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

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2013
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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 practices 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\textsubscript{2} and NH\textsubscript{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 FARMERS

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 (landscape 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

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<tr>
<td>10:00 – 10:15</td>
<td>Arrival and registration of participants</td>
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<td>10:15 – 10:30</td>
<td>Opening and welcome</td>
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<td>Introduction of experts</td>
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<td>Purpose and goals of the meeting</td>
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<td>11:15 - 12:00</td>
<td>Introduction of the sectoral reference documents on best environmental management practise (BEMP) and lessons learnt so far</td>
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<td>12:00 - 12:45</td>
<td>Overview of the Agriculture - Crop and Animal production sector and definition of the scope of the sectoral reference document</td>
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<td>Environmental aspects of the Agriculture - Crop and Animal production sector</td>
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<td>Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Soil fertility and grass and grazing management BEMPs</td>
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<td>Coffee Break</td>
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<td>16:15 - 17:15</td>
<td>Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Animal husbandry and manure management BEMPs</td>
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<td>Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Tillage and irrigation</td>
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<td>18:15 - 18:30</td>
<td>Wrap-up and close of the day</td>
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### 15 October 2013 – Venue: DG Taxation and Custom Union (TAXUD), Room 1/01

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<tr>
<td>08:45 - 09:00</td>
<td>Arrival and registration of participants</td>
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<td>09:00 - 09:15</td>
<td>Opening of the day</td>
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<td>09:15 - 09:45</td>
<td>Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Agro-chemical management BEMPs</td>
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<td>09:45 - 10:15</td>
<td>Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Horticulture BEMPs</td>
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<td>Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: Cross-cutting and farm management planning BEMPs</td>
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<td>Topic</td>
<td>Time</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>Techniques used in the Agriculture – Crop and Animal production sector to address environmental issues: gaps/missing techniques</td>
<td>11:45 - 12:15</td>
</tr>
<tr>
<td>Environmental Indicators and Benchmarks of Excellence</td>
<td>12:15 - 12:45</td>
</tr>
<tr>
<td>Conclusions, way forward and information gathering</td>
<td>12:45 - 13:15</td>
</tr>
<tr>
<td>Wrap-up and close of workshop</td>
<td>13:15 - 13:30</td>
</tr>
</tbody>
</table>
## ANNEX 2: LIST OF PARTICIPANTS

<table>
<thead>
<tr>
<th>Name</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audrey Moulierac</td>
<td>Agriculture and Horticulture Development Board</td>
</tr>
<tr>
<td>Xavier Poux</td>
<td>ASCA - European Forum on Nature Conservation and Pastoralism</td>
</tr>
<tr>
<td>David Styles</td>
<td>Bangor University</td>
</tr>
<tr>
<td>Julie Williamson</td>
<td>Bangor University</td>
</tr>
<tr>
<td>Laure Le Quéré</td>
<td>FARRE</td>
</tr>
<tr>
<td>Tanja Runge</td>
<td>Copa-Cogeca</td>
</tr>
<tr>
<td>Arnaud Petit</td>
<td>Copa-Cogeca</td>
</tr>
<tr>
<td>Christian Pallier</td>
<td>EFA</td>
</tr>
<tr>
<td>John Boardman</td>
<td>Environmental Change Institute - University of Oxford</td>
</tr>
<tr>
<td>Bram Moeskops</td>
<td>IFOAM</td>
</tr>
<tr>
<td>Urs Niggli</td>
<td>FIBL</td>
</tr>
<tr>
<td>Philippe C. NICOT</td>
<td>INRA</td>
</tr>
<tr>
<td>Jaroslav Prazan</td>
<td>Institute of agricultural economics and information</td>
</tr>
<tr>
<td>Claude Bourguignon</td>
<td>Laboratoire Analyses Microbiologiques Sols</td>
</tr>
<tr>
<td>Caroline Drummond</td>
<td>LEAF</td>
</tr>
<tr>
<td>Karin Stein-Bachinger</td>
<td>Leipniz-Zentrum fuer Agralandschaftsforschung</td>
</tr>
<tr>
<td>Richard Riester</td>
<td>LEL - State institute for development of agriculture and rural areas</td>
</tr>
<tr>
<td>Henk Westhoek</td>
<td>PBL Netherlands - Environmental Assessment Agency</td>
</tr>
<tr>
<td>Euan Brierley</td>
<td>Soil Association</td>
</tr>
<tr>
<td>Karl Richards</td>
<td>Teagasc</td>
</tr>
<tr>
<td>Juern Sanders</td>
<td>Thunen Institute</td>
</tr>
<tr>
<td>Esther Zippel</td>
<td>UGA – German EMAS Advisory Board</td>
</tr>
<tr>
<td>Rodney Thompson</td>
<td>Universidad de Almeria</td>
</tr>
<tr>
<td>Miguel Quemada</td>
<td>Universidad Politécnica de Madrid</td>
</tr>
<tr>
<td>Katarina Hedlund</td>
<td>University of Lund</td>
</tr>
<tr>
<td>Carlo Leifert</td>
<td>University of Newcastle</td>
</tr>
<tr>
<td>Alberto Pardossi</td>
<td>University of Pisa</td>
</tr>
<tr>
<td>Birgit Wilhelm</td>
<td>WWF</td>
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<tr>
<td>Frank Brentrup</td>
<td>Yara International Fertilisers</td>
</tr>
<tr>
<td>Olivier Diana</td>
<td>European Commission - DG AGRI</td>
</tr>
<tr>
<td>Angelo Innamorati</td>
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<tr>
<td>Gilles Vincent</td>
<td>European Commission - DG ENV</td>
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<tr>
<td>Rolf-Jan Hoeve</td>
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<tr>
<td>Victor Palacios</td>
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<tr>
<td>Karin Nienstedt</td>
<td>European Commission - DG SANCO</td>
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<tr>
<td>Marco Dri</td>
<td>European Commission - JRC</td>
</tr>
<tr>
<td>Ioannis Antonopolus</td>
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<tr>
<td>Paolo Canfora</td>
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<tr>
<td>Harald Schoenberger</td>
<td>European Commission - JRC</td>
</tr>
<tr>
<td>Franz Weiss</td>
<td>European Commission - JRC</td>
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</tbody>
</table>
ANNEX 3: PRESENTATIONS
Crop and Animal Production: Sector overview and scope of the 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

<table>
<thead>
<tr>
<th>Type of Farming</th>
<th>No. of Holdings (thousand)</th>
<th>AUA (LAU)</th>
<th>AWA</th>
<th>FNV added (average result per holding, 1000 EUR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field crops</td>
<td>1,498,467</td>
<td>42.93</td>
<td>1.50</td>
<td>19.89</td>
</tr>
<tr>
<td>Horticulture</td>
<td>84,547</td>
<td>5.30</td>
<td>1.39</td>
<td>62.34</td>
</tr>
<tr>
<td>Wine</td>
<td>23,176</td>
<td>15.94</td>
<td>1.79</td>
<td>36.16</td>
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<tr>
<td>Permanent crops</td>
<td>85,398</td>
<td>9.28</td>
<td>1.30</td>
<td>17.05</td>
</tr>
<tr>
<td>Milk</td>
<td>500,383</td>
<td>39.87</td>
<td>1.86</td>
<td>30.28</td>
</tr>
<tr>
<td>Grazing livestock (excl. milk)</td>
<td>61,024</td>
<td>54.41</td>
<td>1.05</td>
<td>23.72</td>
</tr>
<tr>
<td>Pig and/or poultry</td>
<td>137,761</td>
<td>21.64</td>
<td>1.50</td>
<td>51.12</td>
</tr>
<tr>
<td>Mixed (crops + livestock)</td>
<td>951,804</td>
<td>30.00</td>
<td>1.68</td>
<td>14.33</td>
</tr>
</tbody>
</table>

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

Detailed in next presentation!
2. Scope: summary

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

2. 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 application)
  - 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?

- **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. 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 NOx emissions
- **(Manufacture of organic fine chemicals)**
  - SRD will guide on avoidance and GP to reduce toxicity (focussed on use stage)

3. Regulatory drivers

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. 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

Proposed Indicators
- E Feed crude protein contents (kg/kg DM)
- E N retention/excretion (kg N/kg live weight)
- E kg crude protein / LUL
- E kg CP / kg meat(1000 L milk) output
- E Feed conversion efficiency
- E N surplus (kg/1000 L milk, kg/ha)
- E N leakage losses from housing and slurry storage (kg/yr)

4. BEMP sequence

<table>
<thead>
<tr>
<th>BEMP</th>
<th>Target actors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross cutting for policy makers</td>
<td>Policy makers</td>
</tr>
<tr>
<td>Farm planning</td>
<td>All farmers, advisors</td>
</tr>
<tr>
<td>Soil fertility management</td>
<td>All farmers, advisors</td>
</tr>
<tr>
<td>Grass and grazing</td>
<td>Pasture based farmers, advisors</td>
</tr>
<tr>
<td>Animal husbandry (cross-ref BREF)</td>
<td>Livestock farmers, advisors</td>
</tr>
<tr>
<td>Manure management (cross-ref BREF)</td>
<td>Livestock farmers, advisors, receiving tillage farmers</td>
</tr>
<tr>
<td>Tillage</td>
<td>Tillage farmers, advisors</td>
</tr>
<tr>
<td>Irrigation</td>
<td>Tillage and horticulture farmers, advisors</td>
</tr>
<tr>
<td>Agro-chemical management</td>
<td>Tillage, horticulture</td>
</tr>
<tr>
<td>Horticulture</td>
<td>Horticultural farmers, advisors</td>
</tr>
</tbody>
</table>

p.267-271
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

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

- \( \text{N}_2\text{O} \) 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

- 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 Bidolgio, 2013).

1. Phosphorus (global)

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

Source: Cordell et al. (2009)
1. Soil degradation

- 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?

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

2. Global land constraints

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

2. Yield trends

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

![Graph: NUE trends over time] (Source: IFA (2007))

3. 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 mismatches)
- Little 'spare land' available
- Can further yield gains be made without increasing land take and further decreasing NUE?

3. "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

<table>
<thead>
<tr>
<th>Service/activity</th>
<th>Direct/indirect aspects</th>
<th>Main environmental pressures</th>
<th>Indirects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tillage/harvesting</td>
<td>- Energy consumption</td>
<td>GHG emissions</td>
<td>Machinery manufacturing</td>
</tr>
<tr>
<td>Fertiliser application</td>
<td>- Nutrient losses to water</td>
<td>Nutrient losses</td>
<td>Manufacturing and transport energy (and associated impacts)</td>
</tr>
<tr>
<td>Transport</td>
<td>- Energy consumption</td>
<td>Manufacturing and transport energy (and associated impacts)</td>
<td></td>
</tr>
<tr>
<td>Machinery use (e.g. harvesting)</td>
<td>- Energy consumption</td>
<td>Manufacturing and transport energy (and associated impacts)</td>
<td></td>
</tr>
<tr>
<td>Irrigation</td>
<td>- Energy consumption</td>
<td>Manufacturing and transport energy (and associated impacts)</td>
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</tr>
<tr>
<td>Crop production</td>
<td>- Energy consumption</td>
<td>Manufacturing and transport energy (and associated impacts)</td>
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<td>Agricultural application</td>
<td>- Energy consumption</td>
<td>Manufacturing and transport energy (and associated impacts)</td>
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</tbody>
</table>
3. Aspects > Pressures: livestock

<table>
<thead>
<tr>
<th>Service/Activity</th>
<th>Main environmental pressures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertiliser application</td>
<td>NH3 emissions, N2O emissions, manure losses to water, biodiversity loss</td>
</tr>
<tr>
<td>Feed</td>
<td>Off-site cultivation (see arable below)</td>
</tr>
<tr>
<td>Manure Management</td>
<td>Off-site cultivation (see arable below)</td>
</tr>
<tr>
<td>Grazing</td>
<td>NH3 emissions, N2O emissions, soil erosion and compaction</td>
</tr>
<tr>
<td>On-farm operations</td>
<td>Energy (fuel) consumption, electricity generation</td>
</tr>
</tbody>
</table>

4. Product burdens

- Crop and animal products major drivers of EU env impact

4. Winter wheat BEMP

<table>
<thead>
<tr>
<th>Source</th>
<th>Key BEMP measures</th>
<th>Section</th>
</tr>
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<tbody>
<tr>
<td>Agro-chemicals and upstream impacts</td>
<td>Select reduced impact synthetic fertilisers</td>
<td>Section 5.6</td>
</tr>
<tr>
<td>Crop rotation and BPM technologies</td>
<td>Section 11.2</td>
<td></td>
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<tr>
<td>Crop protection agent product selection</td>
<td>Section 11.1</td>
<td></td>
</tr>
<tr>
<td>Restrict tillage to appropriate areas</td>
<td>Section 9.1</td>
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<tr>
<td>Soil emissions</td>
<td>Soil Nutrient Management Planning</td>
<td>Section 5.1 and 9.2</td>
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<tr>
<td>Sustainable organic matter amendments</td>
<td>Section 5.2</td>
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<td>Soil drainage management</td>
<td>Section 5.3</td>
<td></td>
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<td>Cover crops</td>
<td>Section 5.6</td>
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<tr>
<td>Low-impact tillage operations</td>
<td>Section 9.5</td>
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<tr>
<td>Precision fertiliser/manure application</td>
<td>Section 5.4 and 9.4</td>
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</table>

4. Winter wheat LCA (simple)

4. Dairy LCA example

0.9 to 1.0 kg CO2e per L milk on optimised large/medium sized farms (ex. LUC). Source: BU LCA tool
4. Feed strategies

- Grass
- High fertiliser per kg DM
- Lower digestibility (higher CH₄)
- High SOC
- Ecosystem services

**Metrics: soil degradation on large farm?**

- Shift medium to large = LUC
- Sustainable? intensification

---

**Feed type**

- Winter wheat
- Winter wheat + LUC

<table>
<thead>
<tr>
<th>CF (kg CO₂/kg)</th>
<th>SBME</th>
<th>SBME + LUC</th>
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<tbody>
<tr>
<td>0.577</td>
<td>0.8</td>
<td>0.145</td>
</tr>
<tr>
<td>9.26</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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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

---

**Grass**

- High fertiliser per kg DM
- Lower digestibility (higher CH₄)
- High SOC
- Ecosystem services

---

**4. Indicators**

- SMN
- kg N/ha

**Farm system:**
- e.g. NUE

**Product LCA:**
- e.g. CF

---

**4. Dairy BEMP**

<table>
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<tr>
<th>Source</th>
<th>Key BEMP measures</th>
<th>Section</th>
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<td>Breeding for improved productivity</td>
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<tr>
<td>Maintaining animal health</td>
<td>Section 7.6</td>
<td></td>
</tr>
<tr>
<td>Diet (feed conversion ratio)</td>
<td>Section 6.1 and 7.4</td>
<td></td>
</tr>
<tr>
<td>Manure management in housing</td>
<td>Section 8.1</td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td>Section 8.2 and 8.3</td>
<td></td>
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<tr>
<td>Anaerobic digestion</td>
<td>Section 8.2</td>
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<tr>
<td>Soil Nutrient Management Planning</td>
<td>Section 5.1</td>
<td></td>
</tr>
<tr>
<td>Dietary optimisation of N intake (excretion)</td>
<td>Section 7.3</td>
<td></td>
</tr>
<tr>
<td>Precision fertiliser/manure application</td>
<td>Section 5.4 and 5.5</td>
<td></td>
</tr>
<tr>
<td>Grass-clover swords</td>
<td>Section 6.3</td>
<td></td>
</tr>
<tr>
<td>Trailing shoe/handed slurry application</td>
<td>Section 6.5</td>
<td></td>
</tr>
<tr>
<td>Nitrification inhibitors</td>
<td>Section 6.6</td>
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**Soil emissions**

<table>
<thead>
<tr>
<th>Source</th>
<th>Key BEMP measures</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Nutrient Management Planning</td>
<td>Section 5.1</td>
<td></td>
</tr>
<tr>
<td>Dietary optimisation of N intake (excretion)</td>
<td>Section 7.3</td>
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<td>Grass-clover swords</td>
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<tr>
<td>Trailing shoe/handed slurry application</td>
<td>Section 6.5</td>
<td></td>
</tr>
<tr>
<td>Nitrification inhibitors</td>
<td>Section 6.6</td>
<td></td>
</tr>
</tbody>
</table>

**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**
Best Environmental Management Practice in Agriculture

Proposed Techniques
(measures and key indicators)

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30/10/2013

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

Objective: Improve nutrient use efficiency

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

Legend

M Management action
E Environmental performance indicator
S State/environmental condition indicator

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

TWG input

Please
✓ Propose additional/alternative
✓ Techniques
✓ Measures
✓ Indicators
✓ Propose deletions
✓ Indicate data sources
✓ Indicate examples for case studies

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

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/yr)

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\textsubscript{3} emissions (+inhibited N\textsubscript{2}O emissions?)

Proposed Indicators
E (Certified) fertiliser carbon footprint (kg CO\textsubscript{2}e/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

Objective: Minimise grass and
feed impacts

Direct effects

Indirect effects

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/cm³,
% organic matter
E Other quality indicators e.g. N₂O and NH₃ 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 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 CO₂e/kg silage)

p.229-234
Grass & Grazing Management: Technique 6.5

Description: Efficient application of slurry to grassland
- Employ efficient slurry application techniques (banded, trailing shoe, injection)
- Calculate plant-available nutrients supplied by application technique type (e.g. MANNER-NPK calculator)

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

Grass & Grazing Management: Technique 6.6

Description: Nitrification Inhibitors
- Application of nitrification inhibitors to grazed grassland

Proposed Indicators
- N\textsubscript{2}O emissions (fraction of applied N)
- Nitrate leached (fraction of N applied)
- Stocking rate (LU/ha) via increased DM yield
- N fertiliser application rate change (kg/ha/yr)

CHAPTER 7

Animal Husbandry

7.1 Breed Selection
- Stock local productive breeds where relevant, or resource efficient breeds where not

Proposed Indicators
- % stock as local breeds
- Productivity: live weight gain or L milk/head/yr
- Feed conversion ratio
- Herd health (% ill), mortality rate (%), fertility rate
- Improvement in EBI
- Lifecycle burdens (e.g. kg CO\textsubscript{2} e / kg product)

Objective: Minimise animal emissions
- Maximise feed conversion efficiency
- Minimise enteric fermentation CH\textsubscript{4}
- Minimise N excretion
- Minimise upstream feed impacts...per unit meat/milk produced

Animal Husbandry: Technique 7.1

Description: Breed selection
- Stock local productive breeds where relevant, or resource efficient breeds where not

Proposed Indicators
- % stock as local breeds
- Productivity: live weight gain or L milk/head/yr
- Feed conversion ratio
- Herd health (% ill), mortality rate (%), fertility rate
- Improvement in EBI
- Lifecycle burdens (e.g. kg CO\textsubscript{2} e / kg product)

Animal Husbandry: Technique 7.2

Description: Nutrient Budgeting on livestock farms
- Calculate holistic nutrient budget for farm enterprise

Proposed Indicators
- Feed crude protein contents (kg/kg DM)
- N retention/excretion (kg N/kg live weight)
- Feed conversion efficiency
- % NUE
- % crop NUE\textsubscript{a} for fodder crops
- N and P surplus (kg/1000 L milk, kg/ha)
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 NH₃ losses from housing and slurry storage (kg/yr)

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 digestibility of diet (within feed strategy constraints)
M Add supplements to reduce enteric fermentation CH₄?

Proposed Indicators
E D value feed (trade-off with grass SOC)
E Feed conversion efficiency
E Methane conversion factor feed
E kg CH₄ / kg meat (1000 L milk) output

Animal Husbandry: Technique 7.5

Description: Green procurement of feed
M Select feeds with low upstream (cultivation and transport) impacts

Proposed Indicators
E kg CO₂e / 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)

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 (milkJ / head/y
E % animals with health problems
E Use of medicines (kg/LU/yr)
E Frequency vet inspections
Objective: Maintain nutrients, avoid emissions

- Conserve N in manures (and enhance availability)
- Avoid losses to water (poor storage or bad app. timing)
- Minimise fugitive CH₄ and NH₃ losses
- Adequate capacity, capped storage, AD

Manure Management: Technique 8.1

Description: Manure management in housing
- Minimise time indoors (cross ref BEMP 6.1)
- Installation of grooved floors (separates urine from dung) and automated floor scrapers
- Installation of barn ventilation (and ammonia scrubbers in exhaust system for intensive pig/poultry systems)

Proposed Indicators
- E NH₃ emitted (kg / LU / yr)
- E Housing NH₃-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
- Send slurry and manure for (on farm) anaerobic digestion with capped digestate storage (BEMP 8.3)

Proposed Indicators
- E Fugitive CH₄ emissions (% generated CH₄)
- E Digestate storage NH₃ emissions (NH₃-N EF TAN)
- E Avoided emissions of CH₄, NH₃, N₂O 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
- Ensure adequate capacity, covered slurry storage
- Produce a manure management plan (NVZ regs basis for universal BEMP?)

Proposed Indicators
- E Manure storage NH₃-N EF (fraction TAN)
- E Manure storage N₂O EF (fraction slurry N)
- E Manure storage CH₄ EF (or MCF)
- E Volume of storage (m³ 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

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 CO₂ and N₂O for cultivated peat soils
E Soil organic matter content (%) in topsoil

Tillage: Technique 9.2

Description: NMP on arable farms

Proposed Indicators
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
E N and P surplus, NUE

Tillage: Technique 9.3

Description: Optimised crop rotation

Proposed Indicators
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...)

Tillage: Technique 9.4

Description: Efficient application of slurry to arable land

Proposed Indicators
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)

Tillage: Technique 9.5

Description: Low-impact tillage options

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

Proposed Indicators
E Erosion losses (t/ha/yr)
E Erosion degree (visual inspection)
E % land area receiving low-impact tillage (cf. CT)
E Emission factors CO₂, N₂O
E Soil bulk density (g/cm³)
E Topsoil SOM content (%C, LOI)
E Soil colour
E Soil aggregate structure

Tillage: Technique 9.6

Description: Cover crops

Proposed Indicators
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 NO₃-N/L water
E Avoided fertiliser requirement (kg/ha)
E Earthworm abundance / m²
CHAPTER 10

Irrigation

10.1 Minimise irrigation demand
10.2 Efficient irrigation

p.331-334

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 (m³/yr, m³/ha/yr)
E Water footprint (blue water component) (L/tonne crop)
E Soil water-holding capacity (cm³/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 (m³, m³/ha, m³/tonne)
E Water footprint (blue component) (L/tonne crop)
E Productivity /unit water abstracted (kg/m³, €/m³)

p.333-334

CHAPTER 11

Agro-chemical Management

11.1 IPM
11.2 Select lower-impact active ingredients

p.335-342

Agro-chemical Management

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

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CHAPTER 12

Horticulture

12.1 Waste heat and renewable energy

12.2 Water management in S. Europe

12.3 Waste Management

pp.343-347

Objective: Maximise resource efficiency, waste management

✓ 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/m²/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 m³/m²/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/m²/yr)
E % materials reused or recycled
S Local waste contamination

CHAPTER 3

Cross-cutting policy makers

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

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?)

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

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
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

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...

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

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

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)
Cross-cutting policy: Technique 4.5

Description: Energy management

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

Proposed Indicators

- L/ha diesel for field operations
- Tractor energy efficiency rating
- kWh/L electricity for milking
- kWh/m²/yr for HVAC (animal housing)
- % energy used that is renewable (on-farm or certified additional sources only)

p.344-345

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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.
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.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new standards, methods and tools, and sharing and transferring its know-how to the Member States and international community.

Key policy areas include: environment and climate change; energy and transport; agriculture and food security; health and consumer protection; information society and digital agenda; safety and security including nuclear; all supported through a cross-cutting and multi-disciplinary approach.