How to Reduce Nutrient Emissions from Agriculture?

International Workshop Summary Report
Utrecht, 19-20 November, 2009

Hein ten Berge & Wim van Dijk
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Samenvatting

Dit verslag vat de resultaten samen uit de internationale workshop ‘How to reduce nutrient losses from agriculture?’ gehouden 19-20 November 2009 te Utrecht. De workshop werd opgedragen door de ministeries van LNV en VROM, via de resp. adviescommissies CDM (Commissie Deskundigen Meststoffenwet) en TCB (Technische Commissie Bodem).

Doelen van de bijeenkomst waren:

- Vaststellen welke beleidsmaatregelen effectief zijn gebleken in ons omringende landen om nutriëntenverliezen uit de landbouw te beteugelen. (Reductie van stikstofgebruik, nitraatuitspoeling, ammoniakvervluchtiging, fosfaatophoping, verlies organische stof, bodemstructuurverlies.)
- Het vergelijken van ‘Codes of Good Agricultural Practice’ en de bijdrage van maatregelen daaruit, aan efficiënt nutriëntengebruik in lidstaten, leidend tot het verminderen van verliezen naar de omgeving. (Welke maatregelen zijn verplicht, welke zijn vrijwillig? Welke mechanismen bestaan om af te dwingen dan wel te stimuleren? Wat is succesvol gebleken?)
- Identificeren van de belangrijkste succesfactoren in het beleid. (Wat kunnen overheden doen?)

Aan de workshop namen vertegenwoordigers deel uit Denemarken, België (alleen Vlaanderen), Duitsland, het Verenigd Koninkrijk en Nederland. Genodigden uit Frankrijk meldden zich af. Deze landen werden door de opdrachtgevers aangewezen wegens de gelijkenis tussen de landbouw in (delen van) deze landen en die in Nederland; en wegens het daarmee samenhangende relatief sterk ontwikkelde mestbeleid in deze landen.

De belangrijkste bevinden volgen hieronder.

Codes van Goede Landbouwpraktijk (GLP-Codes) spelen voor de sturing van nutriëntengebruik geen rol van betekenis in Denemarken, Vlaanderen, Duitsland en Nederland, noch in het Verenigd Koninkrijk binnen de gebieden aangewezen als nitraatuitpoelingsgevoelig (Nitrate Vulnerable Zones, NVZ).

De betekenis van GLP-Codes, als sturingsmechanisme om emissies te verminderen, is verdwenen met de aanwijzing van uitpoelingsgevoelige gebieden ('Nitrate Vulnerable Zones’ – NVZ) waarvoor Actieplannen werden opgesteld. In Denemarken, Vlaanderen, Duitsland en Nederland zijn deze Actieplannen op toepassing op het gehele nationale grondgebied. In de Actieplannen zijn vrijwel alle maatregelen – welke voorheen als aanbeveling golden in landen met een GLP-Code – nu wettelijk verplicht gesteld middels geboden en verboden. Daarnaast werden veelal verdergaande verplichtingen opgenomen. Een GLP-Code is echter wel van toepassing in het Verenigd Koninkrijk buiten de NVZ gebieden, en is daar goed gedocumenteerd. De toepassing wordt daar sterk door de voorlichting gestimuleerd.

Van alle reeds toegepaste beleidsmaatregelen – in de verschillende landen – hebben beperkingen op het gebruik van dierlijke mest het meest bijgedragen aan de vermindering van emissies vanuit de landbouw.

Hieronder volgt een overzicht van beleidsmaatregelen voor verdere reductie van nutriëntengebruik en –emissies, in volgorde van belang zoals gerangschikt op basis van een enquête na afloop van de workshop. (Zie ook Tabel 1, p.14).

1. Verdere aanscherping van wettelijke beperkingen (Score 119)

   Een strakke wetgeving wordt gezien als cruciaal. Van 10 genoemde maatregelen wordt een verbod op gebruik van dierlijke mest na de oogst van het hoofdgewas als meest effectief beoordeeld. Zo’n verbod zou het ‘volrijden’ van gebruiksruiinte met dierlijke mest - zoals nu o.a. in Nederland en Denemarken voorkomt - moeten uitbannen. Andere effectieve maatregelen zijn: (a) verdere verlaging van gebruiksnormen, (b) verplichte teelt van vanggewassen op grote schaal (niet alleen na mais), en met eisen aan inzaai-tijdstip om de teelt effectief te doen zijn. Deelnemers waren het unaniem eens dat wettelijke verplichtingen weliswaar essentieel zijn, maar tegelijk ook onvoldoende. Technische en economische haalbaarheid zijn eveneens noodzakelijk.
2. **Technologische innovatie voor hogere nutriëntenbenutting (Score 35)**

Een aantal kansrijke maatregelen in deze categorie werd beoordeeld. Als belangrijkste kwamen naar voren: (a) gewasveredeling, met name van wintergranen waarbij gelet moet worden op grote opnamecapaciteit voor stikstof in het najaar; (b) bewerking van mest tot produkten die goed aansluiten bij de gewasvraag; (c) technologie voor geleide bemesting en precisiebemesting, om stikstof tijdens het seizoen te doseren naar gelang de gewasvraag.

3. **Ontwikkelen van financiële mechanismen (Score 30)**

Aanscherping van wetgeving zal voor bedrijven in gevoelige gebieden leiden tot inkomensderving. Vooral op een deel van de zandgronden (o.a. in Nederland, Vlaanderen, Denemarken) en scheurende kleigronden (Verenigd Koninkrijk) kan de gewenste milieukwaliteit mogelijk niet worden gehaald bij een rendabele bedrijfsvoering. Het behalen van de gewenste milieukwaliteit vereist dan financiële ondersteuning, indien men de landbouw (dan weliswaar bij lager input-niveau en mogelijk meer extensief) in deze gebieden wenst te behouden. Mechanismen hiertoe moeten in kaart gebracht worden. Voorbeelden bestaan in Vlaanderen en Duitsland.

Meer in het algemeen verdient het aanbeveling om financiële instrumenten te gebruiken teneinde hogere nutriëntenbenutting te bereiken. Daaronder vallen verhandelbare N- en P-quota, verzekeringen, en het verbinden van cross-compliance vergoedingen met eisen aan nutriëntenbenutting.

4. **Betere onderbouwing van bemestingsadviezen (Score 25)**

Het stikstofbemestingsadvies voor een aantal gewassen varieert sterk tussen diverse landen, ondanks vergelijkbare opbrengstniveaus. Gezien de belangrijke plaats die het advies inneemt bij het vaststellen van gebruiksnormen, is een internationale vergelijking van de wetenschappelijke onderbouwing gewenst. Voorts wordt verwacht dat bemestingsadviezen beter toegesneden kunnen worden door rekening te houden met de opname van stikstof uit de bodem zelf, en met het lokaal haalbare opbrengstniveau.

5. **Kennisoverdracht (Score 28)**

Aan kennisoverdracht werd een score toegekend die vergelijkbaar is met voorgaande punten 2-4. Kennisverspreiding is onmisbaar om bovengenoemde maatregelen te effectueren, maar is ook slechts een hulpmiddel. Ingrijpende maatregelen (zoals in sommige delen van Duitsland) vereisen ‘massieve ondersteuning’ door kennisverspreiding; dat is effectief indien gecombineerd met voldoende (financiële) compensatie.
Summary

This report presents the outcome of a workshop entitled ‘How to reduce nutrient losses from agriculture?’, held 19-20 November 2009 in Utrecht, The Netherlands. The workshop was commissioned by the Dutch Ministry of Agriculture, Nature and Food Quality (LNV), and the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM), via their respective advisory boards (CDM, TCB).

The goals of the meeting were:
- to assess which policy measures proved effective in neighbouring countries to mitigate nutrient losses from agriculture (Reduction of nitrogen use, nitrate leaching, ammonia volatilization, accumulation of phosphate, loss of soil organic matter, loss of soil structure).
- To compare ‘Codes of Good Agricultural Practice’ and their contribution to efficient nutrient use in the various countries. (Which measures are compulsory, which voluntary? Which mechanisms are used to induce ‘good conduct’? What has proven to be successful?)
- Identify key factors for success. (What can governments do?)

The workshop was attended by experts from Denmark, Belgium (Flanders region only), Germany, the UK, and the Netherlands. Invitees from France cancelled their participation.

The key conclusions are summarised below.

Codes of Good Agricultural Practice (GAP) play no significant role in the regulation of nutrient use and emissions in Denmark, Flanders, Germany and the Netherlands, nor within NVZ areas in the UK. In all these areas, Action Programmes are in force, which have incorporated virtually all voluntary GAP actions as obligations. A Code of GAP applies, however, outside NVZ areas in the UK, and is well documented and actively promoted.

Of all policy measures currently in place, those relating to manure production per ha, and to the use of manures, are viewed as having contributed most to the reduction of nutrient emissions from agriculture.

Policy options to achieve further reductions in nutrient use and emissions, are ranked as given below, based on participants opinions as reflected in a post-workshop poll. (See also Table 1, p.14).

1. Further tightening of legislation (constraints and obligations). (Score 119)
   Tighter legislation is viewed as crucial. Among 10 measures listed, foremost would be a ban on animal manure applications after harvest of the main crop. This would stop the current practice of ‘cashing allotted quota’ by accepting manures for profit in late season. Other high-ranking measures are (a) further reduction of N application standards, and (b) extensive demands on compulsory catch crops (including required acreage, required establishment dates). While participants agreed that strict legislation is required to ‘make things happen’, it is recognized that, by itself, it will be insufficient. Technical and economical feasibility may frustrate compliance. See also the complete list.

2. Technological innovation for increased nutrient use efficiency. (Score 35)
   A number of search directions were listed in this category. The most important are: (a) Breeding, notably of cereal crops, to focus on traits for increased N uptake capacity before winter. (b) Processing of manures to achieve products tailored to crop demand; and (c) technologies for precise in-season dosage to match crop demand. See also the complete list.

3. Developing financial mechanisms. (Score 30)
   Tightening of legal constraints and obligations is expected to bear significant impact on farm income. In sensitive areas - such as those with light soils over shallow aquifers, or drained cracking soils - farming within environmental
standards may not be viable without financial support. If farming is to be sustained there, support mechanisms should be developed.
More generally, financial instruments could be invoked to enforce higher nutrient use efficiencies. Among these are tradable input quota, insurance mechanisms, and linking cross-compliance mechanisms with high efficiency requirements. See also the complete list.

4. **Better foundation to fertiliser recommendations. (Score 25)**
Nitrogen fertilizer recommendations for several crops vary widely between member states. Given the important role of formalized N-recommendations in justifying statutory N application standards, an international comparative audit of the science behind recommendations would be highly relevant. Further improvement is expected from recommendations that account for soil N supply (despite inadequacy of current soil tests), and for expected yield.

5. **Knowledge transfer (Score 28)**
Knowledge transfer was ranked similar to the above items 2-4. It is viewed as an indispensable but auxiliary tool, for above measures to take effect. Invasive policies seem to require massive back-up by extension. This, in turn, is likely to remain ineffective in absence of suitable economic incentives.
Introduction

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Nutrient emissions from agricultural land must be reduced to meet targets of the Nitrates Directive and the Water Framework Directive. Different EU member states follow different approaches in their Action Programs and related policies, to make farmers use less nutrients, enhance nutrient efficiency, and so reduce nutrient emissions. The principal aim of the meeting was to identify successful policy options for the reduction of nutrient use and emissions, by evaluating the experiences gained in various EU member states. Delegates were invited from neighbouring countries with production conditions similar to those in the Netherlands: Denmark, Flanders, France, Germany and the United Kingdom.

Besides having the above broader aim, the workshop was also the follow-up on an earlier benchmark study comparing legislation on nitrogen use, and fertilizer recommendation systems. That benchmark study was reported by Van Dijk & Ten Berge (Eds.), 2009. (Agricultural Nitrogen Use in Selected EU countries. PPO Report 382.) Contents from the benchmark report are not repeated here, but the study provided a logical starting point for the workshop: contributors to the benchmark study were invited to convene in the workshop and discuss the broader context of nutrient regulation.

All participants were asked (See App. 5) to prepare an overview of the main elements of Good Agricultural Practice with respect to nutrient and soil management, as perceived in their respective countries. They were also asked to reflect on mechanisms that work to get farmers involved effectively in the plight to improve environmental quality. See App. 4 for short notes on the presentations given at the workshop. The printed version of this document comes with App. 8, listing the full Power Point presentations.

A total of 18 delegates attended the workshop (3 from Denmark; 1 from Flanders; 3 from Germany; 2 from the United Kingdom; and 9 from the Netherlands). Delegates were agronomical en environmental scientists from research institutes and universities, and extension specialists. Delegates were invited based on their knowledge of their national - or regional - legislation on nutrient use in agriculture, of its scientific basis and practical working, as well as their ability to represent their country in this field. See App. 7 for the list of participants and their affiliation.
Workshop Outcome

Status of Good Agricultural Practice

The concept of Good Agricultural Practice, as a policy tool to promote sustainable agriculture, no longer plays a key role in regulating nutrient management in the participant countries, except in the UK.

GAP was originally a set of rules outlining ‘good conduct’ in agricultural practice, but its role was gradually marginalized as more and more recommended (voluntary) measures became compulsory. Thus, GAP as a set of recommendations was replaced by legislation outlining in detail what is permitted and what is prohibited (see App. 2 for a summary of compulsory measures in Action Programs of different countries). This transition was most apparent in Denmark, where it took place from the early 90’s, resulting in today’s very detailed legislation.

This development was closely linked with the designation of NVZ’s (‘nitrate vulnerable zones’). Within NVZ’s, compliance with virtually all GAP components is enforced via the Action Programs. The Netherlands, Denmark, Flanders, assigned NVZ status to their entire territory; also in Germany, the Action Programme (DüV) applies throughout the entire country. Legislation in Denmark was motivated by problems with ecological quality of the marine environment in inlets and coastal areas, rather than by groundwater quality.

In the UK, the Action Programme refers to the 42% of the total territory that is designated as NVZ (100% Northern Ireland, 68% England, 14% Scotland, 4% Wales). In the remaining area, farmers are advised to fulfil GAP requirements. GAP in the UK is well documented in a published handbook. The implementation of GAP is partly documented in an annually updated ‘soil protection review’. The Fertiliser Manual (RB209) formalises nutrient management recommendations (manures and fertilizers).

In Germany a concept of GAP was formulated at federal level; it aims mainly at sustaining soil productivity and fertility. States within Germany have to implement the GAP policy, each according to local requirements. Nutrient management in Germany is rather enforced by the Dünger Verordnung, and soil protection by the Federal Soil Conservation Act, than by another separate Code of GAP. Full compliance with Dünger Verordnung is required to be eligible for Cross Compliance (whole of Germany) or MEKA (Baden-Württemberg).

Current policies: which measures were key to success?

All participants agreed that strict regulation on animal manures is the most important component of policies to reduce nutrient emissions and improve environmental quality. This entails storage capacity, closed spreading periods, non-spreading conditions, and low-emission application techniques. Setting high legal values for the N fertilizer value (NFV) of manures, enforces high utilisation efficiency if used within a framework of maximum permitted total N rates (manure + mineral fertilizers).

Danish participants argued that, of all regulation on animal manures, the introduction of limits on livestock units per ha at farm level was the most effective measure. While this is consistent with limiting manure N application (as required by the Nitrates Directive) it reaches further by limiting also manure production per ha. This would reduce opportunities for unlawful disposal of excess manures, and might increase appreciation of manures. Other countries do not have such limits at farm level, some do at national level.

Further, participants mentioned as important measures: the use of N- and P-application standards, and requirements on minimum fraction of over-winter crop cover. Tight application standards are likely to result in increases of N efficiency, and might so render additional separate rules redundant.
Options to further reduce emissions and improve environmental quality.

Further tightening via legislation

The following measures were mentioned by the participants. (See also Green Growth plan of Denmark.)

*Ban on manure application after harvest of the main crop, if the next crop is spring sown.*

At the moment, farmers (The Netherlands, Flanders) fill up the permitted quota in late summer to receive cash with manures accepted from livestock farmers. Most of the applied N is then lost.

*Decreased manure rates / no manures*

This measure is aimed at situations with high risks of nitrate leaching (e.g. sandy soils, crops prone to nitrate loss like potato, silage maize). In Denmark, where leaching was already reduced substantially, little more contribution is expected from a total ban on manures.

*Ban on chemical phosphate fertilizer.*

This measure enforces the use of manures if P fertilization is necessary (soils with low P content). In FL, the use of mineral phosphate fertilizer is already limited to max 20 kg P₂O₅ per ha and even prohibited under certain conditions: (a) on P saturated soils; (b) on soils with limited P sorption capacity; (c) in 'areas sensitive to water quality'.

*Catch crops.*

Growing catch crops is compulsory in Denmark and – only after maize – in The Netherlands. In Denmark after catch crops only spring crops are allowed. This may induce a shift from winter cereals to spring cereals, which may not be desirable from an economical point of view. Effects should be evaluated on entire crop rotation.

*Limited or zero tillage in autumn*

This measure aims at decreasing soil mineralization in autumn. In Denmark it is included in the Green Growth program which is now under debate (see also App. 4).

*Further tightening of general N and P application standards.*

This jeopardizes yield potential, and so compliance will be hard to achieve without compensation in some form.

Financial mechanisms

*Remove farmers’ financial risk associated with lower N inputs.*

Farmers give extra N (often even beyond recommendation) to avoid risk. Besides technology options (see below) one could introduce financial insurance systems. Farmers get compensated for (proven) yield loss. This requires ‘annual reference yield’ values. The possible options with their pro’s and con’s must be further studied.

*Compensation schemes*

Straight financial compensation for the application of selected measures exists in most German states (e.g. SchALVO and MEKA system in Baden-Württemberg; NAU in Lower Saxony) and in Flanders (specific contracts, voluntary, in sensitive areas). In both cases, drastic changes in farming operations are sometimes required. Payments in Baden-Württemberg range from €100 to €1200 per ha; payments in FL up to more than €500/ha.

SchALVO was launched and is executed by the government of Baden-Württemberg, to ensure consistent constraints and financial compensation in the state with 1250 independent water companies. SchALVO is a very detailed regulation that addresses all agricultural pollutants (pesticides, microbial, nutrients), in all water protection areas; which cover about a quarter of the agricultural area of Baden-Württemberg. It stands apart from the general Action Plan (Dünger Verordnung) that applies to the whole of Germany, and is fully additional to it. Rules depend on
pollution status of the water protection area (in three classes: normal, problem, remediation), soil type, and distance to water source. Details in regulation include dates for establishing catch crops dependent on cultivar; time windows for tillage, depending on elevation; types of industrial fertilizers (including slow release forms); crop choice (permanent grass without grazing in most sensitive domains), bans on animal manures. SchALVO is compulsory in designated water production domains. Extensive sampling for soil Nmin in autumn is part of SchALVO; farmers are entitled to payment only if they meet the standard for residual inorganic soil N. The payments are generated from water sales (consumer pays).

The MEKA and NAU schemes in Germany are voluntary and are based on a modular point system (point per specific measure). Farmers are paid for accumulated points. Key elements are extensification, and care for landscape.

** Tradable quota for N and P.**
In this approach, unused quota can be sold to other farmers or to the government. This may serve to prevent ‘filling up’ of quota in absence of agronomical necessity (e.g., accepting manures by end of summer). Consequently, N efficiency may increase if N use shifts to where its efficiency is highest. If government joins in this market, quota could be bought up and so forever eliminated.

In its simplest form, tradable quota are input quota; more elaborated forms can work to maximize environmental improvement: surplus quota, or emission quota. Surplus quota could well serve to speed up the reduction of emissions from ‘hot spot’ areas.

A first step towards valuation of quota is to permit farmers to take residual quota to the next year. This, too, would reduce the tendency to ‘fill up’ the available quota with manures (that provide extra income) in late season. It gives farmers the flexibility to apply more N if really necessary (e.g. wet conditions), while providing an incentive to save N when possible. The disadvantage of uncontrolled quota accumulation can be countered by setting absolute or relative limits to annual accumulation of unused quota, e.g. max 25% of annual quota can be transferred to next year.

The invited paper by the Netherlands Envir. Assessment Agency (PBL) elaborated the issue of economic optimum N rate, from private (farmer) or public perspective (accounting for quantified costs of pollution, diseases, ecosystem degradation, etc.). Large differences exist between the two optima. If we want farmers to move towards the ‘public’ optimum via financial incentives, choice seems to be between internalization of public cost (e.g. tax on fertilizers) or compensation for lost income (between private and public optimum).

**Knowledge transfer**
In the UK as well as Germany, farmers can make use of extension services, appointed (and in UK financially supported for this task) by the government; these give group-based (in England) advice on how to implement the NVZ and other policy measures on farm. (Advice otherwise is to be paid for by the farmer). The UK has accredited FACTS advisors for this purpose. Their written advice can be used for granting a limited number of exemptions for specific crops.

German participants emphasized the need for increased government support for knowledge transfer. Also in the Netherlands, knowledge transfer is important, especially to demonstrate how farmers can work within legislation given their specific farm characteristics. Special projects with experimental and pilot farms have been set up, to identify bottlenecks and solutions. There still remains the issue of how to reach the broad farming community, after pilot farms and study groups.

UK participants reported the success of computer applications (MANNER, PLANET) that generate farm specific fertilizer recommendations. However, the main reason for farmers using them appeared to be calculation and demonstration of compliance with the Action Program, and cross-compliance rules.

Certain control instruments (e.g. residual inorganic soil N in autumn (Nmin) as applied in Flanders and in water protection areas of some states in Germany) also provide useful information with regard to farm nutrient
management. Although the methodology generates much discussion, the direct feedback makes farmers more conscious of the impact of their nutrient management. In Baden-Württemberg, clear declining trends in soil mineral N have been observed.

Structural adjustments in agriculture

*Mixing livestock farming with arable farming.*

Can be done within farms, as well as between farms within a region. Note: calculations on (sub)system efficiency easily lead to artifacts, arising from the isolation of components. Comparative evaluations should always refer to a given set of outputs (sum crop produce and animal produce). Mixing can be useful if it helps to close the feed-manure cycle. Perhaps this is its only true advantage: to reduce the attraction of fraud, by making cycling more obvious (reduced transaction and transportation cost), thus reducing the need for feed imports and manure exports (from farm; from region). In a well regulated system, with requirements for manure management and full compliance, the advantage of mixed farming is not evident.

*Extensification of agriculture*

This was mentioned as an effective but drastic measure. The good environmental score of organic farming is often mentioned in support of this option. However, extensification seems impossible without legal enforcement, or strong financial incentives. Moreover, apart from a clear definition of the concept, consequences of extensification must be assessed in terms of food production (crop type; output level), resource use efficiency (land, labor, inputs) and emissions. How do the answers depend on the scale of averaging, and at what scale (size of regions) should we aim for as ‘extensive’ agriculture. Such analyses must be executed for extensification per unit food output, and per unit land area.

Increased nutrient utilization by proper soil management

The participants emphasized the importance of proper soil management (organic matter, soil structure) but no examples of a direct relationship with nutrient efficiency were mentioned.

There is a need to assess the long term effects of N management strategies on dose response relationships and overall N efficiency. Dose-response relationships and recommendations refer to current soil fertility levels. As soil fertility decreases over time due to input reduction (e.g. decreased application standards), N input demand will increase. It may be simple as that. For a complete analysis, however, we need to assess which soil fertility strategy serves to achieve the highest overall N efficiency (e.g. maintaining low or high soil organic matter content and associated N pools). Such comparative studies (of different strategies) should be done at equal target yields.

Technological innovation for increased nutrient efficiency

*Matching N supply with crop N demand during the growing season*

Crops are often fertilized above recommended levels, to avoid the risk of yield loss. Such risk can also be decreased by improving fertilization techniques, to better match nutrient supply with crop demand during the growing season. Important elements of such systems are rapid and simple diagnosis of crop N status (e.g. reflection measurement by crop sensing) and/or soil N status; application techniques enabling rapid N uptake (e.g. injection, application combined with irrigation). Estimation of soil N supply is given high priority by all countries (UK: total soil N content is a useful indicator of soil N that will be mineralized for crop uptake). The above mentioned techniques can be combined, with site specific application of possible benefit in fields that are strongly heterogeneous.
Placement of fertilizers
Efficiency can also be increased by placement of fertilizers near plant roots (e.g. row or plant application).

Processing animal manure
Processing of animal manures results in products that better match crop nutrient demand (e.g. separation of liquid and solid fractions). This offers considerable potential and the marketing of such 'natural' standardized fertilizers warrants further support.

Some countries (Flanders, the Netherlands) have solved part of the manure issues either by biological treatment or by burning, the latter often involving some energy recovery. This is wasteful (e.g. organic matter) but reduces the 'nutrient pressure' on land and water. Emissions (nitrous oxide) may be problematic. Moreover, this ‘solution’ promotes the continued import of soil fertility from abroad into Western Europe, which by itself is unsustainable, too, if nutrients are not recycled back to the source countries.

Breeding
In the longer term, improvements may also be expected from breeding.
- Animal breeds with higher feed conversion efficiency
- Increased nutrient crop uptake capacity and uptake efficiency by improved root exploration of the soil (especially important for soils with low P status)
- Higher N uptake capacity of winter cereals in autumn, with effective mobilization of this N spring
- Wheat varieties providing sufficient baking quality at lower protein content

Fertiliser recommendations
In all Action Programmes and Codes of GAP, integrated nutrient planning at various levels (farm, field; strategic, tactical, operational) is the starting point for good management. Therefore, fertilizer recommendations still need attention, even though in many countries they are now capped by N and P application standards (maximum allowed amounts to be applied).

Differences between countries
Depending on the crop, considerable gaps are observed between recommendations in different countries (e.g. potato), even though climates and soils seem quite similar. What is the science behind these differences? To what extent are cultural aspects involved? It was proposed that we compare – based on shared datasets submitted to the various countries – both the way recommendations are constructed, and the resulting numerical outcomes.

Technology development
Technology development (crop sensing; precision localized application) will also affect recommendation systems. Instead of assessing crop N demand in advance, future recommendations might be based on decision support systems, using frequent (site specific) soil and/or plant status data during the growing season. New placement techniques (e.g. row application) may also affect recommendations by reduced N or P input requirement.

Soil N supply
There’s a general need for appropriate indicators of soil N supply. Current recommendation systems now use corrections based on manuring and cropping history (e.g. N-index in Flanders, the Netherlands, Denmark). Tests to assess soil N supply in advance are unreliable (NL uses total N content in grassland, to correct N recommendation).
In Baden-Württemberg (Germany), reference cases for certain situations (combination of soil, rotation, etc) are used. For these reference cases recommendations are published. This is only done for arable crops as N dynamics in vegetable crop systems are too complex to account for.

**Corrections for yield level**
Most recommendation systems do account for expected yield level of cereals and other combinable crops. However, doubt exists whether relationships between yield level and optimal N rate warrant such corrections. Studies have shown varying results. In UK for cereals there is conflicting scientific evidence that optimal N rates depend on yield level. They recommend farmers to check wheat grain protein contents after harvest. If this is too low or too high, the N rate should be adjusted for the next crop.

**Crop quality**
The target protein value of the harvested product should be accounted for when assessing optimal N rates (Denmark; UK for cereals). For example too low protein contents in forage products will increase the need for compensation – in animal feeds - with N-rich concentrates.

**Ranking of policy options**
Shortly after the meeting, a draft of the executive summary included in this report was submitted to the workshop participants, inviting their corrections and additional remarks. Along with it went the summary list of policy options [for achieving further reductions of nutrient emissions] given in Table 1, with the request for each participant to allocate a total of 20 points to those policy measures perceived as 'most effective'. Responses were received from Denmark, UK, Germany and Belgium. From Denmark, UK and Germany, forms representing 'shared views' (by two respondents per country) were received. Double weight was then attributed to such scores (indicated as 2* in Table 1).

Responses from the Dutch delegates represent Wageningen UR (1 participant); Netherlands Environmental Assessment Agency (PBL, 1); Scientific Committee of the Manure Act (CDM, 1); and the Extension Service, DLV-Plant (1). Authors’ opinions were not tabulated, so as to mitigate overrepresentation of Dutch opinions. Collected responses are tabulated in Table 1.

**Wrap up**
All participants expressed their view that the meeting was very effective in bringing together ideas and opinions on how we should proceed to mitigate nutrient losses from agriculture. While pollution pressure obviously differs between countries and regions, there was general agreement on the key role of restrictive legislation. For this to take effect, the farming community must be supported by suitable technology development and knowledge transfer. Many expressed their doubt, however, that substantial further reductions can be achieved without suitable financial compensation for lost income.
Table 1. Options to further reduce nutrient emissions from agriculture: scores by participants.

<table>
<thead>
<tr>
<th>Option</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Further tightening via legislation</strong></td>
<td></td>
</tr>
<tr>
<td>• No animal manures after harvest (if next comes Spring crop or winter cereals^1)</td>
<td>2<em>6+6+2</em>1</td>
</tr>
<tr>
<td>• No animal manures at all on sandy soils (on specific crops)</td>
<td>2*1</td>
</tr>
<tr>
<td>• Increase N fertilizer value (NFV) of manures</td>
<td>2<em>2+1+1+2</em>2</td>
</tr>
<tr>
<td>• Further reduction of N application standards (manure + mineral fertilizer)</td>
<td>4+5+2*2</td>
</tr>
<tr>
<td>• Restrictions on use of industrial P fertilizers</td>
<td>2*1</td>
</tr>
<tr>
<td>• Compulsory catch crops (overwinter green cover^6), with establishment dates</td>
<td>2<em>4+2+1+2</em>2+2</td>
</tr>
<tr>
<td>• No soil tillage in autumn</td>
<td>1</td>
</tr>
<tr>
<td>• Limits on livestock number per ha at farm level^2</td>
<td></td>
</tr>
<tr>
<td>• Reduction of maximum P applications</td>
<td>1</td>
</tr>
<tr>
<td>• ‘the Danish system’ (added by one respondent as total package^3)</td>
<td>2*20</td>
</tr>
<tr>
<td>• mandatory low emission application of manures</td>
<td>4+2*1</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>119</td>
</tr>
<tr>
<td><strong>Financial mechanisms / incentives</strong></td>
<td></td>
</tr>
<tr>
<td>• Tradable N quota</td>
<td>2+5+2*1</td>
</tr>
<tr>
<td>• Financial compensations for yield loss or for certain farm measures, e.g. catch crops^9</td>
<td>2<em>1+2</em>2+2+2</td>
</tr>
<tr>
<td>• Insurance systems</td>
<td></td>
</tr>
<tr>
<td>• Internalizing public costs of fertilizer use (tax)</td>
<td>2</td>
</tr>
<tr>
<td>• Link cross-compliance mechanism with requirements on N use efficiency</td>
<td>4</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>30</td>
</tr>
<tr>
<td><strong>Knowledge transfer</strong></td>
<td></td>
</tr>
<tr>
<td>• Farm networks (international farm network^4)</td>
<td>1+2+2*1</td>
</tr>
<tr>
<td>• Web applications (e.g. for fertilizer planning/nutrient management)</td>
<td>2<em>2+2</em>1</td>
</tr>
<tr>
<td>• More extension work^12</td>
<td>2*1+3</td>
</tr>
<tr>
<td>• Stimulating measures via specific agri-environmental projects</td>
<td>2<em>1+2</em>1+3</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>28</td>
</tr>
<tr>
<td><strong>Structure of agriculture</strong></td>
<td></td>
</tr>
<tr>
<td>• Mixed farming</td>
<td>2*1</td>
</tr>
<tr>
<td>• Extensification (but at expense of food security^7)</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Soil management</strong></td>
<td></td>
</tr>
<tr>
<td>• improve soil management for better overall N use efficiency</td>
<td>2+2</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>Technology innovation for increased nutrient use efficiency</strong></td>
<td></td>
</tr>
<tr>
<td>• Precision application technology</td>
<td>2+2+1</td>
</tr>
<tr>
<td>• better timing and dosage based on crop/soil indicators</td>
<td>1+2+2</td>
</tr>
<tr>
<td>• fertilizer placement technology (row; per plant)</td>
<td></td>
</tr>
<tr>
<td>• Processing manures into specific products that better match crop demand</td>
<td>2*1+2+2+1</td>
</tr>
<tr>
<td>• Crop breeding^8 for nutrient efficiency (mainly for increased winter N uptake)</td>
<td>2*2+4+1+2</td>
</tr>
<tr>
<td>• Animal breeding^8 for nutrient efficiency traits</td>
<td>1</td>
</tr>
<tr>
<td>• urease / nitrification inhibitors</td>
<td>2*1</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>35</td>
</tr>
<tr>
<td><strong>Improve fertilizer recommendations</strong></td>
<td></td>
</tr>
<tr>
<td>• improve recommendations based on inter-country benchmarking</td>
<td>2*1+4+2+5</td>
</tr>
<tr>
<td>• develop and use suitable indicator for soil N supply</td>
<td>2+2*1+2</td>
</tr>
<tr>
<td>• differentiate recommendations for yield level</td>
<td>2*1+2</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>25</td>
</tr>
</tbody>
</table>

^1 Expansion to include winter cereals was added by one respondent

^2 This issue was listed by one respondent as a prerequisite for any other measure to take effect; respondent then allocated points to other issues.

^3 The Danish regulation is broadly characterized by extensive use of statutory constraints and prescriptions; the score allocated to this package – it was by non-Danish respondents - was therefore listed under ‘Further tightening of legislation’.

^4 International dimension added by one respondent

^5 Sub-items not specified by respondent

^6 Added as condition by one pair of respondents

^7 Remark by one pair of respondents

^8 long term effect only

^9 respondent highlights that combining enforcement with financial compensation increases acceptance as shown in SchALVO

^10 Respondent highlights that massive extension work – ‘no escape’ was effective in SchALVO
Appendix I.

Assignment of the project by Technische Commissie Bodem
Aan
Plant Research International B.V.
t.a.v. de heer dr. ir. H.F.M. ten Berge
Postbus 616
6700 AR Wageningen

TCB 539 (2009)

Den Haag, 3 augustus 2009

Betreft: opdrachtverlening workshop 'how to reduce nutrient losses from agriculture'

Geachte heer ten Berge,

Op mijn verzoek heeft u op 28 juli 2009 offerte\(^1\) uitgebracht voor de organisatie en uitvoering van een internationale workshop over het reduceren van nutriëntenverlies in de landbouw. Hierbij geef ik u opdracht voor deze werkzaamheden conform uw offerte.

Zoals u in uw offerte reeds aangeeft, vindt definitieve vaststelling van de vorm en inhoud van de workshop plaats in overleg met een begeleidingscommissie van de TCB (TCB-BC). Deze TCB-BC bestaat uit de heer Neeteson, lid van de TCB, de heer Oenema, tot 1 juni 2009 lid van de TCB en vanuit die hoedanigheid nog betrokken bij deze activiteit, en mevrouw Bockhold, plaatsvervangend algemeen secretaris van de TCB. Ik stel voor dat u in overleg met mevrouw Bockhold de bijeenkomsten van de TCB-BC organiseert.

De opdracht wordt afgerond op basis van werkelijk gemaakte uren tot een bedrag van maximaal 15.515,- euro exclusief BTW. De TCB hanteert het volgende betalingsschema:
- 50 procent bij aanvang van het project;
- 50 procent bij oplevering van een concept van het samenvattend verslag.
De eindafrekening wordt door u verstuurd na oplevering van een door de TCB goedgekeurd eindproduct.

Inmiddels is bekend dat de workshop wordt gehouden op 19 en 20 november 2009. In uw offerte vermeldt u dat het project uiterlijk 11 december 2009 wordt afgesloten. U wordt uitgenodigd om een concept van uw samenvattend verslag van de workshop aan de TCB te overhandigen en mondeling toe te lichten op de TCB-vergadering van woensdag 2 december 2009.

\(^{1}\) Uw kenmerk 09PR105897/Hbe/09PR10140/EJ, onderwerp Offerte.
In uw offerte gaat u niet in op de vorm waarin het samenvattend verslag wordt aangeleverd. Het projectplan dat door mij bij het offerteverzoek was gevoegd, vermeldt dat u het verslag elektronisch aan de TCB aanleveren, als pdf-file. Dit maakt onderdeel uit van de onderhavige opdracht.

Op deze opdracht zijn de Algemene onderzoekevoorwaarden van VROM uit 2001 van toepassing. Deze voorwaarden zijn u reeds toegezonden met het offerteverzoek.

Wij verzoeken u bij facturering en overige correspondentie over dit onderzoek het TCB projectnummer, P16, als kenmerk op te nemen. Rekeningen dienen te worden gericht aan:

Technische commissie bodembescherming

Mevrouw I. Sennarain
Postbus 30947
2500 GX Den Haag

onder vermelding van het betreffende zaaknummer. In verband met vakanties kan ik u pas begin volgende week informeren over het zaaknummer. Vervolgens kunt u uw rekeningen indienen.

Mevrouw Boekhold zal dit project begeleiden. Voor eventuele vragen kunt u contact met haar opnemen (telefoon 070-3393035, e-mail boekhold@tcbodem.nl).

Indien u nog vragen of opmerkingen heeft naar aanleiding van deze opdracht verzoek ik u om mij daarover binnen een week na dagtekening te berichten.

Met vriendelijke groet,

de algemene secretaris van de

Technische commissie bodembescherming,

Dr. J. van Wensem
Appendix II.

Compulsory measures in Action Programs

Table A.1 gives the compulsory measures in the Actions Programs of the countries. Farm measures aiming to increase nutrient efficiency are distinguished from other policy measures limiting the use of nutrients.

All Action Programs contain fertilizer planning, closed periods for application of manure and mineral fertilizers, rules for low emission application of manure (injection, direct incorporation) and unfertilized zones along surface water.

Growing catch crops is only compulsory in NL (after maize) and Denmark (minimal 10-14% of farm area excluding grass, potatoes and beets).

In the Action Programs, farm measures are always accompanied with limits on N use (application standards in Denmark, Flanders, UK and the Netherlands, maximum allowed N surpluses in Germany). Denmark is also regulating farm manure production via a maximum limit on livestock rate per ha.

Table A.1. Compulsory measures in Action Programs for NVZ. (DK for Denmark, FL for Flanders, GE for Germany, UK for United Kingdom, NL for the Netherlands).

<table>
<thead>
<tr>
<th>Measure</th>
<th>DK</th>
<th>FL</th>
<th>GE</th>
<th>UK</th>
<th>NL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Farm measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilizer planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Keeping records</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>• Soil analysis</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>(if derog.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fertilization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Closed periods manure/mineral fertilizers</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>• Low emission application methods</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>• No manure application on frozen, snow</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>• Covered and waterlogged land</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-harvest measures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Catch crops</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• No tillage in autumn</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unfertilized zones along surface water</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Other policy measures</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max limit for livestock rate</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum limits on N and P use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Manure</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>• Total N (manure + fertilizers)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Maximum N and P surpluses</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum soil mineral N autumn</td>
<td>+</td>
<td>(+)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 In some states of GE (e.g. Baden Württemberg)
2 From 2012 onwards
Appendix III.

Workshop notes from discussions on Good Agricultural Practice, policy measures and fertilizer recommendations

1. GAP and policy measures

The participating countries were asked for the most promising policy measures to decrease nutrient losses.

United Kingdom
- No application of manure in periods with no or low N uptake by crops (closed periods, increased storage capacity)
- Maximum N rates per crop (application standards)
- Maximising green cover
- Longer term: breeding for nutrient use efficiency. E.g. milling quality wheat (cvar. with higher natural protein content), winter wheat with large autumn N uptake capacity (N to be mobilized in spring); crops with rooting systems adapted to lower soil P status; animal breeds with higher feed conversion

Denmark
- Decreased animal manure rates. Livestock rates (manure production) should be related to land area.
- Better timing of manures (closed periods and increased storage capacity)
- If this is not sufficient: use N application standards
- There are two alternatives: (a) giving an environmental target (Nmin, N surplus, …) or (b) giving constraints on inputs. One practical problem is that legislation should include only items that can be checked (enforced).
- Denmark started with GAP; compliance however is hard to verify. Therefore now system with ‘over 200 application standards and 50 types of stables’ defined in legislation.

Germany
- Precision fertilization by improved application techniques (timing, placement). This is particularly important for manures; so in areas with high animal density and high N and P surpluses.
- Growing cover crops; this is more urgent than before, now that there is an increase in maize area (for the purpose of biofuels) and fewer winter crops.
- Reduced soil management, or no tillage in autumn

Flanders
- Restricted application time for manure (closed periods)
- Application of low-emission techniques for manure
- Use fertilizer recommendations
- Limit or ban the use of manures after the harvest of cereals (farmers now tend to ‘fill their N/P gap’, receiving cash with accepted manures).
- Stimulate farmers for improved nutrient management or introduce fines if they do not

Netherlands
- Low-emission application of manure has proven to be a successful measure to increase N efficiency on farms.
- Increased levels for N fertilizer value manure combined with tightened crop application standards will enforce farmers to take measures to increase nutrient efficiency.
- Give farmers the opportunity to take unused nitrogen N quota to the next year. This N can be used in situations where more N is needed than the allowed N quota (e.g. wet conditions). This will increase
acceptance, reduce dumping (filling up quota), and increase efficiency. Accumulation of N quota over years must then be restricted, e.g. 25% of annual quorum.
- Tradable N quota allowing farmers to sell or buy N quota when necessary. Quota can also be sold to government (true removal from market).

A summary of the discussion following the above inventory is given below.

**Catch crops**
Danish participants state that compulsory use of catch crops will give a shift from winter to spring cereals. The effects on environment and farm economy should be studied.

**Tightened application standards**
- Tightened application standards lead low protein content of forage crops resulting in compensations with protein rich concentrates (Denmark).
- In reducing N inputs via imposed N application standards, how should the pain be partitioned over actors/sectors. Should reductions be imposed via a flat percentage (for all crops). Or should economic loss be taken into the calculation.

**Manure processing**
This can be a solution to match crop nutrient demand better with nutrient supply with manure products.

**Mixed farms**
- What can be the role of mixed farming in reducing nutrient losses? The advantages are not always clear. Nutrient losses in one compartment can be very low (e.g. intensive livestock production without land) while in other compartments (crop production) losses are higher. To keep the advantages of specialization on individual farms mixing on a regional scale can be an option.
- Be aware of artificial efficiency gains (artifacts from calculus).

**Extensification**
The often proposed track of ‘extensification’ as a solution to emission problems is still poorly documented. The good environmental score of organic farming is often mentioned in support of this option. We need to assess – apart from a clear definition of the concept - what are the consequences in terms of production (crop type; output level), resource use efficiency (land, inputs), emissions. How do the answers depend on the scale of averaging, and at what scale (size of regions) should we aim for an ‘extensive’ agriculture. Such analyses must be executed for extensification per unit food output, and per unit land area.

**End of pipe solutions**
Most agricultural measures included in Action Programs apply to reasonably accepted farm measures like closed periods for manure and fertilizers, cover crops, etc. In none of the action programs end-of-pipe solutions in the water system like constructed wetlands are included. In Denmark natural wetlands contribute to decreased nutrient contents in surface water, no constructed wetlands are used.

**Packages for integrated nutrient management**
We should strive to overall packages aiming at integrated nutrient management, that is, with a view on N as well as P, but addressing various emission routes and concerns simultaneously: nitrate leaching, greenhouse gases, ammonia loss, and phosphate loading (UK, Denmark). Further, approaches to mitigation of climate change and meeting ammonia emission ceilings are now seen too much as isolated problems. We need to know which of the pollutants determine the strictest constraints (NO\textsubscript{3}; NH\textsubscript{3}; N\textsubscript{2}O). This should enable policy makers to take balanced measures.

**Balance systems**
- Balance systems with maximum allowed surpluses seem to be more reasonable than limiting fertilization levels. However, in the Netherlands a balance system (MINAS) was used till 2006 but it was refused by the EC.
For acceptation all inputs and outputs have to be taken into account and calculated in a correct way (e.g. no default value for crop N offtake of 165 kg N/ha for all arable crops as was the case in the Dutch system). Furthermore, the system must agree with the main elements of the Nitrates Directive.

- Denmark sees potential problems with balance approach (soil fertility; N-fixation by legumes).
- Use N accounting (surplus) as basis for rewards, in addition to input limitation.

**Nmin autumn**
Inorganic soil N in autumn (Nmin), as an indicator for access N, keeps farmers sensitive and aware of their N practices (Germany). However, the large annual variations call for a way to normalize the results; in Baden Württemberg this is addressed by reference fields.

**Bonus/fines/payments**
- Farmers can be stimulated to increase nutrient efficiency by rewarding them for their efforts. Possible mechanisms for farmer compensation should be investigated. In some parts of Germany and Flanders, farmers are rewarded for low residual soil N in autumn. Payments vary from €300 to €500 per ha. Partly, costs could be recovered from trespassing farmers, but this seems no long term solution – what if all comply?

- In situations when N fertilization must be decreased below optimal levels farmers could be compensated for the yield loss by payments or by an insurance. The problem with that kind of systems is that it is difficult to determine which part of the yield reduction is due to decreased application standards and which part to other factors like unfavorable growing conditions. Moreover, it’s not the incentive of a farmer to get paid for yield loss. He wants to earn his money with a well developed crop.

- Another option can be tradable quota; these might be input quota, surplus quota, or leaching quota (latter suggestion from Denmark, given wide ranging nitrate reduction capacities in various parts of the country).

- In line with the presentation by PBL, we should assess not only economically optimal N rates from the farmers viewpoint, but also from public viewpoint, that is, taking into account the public cost of N use (emissions). Such costs are now external. The two can differ widely, as demonstrated in the PBL paper. Differences must be assessed.

**Water Framework Directive (WFD)**
For every watershed action plans have to be developed in order to meet the WFD goals. As the WFD has ecological targets this gives more flexibility to fill the program. Current plans in NL do focus on management of the water system rather than on agricultural measures. Country representatives wonder why the Netherlands treats WFD and Nitrates Directive separately.

In Germany, for example, joint ministeries propose measures, farmers choose and get compensation.

**Relationship groundwater-surface water**
- More insight is needed in groundwater-surface water (fresh/marine) relationships for N as well as P (Denmark, Germany, Flanders).

- With regard to this more attention should be paid to coastal issues (UK, Denmark, Germany), in relation to Water Framework Directive.

- In Denmark, there is little concern about meeting the 50 mg/l target for groundwater. All emphasis is on coastal water quality. There is a need for detailed, georeferenced inventories of nitrate reduction capacity in the subsoil and groundwater systems – the entire system between the root zone where leaching losses start, and the receiving marine systems. This is needed for a differentiated approach, imposing strict limits on N use where needed, but also allowing for relaxation of constraints in zones with higher reduction capacity. In other words, the translation of coastal water quality back into maps of permissible N surplus on the soil surface balance.

**Phosphorus**
More attention should be given to phosphate accumulation and losses (Flanders).
Effects of changes in land use
Germany remarks that we should pay attention to effects of land use change – as induced by increased demand for biofuels – on emissions from agriculture. This involves changes in crop species and cropping intensity, but also conversion of marginal/wasteland (poor; waterlogged) into production land. This also may affect organic matter dynamics and storage, both by changed practices and – possibly - by increased carbon offtake.

Knowledge transfer
In GE it is no longer clear who is responsible for knowledge transfer; as a result, there is a general lack of funding for knowledge transfer on sustainable practices. There are large contrasts between the various states within Germany. There is a general need for more intensive communication with farmers.

Reduce uncertainty farmers
One of the main issues is the uncertainty for farmers. There’s need to focus on technology development to reduce uncertainty (with regard to actual N input requirement). Better indicators for crop N status, soil N supply, and decision rules coupling this information into recommendations can help restrain farmers from applying N unnecessarily.

Monitoring farmer strategies
Farmer strategies should be monitored on a number of sample farms representing a cross section of the farming business (UK). Such annual survey should address the types of fertilizer products used, the timing, splitting etc. From the resulting data, distributions should be compiled, and these can be used for benchmarking by a much larger number of farmers, showing how they fit into the distribution.

Long term effects on overall N efficiency
There is a need to assess the long term effects of N rate on yield curves and overall N efficiency. This aspect remains unaddressed, so far, though a 30-yr study in Denmark was mentioned.

Standards for calculating N surpluses
For comparing N surpluses between countries and regions a standardized method is needed. Participants point at the OECD methodology, and the methods followed by the Task Force on Reactive Nitrogen (TFRN), all of which provide standards (all the same ?).
Countries deal differently with ammonia losses in calculating N surplus. In Germany, N surplus is inclusive of losses from stables and stored manures (gross N soil balance). The use of ‘ab store balance’ in Denmark is after subtraction of losses from stable and storage from the gross N soil balance). In the net soil N balance (for some purposes in the Netherlands) ammonia losses from field application of manure have been subtracted, too.

2.  N fertiliser Recommendations

- Generally, there’s a need for an indicator for estimating soil N supply. Now this is often done indirectly by fixed values based on soil, manure history and crop rotation (e.g. N-index in Flanders, UK, Denmark). Reliable soil tests to measure soil N supply are however scarce. In Denmark, apart from N-total content, there’s not much confidence in chemical soil tests to assess soil N supply. In Germany (Baden-Württemberg) reference cases are used differing in soil type, previous crops, etc. For these reference cases recommendations are published. This is only done for arable crops as N dynamics in vegetable crop systems are too complex to account for.
- More study of N mineralization patterns (over time) and the dynamics of the mineral N pool in the soil. It is also important to assess hotspots for N mineralization (Flanders).
- Most recommendation systems do account for yield level of the crop. However, in UK for cereals there is no clear scientific evidence that optimal N rates depend on yield level. They recommend farmers to check protein contents afterwards. In case they are too low N rates should be adjusted.
- What is the science behind recommendations? Wide gaps are observed between recommendations in different countries, even though climates and soils seem similar. What causes these? To what extent are cultural
aspects involved? It was proposed that we compare – based on shared datasets submitted to the various countries – both the way recommendations are constructed, and the resulting numerical outcomes.

- Recommendations should be regularly be updated due to improved cultivars.
- Should we assess recommendations at rotation level?
- Is there a correction for translating results of field trials to practical field situations (in the latter case yield levels are often lower than in field trials)? In the Netherlands this is not the case, recommendations are directly based on results of field trials.
- The protein value of the harvested product should be included in assessing optimal N rates (Denmark). For example too low protein contents in forage products will increase the need for compensation via N-rich concentrates.
- The situation of assessing/updating recommendations differs between countries. In Germany every state has its own recommendations what makes it difficult to compare methodologies. In the UK updating is restricted mainly to cereals and oil seed rape. Funding is coming from the industry. In Flanders work on recommendations is focused on vegetables. In Denmark recommendations are updated yearly, the sector is paying for it. In the Netherlands there are specific committees for assessing recommendations paid by the sector. However, the willingness to pay for it differs between sectors.
Appendix IV.

Key points abstracted from papers presented at the workshop

Denmark

Presented by Leif Knudsen

The whole agricultural territory is subject to the Action Programme and so effectively treated as NVZ. All GAP measures are implemented in the Action Program via compulsory prescriptions. First restrictions were imposed in 1985 (maximum animal number per ha) followed by N quota in 1992 (at the moment 15% below recommendations), increasing demands for catch crops and increased utilization of manures (NFV) in 2003. Now in 2009, debates about further constraints and demands, called ‘Green Growth’.

Main compulsory elements of current legislation:

- Limit on animal number per ha (most important of all restrictions)
- Closed periods for application of manure
- Low emission techniques for manure application (from 2011 direct injection on grass and bare soil; trailing hoses permitted in cereals).
- Prescribed storage capacity (9 months)
- N application standards (quota)
  - Depending on soil and crop (corrected for N delivery from catch crops and previous –crops)
  - Account for NFV in manures
- Demands on catch crops
- Fertilizer plans and accounts
  - Submission of N quota calculation before April 21st
  - Account of previous year to be submitted before April 1st
  - No journal of fertilizing activities required
  - All submission (Quota; account) electronic
  - Fertilizer companies register electronically to whom they sell

For derogation farms there are specific requirements: soil sampling every 3 yrs; grassland destruction only allowed in a short period in the spring, no application of animal manures before grassland destruction.

N-excretion is calculated by detailed standards (depending on animal and stable type; feeding strategy) but the use of farm-specific excretion values is possible (to be proven by farmer).

The loss of farm income due to legislation is estimated at 19 M€ for the whole country.

No manure is exported from Denmark.

Between 1990 and 2009 leaching losses from the root zone reduced from 107 to 63 kg N/ha. This was mainly attributed to increased utilization of manures. Further fertilization measures are not expected to have marked effects on leaching. For example if no manure should be used anymore, leaching will be reduced by only 10%. What remains is ‘effect of cultivation’.

‘Green Growth’ aims to reduce total leaching to the marine environment by another 33%. This implies a reduction in leaching (average) from 60 down to 40 kg N/ha. No discussion on groundwater; marine system is the target.
Elements of the 'Green Growth' plan considered:
- More catch crops (+190,000 ha) via increased demands (fraction of area in catch crops; sowing and destruction dates)
- No tillage in autumn before spring crops
- Specific regulation in vulnerable areas
- No grassland destruction in autumn
- Tradable N quota.
- More wetlands

Flanders

Presented by Georges Hofman

GAP is described in five booklets on specific items / crops. However, most GAP measures are implemented in the Manure Decree 2006 (implemented from 1.1.2007) and are compulsory as the whole agricultural territory is designated as NVZ.

Main compulsory elements of current legislation:
- Application limits for N and P
  - Limits for total N (5 different crop groups, distinction between N from manure, mineral fertilizers and other organic fertilizers, total N instead of effective N)
  - Limits for phosphate range from 80-100 kg P₂O₅/ha depending on crop group
  - Maximum limit of 20 kg P₂O₅/ha for mineral fertilizers
- Closed periods for manure application
- Manure storage capacity: min 3 months (farmyard manure), up to 9 months (slurry, no grazing)
- Manures application is only allowed with low emission techniques (bare land: injection or incorporation within 2 hours)

Flanders is the first region with derogation on a field level. Important criteria were a long growing season, high precipitation and high N uptake capacity. In 2008 derogation is granted on 12% of potential farms (15% of potential land area).

Animal excretion is assessed by fixed values or by a nutrient balance system (remark: values differ much between countries)

Manure processing is still important to control manure application. The excess of manure is burnt.

Control is done by measurement of residual soil mineral N in the autumn ('nitrate stick'):
- Maximum allowed level 90 kg N/ha (0-90 cm)
- Fines have to be paid above a certain limit but are only applicable in risk areas
- About 5% of area is sampled.

There’s still much discussion about the system due to methodology and used threshold levels. In certain vulnerable areas agreements are made with farmers in order to decrease N losses. These agreements contain measures additional to the Manure Decree (decreased N application levels, more intensive Nmin sampling) and farmers are financially compensated (maximum compensations €685 and €450 for grassland and other crops respectively.

Trends in water quality:
- For nitrate in surface water a clear decreasing trend was observed (% above 50 mg/l at least once: 59 in 2000, 27 in 2009). For ground water no clear trend was observed.
- For soil mineral N in autumn there was some decrease in the period 2004-2008 (median decreased form about 80 to 60 kg N/ha).

In Flanders two systems for N recommendations are used: N-balance, and N-index (correction factors for various conditions). In the balance method, 'latent residual Nmin' is included. Farmers go 10-20% beyond recommendations.
Germany

Presented by Kerstin Panten & Frauke Godlinski

The national (federal) legislation includes the Fertilizer Ordinance (Dünger Verordnung; for nutrients) and the Federal Soil Conservation Act. The Fertilizer Ordinance acts as Action Program that applies for the whole German territory.

Main elements in fertilizer Ordinance
- Fertilizer planning
- Closed periods for manure and mineral fertilizers
- Immediate incorporation of manure on bare soils
- Application of N and P is not allowed within 3 m distance from surface waters
- A nutrient balance needs to be demonstrated on demand (by federal state.)
  - The three year average needs to be below the threshold level, decreasing each year.

Evaluation of the Action Program
Every four year a Nitrates report is made evaluating the implementation and impact of the action programme. Although there’s a strong variation, all states report improvements in farm management with regard to the prevention of water pollution. This is not only due to the Fertiliser Ordinance, but also to changing general agri-policy framework resulting from the reform of the Common Agricultural Policy including support for water-related agri-environmental measures.

Compliance with Fertiliser Ordinance is monitored. Most violations are related to the use of organic manures.

Soil Conservation Act
- The Soil Conservation Act gives the rules of GAP’s with refer to the sustainable protection of soil fertility and the productivity of the soils as natural resource.
- Main principles are (a) soil tillage according to soil type and weather, (b) maintain or improve soil structure, (c) avoid soil compaction, (d) avoid soil erosion, (e) keep structures like hedges if necessary to protect soils, (f) maintain or improve biological soil activity and (g) maintain the site-related soil organic matter content by supply of organic substances.

Regional programs
There are regional programs, addressing specific measures. One of these projects is NAU (Lower Saxony, 2000-2008):
- Examples of measures to be applied are direct drilling, environmental friendly slurry application, flowering strips, assessing catch crops and undersown crops, extensive management of grassland, organic farming and fallow periods. Measures to be eligible for financial support differ between years
- Farmers are financially supported to enhance compliance.
- ~ 79 million € funding; 231,354 ha (9% of agricultural land, 2005).
- Only 27% of the areas with risk of nitrate leaching were covered.

Nutrient surpluses
The German sustainability strategy includes 21 indicators; only one relates to nutrient losses from agriculture: N surplus. The national N surplus map gives N surpluses per state. N surplus on a national level decreased from about 125 kg N/ha in 1991 to about 80 kg N/ha in 2007. In the same period P surplus decreased from 10 to 0 kg P/ha.

The gross soil balance is considered to be most appropriate when comparing nutrient balances between countries. Remarks:
- The used coefficients to calculate balances (e.g. N,P contents of products) differ widely between countries.
- Regional balances (within Germany) difficult to assess as many data are missing on smaller scale level.
- Are there better indicators?
Germany - Baden-Württemberg – SchALVO

Presented by Karin Rather

In Baden-Württemberg (BW) legislation additional to the national Action Program (DüV) has been developed and implemented:

- Schalvo: Water protection areas in BW (=26% of total BW area, including non-agricultural area), compulsory
- MEKA: agri-environmental scheme, whole territory BW, voluntary.

**Schalvo (Schutzgebied und Ausgleichsverordnung)**

Schalvo was introduced in 1988 and aims at protecting the groundwater against contamination with microbes, pesticides and nitrate. Main elements:

- Three types of areas are distinguished depending on nitrate content of the groundwater (normal, problem en remediation areas).
- Restrictions are beyond GAP, measures depend on nitrate status and crop species
- Farmers are financially compensated, the payments depend on restrictions

**Basic rules**

In all areas (normal, problem, remediation) there is the same set of basic rules (do’s and don’ts), which are graded (I, II, III) according to distance from springs.

I

- Only grassland, no grazing

II

- Ban on application of liquid manure
- Limited application of solid manure
- Limited use of pasture land
- No pen

III

- Compliance with codes of good agricultural practice (Düngeverordnung)
- Avoid entry of nitrate
- No ploughing up of permanent grassland
- No application of fungicides terbuthylazin or tolyfluanid

**Additional measures**

Problem areas (II-III)

- Rules for use of mineral N fertilizers
- Rules for application of animal manure
- Periods for growing and ploughing catch/cover crops
- Soil treatment
- Irrigation
- Adjust crop rotation

Remediation areas (II-III):

- Remediation plan specific for the area
- If necessary contracts e.g. crop rotation: cultivation of lambs lettuce outside of the S-area

All measures are differentiated to soil types (A or B : differing in leaching risks).
Constraints include different closed periods, times and amounts of application per manure type, amounts of N fertilizer depending on fertilizer type (e.g. slow release), compulsory in-season Nmin sampling before split applications (remediation areas), periods between split applications, post-harvest measures.

Post harvest measures are prescribed in great detail, e.g., for catch crops (CC) last sowing date (depending on cvar), seeding technique, seeding density, growth rate, N uptake capacity. Ploughing and CC destruction time window depends on altitude and soil type (A/B), and differ between problem and remediation areas.

Record keeping/documentation of all fertilizing actions is compulsory in problem and remediation areas.

With refer to Schalvo implementation there are special advisors for water protection areas, at rural district offices. They give advice, organize soil sampling, and assess supplement payments to farmers compensating for extra work and constraints.

In the autumn Nmin sampling is done on problem and remediation areas. Threshold levels depend on soil type and sampling depth.

The farmers are compensated for the imposed restrictions if threshold levels for Nmin in autumn are not exceeded. They can choose for a flat rate compensation of €165/ha or a special site-related compensation (payments ranging from €100 to €1200). In the latter case they have to provide proof.

Nitrate concentration in groundwater in 1994-2008:
- In water protection areas (Schalvo&MEKA): 27.6 – 23.2 mg/l
- Outside water protection areas (MEKA): 28.6 – 23.7 mg/l

Costs in 2004: €29 M€ (payments: 22 M€ + monitoring/consultancy costs 7 M€). Funding is coming from consumers (€0.05 contribution per m³ water).

MEKA (Marktentlastungs- und Kulturlandschaftsausgleich)

MEKA was introduced in 1992 and aims at care and conservation of agricultural landscape and environmental friendly and extensive land use. It is supported by EU. Participating is voluntary and possible for 5yr periods. It consists of a modular system with points for certain actions (manure application techniques, cover crops, zero tillage, use of pesticides, fertilizers, etc.). Payments to farmers depend on number of points.

Funding in 2004: 75 M€

**United Kingdom, legislation**

Presented by Peter Dampney

Various UK countries have different fractions designated as NVZ (England: 68%; Wales: 4%; Scotland: 14%; Northern Ireland: 100%). The UK average is 43%. Designated is all land (whole catchment upstream) draining into polluted water. Monitoring covers 7000 surface water sites and nearly 3000 groundwater sites (monthly nitrate measurement).

Main rules:
- The livestock manure N farm limit
- Storage of organic manure
- Planning nitrogen use
- Maximum crop N requirement limits (Nmax, effective N)
- Field application of organic manures
- Field application of manufactured nitrogen fertiliser
- Records (risk maps)
The livestock manure N farm limit

- Standard 170 kg N/ha.
- Excretion based on standard values (based on age, weight, milk yield). For pig and poultry farms excretion may also be based on specific farm feeding and manure storage or analysis of manure, and manure production (only farms with 100% solid manures).
- Land area is excluding woodland, hard surfaces, surface water, etc.
- Derogation UK is approved in 2009 and in force in 2010 (Northern Ireland since 2007):
  - 250 kg N (only grazing animals, pigs/poultry max 170 kg N/ha).
  - 250 limit valid for annual application for a calendar year and for each separate field (no dumping). Manure deposited during grazing is excluded.
  - Derogation applies to farms with at least 80% grass.
  - Planning of P fertilization (in addition to N) is compulsory.
  - Derogation area excludes 10m and 50 m buffers along surface water.

Manure storage

- Storage capacity: 6 months pig/poultry (1 oct-1 april); 5 months all other slurry (1 oct-1 march)
- Temporary solid manure heaps on fields are allowed if:
  - they are marked on the farm risk map
  - they are not within prescribed distances from sensitive elements (springs, surface water).
  - not located on land likely to become waterlogged or flooded
  - the duration of storage is no longer than 12 months and not returns to the same site for 2 years

Planning nitrogen use

- The crop N requirement must be assessed by taking into account soil N supply and effective N from manures.
- Farmers have to keep records to show compliance with planning requirements.

Crop N requirement limits (Nmax)

- There are max limits for N rate for major crops (cereals, winter oil seed rap, sugar beet, potato, forage maize, grass; 94% of area). For other crops there are no Nmax values.
- Nmax is expressed as effective N, using fixed NFV values for manure (values are rather low compared to Denmark and Netherlands).
- Nmax in cereals and oilseed rape refers to standard yields. Supplements for higher yields are allowed (2 yrs written evidence is required).
  - 20 kg N/ha extra per ton extra yield (cereals)
  - 30 kg N/ha per half ton extra yield (oilseed rape),
- For cereals supplements are also allowed for milling quality (+ 40 kg N/ha) and on shallow soils (except over sand stone, + 20 kg N/ha)
- On grass 40 kg/ha extra is allowed if cut at least 3 times per season.

Field application of organic manures

- Closed periods for manures with high available N (>30% of total N)
  - Grassland shallow/sandy: 1 Sep-31 Dec (4 mo), other soils: 15 Oct-15 Jan. (3 mo)
  - Arable: shallow/sandy: 1 Aug – 31 Dec (5 mo); other soils: 1 Oct-15 Jan (3.5 mo)
- Closed periods for mineral fertilizers
  - Grassland 15 Sept – 15 Jan
  - Arable 1 Sept- 15 Jan
- Exemptions for specific crops are possible (under conditions). They have to be accompanied with a written advice of a FACTS advisor.
Records

Farms must have risk map giving the locations of sensitive elements (like wells, surface water, sloping land) and indicating the areas where application of manure and fertilizers is not allowed or allowed under certain conditions.

United Kingdom, Good Agricultural Practice

Presented by Brian Chambers

GAP applies to all agricultural land, this is about 50% of national area. Agricultural land consists of 70% grassland, 17% cereals and 13% other crops.

Current situation with refer to nutrient emissions:
- The nitrate problem varies largely between England, Scotland and Wales (highest leaching in England). The highest nitrate concentrations in surface waters are found in East England (low rainfall, arable cropping). Nitrate concentrations in groundwater (most aquifers are deep) are relatively low (compared to NL) and are stable or decreasing.
- P loading of surface water mostly occurs in densely populated areas. The contribution from agriculture is largely decreased by closed periods for manures.
- The contribution of agriculture to total ammonia and nitrous oxide emissions is 85 and 73% respectively.
- Pipe drainage in cracked clay soils makes it difficult to prevent leaching in large areas. Sandy areas are fairly limited.

The government aims at integrated policy development: best balance for reduction of emissions of nitrate, ammonia, phosphorus and nitrous oxide.

Different actions to stimulate farmers:
- Agri-environmental schemes
- Promoting Decision Support Systems (e.g. PLANET)
- Practical courses for farmers on integrated nutrient management
- FACTS advisors: Fertilizer Advisors Certification and Training scheme (certified advisors on nutrient management)

UK has a formal Code of GAP containing measures for:
- Soil fertility and plant nutrient management
- Management plans (soil, manures, nutrients)
- Farm buildings and structures
- Field work
- Wastes
- Water supplies

GAP is voluntary in non-NVZ but includes compulsory measures for NVZ.

Soil management is based on Good Agricultural and Environmental Condition (GAEC) aiming at maintaining soil organic matter, reducing the chances of erosion and reduction of soil structure damage (for more information see booklet ‘Cross compliance guidance for soil management’).

Different booklets and digital tools are available to support farmers:
- Booklets outlining manure application techniques (trailing hose, trailing shoe; injection) on arable as well as grassland.
- Fertilizer Recommendations booklet (RB209, Nutrient management Advice’ DEFRA)
- MANNER. Software for manure management
• PLANET. Software for farm nutrient planning on (includes RB209 and MANNER). PLANET is mostly used by advisors and less by farmers. Main drivers for use are check on compliance with NVZ-regulations, nutrient management planning and farm profitability.

In the UK a large resistance exists against spring application of manures on clay soils. Trailing hoses are allowed and give less compaction problems than injection. Broadcasting slurry is allowed, but incorporation must be done within 24 hrs.

The large pig and poultry units have to account for IPPC (Integrated pollution prevention and control Directive). IPPC requires adoption of best available techniques with refer to storage, handling and application of manures.

Since 1985 mineral fertilizer use has decreased with 27% (N) and 43% (P). Average use at the moment: 105 kg N and 10 kg P/ha (all cultivated land including grass).

Main challenges for future are increased manure efficiency (spring application and improved application techniques) and integrated policy development.

**Netherlands**

Presented by Frank Wijnands

Main elements of Action Program for NVZ (100% of agricultural territory):
- Crop and soil dependent application standard (effective N, fixed NFC values for manure)
- Closed periods for manure and mineral fertilizers
- Low emission techniques for manure application
- Catch crops after maize

In NL no formal code of GAP exists. Mandatory measures are included in the Action Program. However, guidelines for integrated nutrient management (INM) have been developed aiming at maintaining soil fertility, supporting optimal crop production and minimizing impact on environment.

Main elements of INM strategy: strategic (P and K planning, rotation; green manures, crop residue management), tactical (N planning over fields and crops, amount, form, application technique), operational (finetuning N, field and year-specific; N splitting and timing based on crop and soil status).

The process of knowledge development and dissemination consists of basic and applied research (including farm system research) on experimental farms and, consequently, testing and improving on commercial pilot farms.

Farm system research approach:
- In 80-90s comparing conventional with integrated and organic farming characterized by multiple potentially conflicting objectives.
- A substantial reduction of nutrient surpluses on experimental farms was observed. On sandy soils emissions were still too high — > from 2003 onwards focus on sandy soils: project Nutrients Waterproof. Search directions: low organic inputs, removal of crop residues, integral use of Decision Support Systems, constructed wetlands.

Commercial Pilot farm networks approach:
- Building up a network by involving all stakeholders in process
- Using new relevant knowledge / techniques and combining this with innovative power of farmers and stakeholders
- Testing new techniques
- Disseminating knew knowledge in stake holder network
Room for further improvement of nutrient management

- Keys for improvement are adjusting N supply to crop demand and reducing N availability outside the growing season.
- Managing options are optimizing crop rotation and organic matter management (green manures, crop residues and type of organic manures including manure processing products) and application of DDS systems (operational planning).
- Promising developments are DSS technology improvement, precision farming (GPS, row application) and new manure products.

Success factors for implementation

- For a successful application of new methods in practice the farmer must be acquainted with it and be able (in economical and technical terms) to implement it on his farm. He also must have the will and be allowed to do so (social behaviour).
- This can be realized by road testing and improving new technology on commercial farms in a farm network. It is important to involve all relevant stakeholders in this network.
- Major incentives for farmers to change are economically (increased farm income), ethical and legal (rules and legislations).
Appendix V.

Preparations for workshop ‘How to reduce nutrient losses from agriculture’.

Instruction for speakers

The international workshop will bring together a small group of agricultural and environmental scientists from Belgium, Germany, France, Denmark, United Kingdom and the Netherlands. This group prepared, in 2008, a joint benchmark report comparing legislation and recommendations on the use of nitrogen in agriculture, in the respective countries. This workshop aims to take us a step further.

Goals of the workshop

In an earlier mailing we informed you about the specific goals of this workshop. These remain central to our meeting:

Part I. Policy instruments promoting Good Agricultural Practice: broad perspective
- To assess what policy measures proved effective in the respective countries, for reducing N and P use, nitrate leaching, gaseous losses, phosphate accumulation, and to enhance proper soil management
- To compare Codes of Good Agricultural Practice (GAP) and their contribution to enhancing nutrient use efficiency and soil quality, thus minimizing accumulation in soils and losses to the environment while maintaining productivity. What elements are compulsory / voluntary? What mechanisms exist to enforce or stimulate? Are these successful?
- To identify key success factors in nutrient reduction policies. What can governments do? How to engage the farming community? Role of bonuses and penalties? Demonstration-pilots; administrative structure; knowledge infrastructure; other?

Part II. Nitrogen legislation, Nitrogen recommendation systems, joint initiatives
- To identify contrasts (between countries) in N-fertilizer recommendations and N application standards for major crops – including statutory fertilizer value of manures - and to discuss their scientific justification
- To prepare collaboration between scientists from EU member states, in the fields of defining GAP, N recommendations and N legislation, in order to support future national Action Programs responding to the Nitrates Directive.
- To identify issues for joint scientific publication, and discuss form of publication.

If you think we ought to address other points, kindly let us know by email, latest by November 9th.

For Part I of the workshop, may we request you to prepare a 25-minutes oral presentation. Please give a concise overview of the main components of Good Agricultural Practice, with reference to management of soils and nutrients for enhanced nutrient use efficiency and - if possible- also for enhanced general soil quality. The first is to minimize nutrient accumulation and emissions, the latter to enable soils to adequately accomplish functions other than agricultural production (e.g. water storage, regulation of greenhouse gases, carbon storage).

We ask you to reflect on mechanisms that work, or don't work, to induce desired behavior by farmers and achieve desired environmental quality.
Issues you may wish to address

To assist you in preparing your presentation, we suggest below a list of issues you may wish to address. By no means is the list meant to be exhaustive, so don't feel limited.

Nor do we expect you to address all these points. Instead, please focus on those issues relevant to your country’s case.

Codes of Good Agricultural Practice

The Nitrates Directive (ND) prescribes that EU member states have to define Codes Of Good Agricultural Practice (GAP) for the whole territory and that member states have to designate Nitrate Vulnerable Zones (NVZ) and develop Actions Programs with respect to NVZs in order to realize the ND objectives.

- How is Good Agricultural Practice defined in your country?
- Is there a Code of GAP? What is its status? To whom is it addressed?
- What are its main elements? If desired you may use the checklist below.
- Does GAP contain specific additional requirements for farms with a derogation?
- Do you consider GAP – as a whole - as an effective instrument to reduce nutrient emissions and sustain soil quality?
- Which elements of GAP are compulsory, and which are voluntary?
- Which elements of GAP are successful (adopted) and which are less so?
- Which elements of GAP are effective (in reducing nutrient emissions) and which are less so?
- Does GAP prescribe particular practices to sustain/enhance soil quality?
- What are the principal causes for success or failure of adoption of GAP?
- What mechanisms are used to stimulate or enforce (elements of) GAP?
- What mechanisms are used – if any – to prevent pollution swapping?
- Please provide references to written GAP codes, if available for your country

Other measures

What policy measures have proven to be effective in your country for:

- reducing the use of N and P on farms
- reducing leaching losses (if measures other than input limitation)
- reducing soil P accumulation
- reducing ammonia losses
- stimulating proper soil management with regard to enhanced nutrient use efficiency and general soil quality

How effective have policy measures been to reduce nitrogen and phosphorus use, and nitrate leaching?

- If possible, please provide trends in N and P use (or N, P surpluses); and in groundwater nitrate or surface water N concentrations;
- How large (if any) is the gap between current water quality and Nitrates Directive goals?

What are the key success factors for effective policy measures?

- What is the role of bonus and penalties?
- What is the role of knowledge transfer to farmers (demonstration pilots, courses, etc)?
- What is the role of the administrative structures (national and regional government, farmer organizations; other ??)
- Which other factors were crucial to the successful implementation of policy measures on the farm ?
Checklist elements of GAP – use only insofar as relevant to your case !!!

Assessing crop nitrogen and phosphorus demand: compulsory/voluntary?
- Fertilizer planning (fertilizer recommendations)
- Assessing soil nutrient status (soil sampling)
- Other………..

Manure application
- Closed periods
  - Do they depend on soil, crop and manure type?
    (e.g., animal manures, animal type, liquid versus solid, plant composites, other factors)
- Prescribed application methods (techniques to reduce ammonia volatilization)
  - Do they depend on soil and crop type, manures type?
- Fertiliser equivalency of manures: how is it accounted for?
- If late summer or autumn application is allowed, are there rules for combination with a green manure crop?
- Is spring application common use? If not, which factors are impeding it?
- Restrictions with refer to application on snow covered and frozen land
- Is assessing nutrient content of manures common in practice?
- Are specific weather conditions taken into account (e.g. manure application in relation to rain showers)?

Mineral fertilizers
- Closed periods
  - Do they depend on soil, crop and fertilizer type, other factors?
- Split-application of nitrogen (fixed rates system or crop-/soil-indicator-based splits)
  - Is splitting N rates common use in practice?
  - Which factors impede its implementation in practice?
- Placement of N and P fertilizers (row application)
  - Is this common use in practice?
  - Which factors impede implementation in practice?
- Restrictions on application on snow covered /frozen land?
- Restrictions in crops (for example vegetables) with late-autumn or winter nutrient demands?

Post-harvest measures
- Growing catch/cover crops
  - How is current use in practice?
  - Which factors impede implementation in practice?
  - Is winter cover compulsory?
  - After which crops / in which cases are catch crops compulsory?
  - Are there any obligations to assure effective functioning of cover crops? (early establishment; destruction period; how to account for N from cover crops in new season fertilizer planning?
- Crop residue management
  - Are there closed periods for ploughing grassland swards?
    If so, do they depend on soil type?
  - Which crops are allowed (restrictions) after ploughing grassland swards?

Crop rotation
- Alternation of shallow and deep rooting crops
**Specific measures along surface water**

- Unfertilized zones: are they compulsory, how wide?
- Unfertilized buffer strips: are they compulsory, how wide?
- Constructed wetlands, are they applied on farms?

**Soil management**

- Are farmers worried about maintenance of soil organic matter? In which conditions/cases?
- Measures that improve soil quality and, subsequently, growing conditions and nutrient utilization for crops
- Measures to conserve or improve the multiple functions that soils have (water storage; regulation of greenhouse gases / carbon storage; other ‘ecosystem services’)

**Hydrology**

- Does GAP contain measures for drainage (e.g. controlled deep pipe drainage) and ground water table level?
Appendix VI.

Workshop Programme

Hotel and Venue:
Hotel rooms and venue are at the same address:
Grand Hotel Karel V, Geertebolwerk 1, 3511 XA Utrecht, the Netherlands
T:+31.30.2337555; F: +31.30.2337500; W: www.karelv.nl; e : info@karelv.nl

Programme

*Wednesday 18 November* (evening): arrivals in Grand Hotel Karel V.

*Thursday 19 November – Chair: Jacques Neeteson (Agrosystems Research, Plant Research International, Wageningen-UR)*

**Part I. Policy instruments promoting Good Agricultural Practice: broad perspective**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>09.00 – 09.15</td>
<td>Welcome, introduction, goals workshop</td>
<td><em>Jacques Neeteson</em></td>
</tr>
<tr>
<td>09.15 – 10.00</td>
<td>Keynote: Benefits and costs of nitrogen fertilizer for farmers and society</td>
<td><em>Hans van Grinsven, Neth. Env. Assessment Agency (PBL)</em></td>
</tr>
<tr>
<td>10.00 – 10.35</td>
<td>Policy instruments and GAP in Denmark</td>
<td><em>Leif Knudsen</em></td>
</tr>
<tr>
<td>10.35 -10.55</td>
<td>Coffee / tea</td>
<td></td>
</tr>
<tr>
<td>10.55 – 11.30</td>
<td>Policy instruments and GAP in Flanders</td>
<td><em>Georges Hofman</em></td>
</tr>
<tr>
<td>11.30 – 12.05</td>
<td>Policy instruments and GAP in the Netherlands</td>
<td><em>Frank Wijnands</em></td>
</tr>
<tr>
<td>12.05 – 13.15</td>
<td>lunch</td>
<td></td>
</tr>
<tr>
<td>13.15 – 13.50</td>
<td>Policy instruments and GAP in Germany</td>
<td><em>Kerstin Panten / Frauke Godlinski</em></td>
</tr>
<tr>
<td>13.50 – 14.25</td>
<td>The SchALVO experience (Baden-Württemberg, GE)</td>
<td><em>Karin Rather</em></td>
</tr>
<tr>
<td>14.25 – 15.00</td>
<td>Policy instruments and GAP in the United Kingdom</td>
<td><em>Brian Chambers</em></td>
</tr>
<tr>
<td>15.00 – 15.30</td>
<td>Coffee / tea</td>
<td></td>
</tr>
<tr>
<td>15.30 – 17.00</td>
<td>Discussion to identify and characterize policies that proved effective to reduce nutrient inputs and emissions.</td>
<td></td>
</tr>
<tr>
<td>17.00 – 18.30</td>
<td>Relax, walk old town Utrecht</td>
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</tr>
<tr>
<td>18.30 – 20.30</td>
<td>Dinner at Hotel Karel V</td>
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<tr>
<td>20.30</td>
<td>Resume programme</td>
<td></td>
</tr>
</tbody>
</table>
Part II. Nitrogen legislation, Nitrogen recommendation systems, joint initiatives

20.30 – 21.00  Legislation on N use in the UK  
(was not covered in benchmark report)  
Peter Dampney

21.00 – 22.30  Nitrogen legislation. Discuss issues from Benchmark Report  
(based on prior inventory of points raised by participants).  
Introduced by  
Hein ten Berge

22.30 +++  Relax over drinks

Friday 20 November - Chair: Jacques Neeteson

06.30 – 8.15  Breakfast

Part II continued

8.30 – 10.30  Nitrogen recommendation systems. Discuss issues from  
Benchmark Report (based on prior inventory of points raised  
by participants). Introduced by  
Wim van Dijk

10.30 – 11.00  Coffee / tea

On further collaboration:

11.00 – 11.25  The OLAT platform in Heidelberg  
Karin Rather

11.25 – 11.55  Identify issues and approach for joint scientific paper

11.55 – 12.30  Discuss further forms of collaboration: COST, other.

12.30 – 14.00  Lunch and farewell.

14.00  End of meeting.
## Appendix VII.
### List of Workshop Participants

<table>
<thead>
<tr>
<th>Country</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Denmark</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leif Knudsen, Danish Advisory Service, Aarhus</td>
</tr>
<tr>
<td></td>
<td>Susi Engholm, Danish Advisory Service, Aarhus</td>
</tr>
<tr>
<td></td>
<td>Finn Piliaard Vinther, Aarhus University</td>
</tr>
<tr>
<td><strong>Flanders</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Georges Hofman, Ghent University</td>
</tr>
<tr>
<td><strong>Germany</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Kerstin Panten, Julius Kühn-Institute, Braunschweig</td>
</tr>
<tr>
<td></td>
<td>Frauke Godlinski, Julius Kühn-Institute, Braunschweig</td>
</tr>
<tr>
<td></td>
<td>Karin Rather, State Horticultural College and Research Institute, Heidelberg</td>
</tr>
<tr>
<td><strong>United Kingdom</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brian Chambers, Agricultural Development and Advisory Service, Mansfield</td>
</tr>
<tr>
<td></td>
<td>Peter Dampney, Agricultural Development and Advisory Service, Cambridge</td>
</tr>
<tr>
<td><strong>The Netherlands</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hans van Grinsven, Netherlands Environmental Assessment Agency (PBL)</td>
</tr>
<tr>
<td></td>
<td>Frank Wijnands, Applied Plant Sciences, Wageningen UR</td>
</tr>
<tr>
<td></td>
<td>Harm Brinks, DLV-Plant, Wageningen</td>
</tr>
<tr>
<td></td>
<td>Jaap Schröder, Plant Research International, Wageningen UR</td>
</tr>
<tr>
<td></td>
<td>Oene Oenema, Commissie Deskundigen Meststoffenwet (CDM); and Wageningen UR</td>
</tr>
<tr>
<td></td>
<td>Sandra Boekhold, Technische Commissie Bodem (TCB, secretary)</td>
</tr>
<tr>
<td></td>
<td>Jacques Neeteson, Technische Commissie Bodem (TCB); and Wageningen UR</td>
</tr>
<tr>
<td></td>
<td>Hein ten Berge, Plant Research International, Wageningen UR</td>
</tr>
<tr>
<td></td>
<td>Wim van Dijk, Applied Plant Sciences, Wageningen UR</td>
</tr>
<tr>
<td></td>
<td>Ben Rutgers, Plant Research International, Wageningen UR</td>
</tr>
</tbody>
</table>
Appendix VIII. Presentations

Presentation by Jacques Neeteson
Presentation by Hans van Grinsven

Big picture
- N-fertilizer feeds half of the world population
  - N-fertilizer increased EU wheat production 75%; equiv to 64 million ton; 8 billion euro; 280 euro/ha
- Fertilizer a key factor to feed growing and wealthier population, and to save land, biodiversity and climate
  - Improve agricultural production in developing countries
  - Increase productivity (N-efficiencies) in old world
- Nitrogen is key driver or factor for almost all environmental problems
  - EU27 75% N from agriculture, = 50% Environmental cost

Remaining problem areas in 2020:
(Airborne N: excluding Neros+runoff & aquatic ecosystems)

Indication of N-share in 2020
- 20% Health + PM
- 70% Health + vegetation + ozone
- 100% Forest - acid dep.
- 40% Semi-natural - acid dep.
- 40% Freshwater - acid dep.

Nitrogen in EU agricultural practice confusing
- Economic cost of 30% cut on N-application standards for Dutch arable agriculture is very moderate (4 million euro/yr)
- There is no clear effect of total N-input in Dutch dairy (180-310 kg/ha) on the net profit per L of milk
- Sugar beet: N-rate > N-recom > ECNR
  - 2008: 145 > 116 > 100 kg/ha (data sugar industry)
- N-recom for potato in NL-DK-FL-GE-FR inconsistent
  - range N-recom: 120-250 kg/ha, N-yields: 40-46 t/ha
- Appears to be scope for improvement!

Broad context for change of N-practices

What is the optimum N-rate for society?
- Compromise between food security, quality & price, farm income, environment
  - Assessment requires information
    - Yield response to N-rate
    - Prices of crops and fertilizer
    - Response of emission to N-rate
    - Societal cost of environmental impacts (externalities)
    - Transaction and handling costs
Framework for cost assessment

- Total cost
  - Financial & economic approach

- Cost and benefits
  - N-input (kg/ha)

- Not considered
  - Administrative costs
  - Income transfer
  - Side effects unrelated to N

Yield response curves

- Not easily generalized
  - Yield gap
  - Fitting function
  - Intercept
  - Other limiting factors
  - Trial setup

Prices of fertilizer and crops

- Fertilizer prices increase
- Crop prices volatile
- Pest 2006 food crisis
- Food prices correlated with N-prices
- Price ratio (€/€)
- Price ratio increasing
- Incentive for improving N-efficiency, but
- N-cost ~ 5% of total cost

Environmental impacts

- Human health
- Ecosystems
- Climate

- Nitrate-water
- Colon cancer
- Aquatic Eutrophication
- GHG-balance

- N2O-air
- Deposition ozone layer
- Acidification
- Carp cancers

- NOx-air
- Secondary Particulates
- Acute to chronic

Environmental emissions

- Emission factors:
  - case Wheat Germany (% relative to total N-input)

<table>
<thead>
<tr>
<th>Emission factor</th>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2NCONH2 (kg)</td>
<td>18</td>
<td>4</td>
</tr>
<tr>
<td>N2H4 (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NOx (kg)</td>
<td>0.5</td>
<td>0.005</td>
</tr>
<tr>
<td>NH3 (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-air (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-oil (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-urea (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-gr. water (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-clean water (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-polluted water (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-flue gas (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-total (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-total (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
<tr>
<td>NH3-total (kg)</td>
<td>1</td>
<td>0.15</td>
</tr>
</tbody>
</table>

Assessment cost & benefits of nitrogen

- Wheat, OSR, milk
- Variety of yield response data EU
- Uncertainties: prices, EF and damage costs
- EONR vs SCONR
- Food security issues ignored

Example: Winter Wheat Germany

- Farm optimum (CONR)
- Optimal optimum (SOCNR)

Damages Unit N-costs for society

- Method: WTP for linear, "clean" water + dose response functions
- Considered uncertainties and conceptual differences
- Disaggregate on impacts of nitrate and ammonia on human health
- Large regional differences, factor 20-100 (atmospheric deposition)
Example: Winter Wheat Germany
50% mature; soil incorporation

- Mean weight kg/ha
- EONR
- SONR

Overview results Winter Wheat
- Differ. EONR-SONR = 60 kg/ha
- Uncertainty yield curve for EONR ± 30 kg/ha
- Uncertainty EF and UC for EONR ± 15 kg/ha
- EONR similar to lower limit of N-recommendations (IPPO reg 362)
- Similar results for OSR
- N removal wheat similar to OSR?

LCA to assess SONR Winter Wheat

Grass and milk yield response UK and NL
- Grass yields increase up to high N-rates
- Up to moderate levels of grain yield (10 ton/ha), grass (N-fertilizer) and concentrates are exchangeable feed stuffs and N-resources.

Example: Dairy UK and Netherlands
- SONR for UK very low; due to low N-efficiency
- EONR very high, due to continuing N-response at high N-rates

Overview preliminary results dairy (no concentrates)
- EONR values are higher than N-recommendations
- Cost of manure handling is ignored
Overview preliminary results dairy

General conclusions
- In NW EU arable agriculture there is still scope to increase N-efficiency without loss of farm income
  - Discouraging N-use beyond N-recommendation
  - Harmonizing and updating N-recommendation
  - Anticipating on increasing price ratios
- SONR could be a target for future agricultural EU N-policies to benefit society as a whole, but:
  - Farmers need to be financially compensated
  - Loss of agricultural production needs to be compensated

Discussion points
- Use of field trials to determine EONR and to underpin N-recommendation is too arbitrary
  - LT effect of changed N-rates on yield intercept
  - Length of trials not fit for LT N-recommendation
- Environmental cost data are still too uncertain to allow integrated cost-benefit assessment of N
  - Health and ecosystem impacts of nitrate and ammonia
  - N-costs less tangible / communicable than N-benefits

Preliminary quantitative conclusions
- Arable: N-rates > N-recem > EONR
- Dairy: EONR > N-recem = SONR
- Arable: SONR-EONR = 60 kg/ha
- Dairy: SONR-EONR = 203 kg/ha

Effect expected increase price ratio (coming = 5 yr):
- Wheat 0 kg/ha, O3R -0 kg/ha, Mlk -0 kg/ha

Some options for improved N-regulation
- Integrated N-approach
  - Societal cost of agricultural N2O far less than of ammonia and N (N2O-leaching)
  - Strict Nlimits, more flexible implementation
  - Focus on N-efficiency
  - Criterion for cross compliance
  - Reward farmers who are “above-average N-efficient”
  - Deal with risk aversion
  - Subsidized assurance against yield loss for fore-runners
  - A EU-wide ban on surface spreading manure

Thank you
Presentation by Jacques Neeteson

How to Reduce Nutrient losses from Agriculture?

Main questions for this meeting
- Which mechanisms are effective to reduce nutrient input and emissions?
  - Direct reduction from uses of topsoil policy
- Which issues require further research?
  - To support policy (future action programs)
  - To support the farming community
- On what issues, if any, should we strive to uniformity (across EU)?
- How to organize exchange & collaboration, if desired?
Presentation by Leif Knudsen

Policy Instruments and GAP in Denmark

Chief advisor Leif Knudsen
Danish Advisory Service

<table>
<thead>
<tr>
<th>Year</th>
<th>Action plan</th>
<th>Main instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980</td>
<td>NPO</td>
<td>Max. livestock units per ha no direct cuts of manure</td>
</tr>
<tr>
<td>1987</td>
<td>Water envr. mental protection plan I</td>
<td>Obligated fertilizer plans, demands for storage capacity of slurry, wastewater fields</td>
</tr>
<tr>
<td>1992</td>
<td>Sustainable agriculture</td>
<td>Max quotas for nitrogen, minimum utilization of N in manure, restrictions on slurry application in autumn and winter</td>
</tr>
<tr>
<td>1993</td>
<td>Water envr. mental protection plan II</td>
<td>Reduced N-point to 10 percent under optimal rates, demands on catch-crops, establishment of “wetlands”</td>
</tr>
<tr>
<td>2003</td>
<td>Water environmental protection plan III</td>
<td>Extended demands for catch-crops, extended demands for utilization of manure</td>
</tr>
<tr>
<td>2009</td>
<td>“Greens Growth”</td>
<td>Extended demand for catch crops, specific regulations of vulnerable areas, no storage in autumn before spring sown crops entered in regulation system based on established N quotas</td>
</tr>
</tbody>
</table>

Demands for catch crops
- Catch crops can be undersown grass in cereals, mustard or reddish established before or after harvest (latest 20th of August)
- Catch crops must be followed by a spring sown crop
- Catch crops must not be ploughed in or treated with herbicides before the 20th of October
- Demands: 10 percent of farmland (except grass, beets, potatoes) on plant production farms
  - 14 percent farmland (except grass, beets, potatoes) on plant production farms

Nitrogen regulation in DK now:
- Maximum livestock units per ha
- Restrictions in application time for animal manure
- Demands for storage capacity for manure
- Demands for catch crops
- Maximum quotas of nitrogen on farm level including:
  - Calculation of quota from crops, silage,...
  - Minimum utilization of nitrogen in animal manure
- Obligated fertilizer plans and fertilizer accounts

Maximum livestock units per ha

<table>
<thead>
<tr>
<th>Animal type</th>
<th>Max. Lu/ha</th>
<th>No. per Lu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy</td>
<td>1.7</td>
<td>1 cow = 1.73 Lu, 1 cow + inc. feders = 1.77 Lu</td>
</tr>
<tr>
<td>Pigs for slaughtering</td>
<td>1.4</td>
<td>36 produced pigs x 2.17 kg = 1 Lu</td>
</tr>
<tr>
<td>Pigs</td>
<td>1.4</td>
<td>200 produced pigs x 20 kg = 1 Lu</td>
</tr>
<tr>
<td>Ducks</td>
<td>1.4</td>
<td>4.5 eggs = 1 Lu</td>
</tr>
<tr>
<td>Chickens</td>
<td>1.4</td>
<td>2900 produced, 44 days = 1 Lu</td>
</tr>
</tbody>
</table>

1 livestock unit (Lu) = 100 kg N ab store for “best system”

Derogation rules for the nitrate directive

2.3 Lu per ha for cattle allowed if:
- 70 percent of area in autumn with grass or beets
- No animal manure to grass in the period fra 31st August to the 1st of March, if the grass is ploughed down the same year
- Only ploughing of grass from 1st March to 15th of June
- Soil analyses for N and P for each 3 years (1 sample per 5 ha)

NB! Not complete
Restriction in application times

<table>
<thead>
<tr>
<th>Type</th>
<th>Restrictions</th>
<th>Technique</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid manure</td>
<td>No application from harvest to 15th of February except: harvest to 1st of October to winter oilseed rape and grass.</td>
<td>From 2011 direct injection on bare soils and grass. To winter cereals with trailing hoses.</td>
</tr>
<tr>
<td>Solid manure</td>
<td>Without crop in winter: banned from harvest to 15th of November.</td>
<td>Incorporation on bare soils within 6 hours.</td>
</tr>
</tbody>
</table>

Demands for storage capacity

- In general 9 month for liquid manure
- Normal practice with new stables one year for liquid manure.
- Demand for natural cover on the tanks or if not practice a test or concrete cover.

Maximum Nitrogen quotas on farm level

- The N-quotas is calculated from crop, soil type...
- The farmer must take account for a certain percentage of the nitrogen in animal manure.
- The nitrogen in animal manure is calculated from standard norms.
- From the quota is subtracted the nitrogen effect of catch crops.
- The quota is corrected of the yearly N-prognosis.

Setting the N-quotas per crop

- The quota is based on the optimal N rate for the crop determined in field trials.
- The optimal rate is decided each year of a board from research and the advisory service.
- The ministry of Agriculture reduced the optimal rate to a quota which are a political decision (10 percent below the optimal rate in 1996).

An example

<table>
<thead>
<tr>
<th>N compound</th>
<th>Crop</th>
<th>Yield level ha</th>
<th>Quota kg</th>
<th>Next year effect</th>
<th>Quota total</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Winterfat</td>
<td>9.4</td>
<td>191</td>
<td>137</td>
<td>13.700</td>
</tr>
<tr>
<td>150</td>
<td>Winterfat</td>
<td>9.3</td>
<td>183</td>
<td>183</td>
<td>15.200</td>
</tr>
<tr>
<td>100</td>
<td>Winterfat</td>
<td>9.4</td>
<td>183</td>
<td>183</td>
<td>15.200</td>
</tr>
<tr>
<td>150</td>
<td>Winterfat</td>
<td>9.4</td>
<td>183</td>
<td>183</td>
<td>15.200</td>
</tr>
<tr>
<td>40</td>
<td>Spring barley</td>
<td>0.7</td>
<td>114</td>
<td>5.540</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>52.738</td>
<td></td>
</tr>
</tbody>
</table>
- Effect of each crop (25 kg N per ha) -1.275
- Minimum utilization of pig manure 140 N 15 pct 126 36.645
- Residual in mineral fertilizer 31 14.816

Nitrogen in manure - calculation

- Standards for nitrogen in animal manure is given yearly for different animal type and types on stables.
- The background is data for feeding and coefficients for ammonia emission in stable and storage.
- If the farmer can prove a better utilization of nitrogen in stable (e.g. low protein diet), it is allowed to use own figures.

Minimum utilization of nitrogen in manure (pct. of total nitrogen)

<table>
<thead>
<tr>
<th>Type of manure</th>
<th>Minimum utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slurry, cattle</td>
<td>25</td>
</tr>
<tr>
<td>Slurry pigs</td>
<td>70</td>
</tr>
<tr>
<td>Animal manure (solid) + cattle</td>
<td>65</td>
</tr>
<tr>
<td>Dung Litter</td>
<td>45</td>
</tr>
<tr>
<td>Slurry for municipalities</td>
<td>45</td>
</tr>
<tr>
<td>E.g. Use from poultry - search production</td>
<td>45</td>
</tr>
</tbody>
</table>

Fertilizer plan and fertilizer account

- Before the 21st of April the farmer must have calculated his quota. Can be done electronically together with EU-application.
- No obligated demands to keep a journal of fertilizing.
- Before 1st of April the following year, the farmer must do and report a fertilizer account for the previous year to the ministry.
New action plan: “Green Growth”

- Task: to reduce nitrogen leaching with 1/3. It means from an average 80 to 40 kg nitrogen per ha.
- Instruments
  - 140,000 more catch crops
  - No soil tillage in autumn before spring sown crops
  - No ploughing of grass in autumn
  - More wetlands
  - Tradable nitrogen quotas
Presentation by Georges Hofman

NUTRIENT LEGISLATION IN FLANDERS (BELGIUM)

Salomons J.1, De Boer S.2, Sleutel S.2, De Neve S.2, & Hofman G.2
Ministry Flemish Community, Department Environment, Nature and Energy
Faculty Bioscience Engineering, Ghent University

Policy instruments

GAP
- 5 booklets: crop protection – nutrients in grassland and green fodder, vegetables and fruits – arable crops – nature
- All in Dutch
- No further comments

Manure Decree

Manure Decree 1961
- Originally implementation of Nitrates Directive with a restricted area of Nitrates Vulnerable Zones (NVZ)
- A lot of changes during the years

Manure Decree 2006

- Entire territory designated as "Nitrates Vulnerable Zone" (NVZ)
- Consequence: Maximum 170 kg N/ha from livestock manure
- Important
- Some countries: total area NVZ
- Other countries: restricted areas as NVZ

Derogation

- Based on:
  - high N-uptake
  - long growing season
  - high precipitation
- Flanders: first region with derogation on parcel basis

250 kg N-animal/ha/yr
- Grassland
- Grass in combination with maize
- 260 kg N-animal/ha/yr
- Winter wheat followed by green manure or catch crop
- Sugarbeets and fodderbeets
### Potential and real derogation in 2008

<table>
<thead>
<tr>
<th>Crop</th>
<th>Potential N$_{\text{total}}$</th>
<th>N$_{\text{animal}}$</th>
<th>N$_{\text{other}}$</th>
<th>N$_{\text{chemical}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td>150</td>
<td>150</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>Mower</td>
<td>95</td>
<td>270</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>Leguminous, not peas or beans</td>
<td>90</td>
<td>9</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>90</td>
<td>220</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>Other crops</td>
<td>85</td>
<td>250</td>
<td>170</td>
<td>170</td>
</tr>
</tbody>
</table>

### Fertilization limits
- For N and P$_{2}$O$_{5}$
- Variation in function of group of crops
- Some more restrictions on sandy soils
- Restrictions for N$_{\text{total}}$, N$_{\text{animal}}$, N$_{\text{other}}$ and N$_{\text{chemical}}$ (restricted choice for the farmer)
- It concerns always total N and not effective N
- Maximum 20 kg P$_{2}$O$_{5}$/ha as chemical fertilizer

### Time of application

<table>
<thead>
<tr>
<th>Animal manure</th>
<th>Other fertilizers</th>
<th>Maximum</th>
<th>1 Oct</th>
<th>15 Nov</th>
</tr>
</thead>
<tbody>
<tr>
<td>Animal manure on heavy clay soils</td>
<td>Stable manure - Grass</td>
<td>1 Oct</td>
<td>15 Nov</td>
<td></td>
</tr>
<tr>
<td>Other fertilizers - prosemanure</td>
<td>(Low N-content / slow N-release)</td>
<td>1 Oct</td>
<td>15 Nov</td>
<td></td>
</tr>
</tbody>
</table>

### Storage and way of application of animal manures
- Storage capacity: between minimum 3 months to minimum 9 months for in-door housed animals
- Way of application: Methods with low emissions rates are compulsory
- Remark: large differences between countries

### Control mechanism
- On a field basis ‘Nitrification inhibitor stick’
- Maximum 80 kg N$_{2}$O$_{5}$/ha from 0-80 cm
- Measurements between 1 October and 15 November
- Fines have to be paid above a certain limit

### Calculation administrative fines

For DN higher than 5xTh with

\[ GN = \text{measured residual NO}_x - \text{N} \]

Th normally 30 kg NO$_x$/ha

F = number determined by Flemish Government

Originally 150

Th and F will be revised in function of croptype (rooting depth)

### Remarks:
- Only applicable in so-called “risk areas”
- System introduced in 2007 but still a lot of debate
- Threshold values have to be further classified
- Discussions about the methodology
**Nutrient excretions by animals**

Two systems:
- Fixed rate system with default excretion standards
- Nutrient balance systems

By surplus of nutrient, transport to other farms or processed

Remark: differences in excretion values between countries are high

---

**Evolution of animal amounts since 2002**

---

**Evolution nitrate-N residue in soils (kg/ha)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>106</td>
<td>79</td>
</tr>
<tr>
<td>2005</td>
<td>94</td>
<td>78</td>
</tr>
<tr>
<td>2006</td>
<td>107</td>
<td>83</td>
</tr>
<tr>
<td>2007</td>
<td>71</td>
<td>53</td>
</tr>
<tr>
<td>2008</td>
<td>75</td>
<td>59</td>
</tr>
</tbody>
</table>

---

**Cumulative nitrate residue (%) on soils with agreement (payment)**

---

**Evolution of nitrate-N in ground- and surface waters**

Specific measuring network for agriculture

Groundwater:
- About 2000 measuring points
- Results still fragmentary - 25 to 40% exceed at least once the 50 mg nitrate/L

Surface water:
- About 800 measuring points
- Clear decreasing trend

---

**Evolution of nitrate in surface water**

Measuring points (in %) exceeding at least once the norm of 50 mg nitrate/L

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanders</td>
<td>59</td>
<td>48</td>
<td>48</td>
<td>40</td>
<td>37</td>
</tr>
<tr>
<td>Flanders</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>37</td>
<td>27</td>
</tr>
</tbody>
</table>

---

**% exceeding at least once some threshold values**
Evolution NH₃ emissions

Losses by emissions in stables and by storage

Originally 15% in new Decree differentiated
- For cattle between 10 and 20% (depending on the amount of produced farmyard manure)
- For pigs and chickens depend on type of stable
In total: netto N production is 21% lower than gross production

Fertilization advice systems

Two systems are used in Flanders:
- N-index method
- Mineral N-balance method

N-index method

N-advice = a - b x Nₐₘₑₚ
a and b differ between regions, cultivars and destination of the product

N-index = X₁ + X₂ + .......... + Xₜₐₐ
X₁ = Nₑₚ (till rooting depth)
X₂ till Xₜₐₐ = N mineralization
Xₜₐₐ till Xₚₚₐₐ = negative factors (like compaction, low pH, etc.)

Mineral N-balance

Theoretical N-fertilization:
N-need of the crop + Latent Nₑₚ residuum + Nₑₚ residua at planting = N-mineralization
N-fertilization in practice = Theoretical + 10 till 20% theoretical
The 10 to 20% depend especially on soil type and moisture regime

Conclusions

Since the first Manure Decree the rules became stricter and the whole territory has been designated as NVZ
Effect of more stringent rules:
- Amount of animals decreased
- N and P₂O₅ applications decreased
- Fertiliser manure balance is ok

Conclusions

- Surface waters: less places exceeding the threshold value of 50 mg nitrate/L
- Groundwater: no clear trends
As a whole these results are important to get a new derogation in 2010
Presentation by Frank Wijnands

Policy instruments and GAP in the Netherlands

Frank Wijnands

Road map
- NL legislation framework
- GAP, Integrated nutrient management (INM)
- Knowledge development and dissemination for INM
  - Farming systems research, experimental farms
  - Testing and improving in practice, pilot farms network
  - Room to improve, minimising losses
- Learned lessons
- Incentives?

Dutch legislative framework fertilizer use
- Application standards for N and P
  - N-available: crop specific, full farm scale
- Organic manure:
  - restrictions in amount (N total / ha)
  - application time
  - working coefficient defined (as part of the equation for N-available rules)
- Catch crop obligatory after maize
- Contributing to substantial lower surpluses

Good Agricultural Practice (GAP)
- Not as such defined in NL
- Informal = GAP the intelligent agronomic approach to fertilisation applicable for 70-80% of farmers
- Lets call it: Integrated Nutrient Management (INM)

3 objectives:
- Maintaining or increasing soil fertility (P,C,B)
- Supporting optimal crop production
- Minimising impact on ecology and environment

Integrated nutrient management
- Principles:
  - Maintaining agronomic desired and ecopathological acceptable nutrient reserves for P and K
  - Maintain agronomic desired level of organic matter in soil
  - Balance principle: input = output + unavoidable losses
  - Adjust N fertilisation for expected N availability from preceding crops/green manures and soil organic matter, leaving room for the N timing during growing season
  - Optimize agronomy (cropping, soil tillage, etc)

Multiple methods - multiple objectives
- Crop rotation
- Fertilisation
- Fertile soil
- Soil calibration

Optimising and fine-tuning of the interactions between crop rotation, soil calibration and fertilisation

INM methods & techniques - elements
- Proper crop rotation
- Careful choice planting on farm level
- Choice of organic manure or manure products
- Organic manure only in spring (also on fields)
- Green manure use
- Credit planning / calculation of N fertilisation, crop and field specific
- Fertilizer formulation
- Optimum application of N
- N use efficiency P or N
- Precision farming, spot specific
- Decision support systems
  - Fertilizer in soil before growing season
  - N is not N in crop
- Crop scans, satellite images
Knowledge development and dissemination for INM

- **Step 1:**
  - Basic research into mechanisms, causal relations etc.

- **Step 2:**
  - Applied research: fertilisation (techniques, fertilisers, amounts etc.), including systems approach

- **Step 3:**
  - Promising techniques are road tested on commercial farms (on-farm research, participatory approach)

- **Step 4:**
  - Dissemination of feasible and effective techniques in farming community

Farming systems research: integral approach

INM & Integrated Farming Systems

- INM was integral part of the farming systems research in the Netherlands during the 80-90's
  - Integrated farming systems in comparison with organic and conventional farming practices
  - Development and comparison
  - Multiple potentially conflicting objectives
  - Testing and improving strategies and methods
  - European network (INBEC) EU supported from 1996-2000

- UFZ Leipzig Comparison conventional, organic and integrated 1988-2000, single crop: sugar beet, 73 ha
- Conventional system dropped in 1989
- Mixed experimental sites in different regions and sectors: period 1996-2003

Results NL experimental farms

- Period 1990-2000
  - Substantial reductions in surpluses compared to past, or to conventional systems or practice reference
  - Clay soils: low NH4 losses through drainwater (< 5 mg NH4-N/L)
  - Sandy soils: strong reductions in losses and measured content of groundwater, but still too high

New experimental farming systems (2003-)

- Continuous need for innovations
  - Still too high losses on sandy soils

  - Search directions
    - Minimising organic matter inputs
    - Minimising organic matter inputs
    - Minimising organic matter inputs
    - Minimising organic matter inputs
    - Minimising organic matter inputs

Pilot farm approach: road testing new approaches

Pilot farm networks over the years (plant production)

- Pilot farm network integrated farming
  - 1993-1994: 38 farms (arable)
  - 1995-1996: 13 farms (vegetable)

Farming with future

- 2003-2003: 40 farms (all sectors)
- 2004-2007: 350 farms (all sectors, study groups)
- 2008-2010: network based activities

Characteristics Pilot farm networks (1/3)

- Cooperation: extension/advisory organisations, research and farmers
  - Bringing together different professions, experiences, tacit and formal knowledge

- Objectives
  - Testing and developing new relevant knowledge
  - Exploring the future options & complications
  - Feedback to sectoral organisations, policy and research
  - Knowledge dissemination together with farmers, suppliers, advisory organisations etc. in relevant stakeholders
Characteristics Pilot farm networks (2/3)

- Limited number of farms (10-40)
  - High costs, sufficient to represent variation in soil, farm type
  - Ensure at least a minimal "replication" - but forms: pair
- Intensive guidance
  - Whole farm approach, that's the strength
  - Agronomical demands
  - Analysis current situation
  - Implementation and improvement plans
  - Guidance in building up experience with new approaches
  - Decision farmers responsibility

Characteristics Pilot farm networks (3/3)

- Additional research and measurements
  - Soil and plant N-status, soil fertility
  - Mineral N in soil after harvest
  - Yields
  - Water quality etc.
- Demonstrations, experiments, comparisons etc.
- Registration / analysis / evaluation
- Exchange in groups of experiences, farm data and evaluation

Knowledge development - cartoon

Road testing knowledge

- Use the newest, promising, knowledge
  - from government and sector sponsored research programmes on fertilisation
- Link the web
  - The practical experience and innovative powers of farmers + stakeholders
- Develop and test
  - The promising techniques whenever possible into feasible and effective methods
- Disseminate the new knowledge via the agricultural network: sapers, collectors, advisors, agribusiness etc.

Knowledge dissemination / "circulation"

- Only if together with stakeholders, in their events and media
- Focus on consistent message from all stakeholders
- Large amount of varying forms of communication:
  - demonstrations, articles, open days, workshops, inclusions, newsletters, flyers, lectures, presentations etc.
- Reaching large groups of farmers

Pilot farms benefits

- Practical tests of new methods in a farm setting under a wide range of varying conditions of soils, farm types and management
- Helps to gain insight in and understand implications of possible future steps in legislation and rules
- What are characteristic challenges, conflicts etc for different farm types
- Valuable antennas for "the future in practice or the practice of the future"

Managing limitations – room to improve

Experiences in recent years – pilot farms

- NVP Application Standards are narrowing the playing field
  - However, in general not (yet) restricting an optimal approach
- Organic matter inputs are NPK fertilizers
  - purpose to maintain soil organic matter levels and optimize N availability at the right moment
  - N is abundant organic manure, specific related problems
- Entrepreneurs don't like to manage limitations
Substantial Room to improve (reduce losses)

Key aspects
- Adjustment of N supply to demand of crops,
- Limit too high N availability also outside growing season.

Management improvements
- Strategic and tactic planning
- Operational management (DSS use)

Operational management
- Dutch soils and farm types
  - Large temporal and spatial variation in N delivery from the soil (also over the years)
  - Strong dynamics
- As a result large variation in optimal N amount
- Substantial room to improve in many crops
- Minimising costs and surpluses
- Therefore DSS (Decision Support systems), vital importance

Constraints for DSS use
- Dependency on precipitation or irrigation when dry when fertilising
- Costs
- Need for attention
- Risk perception
- Validated norms for different crops and cultivars

Future developments and needs
- New techniques with perspective
  - Precision farming (GPS)
  - Row application
  - Manure products (matching profile NPK demands for specific situation)
- Substantial more research to develop new technology
  - Public and private interests jointly this input

Lessons learned, perspectives, incentives for change

Critical success factors: farmers
- Very hard to change existing routines
- They got the "power of reality"
- Changing behaviour is difficult and takes time

For a successful application of new methods and strategies in practice, the farmer has to:
- Know (knowledge of techniques and methods)
- Be able in technical and economical terms, labour, costs etc.
- Have the will (willing and motivated)
- Be allowed to do so ("socially gaining" behaviour, acceptance in network)

Process of change farmers
- Awareness
- Mentally
- Behaviour
- Necessity/Urge
- Vision/Point of view/Strategy
- Success
Lessons learned – success factors

- Excellent technology
  - Increasingly hard to find
  - Innovations needed, new principles, new approaches
  - Substantive control
  - New, more sustainable approaches should be profitable
  - Requires vision, policy, money, courage and support

- Road tested technology
  - Tested with farmers and stakeholders
  - Feasible and effective
  - Basis for dissemination
  - Requires participatory approaches, networks, advisory services, research, farmers

Incentives (inspired by crop protection)

- Economically
  - New technology makes money
  - Government EU support, public concerns, support methods and techniques
  - Market demands certification

- Ethical – ecological – environmental
  - Responsible behaviour – sustainability
  - Feedback on measured quality environment
  - Make it the “norm”

- Legal
  - Rules and regulations
  - Additional rules (buffer strips, control machinery etc.)

Lessons learned – success factors

- Involve agricultural community – stakeholders
  - Responsibly for economic and ecological interests
  - Link interests – values at stake for DH with the sustainability issue
  - Support these developments by an organisation – project
    - Independent
    - Flexible
    - Highly knowledgeable, expertise
    - Skill in process and content

Thank you very much
Presentation by Kerstin Panten, Frauke Godinsky and Ewald Schnug

Policy instruments and GAP in Germany

EC Legislations
- e.g. 1161/2011, 91/676/EEC

German legislations, e.g.:
1. Düngeregelung (DüngG), Fertilisation Act
2. Düngeringordnung (DüV; Fertiliser Ordinance)
3. Bundesboden schutzgesetz (BodSchG), Federal Soil Conservation Act
4. Bundesseuchenverordnung (BlauSchG), Federal Animal Disease Act
5. Chemikaliennutzungsverordnung (ChemSchV, 2006)

GAP’s in relation to nutrient losses from agriculture

Two major legislations
1. Düngeringordnung (DüV; Fertiliser Ordinance)
   Focus on nutrient use efficiency
2. Bundesboden schutzgesetz (BodSchG; Federal Soil Conservation Act)
   Focus on general soil quality

Düngerringordnung (DüV; Fertiliser Ordinance)
§ 3 Basic principles for application (free translation, summary and interpretation)
(2) Assessment of fertiliser demand for each field considering a variety of parameters (expected yield and quality, availability of soil nutrients, soil pH and C, other nutrient sources, other cultivation conditions like previous crop, soil tilage, irrigation).
(3) Before application of fertilisers farmers need to calculate the demand based on available soil contents for each field annually. P at least every 4 years.
(4) Time and amount of application of nutrients close to uptake by plants.
(5) N application prohibited if soils are waterlogged, frozen or covered by more than 1 cm of snow.
(6) When applying N and P of at least 5 cm distance to surface waters. Runoff in surface water needs to be avoided.

Düngerringordnung (DüV; Fertiliser Ordinance)
§ 4 Further requirements for the application of nutrients
(1) Application of organic fertilizers if N and P concentrations are known (a) because of breeding, (b) based on data of Federal legislation calculated on (c) by analysis.
(2) Organic N and P uses has to be incorporated immediately.
Presentation by Karin Rather

**Groundwater protection measures in Baden-Württemberg - SchALVO**

**Dr. Karin Rather**

State Horticultural College and Research Institute Heidelberg, Germany
- State Institute of Ministry of Nutrition and Rural Areas Baden-Württemberg

Department 14 “Ecology and SchALVO”

**Workshop “How to reduce nutrient losses from agriculture?”**
19-20 November 2009, Utrecht, the Netherlands

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**Legal regulations on water protection at different levels**

<table>
<thead>
<tr>
<th>EU</th>
<th>National (Bundesländer)</th>
<th>Federal state (Bundesländer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water protection general water directive</td>
<td>Wasserhaushaltsgesetz (WHG)</td>
<td>Wasserwirtschaftsgesetz (WwG)</td>
</tr>
<tr>
<td>Groundwater protection directive 2006/60/EC</td>
<td>Bundeswassergesetz (BwG)</td>
<td>Wasserwirtschaftsgesetz (WwG)</td>
</tr>
<tr>
<td>Nitrate directive 91/676/EEC</td>
<td>Water Act §19</td>
<td>Water act decrease</td>
</tr>
<tr>
<td>Drinking water directive 80/778/EEC</td>
<td></td>
<td>Baden-Württemberg (Landwirtschaftsamt, LWA)</td>
</tr>
<tr>
<td>Water framework directive 2000/60/EC</td>
<td></td>
<td>→ SchALVO</td>
</tr>
</tbody>
</table>

**Water protection areas in Baden-Württemberg**

- Water protection area 2002
- Water protection area 2008
- 1200 water companies

- 7%
- 9125 km²: 40% in agricultural use

**SchALVO measures**

- Mitigation strategy to protect the groundwater
  - Avoidance of microbial contamination
  - Prevention of contamination with pesticides
  - Minimizing nitrate entry
  - Remediation of nitrate contaminated groundwater as soon as possible

For this purpose good agricultural practice is restricted

- Payment of compensation according to the restriction

---

**Classification of protected areas in categories depending on nitrate content of the groundwater**

<table>
<thead>
<tr>
<th>Nitrate concentration</th>
<th>Trend decrease in mg/l</th>
<th>Category</th>
<th>%a LfA</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 35 mg/l</td>
<td></td>
<td>Normal area</td>
<td>232.50</td>
</tr>
<tr>
<td>25 - 35 mg/l</td>
<td></td>
<td>Normal area</td>
<td>63%</td>
</tr>
<tr>
<td>&gt; 0.5</td>
<td></td>
<td>Problem area</td>
<td>91.60</td>
</tr>
<tr>
<td>35 - 40 mg/l</td>
<td></td>
<td>Problem area</td>
<td>25%</td>
</tr>
<tr>
<td>&gt; 40 mg/l</td>
<td></td>
<td>Remediation area</td>
<td>20.40</td>
</tr>
<tr>
<td>50 mg/l</td>
<td></td>
<td>Remediation area</td>
<td>6%</td>
</tr>
</tbody>
</table>

**LfA = agricultural用地, water protection area**
Monitoring nitrate-N content of soil according to SchALVO:

- Compliance, reclaim, revocation (Ernsting, Rickert, Hohenvergen, Vaterfeld)

<table>
<thead>
<tr>
<th>Threshold Value</th>
<th>Light Soils 0-90 cm</th>
<th>Heavy Soils 30-90 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate-N (N-NO₃)</td>
<td>45 kg N/ha</td>
<td>90 kg N/ha</td>
</tr>
</tbody>
</table>

Tolerance:
- Pauschalausgleich 165/ha
- Ebene Ausgleich auf Nachweis

Nitrate-N content in the soil of different arable and horticultural crops 2005-2008 – harvest monitoring results

Graph showing nitrate levels in different crops from 2005 to 2008.

Development of nitrate level of groundwater 1984-2009:

- Average nitrate concentration of permanent measuring points

Graph showing change in nitrate levels over time.

MEKA programme Baden-Württemberg - voluntary

- Markenlärungs- und Kulturlandschaftsausgleich
- agri environmental scheme, since 1992, EU notified

Objectives:
- Care and conservation of the agricultural landscape
- Environmental-friendly cultivation and extensive land use
- Unload of agricultural market

Programme:
- Participation is voluntary
- Participants enrol in the programme for five years
- According to a modular design principle
- Calculation of compensation based on a point-scores system

Voluntary measures to protect groundwater:

<table>
<thead>
<tr>
<th>Measure</th>
<th>Points (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application technique lime (Siebischlack)</td>
<td>10</td>
</tr>
<tr>
<td>Application technique lime (Siebischlack)</td>
<td>10</td>
</tr>
<tr>
<td>No destruction of cover crops, no application of pesticides</td>
<td>10</td>
</tr>
<tr>
<td>No application of chemical-synthetic pesticides and fertilizers</td>
<td>10</td>
</tr>
<tr>
<td>Post harvest management: cover crops in summer</td>
<td>10</td>
</tr>
<tr>
<td>Cover crops in permanent crops (70%, 90%, 100%)</td>
<td>10</td>
</tr>
<tr>
<td>Zero tillage management</td>
<td>10</td>
</tr>
</tbody>
</table>

Financial expenses for groundwater protection measures SchALVO and MEKA:

- MEKA groundwater protection measures: ~75 Mio. €
- SchALVO compensation payments: ~22 Mio. €
Presentation by Brian Chambers

Policy Instruments and Good Agricultural Practice in Britain

Brian J Chambers and Peter Dampney

Pollutant losses to water in Britain

Agriculture is estimated to be responsible for:

- Around 60-70% of nitrate losses – ground/surface waters (NVZ Action Programme)
- 20-60% of phosphorus losses – surface waters (Water Framework Directive)
- 35% of microbial pathogen losses (bathing/shellfish waters)
- 20% of ammonium losses – surface waters

Average nitrate concentrations in groundwaters

Most aquifers are deep, in chalk, limestone or sandstone

Network of 2,407 monitoring sites in Britain

England: 65 sites >25 mg/l nitrate, 22% sites >50 mg/l nitrate
Scotland: 24% sites >25 mg/l nitrate, 9% sites >50 mg/l nitrate
Wales: 64% sites <25 mg/l nitrate, 5% sites >50 mg/l nitrate

Most nitrate concentrations are stable or decreasing

Average nitrate concentrations in surface waters

Agriculture contributes to all waters:
- England & Wales: 66% & 74%

Network of 7,407 monitoring sites in Britain

England: 64% sites <20 mg/l nitrate, 9% sites >50 mg/l nitrate
Scotland: 69% sites <20 mg/l nitrate, 9% sites >50 mg/l nitrate
Wales: 67% sites <20 mg/l nitrate, 9% sites >50 mg/l nitrate

Highest concentrations are in the East of Britain:
- Low rainfall, arable farming

Phosphorus in surface waters

- Highest soluble P concentrations come from densely populated areas

Contribution from agriculture most important in rural areas:
- England: 20%
- Scotland: 62%
- Wales: 87%

- Mainly winter losses and tackled by the revised Nitrates Regulations 2008
- Closed manure spreading periods during winter months

Ammonia emissions to air

Agriculture is estimated to be responsible for 85% of UK ammonia emissions

Ammonia emissions from agriculture in UK

Around 85% of UK total (320 kt) comes from agriculture

- Cattle: 53%
- Pigs: 37%
- Poultry: 3%
- Other livestock: 5%
- Other sources (fertiliser): 2%
Nitrous oxide emissions in UK

From: 2001 UK National Greenhouse Gas Inventory

Soil types in England and Wales

Nutrient loss pathways

Cracking Clay soils

6.4 million ha of drained soils in England and Wales
(70% of agricultural land area)

Drainage systems on Cracking Clay soils

Following rainfall events (>20mm) drainflow typically occurs within 2 hours

Integrated Policy Development - finding the ‘best’ balance

Actions to tackle water pollution in Britain

- Government actions:
  - Key policy objective to protect the environment
  - Water, soil, air, biodiversity
  - Mix of advice, incentives and regulation
  - Environment schemes:
    - Decision support tools (e.g., PLANET)
    - Nutrients advice programme

- Industry and farmer action:
  - Fertiliser Advisers Certification and Training Scheme (FACTS)
  - Accreditation of nutrient management advisers
  - Professional Nutrient Management initiative
  - Practical help to farmers

Code of Good Agricultural Practice

- Soil fertility and plant nutrients
- Management Plans (soil, nutrient, manure)
- Farm buildings and structures
- Field work
- Specialised horticulture
- Wastes
- Water supplies

Note: N/S rules are mandatory — the remainder of the document is guidance
**Soil Management - Good Agricultural and Environmental Condition (GAEC)**
- GAEC for Soils involves taking action to:
  - Maintain soil organic matter levels
  - Reduce the chances of soil erosion (water and wind)
  - Reduce damage to soil structure
  - Take account of guidance in the “Cross Compliance Guidance for Soil Management” booklet

*Produce and implement a cross compliance Soil Protection Review (from 2006, updated annually)*

**Nutrient Management Advice – Defra ‘Fertiliser Recommendations booklet (RB209)’**
- The recognised industry ‘standard’ used by farmers, consultants, trade, etc. (England, Wales and N. Ireland)
- Very influential in most other recommendation systems
- Over 11,000 copies sold
- Covers use of fertilisers and organic manures for all major crops and grass
- A key standard for nutrient management planning and farm assurance schemes

**PLANET NUTRIENT MANAGEMENT**
Planning the Land Application of Nutrients for Efficiency and the Environment
- Electronic version of RB209 and MANNER combined.
- Integrated into commercial agricultural software systems (under licence)

**PLANET User Survey - ‘key’ feedback**
- Majority of standalone users were advisers (70%) rather than farmers - mainly arable farmers
- Importance of rolling out PLANET via Commercial Software companies
- Drivers for use (in priority order):
  - Compliance with NVZ regulations
  - Nutrient Management Planning
  - Farm profitability

**Managing Livestock Manures booklets**

**New slurry application techniques - lower emitting surface area**
- Use slurry bandspreading / shallow injection equipment to minimise ammonia losses and odour nuisance
Trailing hose vs. surface broadcast slurry application

IPPC – Integrated Pollution Prevention and Control Directive (‘large’ pig and poultry units)

- IPPC aims to prevent or reduce pollution to achieve: “a high level of protection of the environment” and requires the adoption of “best available techniques” (e.g. band spreading for pig slurry, rapid soil incorporation of poultry manure, covering new slurry stores)
- All existing ‘large’ units from 2007

Farming economics - manufactured fertiliser use

There are challenges ahead!

- Water quality (NVZs: WFD): - closed spreading periods for slurry (heavy soils) - more storage needed on many farms (£million)
- Improve manure N efficiency:
  - Reducing ammonia losses:
  - improved spreading equipment - covering new stores
  - More spring application:
    - reduce nitrous oxide losses
- Integrated Policy Development - the major challenge .... for UK government ...

Average rate of crop and managed grazing
- 105 kg NHa
- 10 kg Pha

Since 1995 ....... 27% less chemical N
....... 45% less chemical P

Thank you - Questions?
Designation methodology (England and Wales)

Polluted water sampling points identified using
• monthly water analysis data for nitrate
• 7,407 surface water sites
• 2,076 ground water sites
• evidence of eutrophication
• trend analysis

All land draining to a polluted water is designated
• all of the upstream catchment

Summary of NVZ rules (England and Wales)

Storage of organic manure
The livestock manure N farm limit
Planning nitrogen use
The crop N requirement limits (Nmax)
Field application of organic manures
Field application of manufactured nitrogen fertiliser
Records

The Livestock Manure N Farm Limit

170 kg N/ha limit based on:
• Area of the farm
  • excluding surface water, hard-standing, buildings, roads and woodland

N produced by all livestock types
• standard N production values

Imported and exported livestock manure N

British derogation to the 170N limit

Approved in 2009, in force from January 2010
• N Ireland derogation in force since January 2009

250 kg N/ha per year on eligible farms
• at least 50% grassland
• only for manure from grazing animals
• manure from pigs/poultry will have a limit of 170N
• annual application for a calendar year

Extra conditions will apply
• P planning
• most other conditions are same as other Member States

N production standards – some cattle examples

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Age, milk yield (litres) or weight (kg)</th>
<th>N produced (kg/60kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Dairy cow</td>
<td>➢ 6000 litres  ➢ 8000 litres</td>
<td>115</td>
</tr>
<tr>
<td>1 Dairy heifer</td>
<td>➢ 13 months to first calv</td>
<td>17</td>
</tr>
<tr>
<td>1 Beef wether (large)</td>
<td>➢ 36 months and over, over 600kg</td>
<td>33</td>
</tr>
<tr>
<td>1 Beef cow or steer</td>
<td>➢ 15-36 months</td>
<td>60</td>
</tr>
</tbody>
</table>

See Defra NVZ Guidance leaflet 3 for all standards.
Options for permanently housed pigs or poultry only

N production standards based on specific farm feeding and manure storage
- ENCASH software (free from ADAS)

Analysis of the solid manure combined with total weight of the manure produced
- only if all manure production is solid manure

Manure storage capacity

6 months capacity for pig slurry and poultry manure
- manure collected for storage between 1 October to 1 April

5 months capacity for all other slurry
- manure collected for storage between 1 October to 1 March

Excludes dirty water that is not mixed with slurry
- 'Lightly contaminated run-off from fenced concrete yards or from the dairy parlour that is collected separately from slurry'

Standard livestock excreta values

Temporary storage of solid manures in field heaps

Solid livestock manures are common in Britain

Temporary field heaps are allowed but not:
- within 10 m of surface water or land drains
- within 50 m of springs, wells or boreholes
- on land likely to become waterlogged or flood
- in any single position for more than 12 months
- return to same site for 2 years

Sites must be marked on farm risk map

Planning nitrogen use

Farmers must keep Records to show that they have followed the N planning process:
1. Assess the Soil Nitrogen Supply (SNS)
2. Assess the Crop N Requirement
   - the optimum amount of N to apply
3. Assess the supply of crop available manure N
4. Assess manufactured nitrogen fertiliser required

Excreta standards – some cattle examples

<table>
<thead>
<tr>
<th>Livestock type</th>
<th>Age, milk yield (litres)</th>
<th>Excreta (m³/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Dairy cow</td>
<td>&gt;3000 litres</td>
<td>1.50</td>
</tr>
<tr>
<td>1 Dairy heifer</td>
<td>24 months to first calf</td>
<td>1.25</td>
</tr>
<tr>
<td>1 Beef suckle</td>
<td>(large) 25 months over,</td>
<td>1.35</td>
</tr>
<tr>
<td></td>
<td>over 500kg</td>
<td></td>
</tr>
<tr>
<td>1 Beef cow or</td>
<td>(other) 13-25 months</td>
<td>0.75</td>
</tr>
</tbody>
</table>

See Delta RVZ Guidance leaflet 3 for all standards

Planning nitrogen use and Crop N requirement limits

The Crop N Requirement limits (N max)

Standard limits for the major crop types (84% of cropped area)
- cereals, winter oilseed rape
- sugar beet, potatoes, forage maize
- grass
- there are no N max limits for other crops

Some standards can be adjusted
- crop yield, market

Nitrogen
- from manufactured fertiliser N
- from crop available N from livestock manures
- minimum N availability coefficients apply

Limit is an average across the whole area of crop
N max rate (as kg N/ha) - cereals

<table>
<thead>
<tr>
<th>Crop</th>
<th>N max (kg N/ha)</th>
<th>Standard yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat, autumn and early winter sown</td>
<td>220</td>
<td>8.0</td>
</tr>
<tr>
<td>Wheat, spring sown</td>
<td>180</td>
<td>7.0</td>
</tr>
<tr>
<td>Winter barley</td>
<td>180</td>
<td>6.5</td>
</tr>
<tr>
<td>Spring barley</td>
<td>150</td>
<td>5.5</td>
</tr>
</tbody>
</table>

- An additional 20 kg/ha is permitted to winter wheat and winter barley if grown on shallow soils (except over sandstone).
- An additional 20 kg/ha is permitted for every t/ha of expected yield above the standard yield (need 2 years written evidence).
- An additional 40 kg/ha is permitted to mixing wheat varieties.

N max rate - other arable crops

<table>
<thead>
<tr>
<th>Crop</th>
<th>N max (kg N/ha)</th>
<th>Standard yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter colza rape</td>
<td>30 (maximum)</td>
<td>5.5</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>120</td>
<td>n/a</td>
</tr>
<tr>
<td>Potatoes</td>
<td>270</td>
<td>n/a</td>
</tr>
<tr>
<td>Forage maize</td>
<td>160</td>
<td>n/a</td>
</tr>
<tr>
<td>Field beans</td>
<td>0</td>
<td>n/a</td>
</tr>
<tr>
<td>Peas</td>
<td>0</td>
<td>n/a</td>
</tr>
</tbody>
</table>

For winter oilseed rape, the spring N rate may be increased by 30 kg/ha for every half tonne that the expected yield exceeds the standard yield.

N max - grass

<table>
<thead>
<tr>
<th>Crop</th>
<th>N max (kg N/ha)</th>
<th>from Jan 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grass</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>

An additional 40 kg/ha is permitted to grass that is cut at least 3 times during the season.

Minimum manure N availability coefficients

<table>
<thead>
<tr>
<th>Crop available (N as % of total N) in year of application</th>
<th>Crop available (N as % of total N) in year of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>from 1 January 2009</td>
<td>from 1 January 2012</td>
</tr>
<tr>
<td>Cattle slurry</td>
<td>25</td>
</tr>
<tr>
<td>Pig slurry</td>
<td>25</td>
</tr>
<tr>
<td>Poultry manure/litter</td>
<td>20</td>
</tr>
<tr>
<td>Other livestock manures</td>
<td>10</td>
</tr>
</tbody>
</table>

Organic manure closed periods: grassland

Organic manures with a high readily available N content (>30% of total N)
- e.g. slurry, poultry manure, liquid digested sludge

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Sandy or shallow soils</th>
<th>All other soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Sep - 31 Dec</td>
<td>15 Oct - 15 Jan</td>
<td></td>
</tr>
<tr>
<td>(4 months)</td>
<td>(3 months)</td>
<td></td>
</tr>
</tbody>
</table>

Manufactured fertiliser closed periods

<table>
<thead>
<tr>
<th>Grassland</th>
<th>Tillage land</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 September to 15 January</td>
<td>1 September to 15 January</td>
</tr>
</tbody>
</table>

There are exemptions for specific crops that have a crop N requirement during the closed period. Conditions apply.

N application allowed to other crops during the closed period if written advice from a FACTS qualified adviser.

*On sandy or shallow soils, application is permitted between 1 August and 15 September provided a crop is sown on or before 15 September.
Manufactured nitrogen fertiliser allowed during the closed period

<table>
<thead>
<tr>
<th>Winter-cropped crops</th>
<th>kg N/ha maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canola</td>
<td>10</td>
</tr>
<tr>
<td>Autumn-sown grass</td>
<td>50 (not after 31 October)</td>
</tr>
<tr>
<td>Grass</td>
<td>80 (max 60 kg N/ha per application, not after 31 October)</td>
</tr>
<tr>
<td>Peas</td>
<td>40</td>
</tr>
<tr>
<td>Sweetcorn</td>
<td>40</td>
</tr>
<tr>
<td>Bulb onions</td>
<td>40</td>
</tr>
<tr>
<td>Grass</td>
<td>80</td>
</tr>
</tbody>
</table>

The Organic Manure N Field Limit

Limit of 250 kg N/ha in any 12 month period
- does not include manures deposited by grazing animals
- area excludes the 10m and 50m buffer areas

Risk map must show

- All fields (show area in ha)
- Surface water
- Land within 10m surface water
- Springs, wells & bores (and those on neighboring land within 50m)
- Land drains (effective at removing water, not sealed impermeable pipes)
- Sandy & shallow soils
- Sites for field heaps (optional)
- Slopes of more than 12 deg (1 in 5)
- Low run-off risk land (optional)

Non-spreading areas and conditions

- No organic manure
  - within 10m of surface water
  - within 50m of spring, well or borehole

- No manufactured N fertiliser
  - within 200m of surface water

Must not spread if there is a significant risk of nitrogen getting into surface water, taking account of:
- slope (particularly if more than 12 deg), ground cover, proximity to surface water, weather conditions, soil type and presence of land drains

Must not spread if the soil is:
- waterlogged, flooded, snow covered, or frozen for more than 12 hrs in previous 24 hrs.
Presentation by Hein ten Berge

Legislation on Nitrogen Use – kick-off for discussion

- Key components Nitrates Directive
- Main contrasts: how countries responded to ND
- Which issues require further research?
- On what issues – if any – do we need uniformity?

Nitrates Directive

- Define Codes of Good Agricultural Practice (GAP) (voluntary measures; whole country)
- Designate Nitrate Vulnerable Zones (NVZ): drain into fresh surface/ground water that could contain >50 mg/l if actions were not taken
- Establish Action Programs towards objectives of ND
- Implement suitable Monitoring Programs

Summary of contrasts

Policy instruments to limit N use

- Denmark, Netherlands, Flanders: N application standards (max N input per crop-soil)
- Germany: GAP plus constraints on N surplus
- France: limits total N input in sensitive areas

N application standards: bounds

- Flanders: upper bound: N demand + N uptake minus N supply of sources
- Denmark: upper bound: National N-quantities divided over crops
- N 2009: 90% of recommended N rate + N fertilizer reductions
- Netherlands: lower bound: max allowable N surplus (postponed to 2016/17?)
- Upper: bound: recommended N rate
- Working assumption: crop N/4 (45% of recommended 2009 (DG/05) + 4 AP 2010/2011)

Structure of N application standards

<table>
<thead>
<tr>
<th>Country</th>
<th>Total N</th>
<th>N manures</th>
<th>N other organic</th>
<th>N fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>250</td>
<td>170</td>
<td>0</td>
<td>250</td>
</tr>
<tr>
<td>Netherlands</td>
<td>250</td>
<td>170</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>Flanders</td>
<td>220</td>
<td>170</td>
<td>0</td>
<td>150</td>
</tr>
</tbody>
</table>

Flanders:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Total N</th>
<th>N manures</th>
<th>N other organic</th>
<th>N fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains</td>
<td>150</td>
<td>125</td>
<td>170</td>
<td>250</td>
</tr>
<tr>
<td>Mixture</td>
<td>250</td>
<td>170</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>200</td>
<td>170</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td>LowN crops</td>
<td>125</td>
<td>125</td>
<td>125</td>
<td>70</td>
</tr>
<tr>
<td>Leguminous</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>275</td>
<td>170</td>
<td>170</td>
<td>175</td>
</tr>
</tbody>
</table>
Values of N application standards 2009 (kg N/ha) as effective N

<table>
<thead>
<tr>
<th></th>
<th>Flanders</th>
<th>Denmark</th>
<th>Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>210</td>
<td>205</td>
<td>140-165</td>
</tr>
<tr>
<td>Potato</td>
<td>225</td>
<td>215</td>
<td>135-155</td>
</tr>
<tr>
<td>Sugar beet</td>
<td>150</td>
<td>160</td>
<td>155-190</td>
</tr>
<tr>
<td>White wheat</td>
<td>225</td>
<td>215</td>
<td>230</td>
</tr>
<tr>
<td>Green barley</td>
<td>210</td>
<td>200</td>
<td>120-130</td>
</tr>
<tr>
<td>Beans</td>
<td>85</td>
<td>75</td>
<td>100</td>
</tr>
</tbody>
</table>

N fertiliser value of manures (on arable land)

<table>
<thead>
<tr>
<th></th>
<th>Statutory value (%)</th>
<th>in recommendations (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Denmark</td>
<td>Netherlands</td>
<td></td>
</tr>
<tr>
<td>Dairy slurry</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Pig slurry</td>
<td>75</td>
<td>65</td>
</tr>
<tr>
<td>Poultry manure</td>
<td>65</td>
<td>55</td>
</tr>
<tr>
<td>Farmyard manure</td>
<td>65</td>
<td>45</td>
</tr>
</tbody>
</table>

N legislation France

- No general limits on N
- No in NZC (such as Compost, manure)
- Direct in 2AC (Zones d’Action Complémentaire)
  - Zones for ‘drinking water’ production, with high nitrate (+ 50 mg/l in surface water)
    - Total N max 20 kg N/ha
    - Nitrate, e.g. dairy farms: total N max 140 (of which 40 as fertilizer N)
    - Cattle farms total N max 170 (of which 70 as fertilizer N)

N legislation Germany

- Whole country:
  - Good Agricultural Practice
  - Nutrient management plan
- N surpluses (field level)
  - Past 3 years
  - 90 kg N/ha (2006-2008)
  - 60 kg N/ha (2009-2011)
  - Vegetable crops: extra ‘normal’ term: 50; 20 kg N/ha

Max. Soil Nitrate-N in autumn

- Flanders
  - Sampling October 1st – November 15th
  - Not allowed: 90 kg nitrate/N/ha (0.90 cm depth)
- Germany
  - In groundwater protection areas (HW, BW)
  - Sampling October 15th – November 15th
  - Not allowed
    - 15 kg nitrate-N/ha (per 0-10 cm) (0-30 cm)
    - 50 kg nitrate-N/ha (per 0-90 cm)
    - 45 kg nitrate-N/ha other soils (0-90 cm)

In summary

Considerable differences between countries
- Type of constraints (input; surplus; GAP balance)
- Level of constraints
- Degree of differentiation (crops, soils, yield levels, …)
- Fertilizer value of manures: explicit or explicit
- Statutory versus recommended values
- In: exclusive of long-term effect
- Additional ‘targets’: soil nitrate N

Possible research issues

- First try only,………..
- Any – not only shared issues
Policy instruments:
- Structure: limits on input / surplus / residual N
- Need to compare instruments?
- Need to compare values?
  - yield levels
  - attainable efficiencies
- Enforcement – administrative pressure?

Internalize environmental costs:
- Taxation on fertilisers?
- Tradable N quota? (input, surplus)
- Other ....?

Differentiation of N input constraints:
- Differentiation by yield
  - by soil N supply – indicators for soil supply
  - Hotspots
    - identify soil status
    - or defined by dominantly cropping patterns
  - Annual variation: assess quota afterwards
  - N quota transfer between years

Uniformity – why?
- Would help judgement of AP's by EC
- More efficient legatuages?
- Efficient data use/sharing
- Avoid unfair competition (across border) e.g. in fresh vegetable products
- Differentiation within and between countries on the same grounds? By which key variables?
- Shared definition for N demand as upper bound for NAF's?
- Other .......

Issues for uniform approaches (???)

Technology development:
- Reduce farmer uncertainty on N requirement
  - account for soil N
  - feedback for crop monitoring
  - enabling rapid uptake
- Reduce actual N requirement
  - increase uptake efficiency;
  - reduce uptake requirement per unit product
  - (optimize non-N conditions; varietal improvement)
- Other ???

Translating 50 mg/l 'back' into input/surplus limits?
- (final constraints, as opposed to transitional)
- By trial and error (OX approach)?
- Calculus (WL scheme)
- Rain partitioning, e. or kg N
- Compliance: scale issues, averaging
- Exemption of vegetable / ornamental crops
- Requirement for growth ('flanders) vs offtake (Germany) ...

Policy instruments: global structure?
- Translating 50 mg/l 'back' into input/surplus limits?
- Ways to internalize environmental costs?
- Technology development?
- Differentiation of standards?
- Other issues ?????
1. Level playing field – sensible idea?

Countries/regions differ in:
- cost of land
- product prices
- yield levels

→ different economic optima
→ different emissions at optimum
→ different cost of meeting NO targets

That’s for a start only……
Presentation by Wim van Dijk

N fertilizer recommendations
Kick-off for discussion

Wim van Dijk
Hein ten Berge

Content
- Summary main contrasts between countries
- Which issues require further research?
- On which issues – if any – should we strive for uniformity within EU

Summary of comparison recommendations
- How are recommendations derived?
- Correction for yield and N sources
- Average recommended levels for major crops

Basis recommendations
- Dose-response trials
  - Series of trials
    - Nopt
    - Recommendation: average of Nopt
  - FL, DK, GE and NL
- N balance
  - N_{opt} = N_{opt} / N_{res} = N_{soil}
  - FL, GE and FR
- N-difference method (NL)
  - Current recommended level – higher/lower level

Dose-response trials
- Nopt depends on selected regression model
  - What to do if models perform comparable but derived Nopt differ considerably?
  - Prices of fertilizers and marketable products can easily be accounted for (derivative = price ratio)
  - Corrections for site specific conditions less directly
  - Yield level and soil N delivery already implied in average Nopt

N balance
- N_{opt} = N_{opt} / N_{res} = N_{soil}

Differentiation more easily applicable
- Dependency of parameters
  - E.g. higher recovery at higher yield/uptake level
  - Prices of fertilizers and marketable products can not easily be accounted for

NL protocol for assessing recommendations
- Recommendations basis for application standards
- Guidelines for
  - Number of trials, locations, years
  - Analysis data
  - N-balance
  - Difference method (new level > current level)

Fertilization Committees NL
- Main task: assessing fertilizer recommendations
- Representatives
  - Farmers organizations (chair)
  - Universities (chair)
  - Laboratories
  - Extension service
  - Ministry of Agriculture
- Sectors
  - Forage crops
  - Fruits and horticultural crops
  - Since 2006: also governmental committee
  - Status FC becomes less clear
### Le year N fertilizer value animal manure (€)

**Application on arable land before sowing/planting**

<table>
<thead>
<tr>
<th></th>
<th>FL</th>
<th>DK</th>
<th>GE</th>
<th>FR</th>
<th>NL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle dry</td>
<td>55</td>
<td>55-70</td>
<td>50</td>
<td>55</td>
<td>59-65</td>
</tr>
<tr>
<td>Pig dry</td>
<td>65</td>
<td>75-85</td>
<td>60</td>
<td>60-75</td>
<td>75-75</td>
</tr>
<tr>
<td>Solid swine manure</td>
<td>55</td>
<td>65</td>
<td>60</td>
<td>65-75</td>
<td>55-65</td>
</tr>
<tr>
<td>Solid cattle manure</td>
<td>30</td>
<td>45</td>
<td>25</td>
<td>15-30</td>
<td>30</td>
</tr>
</tbody>
</table>

### Conclusions

- Basis for deriving recommendations differs between countries.
- In all countries recommendations include corrections for yield and N sources, but approaches differ.
- Differences in average recommended levels are greatest for potato, winter wheat and spring barley.

### Methodology for deriving recommendations

- Which basis (dose response, N balance)?
- How to account for variation in economic parameters? Taking into account also environmental costs

### Issues to address for discussion (and joint actions)

- Methodology for deriving recommendations
  - Differentiation of recommendations
    - Correlations for soil N supply
    - Correlations for yield
  - Gap between allowed N application and recommendations

### Differentiation of recommendations

- Soil N supply
  - Fixed values or soil analysis
  - Availability appropriate indicators
- Yield level
  - Does yield level affect crop N demand?

### Gap between allowed N application and recommendations

- What is the value of recommendations when legislation does not allow to apply them?
- Possibilities of fertilization techniques to decrease yield reductions
  - Placement
  - Split N systems based on soil/crop analysis
- Guidelines for economical optimal partitioning of allowed N between crops?

### Why joint EU action with refer to recommendations?

- Improved justification of recommendation linked parts of Action Programs
- Improved quality of recommendations systems of individual countries
- More efficient use of available data (exchange of data between countries with comparable growing conditions)

### Now it's up to you......