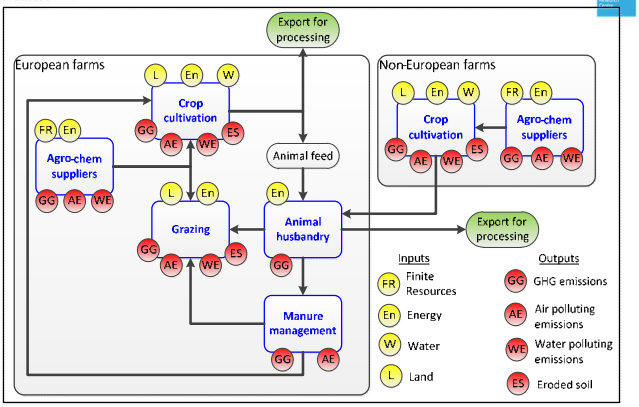
2. Pressures: key points

- Increased food demand since 1950s met by:
  - Massive increases in fertiliser application
  - Expanding agricultural land area
- Areal efficiency of production has increased, but NUE has decreased
- Nutrient recycling is too low (spatial and temporal mis-matches)
- Little 'spare land' available
- Can further yield gains be made without increasing land take and further decreasing NUE?

2. "Sustainable intensification"

- (UK) Policy objective (=land sparing)
  - Rationale depends on demand projects (diet change and waste reduction politically unpalatable alternatives?)
- For crops, higher yields per ha may mean avoided LUC (c.LCA) = GWP, EP and ES benefits
  - How to achieve higher yields per kg N AND avoid soil degradation (e.g. SOC depletion)?
- For dairy/livestock, more complicated
  - See example later: feed conversion efficiency vs LUC trade-off

3. Environmental aspects



3. Environmental aspects

	Ent ferm	Grazing	Feed produciton	Manure man	Tillage	Syn fertilisers	Agro-chem app.	Irrigation
Dairy	+++	++	+++	+++	|++|	++	++	|++|
Beef	+++	+++	++	++	|++|	++	+	|+|
Sheep	++	+++	+	+	|+|	+	++	
Pigs		+	+++	+++	|+++|	|+++|	+++	|++|
Poultry			+++		|+++|	|+++|	+++	|++|
Wheat					+++	+++	+++	++
Barley					+++	+++	+++	++
Maize					+++	+++	++	++
OSR					+++	++	++	++
Sugar beet					+++	++	++	+++
Potatoes					+++	++	+++	+++
Vegetables					+++	++	+++	+++
Fruit					++	++	+++	+++

Direct and (indirect) aspects

3. Aspects > Pressures: arable

Service/Activity	Main environmental pressures	
	Direct	Indirect
Tillage/ploughing	Soil C and N loss Erosion Potential water sedimentation GHG emission	Fuel supply chains Machinery manufacture
Fertiliser application	NH_3 emissions N_2O emissions Nutrient losses to water Biodiversity loss	Manufacturing and transport energy (and associated impacts)
Transport	Air emissions	Manufacturing and transport energy (and associated impacts)
Machinery Use (e.g. harvesting)	Energy consumption GHG emissions NO_x and SO_x emissions	Electricity generation Machinery production
Food production	Resources, energy, heat, water	
Irrigation	Water stress Salinisation Energy consumption	Electricity generation (and associated impacts)
Crop production	Consumption of land resources, deforestation and habitat alteration Energy use, GHG emissions	Nitrogen emissions, energy use
Agrochemical application	Ecotoxicity effects Biodiversity loss	Manufacturing and transport energy

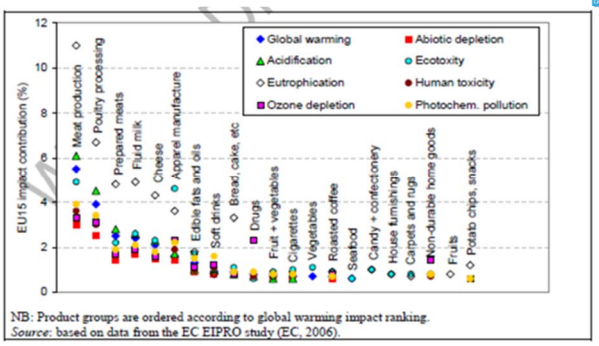
3. Aspects > Pressures: livestock

Service/Activity	Main environmental pressures	
	Direct	Indirect
Fertiliser application	NH_3 emissions N_2O emissions Nutrient losses to water Biodiversity loss	Manufacturing and transport energy (and associated impacts)
Feed	CH_4 from enteric fermentation On-site cultivation (see arable below)	Off-site cultivation (see arable below) Potential land use change Transport energy (CO_2 emissions)
Manure Management	CH_4 emissions N_2O emissions	Storage
Grazing	NH_3 emissions N_2O emissions Soil erosion and compaction Nutrient losses to water Biodiversity loss (potential gain) Biomass C loss if land use has changed from forest	
On-farm operations (e.g. milking)	Energy (fuel) consumption	Electricity generation
Additional services e.g. medical	Equipment, machinery	Energy water and raw material consumption

4. Burden indicators (LCIA)

Impact category	Abbreviation	Interventions (characterisation factors for indicator loading; kg per kg intervention)	Indicator
Global warming potential	**GWP**	– CO_2 (1) – N_2O (298) – CH_4 (25)	**CO_2e**
Eutrophication (RER)	**EP**	– NO_3 (1×10^{-1}) – P (3.06) – NH_3 (3.5×10^{-1}) – NO_x (1.3×10^{-1}) – N (4.2×10^{-1})	**PO_4e**
Acidification (RER)	**AP**	– NH_3 (1.6); – NO_x (5×10^{-1}) – SO_2 (1.2)	**SO_2e**
Resource depletion (fossil fuels)*	**RDP**	– Hard coal (27.91) – Soft coal (13.96) – Natural gas (38.84 per m^3) – Crude oil (41.87)	**MJe**
Abiotic Resource depletion (elements)*	**ARDP**	– See CML (2010); e.g. P (5.52×10^{-6})	**Sb e**
Eco-toxicity potential	**ETP**	– See CML (2010)	**1,4-DCBe**
*RDP and ARDP correlated via CML (2002) equation			

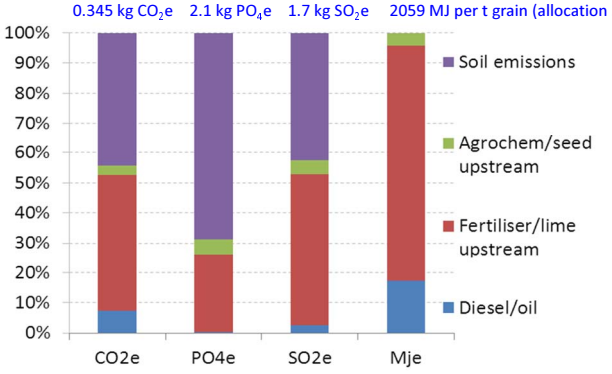
4. Product burdens



- Crop and **animal** products major drivers of EU env impact

4. Winter wheat LCA (simple)

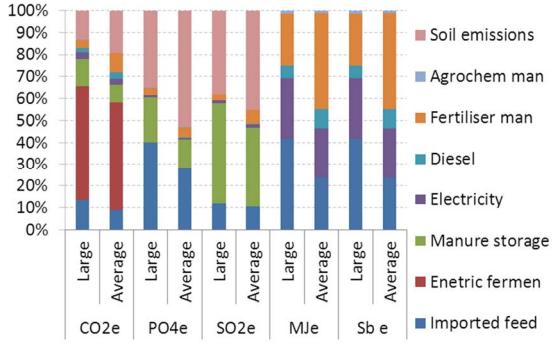
0.345 kg CO_2e 2.1 kg PO_4e 1.7 kg SO_2e 2059 MJ per t grain (allocation straw)



4. Winter wheat BEMP

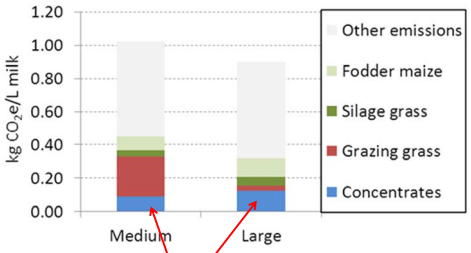
Source	Key BEMP measures	Section
Agro-chemicals and upstream impacts	Select reduced impact synthetic fertilisers	Section 5.6
	Crop rotation and IPM techniques	Section 11.1
	Crop protection agent product selection	Section 11.2
Soil emissions	Restrict tillage to appropriate areas	Section 9.1
	Soil Nutrient Management Planning	Section 5.1 and 9.2
	Optimised cop rotation	Section 9.3
	Sustainable organic matter amendments	Section 5.2
	Soil drainage management	Section 5.3
	Cover crops	Section 9.6
	Low-impact tillage operations	Section 9.5
	Precision fertiliser/manure application	Section 5.4 and 9.4

4. Dairy LCA example



0.9 to 1.0 kg CO_2e per L milk on optimised large/medium sized farms (ex. LUC). *Source:* BU LCA tool

4. Feed strategies



- Grass
- X High fertiliser per kg DM
- X Lower digestability (higher CH_4)
- ✓ High SOC
- ✓ Ecosystem services

Metrics: soil degradation on large farm?

Shift medium to large = LUC

Sustainable? intensification

Feed type	Winter wheat	Winter wheat + LUC[1]	SBME[2]	SBME + LUC[3]
CF (kg CO_2/kg)	0.577	0.8	0.145	9.26

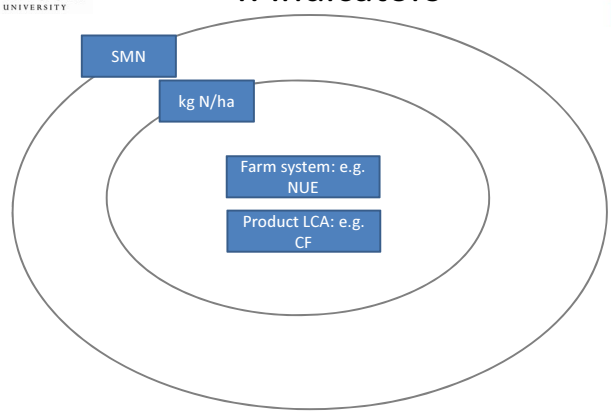
[1]Grass to tillage, 8.8 t ha^{-1} yr^{-1} grain (UK average)
[2]Argentina and Brazil, minus diesel displaced by oil
[3]Assumes deforestation Brazil, loss grassland in Argentina

4. Dairy BEMP

Source	Key BEMP measures	Section
Enteric fermentation	Breeding for improved productivity	Section 7.1
	Maintaining animal health	Section 7.6
	Diet (feed conversion ratio)	section 6.1 and 7.4
Manure storage	Manure management in housing	Section 8.1
	Storage	Section 8.2 and 8.3
	Anaerobic digestion	Section 8.2
Soil emissions	Soil Nutrient Management Planning	Section 5.1
	Dietary optimisation of N intake (excretion)	Section 7.3
	Precision fertiliser/manure application	Section 5.4 and 5.5
	Grass-clover swords	Section 6.3
	Trailing shoe/banded slurry application	Section 6.5
	Nitrification inhibitors	Section 6.6
Feed production	Grazing management	Section 4.2, 6.2 and 6.3
	Efficient silage production	Section 6.4
	Green procurement of feed	Section 7.5

BEMPs can be applied to different feeding strategies: SRD not prescriptive

4. Indicators



David Styles
Email: d.styles@bangor.ac.uk
Tel: +44 (0)1248 382502

Julie Williamson
Email: j.c.williamson@bangor.ac.uk
Tel: +44 (0)1248 383232

Best Environmental Management Practice in Agriculture

Proposed Techniques (measures and key indicators)

TWG input

Please

- ✓ Propose additional/alternative
  - ✓ Techniques
  - ✓ Measures
  - ✓ Indicators

  Already in another (subsequent) chapter?
- ✓ Propose deletions
- ✓ Indicate data sources
- ✓ Indicate examples for case studies

Prioritise frontrunner actions that can achieve high environmental improvement beyond minimum regulatory standards

Presentation Structure

- Chapters 5 and 6
  - Soil management and Grass and grazing
- Chapters 7 and 8
  - Animal husbandry and Manure management
- Chapters 9 and 10
  - Tillage and Irrigation
- Chapter 11
  - Agro-chemical management
- Chapter 12
  - Horticulture
- Chapters 3 and 4
  - Cross-cutting and Farm management

Legend

M Management action

E Environmental performance indicator

S State/environmental condition indicator

Page numbers in draft report

Redundancy? Other key indicators?

CHAPTER 5

Managing Nutrients and Soils

5.1 Soil testing for nutrient management planning

5.2 Sustainable organic matter and nutrient amendments

5.3 Maintain soil drainage

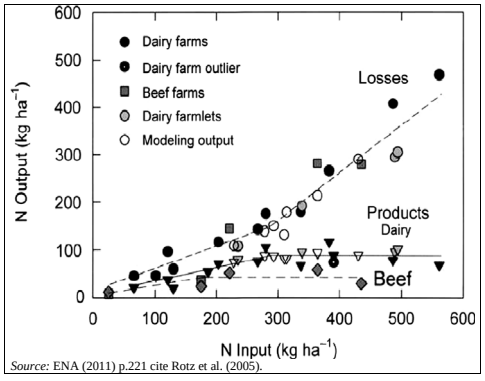
5.4 Slurry separation

5.5 Precision application of fertilisers and manures

5.6 Select lower impact fertilisers

p.146-200

Objective: Improve nutrient use efficiency



Source: ENA (2011) p.221 cite Rotz et al. (2005).

Focus on soil testing and nutrient management: whole-farm and field nutrient budgeting in animal and tillage chapters (7 and 9)

Managing Nutrients & Soils: Technique 5.1

Description: Soil testing for NMP

M Produce farm nutrient plan that includes organic nutrient inputs (total, available), soil nutrient status and crop off-take

M Periodically analyse manures for nutrient content

M Test fields every 3 - 5 y for soil fertility status

M Use recognised nutrient accounting tool

Proposed Indicators

E Soil P, K, Mg, pH, SNS, trace elements, SOM (mg/kg)

E NUE and N, P surplus

E Avoided fertiliser application (LCA results for avoidable emissions per ha)

p.152-168

Managing Nutrients & Soils: Technique 5.2

Description: Sustainable organic amendments

M Import and apply sustainable (certified) organic materials to soils as a conditioner and nutrient source

M Use recognised nutrient management tool to calculate/plan for organic nutrients applied

Proposed Indicators

E Organic matter application rate (t/ha/yr dry matter)

E Organic nutrient application rates (kg/ha/yr; total, available = avoided mineral fertiliser)

E % total crop nutrient requirement as organic fertiliser

E % arable area with cover crop

E SOM (% Loss on Ignition or % C)

E Organic certification labels (PAS for compost and digestate)

p.169-180

Managing Nutrients & Soils: Technique 5.3

Description: Soil drainage

M Install and maintain soil drainage systems (regular checks and unblocking)

Proposed Indicators

E % field areas drained

E Soil moisture status (% water holding capacity)

E Soil colour (grey, mottled = poor, brown = good)

E Pasture rooting depth

E Crumb structure

E % surface ponding

p.181-184

Managing Nutrients & Soils: Technique 5.4

Description: Slurry separation

M Separate liquid slurry into liquid and solid fractions, and transport the latter to optimise P and K application rates

Proposed Indicators

E % dry matter in solid fraction

E % increase in nutrients in respective fractions

E Nutrient surplus / NUE

E Avoided fertiliser import (kg nutrient/ha/y)

p.185-189

Managing Nutrients & Soils: Technique 5.5

Description: Precision application of nutrients

M Apply the 4Rs – right fertiliser, right time, right rate, right method

M Precision application of fertilisers: either high uniformity (avoid overlaps) or based on field mapping (GPS)

M Controlled dosing of organic nutrients (requires trailing shoe or injection of slurry, digestate, etc)

Proposed Indicators

- Coefficients of variation for spreading rate (equipment checks)
- Crop NUE
- Soil P, K indices within each field (regular soil testing)
- Soil N supply

p.190-194

Managing Nutrients & Soils: Technique 5.6

Description: Reduced-impact synthetic fertilisers

M Select lower impact fertilisers: low upstream footprint; low NH_3 emissions (+inhibited N_2O emissions?)

Proposed Indicators

E (Certified) fertiliser carbon footprint (kg CO_2e/kg N)

E % fertilisers used that are certified 'low C'

E % synthetic fertilisers used that are 'enhanced efficiency' (e.g. polymer coated, + inhibitor)

E % fertilisers used that are EU ETS III compliant

p.195-200

CHAPTER 6

Grass and Grazing Management

6.1 Maximise grazing grass uptake
6.2 Manage grazing for water quality
6.3 Grass-clover swards & sward renovation
6.4 Efficient silage production
6.5 Efficient application of slurry to grassland
6.6 Nitrification inhibitors

p.201-250

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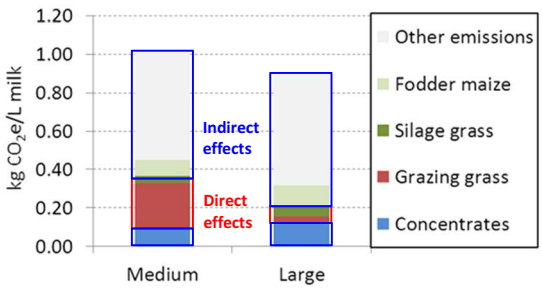
Objective: Minimise grass and feed impacts



Increasing efficiency of grass uptake can reduce imported feed

Grass & Grazing Management: Technique 6.1

Description: Maximise grazing grass uptake

M Extend daily and seasonal grazing duration, within constraints of good soil and water quality management (BEMP 6.2), to minimise imported feed requirements
M Mob grazing?

Proposed Indicators

E Livestock units /ha
E Grazing days /y
E % DM feed (or dietary energy, MJ) as grass
E Supplementary feed requirement (kg or MJ imported feed/kg meat or milk output)
E Soil quality indicators e.g. poaching (% of field area), bulk density g/cm^3, % organic matter
E C footprint of production (kg CO_2e/kg live weight, /L milk, /€ exported via farm gate)
E NUE related to farm output
E N_2O and NH_3 emission factors for grazing deposition

p.206-216

Grass & Grazing Management: Technique 6.2

Description: Managing grazing for water quality

M Manage intensity and timing of livestock grazing to avoid soil degradation, excess nutrient losses in runoff and to avoid livestock access to water courses

Proposed Indicators

E % water courses (and wetlands) fenced off from grazing
E Width buffer strips (min 10 m?)
E Soil quality indicators e.g. poaching (% of field area), bulk density g/cm3, % organic matter
E % grazing area that is peat soil
E Soil and nutrient loss rates (kg/ha/y)
E Water quality indicators in receiving waters e.g. suspended solids (mg/L), ug/L nutrient or pesticide conc., BOD, COD, FIO, biodiversity

p.217-223

Grass & Grazing Management: Technique 6.3

Description: Grass-clover swards & sward renovation

M Include clover in grass swards and reduce mineral fertiliser according to BNF
M Plan for N-release following ploughing-up of leys

Proposed Indicators

E D-value of pasture
E Rate live weight gain during grazing
E (Avoided) Fertiliser-N application rate (kg/ha/yr)
E NUE
E % seed by weight in ley mix as legume
E % non-preferred species in sward

p.224-228

Grass & Grazing Management: Technique 6.4

Description: Efficient silage production

M Maximise efficiency of grass production (see BEMP 6.3)
M Optimise harvest timing and method for yield and sward quality for silage production
M Minimise storage and feedout losses through careful wrapping

Proposed Indicators

E % DM loss post-ensiling
E D value of silage
E Life cycle burdens of silage at feed-out (e.g. kg CO_2e/kg silage)

p.229-234

Grass & Grazing Management: Technique 6.5

Description: Efficient application of slurry to grassland

M Employ efficient slurry application techniques (banded, trailing shoe, injection)

M Calculate plant-available nutrients supplied by application technique type (e.g. MANNER-NPK calculator)

Proposed Indicators

E % volume slurry applied using efficient methods

E % nutrients available to crops

E Nutrient Use Efficiency

E Soil nutrient balance

E Avoided fertiliser requirement (kg/ha/yr)

p.235-245

Grass & Grazing Management: Technique 6.6

Description: Nitrification Inhibitors

M Application of nitrification inhibitors to grazed grassland

Proposed Indicators

E N_2O emissions (fraction of applied N)

E Nitrate leached (fraction of N applied)

E Stocking rate (LU /ha) *via* increased DM yield

E N fertiliser application rate change (kg/ha/y)

p.246-250

CHAPTER 7

Animal Husbandry

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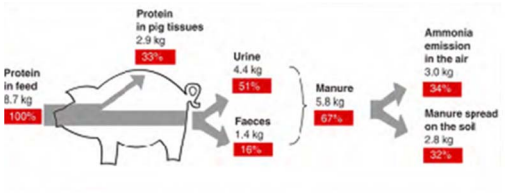
Objective: Minimise animal emissions



✓ Maximise feed conversion efficiency

✓ Minimise enteric fermentation CH_4

✓ Minimise N excretion

✓ Minimise upstream feed impacts

…per unit meat/milk produced

Animal Husbandry: Technique 7.1

Description: Breed selection

M Stock local productive breeds where relevant, or resource efficient breeds where not

Proposed Indicators

E % stock as local breeds

E Productivity: live weight gain or L milk/head/yr

E Feed conversion ratio

E Herd health (% ill), mortality rate (%), fertility rate

E Improvement in EBI

E Lifecycle burdens (e.g. kg CO_2e / kg product)

p.254-259

Animal Husbandry: Technique 7.2

Description: Nutrient Budgeting on livestock farms

M Calculate holistic nutrient budget for farm enterprise

Proposed Indicators

E Feed crude protein contents (kg/kg DM)

E N retention/excretion (kg N/kg live weight)

E Feed conversion efficiency

E % NUE

E % crop NUE_N for fodder crops

E N and P surplus (kg/1000 L milk, kg/ha)

p.260-266

Animal Husbandry: Technique 7.3

Description: Dietary reduction of N excretion

M Analysis of harvested forage nutrient content

M Produce a feed plan to match crude protein in feed with animal production requirements

Proposed Indicators

E Feed crude protein contents (kg/kg DM)

E N retention/excretion (kg N/kg live weight)

E kg crude protein / LU/y

E kg CP / kg meat(1000 L milk) output

E Feed conversion efficiency

E N surplus (kg/1000 L milk, kg/ha)

E NH_3 losses from housing and slurry storage (kg/yr)

p.267-271

Animal Husbandry: Technique 7.4

Description: Dietary reduction of enteric fermentation methane

M Match dietary energy intake to animal production and maintenance requirements

M Maximise digestability of diet (within feed strategy constraints)

M Add supplements to reduce enteric fermentation CH_4?

Proposed Indicators

E D value feed (trade-off with grass SOC)

E Feed conversion efficiency

E Methane conversion factor feed

E kg CH_4 /kg meat (1000 L milk) output

p.272-274

Animal Husbandry: Technique 7.5

Description: Green procurement of feed

M Select feeds with low upstream (cultivation and transport) impacts

Proposed Indicators

E kg CO_2e / kg (or MJ) feed

E % (reduction in) imported concentrate

E 100% certified sustainable soya, palm kernel products

E % of home-produced forage and feed (to max)

p.275-277

Animal Husbandry: Technique 7.6

Description: Maintain animal health

M Produce a health plan that includes routine health monitoring (vet inspections and animal health indicators)

Proposed Indicators

E Feed conversion efficiency

E kg meat (milk) / head/ y

E % animals with health problems

E Use of medicines (kg/LU/yr)

E Frequency vet inspections

p.278-280

Animal Husbandry: Technique 7.7

Description: Optimise animal herd/flock profile

M Produce herd profile plan

M Optimise cull age to minimise CH_4 emissions: calculate growth rate versus CH_4 emissions for each breed

Proposed Indicators

E Daily weight gain (kg/day/animal)

E Daily CH_4 emission (kg CH_4/day/animal)

E kg CH_4 / kg meat (1000 L milk)

E Age at first calving

p.281-282

CHAPTER 8

Manure Management

8.1 Manure management in housing

8.2 Anaerobic digestion of manure

8.3 Appropriate manure storage

p.283-305

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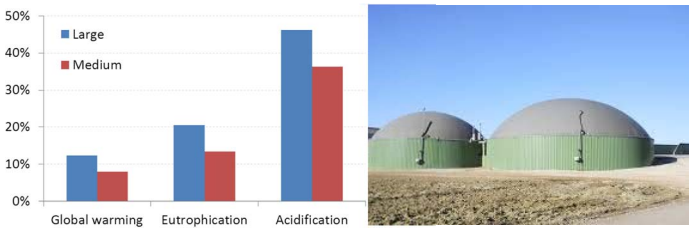
Objective: Maintain nutrients, avoid emissions



- ✓ Conserve N in manures (and enhance availability)
- ✓ Avoid losses to water (poor storage or bad app. timing)
- ✓ Minimise fugitive CH_4 and NH_3 losses

…adequate capacity, capped storage, AD

Manure Management: Technique 8.1

Description: Manure management in housing

M Minimise time indoors (cross ref BEMP 6.1)

M Installation of grooved floors (separates urine from dung) and automated floor scrapers

M Installation of barn ventilation (and ammonia scrubbers in exhaust system for intensive pig/poultry systems)

Proposed Indicators

E NH_3 emitted (kg / LU / yr)

E Housing NH_3-N EF (fraction N_{ex} or TAN)

E NUE

E Time before manure solids are removed from pig/poultry systems

p.286-289

Manure Management: Technique 8.2

Description: Anaerobic digestion of manure

M Send slurry and manure for (on farm) anaerobic digestion with capped digestate storage (BEMP 8.3)

Proposed Indicators

E Fugitive CH_4 emissions (% generated CH_4)

E Digestate storage NH_3 emissions (NH_3-N EF TAN)

E Avoided emissions of CH_4, NH_3, N_2O from manure storage

E kWh/LU or t slurry

E Avoided fossil energy and fertiliser manufacture emissions

E % of manure sent to AD

E Certification of digestate e.g. BS PAS 110 (UK) p.290-298

Manure Management: Technique 8.3

Description: Appropriate manure storage

M Ensure adequate capacity, covered slurry storage

M Produce a manure management plan (NVZ regs basis for universal BEMP?)

Proposed Indicators

E Manure storage NH_3-N EF (fraction TAN)

E Manure storage N_2O EF (fraction slurry N)

E Manure storage CH_4 EF (or MCF)

E Volume of storage (m^3 and months)

E NUE p.299-305

CHAPTER 9

Tillage Agriculture

9.1 Restrict to appropriate soils

9.2 NMP on arable farms

9.3 Optimised rotations

9.4 Banded/injection/incorporated slurry application

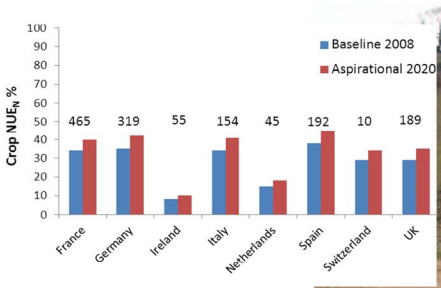
9.5 Low-impact tillage options

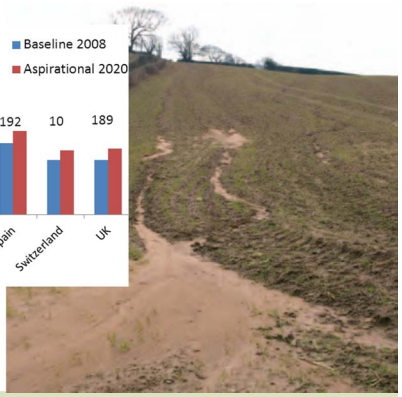
9.6 Establish cover crops

p.306-330

This work has been developed by Bangor University under contract with the European Commission. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

Objective: Optimised crop production





- ✓ Maximise NUE
- ✓ Maintain/improve soil quality (SOM)

Tillage: Technique 9.1

Description: Restrict to appropriate soils

Proposed Indicators

E % soil cultivated that is peat
E Length of ley on peat soils
E Slope of tillage fields
E Water table depth (peat and mineral)
E Emission factors CO_2 and N_2O for cultivated peat soils
E Soil organic matter content (%) in topsoil

p.310-311

Tillage: Technique 9.2

Description: NMP on arable farms

M Regular soil testing (BEMP 5.1)
M Produce a nutrient management plan
M Calculate crop residue N, soil mineralisable N

Proposed Indicators

E Crop nutrient off-takes (kg/ha/yr)
E Fertiliser/manure/residue nutrient inputs (kg/ha/yr)
E Crop NUE_N
E N and P surplus, NUE

p.312-315

Tillage: Technique 9.3

Description: Optimised crop rotation

M Rotate crops according to integrated pest management plan (BEMP 11.1)
M Integrate legumes and break crops into rotation

Proposed Indicators

E No. of break crops (ley, legume, oilseed) in a rotation
E Length of rotation (yrs)
E Soil quality indicators (SOM, SMN…)

p.316

Tillage: Technique 9.4

Description: Efficient application of slurry to arable land

M Employ efficient slurry application techniques (injection or immediate incorporation)
M Calculate plant-available nutrients supplied by application technique type (e.g. MANNER-NPK calculator)

Proposed Indicators

E % volume slurry applied using efficient methods
E % nutrients available to crops
E Nutrient Use Efficiency
E Soil nutrient balance
E Avoided fertiliser requirement (kg/ha/yr)

p.317-325

Tillage: Technique 9.5

Description: Low-impact tillage options

M Employ direct drill practices or minimum tillage alternatives such as strip tillage

Proposed Indicators

E Erosion losses (t/ha/y)
E Erosion degree (visual inspection)
E % land area receiving low-impact tillage (*cf.* CT)
E Emission factors CO_2, N_2O
E Soil bulk density (g/cm^3)
E Topsoil SOM content (%C, LOI)
E Soil colour
E Soil aggregate structure

p.326-327

Tillage: Technique 9.6

Description: Cover crops

M Establishment of legume/natural pesticide cover crops (peas, mustard…)

Proposed Indicators

E % land under bare soil over winter
E % land with cover crops planted
E SOM %
E mg NO_3-N/L water
E Avoided fertiliser requirement (kg/ha)
E Earthworm abundance / m^2

p.328-330

CHAPTER 10

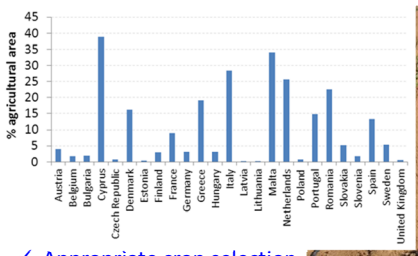
Irrigation

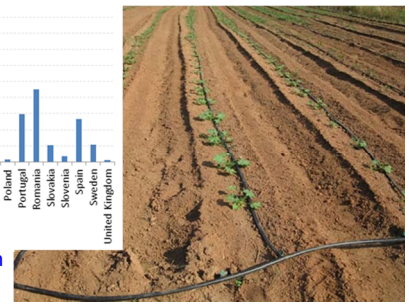
10.1 Minimise irrigation demand

10.2 Efficient irrigation

p.331-334

Objective: minimise water abstraction





- ✓ Appropriate crop selection
- ✓ Soil (whc) improvement
- ✓ Efficient delivery system
- ✓ Optimised demand-led control

Irrigation: Technique 10.1

Description: Minimise irrigation demand

M Calculate SMD for crop *x* in location *y* (software tools)

M Match crops to available water

Proposed Indicators

E % land requiring irrigation (farm, regional)

E % change in irrigation demand (m^3/yr, m^3/ha/yr)

E Water footprint (blue water component) (L/tonne crop)

E Soil water-holding capacity (cm^3/g)

E % soil organic matter

E Local/regional groundwater level (depletion)

pp.332

Irrigation: Technique 10.2

Description: Efficient irrigation techniques

M Drip irrigation installed

M Alternative efficient irrigation (droplet size)

M Irrigation controlled by soil moisture sensors

Proposed Indicators

E Application efficiency (%)

E % taken up by crops?

E Water abstracted (m^3, m^3/ha, m^3/tonne)

E Water footprint (blue component) (L/tonne crop)

E Productivity /unit water abstracted (kg/m^3, €/m^3)

p.333-334

CHAPTER 11

Agro-chemical Management

11.1 IPM

11.2 Select lower-impact active ingredients

p.335-342

Objective: minimise eco toxicity

- ✓ Maintain crop health and productivity
- ✓ Crop rotation planning and habitat provision for natural predators
- ✓ Selection of lower toxicity chemicals
- ✓ Precision application

Agro-chemical Management: Technique 11.1

Description: IPM

M Produce IPM plan that considers rotations, hygiene, cultivars, cultivations, drilling dates, seed treatments, conservation headlands, beetle banks, farm records, crop monitoring, threshold levels, targeted apps, anti-resistance, success

Proposed Indicators

E kg active ingredient /ha/y
E Annual treatment frequency index
E Environmental Impact Quotient
E Abundance natural predators
E Pest abundance
E Residue on product
S All Birds Index

p.336-340

Agro-chemical Management: Technique 11.2

Description: Select lower-impact active ingredients

M Apply/refer to eco-toxicity metric such as environmental impact quotient
M Risk versus hazard approach?

Proposed Indicators

E Environmental certifications/labels?
E % "lower impact" active ingredients applied

p.341-342

CHAPTER 12

Horticulture

12.1 Waste heat and renewable energy
12.2 Water management in S. Europe
12.3 Waste Management

pp.343-347

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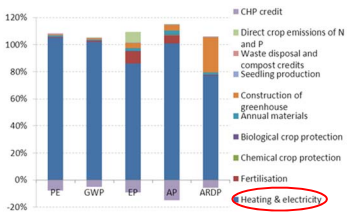
Objective: Maximise resource efficiency, waste management



Dominates burdens, UK tomatoes e.g.

- ✓ Chemical use as per Chapter 11
- ✓ Avoid fossil heating
- ✓ Controlled drip irrigation, water recirculation?
- ✓ Careful (plastic) waste management (reg. compliance issue: BEMP for enforcement by authorities?)

Horticulture: Technique 12.1

Description: Waste heat and renewable energy

M Insulated greenhouse construction
M Use of waste or renewable energy

Proposed Indicators

E Fossil energy use, kWh/m^2/yr
E % electricity consumed environmentally labelled
E % natural refrigerants used (new BEMP?)

p.344-345

Horticulture: Technique 12.2

Description: Water management

M Install controlled drip irrigation, water recirculation?

Proposed Indicators

E Water consumption m^3/m^2/yr or L/kg produce
S Depth ground water table (change)

p.344-345

Horticulture: Technique 12.3

Description: Waste management

M Reuse or recycle (all) materials
M (Comply with all waste regulations)

Proposed Indicators

E Waste generated (kg/m^2/yr)
E % materials reused or recycled
S Local waste contamination

p.344-345

CHAPTER 3

Cross-cutting policy makers

3.1 Encourage responsible consumption
3.2 Landscape planning
3.3 Agri-environmental schemes

pp.343-347

Objective: provide framework for sustainable farming

✓ Reduce food waste through chain
✓ Encourage responsible diets? (Who pays for health and environmental burdens?)

Controversial, pertinent issues: set context and objectives for "sustainable" farming…

✓ Guide land use optimisation at landscape scale (ES services)
✓ Provide effective support for resource-efficient farming

Cross-cutting policy: Technique 3.1

Description: Encourage responsible consumption

M Insulated greenhouse construction
M Use of waste or renewable energy

Proposed Indicators

E (Avoidable) food waste (kg/person/year)
E % food produced that ends up as waste
E (Excess) Kcal/person/day (total, and as meat/dairy)
S Additional land area required for food waste
S Land sparing potential of consumption change (LUC avoidance?)

p.344-345

Cross-cutting policy: Technique 3.2

Description: Landscape management

M Map ecosystem services delivery
M Allocate areas where different ecosystem service provisioning is prioritised

Proposed Indicators

E Ecosystem service provisioning indicators (yields, biomass growth potential, water provisioning, C sequestration…)
E % area allocated to nature or low input agriculture
S Ecosystem service impacts: water quality, SOC, Additional land area required for food waste

p.344-345

Cross-cutting policy: Technique 3.3

Description: Farm agri-environment schemes

M Provide free advice to farmers on best practice (lift poor performers or encourage excellence?)
M Provide tools (e.g. NMP) to facilitate resource efficient practices
M How to engage farmers? Combine regulatory inspections with advice?

Proposed Indicators

E % farmers receiving personalised advice in a given year
E Regional KPIs: NUE, etc
E Farm level KPIs: NUE, carbon footprint
S Regional water quality indicators

p.344-345

CHAPTER 4

Cross-cutting farmers

4.1 Good housekeeping
4.2 Planted buffer strips
4.3 Conservation habitat management
4.4 Constructed wetlands
4.5 Energy management

pp.343-347

This work has been developed by Bangor University under contract with the European Commission. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

Objective: provide framework for sustainable farming

- ✓ Systems perspective to monitor resource efficiency (KPIs)
  - ✓ Farm scale
  - ✓ Process scale (cross-ref other chapters and indicators)
- ✓ Additional water management
  - ✓ buffer strips
  - ✓ wetlands (mop-up unavoidable nutrient/sediment runoff)
- ✓ Additional biodiversity management
  - ✓ maintain/introduce habitats for conservation
- ✓ Link to EMS and certification (GlobalGAP, LEAF, etc)

Cross-cutting policy: Technique 4.1

Description: Good housekeeping

M Produce farm management plans linked to relevant practices and KPIs described throughout the SRD
M Benchmark practices against SRD or other demonstrable best practice level
M Minimise contamination sources for farm yard runoff water
M Install rainwater harvesting

Proposed Indicators

E Crop and farm NUE
E Farm and/or product carbon footprints, water footprints
E Water consumption (m^3/ha/yr): sub-meter animals and crop irrigation
E Total energy use (kWh/ha/yr): diesel, electricity, heating oil, gas…

p.344-345

Cross-cutting policy: Technique 4.2

Description: Planted buffer strips

M Establish planted buffer strips along all water courses inside/adjacent to farm

Proposed Indicators

E Width buffer strip (6 m, 10 m min?)
E Sediment and nutrient losses (kg/ha/yr)
E Infiltration rate on buffer strip
S Water quality indicators
S Species diversity in buffer strip

p.344-345

Cross-cutting policy: Technique 4.3

Description: Conservation and habitat management

M Produce a conservation and habitat management plan for the farm

Proposed Indicators

E % non-farmed area on farm
S Number plant and animal species on farm
S All birds index
S Presence of key indicator species

p.344-345

Cross-cutting policy: Technique 4.4

Description: Constructed wetlands

M Where appropriate to mop up unavoidable nutrient losses, route farm overland flow water through a wetland area
M Harvesting of biomass and recycling of nutrients from wetland area

Proposed Indicators

E Nutrient and sediment conc in runoff water (mg/L)
E Nutrient and sediment conc in wetland exit water (mg/L)
S % farm runoff water flowing into wetland area
S Local surface water quality (mg/L)

p.344-345

Cross-cutting policy: Technique 4.5

Description: Energy management

M Produce an energy management plan for the farm
M Benchmark key activities or processes
M Install appropriate renewable energy capacity on farm

Proposed Indicators

E L/ha diesel for field operations
E Tractor energy efficiency rating
E kWh/L electricity for milking
E kWh/m^2/yr for HVAC (animal housing)
E % energy used that is renewable (on-farm or certified additional sources only)

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David Styles
Email: d.styles@bangor.ac.uk
Tel: +44 (0)1248 382502

Julie Williamson
Email: j.c.williamson@bangor.ac.uk
Tel: +44 (0)1248 383232

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Abstract

The European Commission's Joint Research Centre (JRC) is developing a sectoral reference document on best environmental management practice in the agriculture – crop and animal production sector. Within this framework, the JRC established a European technical working group (TWG), comprising of experts in different aspects of environment and agriculture, to assist the European Commission in identifying these best practices and then validate the final findings. Minutes of the kick-off meeting of the technical working group, held on the 14-15 October 2013 in Brussels, are presented in this report. The meeting allowed analysing and discussing the first draft of a background document which then will be used to develop the final sectoral reference document.

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As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

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