PLANT RESEARCH INTERNATIONAL
WAGENINGEN UR

How to Reduce Nutrient Emissions from Agriculture?

International Workshop Summary Report

Utrecht, 19-20 November, 2009

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Ministry of Agriculture, Nature and Food Quality

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Ministry of Agriculture, Nature and Food Quality

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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 nutrientenverliezen 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 uitspoelingsgevoelige gebieden ('Nitrate Vulnerable Zones' – NVZ) waarvoor Actieplannen werden opgesteld. In Denemarken, Vlaanderen, Duitsland en Nederland zijn deze Actieplannen van toepassing op het gehele nationaal 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 gebruiksruimte 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 maïs), 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 financiele 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 nutrientenbenutting te bereiken. Daaronder vallen verhandelbare N- en P-quota, verzekeringen, en het verbinden van cross-compliance vergoedingen met eisen aan nutrientenbenutting.

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 indispensible 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 P_2O_5 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 it's 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 (maxium 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.

Option		Score
Further tightening via legislation		5[5]
• No animal manures after harvest (if next comes Spring crop or winter cereals[1])		2*6+6+2+2*1
• No animal manures at all on sandy soils (on specific crops)		2*1
• Increase N fertilizer value (NFV) of manures		2*2+1+1+2*2
• Further reduction of N application standards (manure + mineral fertilizer)		4+5+2*2
• Restrictions on use of industrial P fertilizers		2*1
• Compulsory catch crops (overwinter green cover[6]), with establishment dates		2*4+2+1+2*2+2
• No soil tillage in autumn		1
• Limits on livestock number per ha at farm level[2]		
• Reduction of maximum P applications		1
• 'the Danish system' (added by one respondent as total package[3])		2*20
• mandatory low emission application of manures		4+2*1
Subtotal	*119*	
Financial mechanisms / incentives		5[5]
• Tradable N quota		2+5+2*1
• Financial compensations for yield loss or for certain farm measures, e.g. catch crops[9]		2*1+2+2*2+2
• Insurance systems		
• Internalizing public costs of fertilizer use (tax)		2
• Link cross-compliance mechanism with requirements on N use efficiency		4
Subtotal	*30*	
Knowledge transfer		5[5]
• Farm networks (international farm network[4])		1+2+2*1
• Web applications (e.g. for fertilizer planning/nutrient management)		2*2+2*1
• More extension work[10]		2*1+3
• Stimulating measures via specific agri-environmental projects		2*1+2*1+3
Subtotal	*28*	
Structure of agriculture		
• Mixed farming		
• Extensification (but at expense of food security[7])		2*1
Subtotal	*2*	
Soil management		
• improve soil management for better overall N use efficiency		2+2
Subtotal	*4*	
Technology innovation for increased nutrient use efficiency		5[5]
• Precision application technology		
• better timing and dosage based on crop/soil indicators		2+2+1
• fertilizer placement technology (row; per plant)		1+2+2
• Processing manures into specific products that better match crop demand		2*1+2+2+1
• Crop breeding[8] for nutrient efficiency (mainly for increased winter N uptake)		2*2+4+1+2
• Animal breeding[8] for nutrient efficiency traits		1
• urease / nitrification inhibitors		2*1
Subtotal	*35*	
Improve fertilizer recommendations		*2**
• improve recommendations based on inter-country benchmarking		2*1+4+2+5
• develop and use suitable indicator for soil N supply		2+2*1+2
• differentiate recommendations for yield level		2*1+2
Subtotal	*25*	

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 presciptions; 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

Technische commissie bodem

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afgehandeld

Aan
Plant Research International B.V.
t.a.v. de heer dr. ir. H.F.M. ten Berge
Postbus 616
6700 AP Wageningen

TCB S39(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 nutriëntenverliezen uit 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 Boekhold, plaatsvervangend algemeen secretaris van de TCB. Ik stel voor dat u in overleg met mevrouw Boekhold de bijeenkomsten van de TCB-BC organiseert.

De opdracht wordt afgerekend 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.

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[1] Uw kenmerk 09PRI0897/Hbe/05PRI0140/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 aanlevert, als pdf-file. Dit maakt onderdeel uit van de onderhavige opdracht.

Op deze opdracht zijn de Algemene onderzoeksvoorwaarden 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, P46, als kenmerk op te nemen. Rekeningen dienen te worden gericht aan:

Technische commissie bodembescherming
Mevrouw I. Sewnarain
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 algemeen 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).

Measure	DK	FL	GE	UK	NL
Farm measures					
Fertilizer planning					
• Keeping records	+	+	+	+	+
• Soil analysis	+		+		+ (if derog.)
Fertilization					
• Closed periods manure/mineral fertilizers	+	+	+	+	+
• Low emission application methods	+	+	+	+	+
• No manure application on frozen, snow	+	+	+	+	+
• Covered and waterlogged land					
Post-harvest measures					
• Catch crops	+				+
• No tillage in autumn	+				
Unfertilized zones along surface water	+[2]	+	+	+	+
Other policy measures					
Max limit for livestock rate	+				
Maximum limits on N and P use					
• Manure	+	+	+	+	+
• Total N (manure + fertilizers)	+	+		+	+
Maximum N and P surpluses			+		
Maximum soil mineral N autumn		+	(+)[1]		

[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 quotum.

- 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_3; NH_3; N_2O). 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 asses 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 P_2O_5/ha depending on crop group
  - Maximum limit of 20 kg P_2O_5/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 asses 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 tolylfluanid

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 in1994-2008:
- 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 m^3 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 composts, 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

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

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

Denmark

Leif Knudsen	Danish Advisory Service, Aarhus
Susi Engholm	Danish Advisory Service, Aarhus
Finn Pilgaard Vinther	Aarhus University

Flanders

Georges Hofman	Ghent University

Germany

Kerstin Panten	Julius Kühn-Institute, Braunschweig
Frauke Godlinski	Julius Kühn-Institute, Braunschweig
Karin Rather	State Horticultural College and Research Institute, Heidelberg

United Kingdom

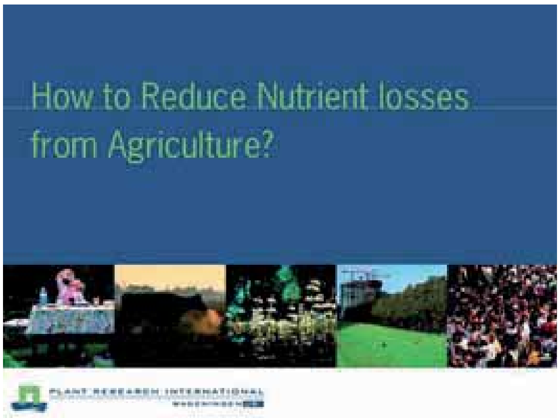
Brian Chambers	Agricultural Development and Advisory Service, Mansfield
Peter Dampney	Agricultural Development and Advisory Service, Cambridge

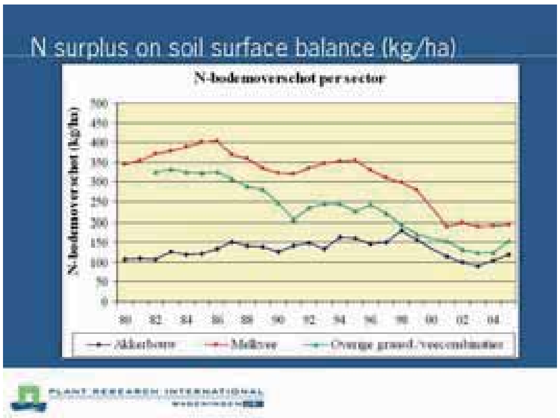
The Netherlands

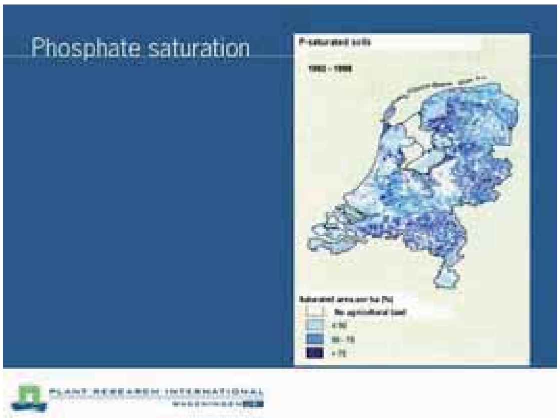
Hans van Grinsven	Netherlands Environmental Assessment Agency (PBL)
Frank Wijnands	Applied Plant Sciences, Wageningen UR
Harm Brinks	DLV-Plant, Wageningen
Jaap Schröder	Plant Research International, Wageningen UR
Oene Oenema	Commissie Deskundigen Meststoffenwet (CDM); and Wageningen UR
Sandra Boekhold	Technische Commissie Bodem (TCB, secretary)
Jacques Neeteson	Technische Commissie Bodem (TCB); and Wageningen UR
Hein ten Berge	Plant Research International, Wageningen UR
Wim van Dijk	Applied Plant Sciences, Wageningen UR
Ben Rutgers	Plant Research International, Wageningen UR

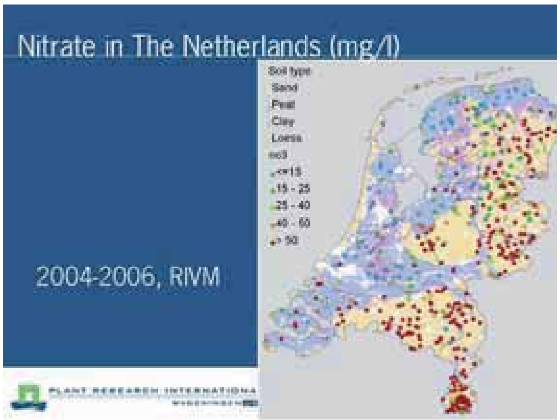
Appendix VIII. Presentations

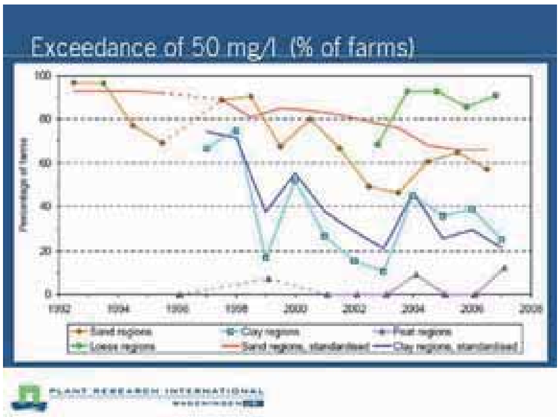
Presentation by Jacques Neeteson



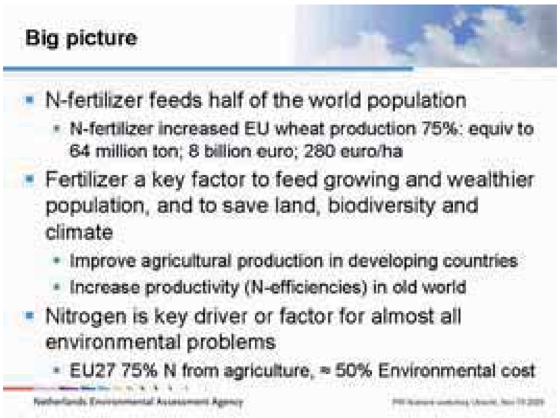


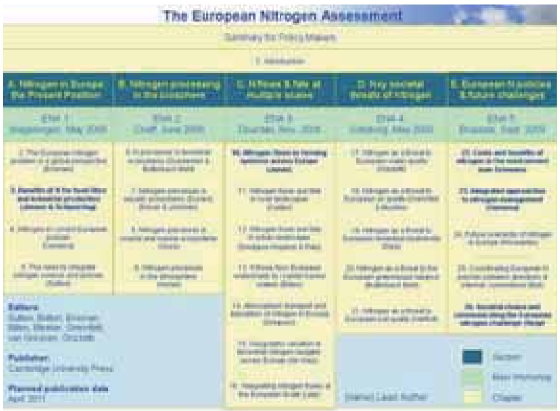


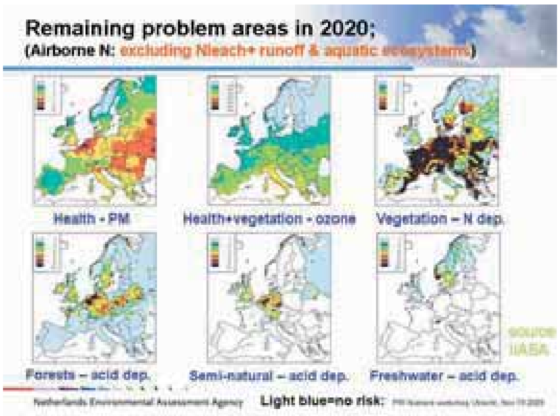


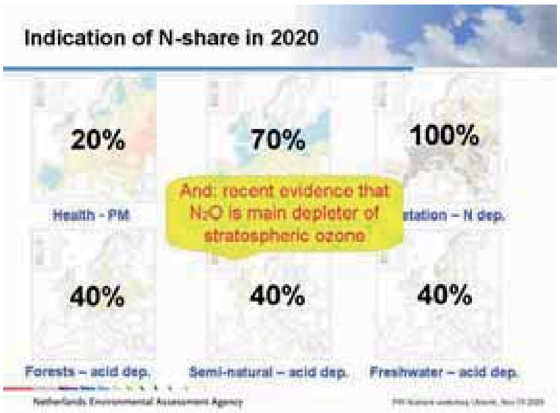


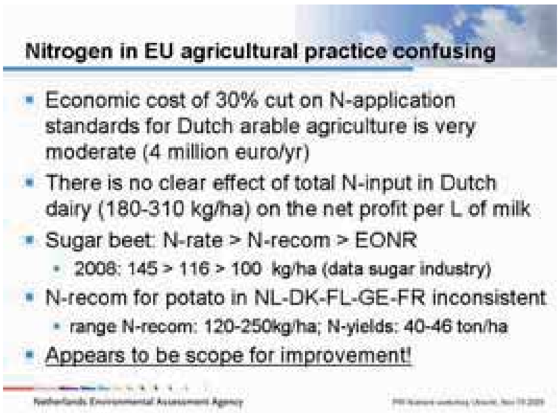
Presentation by Hans van Grinsven

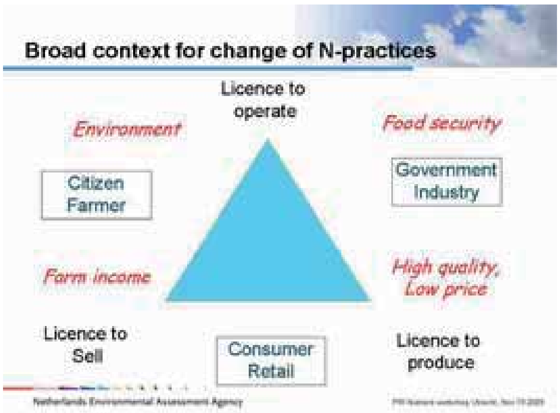


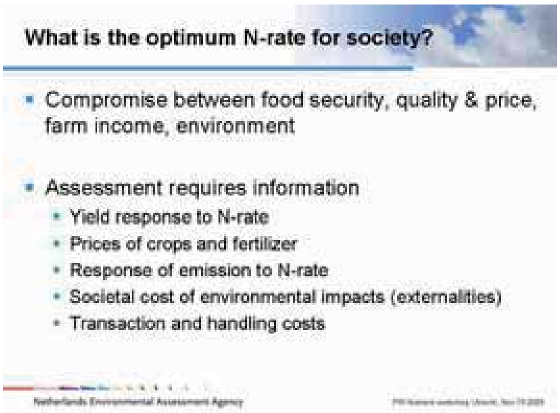












Framework for cost assessment

Total cost

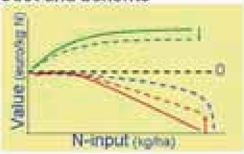
- Financial & economic approach

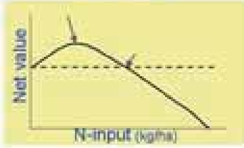
- Benefits
- Damage
- Mitigation

Not considered

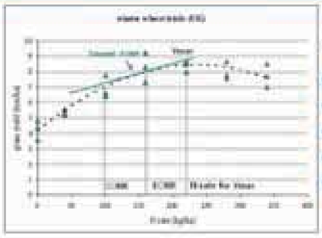
- *Administrative costs*
- *Income transfer*
- *Side effects unrelated to N*

Cost and benefits





Yield response curves

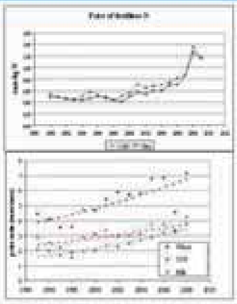


EONR: Economic Optimal N rate
SONR: Economic Optimal N rate

Not easily generalized

- Yield gap
- Fitting function
- Intercept
- Other limiting factors
- Trial setup

Prices of fertilizer and crops



- Fertiliser prices increase
- Crop prices volatile
  - Note 2008 food crisis!
- Food prices correlated with N-prices
  - Price ratio pN/pC (€/ €)
  - 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	
N_2O-air	*Depletion ozone layer?*		GHG-balance
NH_3-air	Secundary Particulates	Eutrophication Acidification	
NOx-air	Cara Cancers	Eutrophication Acidification	

Environmental emissions

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

	100% N fertilizer (CAN)		50% manure N
N-fert eq	0-300 kg/ha		0-300 kg/ha
Total N	0-300 kg/ha		0-560 kg/ha
	low	high	
Nitrate-gr.water	10 kg/ha +25%	40 kg/ha+25%	14%
% to surf.water	25% gr.water	75% gr.water	7%
N_2O-N-air	1%	2%	0,6%
NH_3-N-air	1%	3%	10%
NOx-N-air	0,15%	0,60%	0,15%

Based on EF's in MITERRA-Europe, Velthof et al., 2009 JEQ

Damage unit N-costs for society

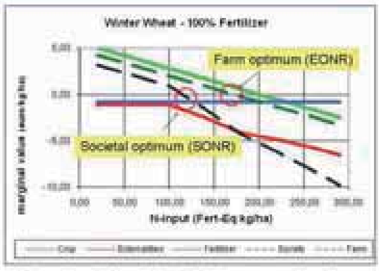
€/kg N emission	Nitrate-leach		N2O		NH3		NOx	
	Min	Max	Min	Max	Min	Max	Min	Max
Human health	0	4			2	20	10	30
Ecosystem health	5	20			4	12	3	10
Greenhouse balance			5	14				

- Method: WTP for life year, "clean"; water + dose response functions
- Consideral uncertainties and conceptual differences
- Dissensus on impacts of nitrate and ammonia on human health
- Large regional differences: factor 20-100; (dispersion-exposure)

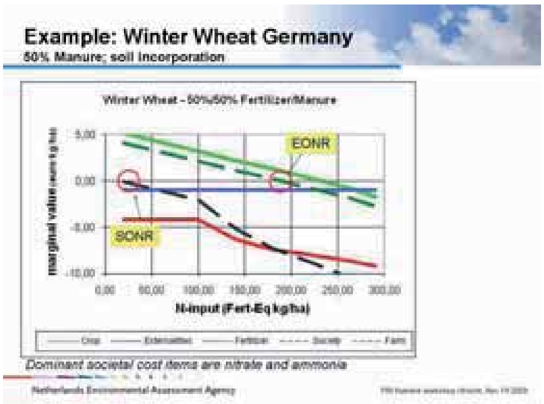
Assessment cost & benefits of nitrogen

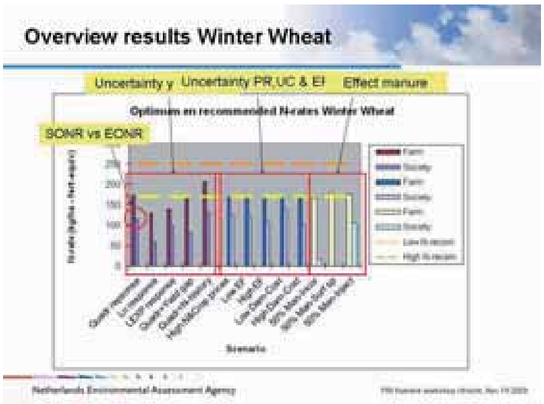
- Wheat, OSR, milk
- Variety of yield response data EU
- Uncertainties: prices, EF and damage costs
- EONR vs SONR
- Food security issues ignored

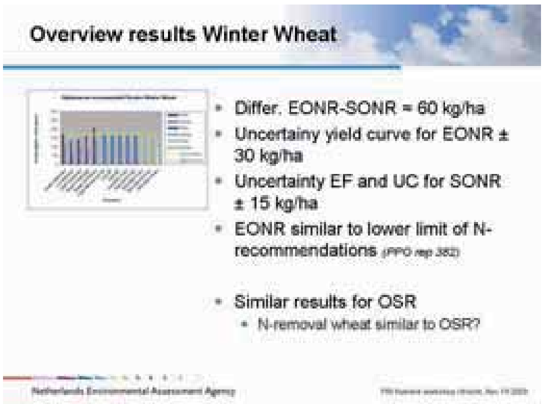
Example: Winter Wheat Germany

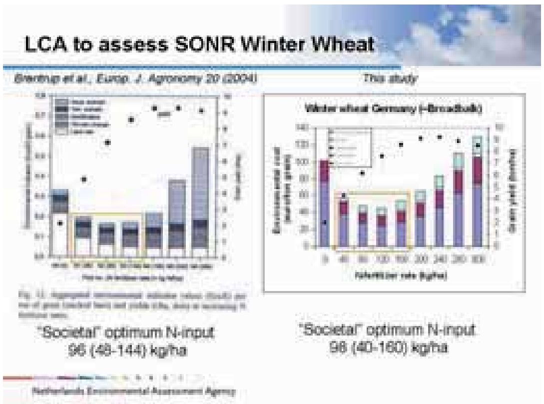


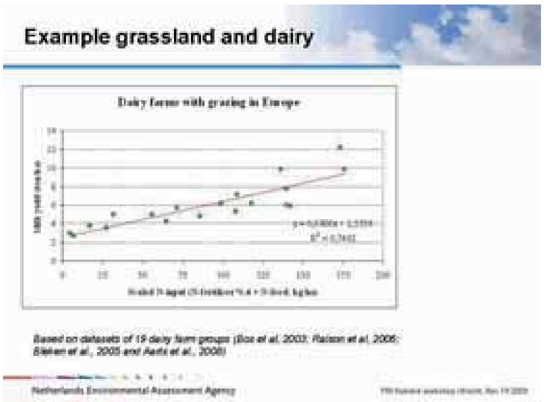
Dominant societal cost item is "nitrate on ecosystems"


Example: Winter Wheat Germany
50% Manure; soil incorporation
Winter Wheat - 50%/50% Fertilizer/Manure
EONR
SONR
marginal value
N-input (Fert-Eq kg/ha)
Crop
Externalities
Fertilizer
Society
Farm
Dominant societal cost items are nitrate and ammonia
Netherlands Environmental Assessment Agency


Overview results Winter Wheat
Uncertainty y
Uncertainty PR,UC & EF
Effect manure
Optimum en recommended N-rates Winter Wheat
SONR vs EONR
Scenario
Netherlands Environmental Assessment Agency


Overview results Winter Wheat
Differ. EONR-SONR = 60 kg/ha
Uncertainty yield curve for EONR ± 30 kg/ha
Uncertainty EF and UC for SONR ± 15 kg/ha
EONR similar to lower limit of N-recommendations (PPO rep 382)
Similar results for OSR
N-removal wheat similar to OSR?
Netherlands Environmental Assessment Agency


LCA to assess SONR Winter Wheat
Brentrup et al., Europ. J. Agronomy 20 (2004)
This study
Winter wheat Germany (-Broadbalk)
Fertilizer rate (kg/ha)
"Societal" optimum N-input 96 (48-144) kg/ha
"Societal" optimum N-input 98 (40-160) kg/ha
Netherlands Environmental Assessment Agency


Example grassland and dairy
Dairy farms with grazing in Europe
Based on datasets of 19 dairy farm groups (Bos et al. 2003; Raison et al. 2006; Sleken et al., 2005 and Aarts et al., 2008)
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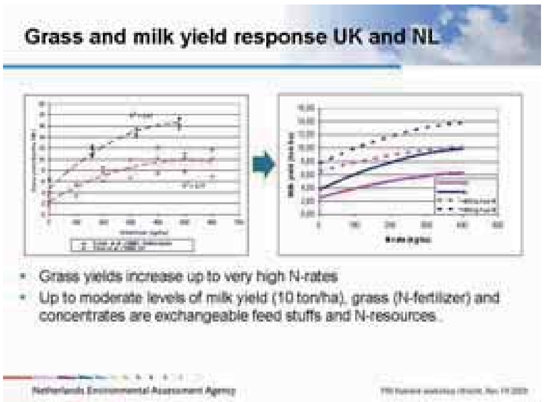
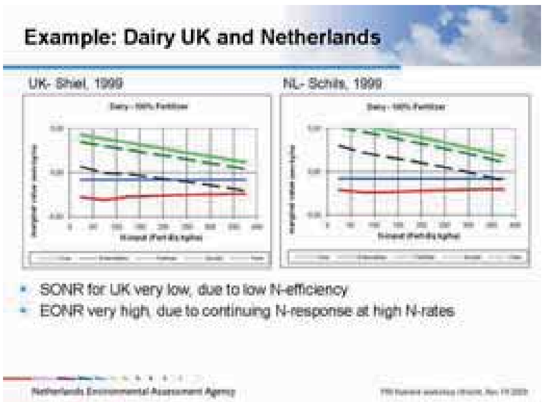
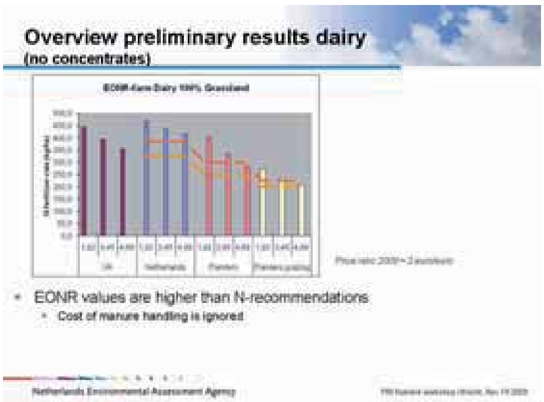
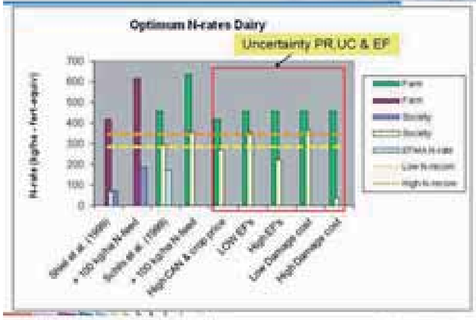

Grass and milk yield response UK and NL
Grass yields increase up to very high N-rates
Up to moderate levels of milk yield (10 ton/ha), grass (N-fertilizer) and concentrates are exchangeable feed stuffs and N-resources.
Netherlands Environmental Assessment Agency


Example: Dairy UK and Netherlands
UK- Shiel, 1999
NL- Schils, 1999
Dairy - 100% Fertilizer
SONR for UK very low, due to low N-efficiency
EONR very high, due to continuing N-response at high N-rates
Netherlands Environmental Assessment Agency


Overview preliminary results dairy
(no concentrates)
EONR-farm Dairy 100% Grassland
UK
Netherlands
Flanders
EONR values are higher than N-recommendations
Cost of manure handling is ignored
Netherlands Environmental Assessment Agency

Overview preliminary results dairy



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Preliminary quantitative conclusions

- Arable: N-rates > N-recom > EONR
- Dairy: EONR > N-recom ≈ SONR
- Arable: SONR-EONR ≈ 60 kg/ha
- Dairy: SONR-EONR ≈ 200 kg/ha

- Effect expected increase price ratio (coming ≈ 5 yr):
  - Wheat -5 kg/ha, OSR -10 kg/ha, Milk -40 kg/ha

- Dominant environmental cost items
  - Wheat: case 100% N-fert versus case 50% manure
  - NO_3 (84%) : N_2O (4%): NH_3 (12%): NO_x (2%)
  - NO_3 (49%) : N_2O (2%): NH_3 (48%): NO_x (1%)

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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

Netherlands Environmental Assessment Agency

Some options for improved N-regulation

- Integrated N-approach
  - Societal cost of agricultural N_2O far less than of ammonia and $N_{(-itrate)}$ -leaching
  - Strict N-ceilings, 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

Netherlands Environmental Assessment Agency

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
  - Lenght of trials not fit for LT N-recommendation

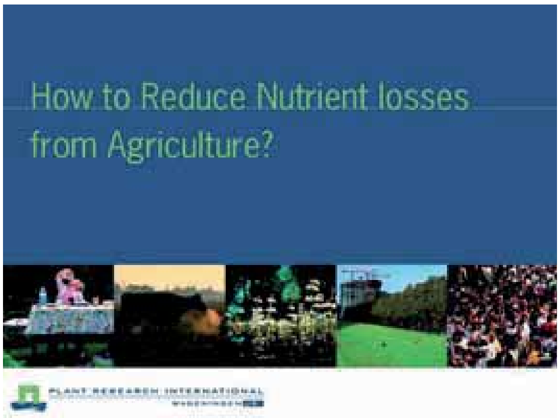
- Environmental cost data are still too uncertain to allow integrated cost-benefit assessment of N
  - Health and ecosystem impacts of nitrate and ammonia
  - N-costs less tangible / communicatable than N-benefits

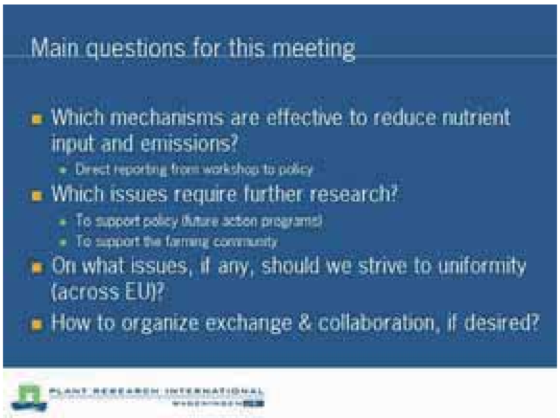
Netherlands Environmental Assessment Agency

Thank you

Netherlands Environmental Assessment Agency

Presentation by Jacques Neeteson





Presentation by Leif Knudsen

Policy instruments and GAP in Denmark

Chief adviser Leif Knudsen
Danish Advisory Service

GOOD AGRICULTURAL PRACTICE

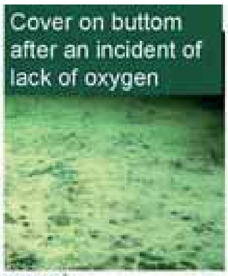
CONTRA

LEGISLATION

Year	Action plan	Main instruments
1985	NPO	Max. livestock units per ha No direct outlets of manure
1987	Water environ-mental protection plan I	Obligated fertilizer plans Demands for storage capacity of slurry, "wintergreen fields"
1992	Sustainable agriculture	Max quotas for nitrogen Minimum utilization of N in manure Restriction for slurry application in autum
1998	Water environ-mental protection plan II	Reduced N-quotas to 10 percent under optimal rates. Demands to catch crops Establishing "wetlands"
2003	Water environmental protection plan III	Extended demands for catch crops Extended demands for utilization of manure
2009	"Green Growth"	Extended demands for catch crops Specific regulation of vulnerable areas No tillage in autum before spring sown crops New N regulation system based on tradable N quotas

Demands for catch crops

- Catch crops can be undersown grass in cereals, mustard or raddish 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 glyphosat 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



Depletion of oxygen has always occured.
Depletion of oxygen is more common with high N and P content.
Depletion of oxygen was more common in the 80'ties and 90'ties than before.

Nitrogen regulation in DK now:

- Maximum livestock units per ha
- Restriction in application time for animal manure
- Demands for storages capacity for manure
- Demands for catch crops
- Maximum quotas of nitrogen on farm level including:
  - Calculation of quota from crops, soiltype,…
  - Minimum utilzation of nitrogen in animal manure
- Obligated fertilizer plans and fertilizer accounts

Maximum livestock units per ha

Animal type	Max Lu./ha	No. per lu.
Dairy cow, Holstein-Frisian	1,7	1 cow =1,33 Lu, 1 cow incl. heifers: 1,77 Lu
Pigs for slaughtering	1,4	36 produced pigs 32-107 kg = 1 Lu
Piglets	1,4	200 produced piglets 7,2-32 kg = 1 Lu
Sows	1,4	4,3 sows = 1 Lu
Chicken	1,4	2900 produced, 40 days = 1 Lu

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 pct. of areal in autumn with grass or beets
- No animal manure to grass in the period fra 31th august to the 1th of march, if the grass is ploughed down the same year
- Only ploughing of grass from 1th march to 1th of june
- Soil analyses for N and P for each 3 year (1 sample per 5 ha)

NB! Not complete

Restriction in application times

Type	Restrictions	Technique
Liquid manure	No application from harvest to 1th of February except: harvest to 1th of October to winter oilseed rape and grass Harvet to 15th of October to grass for seed	From 2011 direct injection on bare soils and grass. To wintercereals with trailing hoses
Solid manure	Without crop in winter: banned from harvest to 1th of november	Incorporation on bare soils within 6 hours

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 tent or concrete cover

Maximum Nitrogen qoutas on farm level

- The N-quota 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-quotes 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 decission (10 percent below the optimal rate in 1998)

An example

Ha	Soil ind ex	Crop	Yield, ton/ ha	Quta Kg	Next year effect	Quta	Total
100	6	Winterwheat	8.0	161		137	13.700
100	6	Winterbarley	7.2	152		152	15.200
100	6	Winteroilseed rape	3.6	183	-27	183	18.300
49	6	Spring barley(+grass)	5.7	114			5.586
Total qouta							52.786
- Effect of catch crops (25 kg N per ha:							-1.225
						148	51.561
Minimum utilization of pigslurry			140 N	X 75 pct.		105	36.645
Rest quta in mineral fertilizer						33	14.916

Nitrogen in manure - calculation

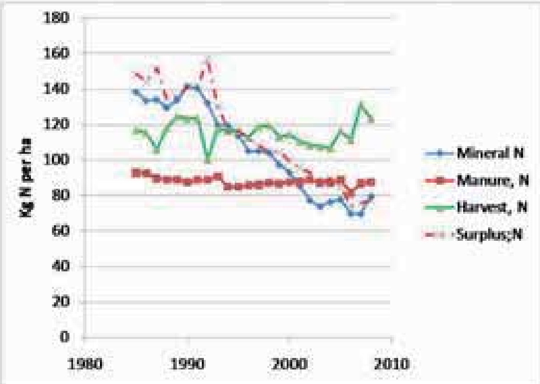
- Standards for nitrogen in animal manure is given yearly for different animal type and types on stables
- The background is data for feeding and coefficients for ammonia emission in stable and storage.
- If the farmer can prove a better utilization of nitrogen in stable (e.g. low protein diet) it is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

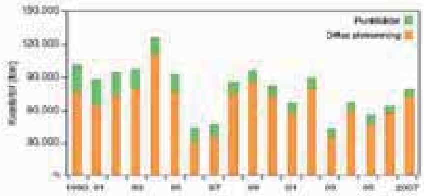
Minimum utilization of nitrogen in manure (pct. of total nitrogen)

Type of manure	Minimum utilization
Slurry, catle	75
Slurry pigs	70
Animal manure (solid) + urine	65
Deep Litter	45
Sludge for municipalities	45
E.g. West from potatoes – starch production	50

Fertilizer plan and fertilizer account

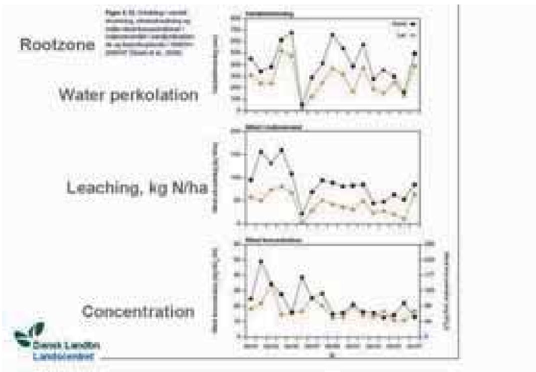
- Before the 21th of April the farmer must have calculated his quota. Can be done electronical together with EU-application
- No obligated demands to keep a journal of fertilizing
- Before 1th of april the following year the farmer must do and report a fertilizer account for the previous year to the minestry.

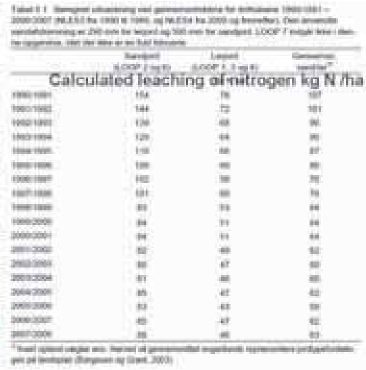




Outlet of nitrogen to the marine environment

Dansk Landbrugsrådgivning
Landscentret





Calculated leaching of nitrogen kg N /ha

New action plan: "Green Growth"

- Task: to reduce nitrogen leaching with 1/3. It means from an average 60 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

Dansk Landbrugsrådgivning
Landscentret

Presentation by Georges Hofman

Potential and real derogation in 2008

	Potential	Application	Awarded	No derogation
Farms	31136	3785	3750	27410
Area (ha)	530380	91263	83500	456740

Surplus application: 6.5×10^6 kg N

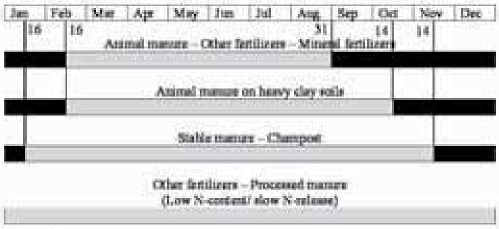
Fertilization limits

For N and P_2O_5
-Variation in function of group of crops
-Some more restrictions on sandy soils
-Restrictions for N-total, N-animal, N-other and N chemical (restricted choice for the farmer)
-It concerns always total N and not effective N
-Maximum 20 kg P_2O_5/ha as chemical fertilizer

Crop	P_2O_5	N-total	N-animal	N-other	N-chemical
Grass	100	350	170	170	250
Maize	85	275	170	170	150
Maize on sandy soils					
2009	85	265	170	170	150
2010	85	260	170	170	150
Low N-need crops[1]	80	125	125	125	70
Leguminosae, not peas or beans	80	0	0	0	0
Sugar beets	80	220	170	170	150
Other crops	85	275	170	170	175
Cereals on sandy soils					
2009	85	265	170	170	175
2010	85	260	170	170	175

[1]Belgian endive, chicory, shallots, onions, flax, peas and beans

Time of application



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
"Nitrate nitrogen residue stick"
Maximum 90 kg NO_3^--N/ha from 0-90 cm
Measurements between 1 October and 15 November
Fines have to be paid above a certain limit

Calculation administrative fines

[(GN – F x TN) x 4 € + 100 €]
For GN higher than FxTN
with:
GN = measured residual NO_3-N
TN originally 90 kg NO_3-N/ha
F = number determined by Flemish Government
Originally 15/9
TN and F will be revised in function of crop type (rooting depth)

Calculation administrative fines

Remarks:
-Only applicable in so-called "risk areas"
-System introduced in 2007 but still a lot of debate
Reasons:
-Threshold values have to be further classified
-Discussions about the methodology

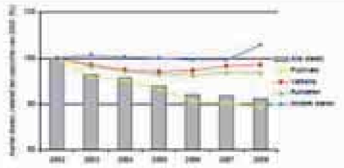
Nutrient excretions by animals

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

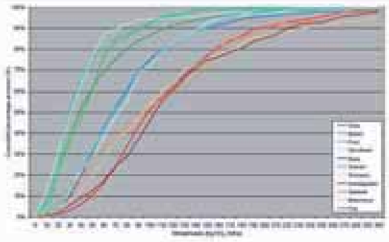
Evolution of animal amounts since 2002



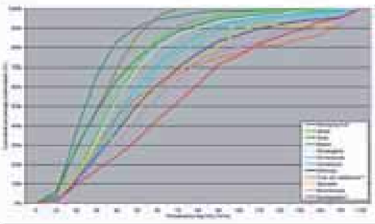
Evolution nitrate-N residue in soils (kg/ha)

	Mean	Median
2004	106	78
2005	98	78
2006	107	83
2007	71	53
2008	75	59

Cumulative nitrate residue (in %)



Cumulative nitrate-N 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 – 35 to 40% exceed at least once the 50 mg nitrate/L

Surface water:

About 800 measuring points

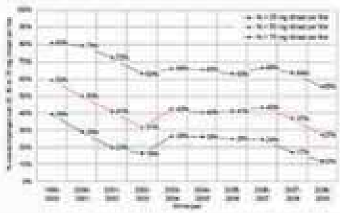
Clear decreasing trend

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

	1999 - 2000	2000 - 2001	2001 - 2002	2002 - 2003	2003 - 2004
Flanders	59	50	41	31	42

	2004 - 2005	2005 - 2006	2006 - 2007	2007 - 2008	2008 - 2009
Flanders	40	41	43	37	27

% exceeding at least once some threshold values



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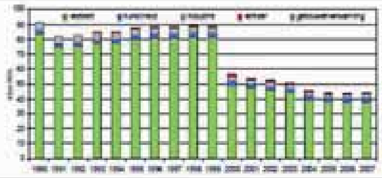
Evolution NH_3 emissions



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Losses by emissions in stables and by storage

Originally 15%

In new Decree differentiated

-For cattle between 10 and 20% (depended on the amount of produced farmyard manure)

-For pigs and chicken depended on type of stable

In total: netto N production is 21% lower than gross production

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Fertilization advice systems

Two systems are used in Flanders:

-N-index method

-Mineral N-balance method

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N-index method

Extension of N_{min}-method

N-index = $X_1 + X_2 + \ldots\ldots\ldots + X_{18}$

$X_1 = N_{min}$ (till rooting depth)

X_2 till X_9: N mineralization

X_{10} till X_{18}: negative factors (like compaction, low pH,etc.)

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N-index method

N-advice = $a - b \times N_{index}$

a and b differ between regions, cultivar and destination of the product

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Mineral N-balance

Theoretical N-fertilization:

N-need of the crop + Latent N_{min}-residu – N_{min}-residue 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

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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 P_2O_5 applications decreased

-Flemish manure balance is ok

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Conclusions

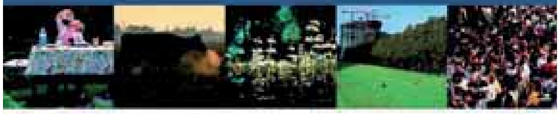
- Surface waters: less places exceeding the threshold value of 50 mg nitrate/L
- Groundwater: no clear trends

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



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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 ?

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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)
  - aplication time
  - working coefficient defined (as part of the equation for N-available rules)
- Catch crop obligatory after maize
- Contributing to substantial lower surplusses

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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 improving soil fertility (P,C,B)
  - Supporting optimal crop production
  - Minimising impact on ecology and environment

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Integrated nutrient management

- Principles:
  - Maintaining agronomic desired and ecological acceptabel nutrient reserves for P and K
  - Maintain agronomic desired level of organic matter in soil
  - Balance principle: input = offtake + unavoidable losses
  - Adjust N fertilisation for expected N availability from preceeding crops/green manures and soil organic matter, leaving room for fine tuning during growing season
  - Optimize agronomy (crop\rotation, soil tillage etc)

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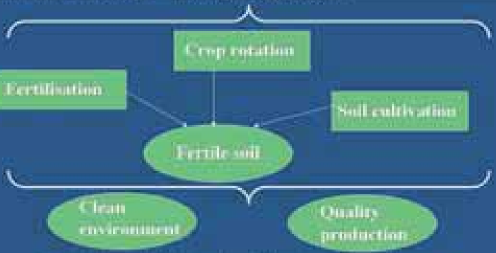
Multiple methods – multiple objectives



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

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Integrated nutrient management - strategy

- Strategic
  - Planning of P and K fertilisation over the crop rotation
  - Planning of green manure and crop residue management
  - Organic matter management (input etc)
- Tactical
  - Planning N-fertilisation over crops and fields
  - Amount and form, partitioning, application technique
- Operational
  - Field and year specific fine tuning N fertilisation
  - DSS (Decision Support Systems) based on crop and soil "status" assessment

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INM methods & techniques - elements

- Proper crop rotation
- Careful strategic planning on farm level
- Choice of organic manure (or manure products)
- Organic manure only in spring (also on clay)
- Green manure use
- Careful planning / calculation of N fertilisation, crop and field specific
- Fertilizer formulation
- Split applications of N
- Row application P or N
- Precision farming, spot specific
- Decision support systems
  - N-mineral in soil before growing season
  - N in soil, N in crop
  - Crop scans or Satelite images.

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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 farmresearch, participatory approach)
- Step 4:
  - dissemination of feasible and effective techniques in famring community

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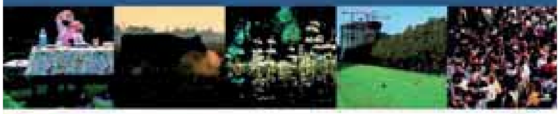
Farming systems research: integral approach



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INM & Integrated Farming Systems

- INM was integral part of the farming systems research in the Netherlands during the 80-90 ties
  - Integrated farming systems in comparison with organic and conventional, semi practical scale
  - Development and comparison
  - Multiple potentially conflicting objectives
  - Testing and improving strategies and methods
  - European network (IOBC EU supported) from 1990-2000
  - DFS Nagele Comparison conventional, organic and integrated 1978-2003, arable cropsclay soil, 72 ha
  - Conventional system stopped in 1990
  - More experimental sites in different regions and sectors period 1986-2003

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Results NL experimental farms

- Period 1990-2000
- Substantial reductions in surplusses
  - compared to past, or to conventional systems or practice reference
  - Clay soils: low N-NO3 losses through drainwater (< 5 mg N-NO$_3$/l)
  - Sandy soils, strong reductions in losses and measured content of groundwater, but still too high

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New experimental farming systems (2003-)

- Continuous need for innovations,
  - still too high losses on sandy soils
- Nutrient waterproof: sandy soils (2003-2009)
  - Search directions:
  - Minimising organic matter inputs
  - Offtake of all residues, composting
  - Redirecting drainwater through biofilters
  - Integral use of (experimental) DSS

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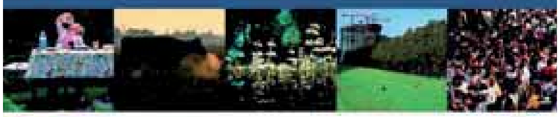
Pilot farm approach: road testing new approaches



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Pilot farm networks over the years (plant production)

- Pilot farm network integrated farming
  - 1990-1993: 38 farms (arable)
  - 1996-1998: 18 farms (vegetable)
- Farming with future
  - 2000-2003: 40 farms (all sectors)
  - 2004-2007: 350 farms (all sectors, study groups)
  - 2008-2010: network based activities

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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 traders, supliers, advisory organisations etc., all relevant stakeholders

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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": twin farms, pair
- Intensive guidance
  - whole farm approach, that's the strenght
  - agronomical demands
  - analysis current situation
  - implementation and improvement plans
  - guidance in building up experience with new approaches
  - decisions farmers' responsability

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 kowledge

- Use the newest, promising, knowledge
  - From government and sector sponsored research programmes on fertlisation
- Link this with
  - 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: suplliers, collectors, advisors, agri-business etc.

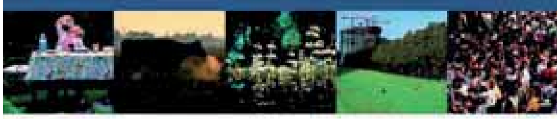
Knowledge dissemination / "circulation"

- Only ! 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, excursions, 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 antenna for "the future in practice or the practice of the future"

Managing limitations – room to improve



Experiences in recent years – pilot farms

- N/P Application Standards are narrowing the playing field
  - However, in general not (yet) frustrating an optimal approach
- Organic matter inputs are NPK fertilizers,
  - puzzle to maintain soil organic matter levels and optimize N availability at the right moment,
  - NL has 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)

Strategic and tactic planning

- Optimal agronomy all around, including crop rotation and soil tillage is the basis for a good soil fertility
  - Buffer, precondition for efficient N use of crops
- Key elements to improve
  - Overall planning and follow up
  - Organic matter management (green manures, crop residues, choice of organic manure)
- Constraints
  - Too difficult
  - Planning of fertilisation is multidimensional and quantatative puzzle
  - Existing "deals" (organic manure), short term interests, ad hoc decisions

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 surplusses
- Therefore DSS (Decision Support systems), vital importance

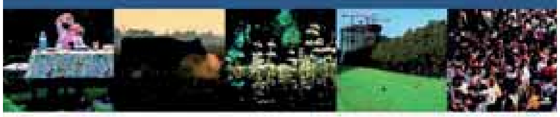
Constraints for DSS use

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

Future developments and needs

- New techniques with perspective
  - Precision farming (GPS)
  - Row aplication
  - Manure products (matching profile NPK demands for specific situation)
- Substantial more research to develop new technology
  - Public and private interests justify 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 successfull 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, risks, costs etc.)
  - Have the will (vision and motivation) and
  - Be allowed to do so ("socially desired" behaviour, acceptance in network)

Process of change farmers

- awareness
- mentality
- behaviour

- necessity/urgence
- vision/point of view/strategy
- –
- success

Lessons learned – success factors

- Excellent technology
  - Increasingly hard to find
  - Innovations needed, new principles, new approaches
  - Substantial contribution
  - 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

Lessons learned – success factors

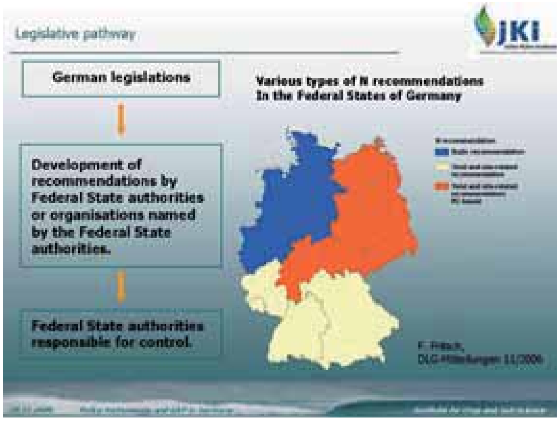
- Involve agricultural community – stakeholders
  - Responsability for economic and ecological interests
  - Link interests – whats at stake for SH with the sustainabilty issue
- Support these developments by an organisation – project
  - Independent,
  - Flexible
  - Highly knowledgeble, expertise
  - Skill in process and content

Incentives (inspired by crop protection)

- Economically
  - New technology makes you money!!
  - Government EU support, public concerns, support methods and techniques
  - Market- demands certification
- Ethical – ecological – environmental
  - Responsibel behaviour – sustainablity
  - Feedback on measured quality environmment
  - Make it the "norm"
- Legal
  - Rules and regulations
  - Additional rules (buffer strips, control machinery etc)

Thank you very much

Presentation by Kerstin Panten, Frauke Godinsky and Ewald Schnug



GAP's in DüV

Düngeverordnung (DüV; Fertiliser Ordinance)

§ 4 Further requirements for the application of nutrients *(free translation, summary and interpretation)*

(3) ≤ 170 kg/ha N a⁻¹ organic fertilisers.

(4) On grassland under certain circumstances ≤ 230 kg/ha N a⁻¹ (derogation granted until 2013).

(5) N fertilisers except manure and poultry manure are not to be applied (a) on arable land between 1.11. and 31.01. and (b) on grassland between 15.11. and 31.01.. These times can be altered by Federal States but must be at least 12 weeks for arable land and 10 weeks for grassland.

(6) Between harvest and the following crop/catch crop ≤ **40 kg/ha NH_4** or ≤ 80 kg/ha N.

§ 5 Nutrient balance

(1) Annual nutrient balances for N and P latest by 31.03., multi-annual balances.

(2) In case of organic fertilisation minimum N-indices need to be considered (appendix).

GAP's in DüV

Düngeverordnung (DüV; Fertiliser Ordinance)

§ 5 Nutrient balance *(free translation, summary and interpretation)*

(3) Under certain circumstances further unavoidable losses can be considered according to Federal State legislation.

(4) Exceptions for some farms: e. g. fields with ornamental plants, nurseries, some grassland with exclusively use for grazing (≤ 100 kg/ha N), without fertilisation, ≤ 10 ha managed fields, ≤ 1 ha vegetables, hops or strawberries, ≤ 500 kg N a⁻¹ from organic manure per farm.

§ 6 Evaluation of nutrient balances

(1) The balance need to be presented on demand (Federal State).

(2) Nutrient balances averaged over 3 years ≤ 90 kg N a⁻¹ (2006-2008), ≤ 80 kg N a⁻¹ (2007-2009), ≤ 70 kg N a⁻¹ (2008-2010) and ≤ 60 kg N a⁻¹ (2009-2011) or P_2O_5 ≤ 20 kg a⁻¹ averaged over 6 years are considered as acceptable.

GAP's in DüV

Düngeverordnung (DüV; Fertiliser Ordinance)

§ 7 Data recording *(free translation, summary and interpretation)*

(1) By 31.03.

(2) Special rules for applications of meat meal, bone meal or meat and bone meal.

(3) Have to be kept for 7 years.

§ 8 Limitations and prohibitions of application

(1) Fertilisers need to be approved by either the German Düngemittelverordnung or the EU 2003/2003 act. Organic fertilisers need also to be according to the Düngemittelverordnung.

(2) Prohibition of fertilisers containing meat meal, bone meal or meat and bone meal on grassland and as top-dressing for vegetables and forage cropping.

(3) Fertilisers produced using 'Kieselgur' are prohibited on cultivated arable land, grassland, forage cropping vegetables and fruit cropping close to soils.

GAP's in DüV

Düngeverordnung (DüV; Fertiliser Ordinance)

§ 8 Limitations and prohibitions of application *(free translation, summary and interpretation)*

(4) Fertilisers labelled with 'for lawn' or 'for ornamental plants' are only allowed accordingly.

(5) Certain fertilisers are not allowed after 2007. Exceptions. Own legislation for the use of sewage sludge.

§ 9 Special requirements for the agency responsible for authorisations

(1) Authorisations need to consider that the fertility of soils, health of humans and animals as well as the natural environment especially water quality are not put at risk.

§ 10 Administrative offence

(1) Administrative offences deliberate or careless are disrespect of ... see above.

(2) Administrative offences deliberate or careless are disrespect of **§ 10 Düngemittelgesetz**

GAP's in BBodSchG

Bundesbodenschutzgesetz (BBodSchG; Federal Soil Conservation Act)

§ 17 Good agricultural practices *(free translation, summary and interpretation)*

(1) Agricultural land use fulfils the duty of precaution by the application of good agricultural practices. By Federal State law named agricultural recommendation authorities have to communicate the rules of GAP's according to (2).

(2) Principle of the GAP's of soil use is the sustainable protection of soil fertility and the productivity of the soils as natural resource. Principles of GAP's 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.

Nitrate vulnerable zones (NVZ) in Germany

Whole territory approach – no NVZ's

- **Requires to establish and apply an action programme through the whole territory.**
- **Düngeverordnung (DüV, Fertiliser Ordinance) accounts as action programme.**
- **Nitrates report every 4 years, last 2008 (reporting period 2003-2006) – Evaluation of the implementation and impact of the action programme.**
- **Strong variation between states in regards to data availability about impacts on agricultural practices.**
- **But, all states report improvements in farm management with the view to the prevention of water pollution.**
- **Caused not only due to the measures of the Fertiliser Ordinance, but also changing general agri-policy framework resulting from the reform of the Common Agricultural Policy including support for water-related agri-environmental measures.**

Monitoring measures regarding fertiliser legislation 2004-2006

Monitoring of compliance with the Fertiliser Ordinance	Inspec-tions	Infringe-ments	Fines imposed
Avoidance of direct deposition and no prevention of runoff of fertiliser into surface waters.	6645 (1818)	109 (45)	47 (24)
Landspreading of nitrogen-containing fertilisers with disregard for absorptive capacity of soils.	6754 (1893)	336 (129)	201 (113)
Immediate incorporation into the soil of slurry, liquid manure, poultry manure and nitrogen-containing secondary raw material fertiliser in the autumn.	9450 (3063)	431 (117)	266 (73)
Exceeding the total allowable nitrogen quantity when landspreading slurry, liquid manure, poultry manure or nitrogen-containing secondary raw material fertiliser in the autumn.	5338 (2678)	44 (20)	20 (18)
Unlicensed landspreading of slurry, liquid manure, poultry manure or nitrogen-containing secondary raw material fertiliser during the period in which applications are prohibited.	6939 (1166)	131 (76)	73 (66)

Numbers in brackets: Nitrate report 2004, values for (2002)

Monitoring measures regarding fertiliser legislation 2004-2006

Monitoring of compliance with the Fertiliser Ordinance	Inspec-tions	Infringe-ments	Fines imposed
Limited application of livestock farm waste on soils with very high P or K contents.	10579 (3524)	17 (3)	8 (1)
Limit to the total amount of nitrogen derived from livestock farm waste which may be applied to land on the holding on average.	15467 (4113)	369 (54)	203 (34)
Regular and correct (as per regulation) determination of available nitrogen, content of P, K and Ca in the soils.	24613 (7036)	4464 (858)	2013 (259)
Correct (as per regulation) determination of N, P and K content of farm wastes to be landspread.	15129 (4189)	189 (87)	40 (19)
Record keeping for the purpose of determining the amount of fertiliser required and for nutrient input/output budgeting.	22901 (8028)	1659 (389)	829 (93)
Compliance with retention period for records.	19083 (3825)	334 (150)	148 (36)
Compliance with provisions regarding construction and capacity of storage facilities for livestock manure.	5959	178	14

Numbers in brackets: Nitrate report 2004, values for (2002)

Further voluntary contributions/programmes for farmers

Example: NAU (funding period 2000-2006)
Agro-environmental programme of Lower Saxony
(Part of PROLAND; Lower Saxony programme for the development of agriculture and the rural areas)

- **10 agro-environmental actions; EU co-financing.**
- **(A2) direct drilling; (A3) environmental friendly slurry application; (A4) flowering areas on fallow land; (A5) flowering stripe outside fallow land; (A6) perennial flowering stripe outside fallow land; (A7) cultivation of catch crops and undersown crops; (B) extensive grassland; (C) organic farming; (D) 10 years period of fallow land.**
- **~ 79 million € funding; 231,354 ha (9 % of agricultural land, 2005).**
- **Evaluation: Only 27 % of the areas with risk of nitrate leaching were covered.**
- **Recommendations for each action, some should not be continued, on the other hand further requirements are seen to improve the protection of resources in sensible areas. The evaluators see additional research demand for new efficient agro-environmental measures.**

Sustainability indicators for Germany

German sustainability strategy
2002

↓

21 Indicators and targets

↓ Only indicator in relation to nutrient losses from agriculture

12a: Nitrogen surplus
2010: 80 kg/ha

Scale of nutrient balances

Country wide
N Surplus in kg / ha, 1997, OECD
e. g.
Denmark 112
Finland 79
Germany 78
Poland 30
Sweden 36

Region (e. g. state, district)

Field (Soil Surface)

Nutrient balance variables

	Farm gate balance	Gross soil surface balance	Livestock balance
Input			
Mineral fertilisers	+	+	
Organic fertilisers	+	+	
Livestock manure		+	
Atmospheric deposition	+	+	
Biological N-fixation	+	+	
Seed and planting material	+	+	
Imported fodder	+		+
Fodder from domestic food industry	+		+
Fodder (internal production)			+
Output			
Total harvested crops and fodder		-	
Cash crops	-		
Livestock market products	-		-
Livestock manure			-
Surplus	= Sum	= Sum	= Sum

Farm gate balance = Gross soil surface balance + Livestock balance

Data sources

(1) DESTATIS tables of the Federal Statistical Office Germany:
Primary data on land use, livestock and yields.

(2) German "Musterverwaltungsvorschrift (1996)„ (Düngeverordnung, DüV):
Nitrogen coefficients until 2007 (part of the German Ordinance on Fertiliser Use).

(3) German Ordinance on Fertiliser Use (2007); (Düngeverordnung, DüV):
Nitrogen coefficients from 2007 onwards.

(4) German Ordinance on Fertiliser Use (Düngeverordnung, DüV):
Coefficients for NH_3 volatilization.

(5) Gauger et al. (2002). Mapping of ecosystem specific long term trends in deposition loads and concentrations of air pollutants in Germany and their comparison with Critical Loads and Critical Levels. Final report on behalf and for the account of the Federal Environmental Agency (UBA). Berlin.
Atmospheric N deposition.

(6) Dämmgen (Hrsg.) 2007). Calculation of Emission from German Agriculture - National Emission Inventory Report (NIR) 2007 for 2005: EMEP-Data.

Uncertainties within data sources

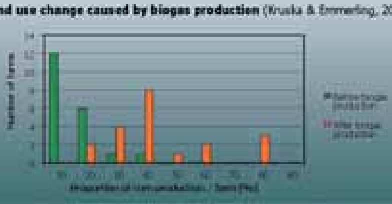
Some examples:

- Mineral fertilisers: Sales numbers, not application numbers.
- Animals in general: Representative recordings at the 3rd of May and 3rd of November; since 2003 general data recording only every four years. Therefore difficulties to estimate the nutrients from animal manure.
- Land use: Since 1999 only farms with > 2 ha agricultural land use area are recorded (> 1 ha until 1998); land use is important for the annual estimation of crop yield. Detailed recording every four years; in between representative projection from a maximum of 100 000 farms.
- Crop yield: For cereals, potatoes and oilseed rape (since 2004) yield is recorded on representative fields; other crops, grassland, fruits, grapes and vegetables are estimated. Sugar beet yield is recorded according to the beets delivered at the sugar plants. Crops with low production numbers are not reported.

External factors influencing nutrient balances

For example:
- Policy, e.g. increased production of renewable resources
- Mineral fertiliser prices
- Prices for marketed crops

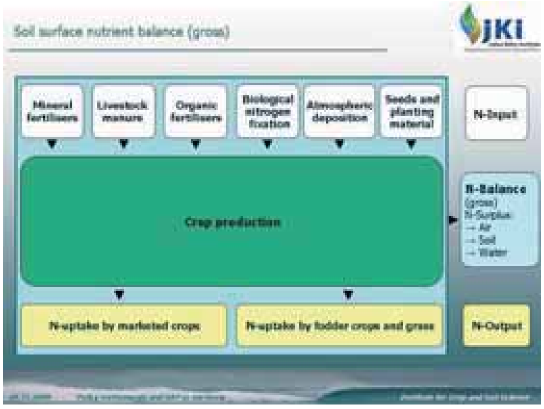
Land use change caused by biogas production (Kruska & Emmerling, 2008):

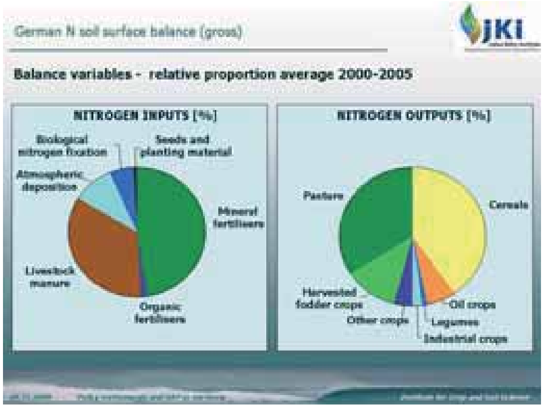


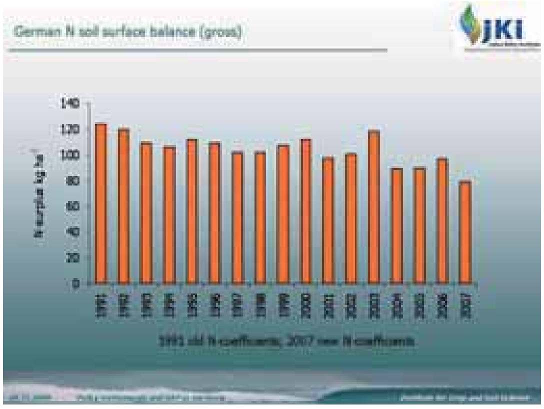
OECD/EUROSTAT

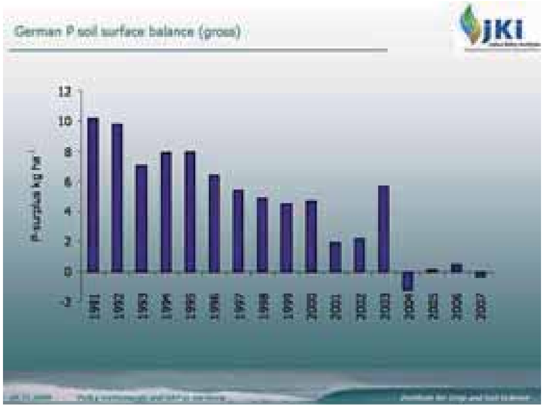
OECD/EUROSTAT gross nitrogen balances (2003): Handbook

- The calculation of nitrogen balances has been identified as a priority agri-environmental indicator by OECD Member countries.
- It is important to be able to calculate nutrient balances in order to identify areas where persistent surpluses or deficits may put natural resources at risk.
- Several meetings have been held to identify and agree on the most robust and feasible methodology for the calculation of a nitrogen balance.
- At present the gross balance methodology is considered by OECD Member countries as the appropriate indicator for calculating comparable nitrogen balances, but does not prevent that some countries use other indicators to track nitrogen balances.



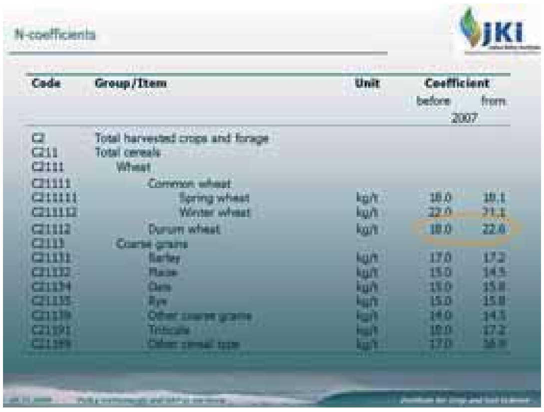




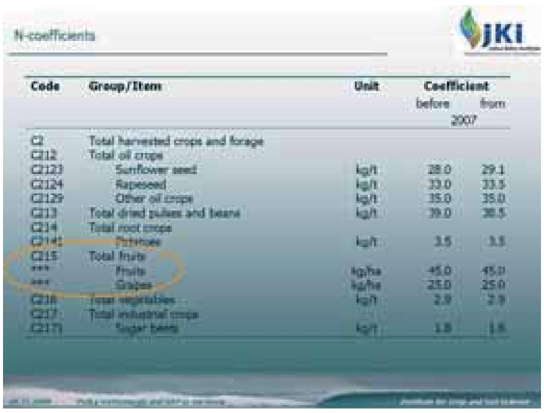



N-coefficients

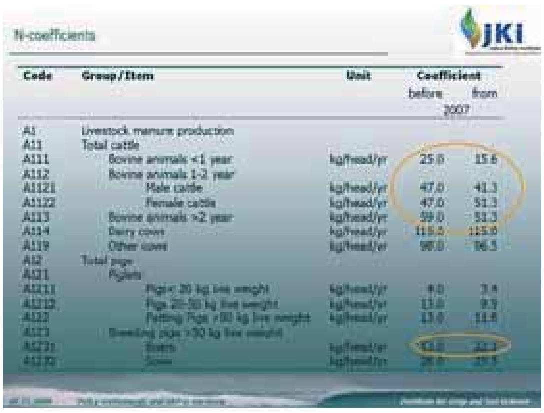
Code	Group/Item	Unit	Coefficient before 2007	Coefficient from 2007
F1	Total fertilisers			
F11	Total inorganic fertilisers			
F111	Nitrogenous fertilisers	kg/t		
F12	Total organic fertilisers			
F121	Sewage sludge	kg/t	39.5	39.5
F122	Urban compost	kg/t	14.0	14.0


N-coefficients

Code	Group/Item	Unit	Coefficient before 2007	Coefficient from 2007
C2	Total harvested crops and forage			
C211	Total cereals			
C2111	Wheat			
C21111	Common wheat			
C211111	Spring wheat	kg/t	18.0	18.1
C211112	Winter wheat	kg/t	22.0	21.1
C21112	Durum wheat	kg/t	18.0	22.6
C2113	Coarse grains			
C21131	Barley	kg/t	17.0	17.2
C21132	Maize	kg/t	15.0	14.5
C21134	Oats	kg/t	15.0	15.8
C21135	Rye	kg/t	15.0	15.8
C21139	Other coarse grains	kg/t	14.0	14.5
C21191	Triticale	kg/t	10.0	17.2
C21199	Other cereal type	kg/t	17.0	16.9


N-coefficients

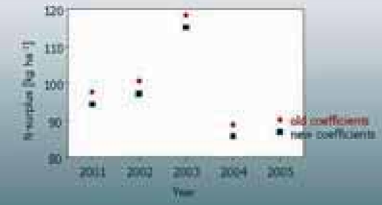
Code	Group/Item	Unit	Coefficient before 2007	Coefficient from 2007
C2	Total harvested crops and forage			
C212	Total oil crops			
C2123	Sunflower seed	kg/t	28.0	29.1
C2124	Rapeseed	kg/t	33.0	33.5
C2129	Other oil crops	kg/t	35.0	35.0
C213	Total dried pulses and beans	kg/t	39.0	38.5
C214	Total root crops			
C2141	Potatoes	kg/t	3.5	3.5
C215	Total fruits			
***	Fruits	kg/ha	45.0	45.0
***	Grapes	kg/ha	25.0	25.0
C216	Total vegetables	kg/t	2.9	2.9
C217	Total industrial crops			
C2171	Sugar beets	kg/t	1.8	1.8


N-coefficients

Code	Group/Item	Unit	Coefficient before 2007	Coefficient from 2007
A1	Livestock manure production			
A11	Total cattle			
A111	Bovine animals <1 year	kg/head/yr	25.0	15.6
A112	Bovine animals 1-2 year			
A1121	Male cattle	kg/head/yr	47.0	41.3
A1122	Female cattle	kg/head/yr	47.0	51.3
A113	Bovine animals >2 year	kg/head/yr	59.0	51.3
A114	Dairy cows	kg/head/yr	115.0	115.0
A119	Other cows	kg/head/yr	98.0	96.5
A12	Total pigs			
A121	Piglets			
A1211	Pigs< 20 kg live weight	kg/head/yr	4.0	3.4
A1212	Pigs 20-50 kg live weight	kg/head/yr	13.0	9.9
A122	Fatting Pigs >50 kg live weight	kg/head/yr	13.0	11.6
A123	Breeding pigs >50 kg live weight			
A1231	Boars	kg/head/yr	[illegible]	[illegible]
A1232	Sows	kg/head/yr	[illegible]	[illegible]

N-coefficients

Old versus new N-coefficients: Soil surface balance (gross)



Difference = 3.3 kg ha⁻¹

N-coefficients

Comparison of the German soil surface nitrogen balance (2005) calculated with N-coefficients of other countries

	NL	A	CH
N-Input total [%]	**107**	**100**	**96**
Mineral fertilisers [%]	100	100	100
Livestock manure production [%]	112	94	98
Cattle [%]	*107*	*82*	*91*
Pigs [%]	*121*	*119*	*109*
Sheep and goats [%]	*235*	*170*	*203*
Poultry [%]	*133*	*102*	*106*
Other input [%]	120	110	83
Atmospheric deposition [%]	*139*	*100*	*100*
Biological nitrogen fixation [%]	*89*	*130*	*52*

Germany = 100%

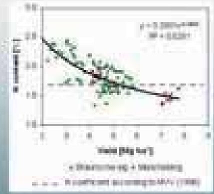
N-coefficients

Comparison of the German soil surface nitrogen balance (2005) calculated with N-coefficients of other countries

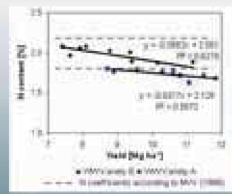
	NL	A	CH
N-output total [%]	**97**	**98**	**92**
Harvested crops [%]	94	98	93
Cereals [%]	*94*	*95*	*92*
Oil Crops [%]	*97*	*100*	*90*
Leguminous [%]	*92*	*100*	*90*
Industrial crops [%]	*97*	*101*	*116*
Fodder [%]	104	99	91
Harvested fodder [%]	*100*	*99*	*90*
Grass [%]	*105*	*99*	*92*
Crop residues [%]	—	100	87
N-Balance [%]	**122**	**101**	**103**

Germany = 100%

Coefficients



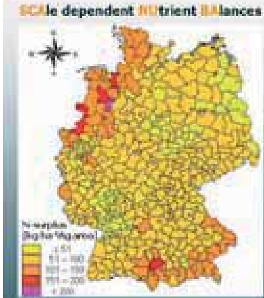
Relationship of yield and N content of **spring feeding barley** derived from long-term field experiments in Müncheberg and Braunschweig, Germany, 1976-2005.



Relationship of yield and N content of **two winter wheat varieties** in Clauen, Germany 1995-2007. The data was provided by the Federal Office of Plant Varieties in Germany and derived from the variety testing database.

SCANUBA: Regional balances

SCAle dependent NUtrient BAlances



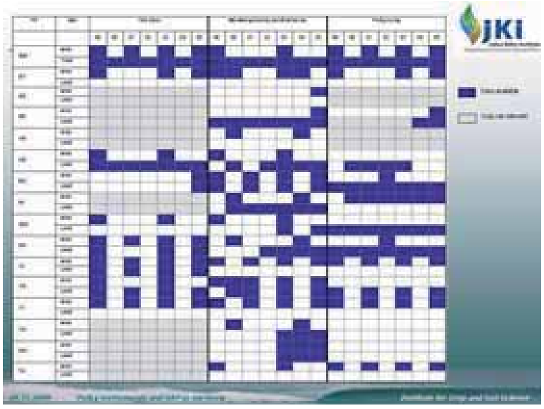
- Preliminary calculations of the N soil surface balance (gross) 2003.
- Administration structure based on rural districts and rural free towns.
- 2003 exceptional dry year.

SCANUBA: Regional balances

Data uncertainties

- Missing data from agricultural census (reason: Data secrecy policy, no publishing when statistics are based on three or less individual values).
- Estimation and validation of N mineral fertiliser quantities.
- Estimation and validation of internal fodder production quantities (harvested yield of roughage).
- Timeliness of coefficients (mostly average values).
- Missing information about the amount of marketed livestock products in higher spatial resolution (NUTS level 3).
- Statistics are recorded in the district where the farm is located, even if some of the fields are in a different administration unit.
- Lack of data for livestock manure export/import between districts.
- Missing information about the land use area planted with legumes and straw yield.
- Lack of information about the land use area cultivated for bio-energy production.

SCANUBA: Regional balances; Data availability



SCAMUBA: Regional balances; Data availability

Examples of data availability on NUTS level 3 in %

Administrative district, NUTS 3	2001	2002	2003
Flensburg, Kreisfreie Stadt	32	17	68
Kiel, Landeshauptstadt, Kreisfreie Stadt	37	27	66
Lübeck, Hansestadt, Kreisfreie Stadt	39	27	80
Neumünster, Kreisfreie Stadt	44	27	66
Dithmarschen, Landkreis	49	27	80
Herzogtum Lauenburg, Landkreis	49	27	79
Nordfriesland, Landkreis	46	27	79
Ostholstein, Landkreis	49	27	78
Pinneberg, Landkreis	46	27	80
Plön, Landkreis	46	27	83
Rendsburg-Eckernförde, Landkreis	49	27	83
Schleswig-Flensburg, Landkreis	49	27	83
Segeberg, Landkreis	49	27	83
Steinburg, Landkreis	46	27	83

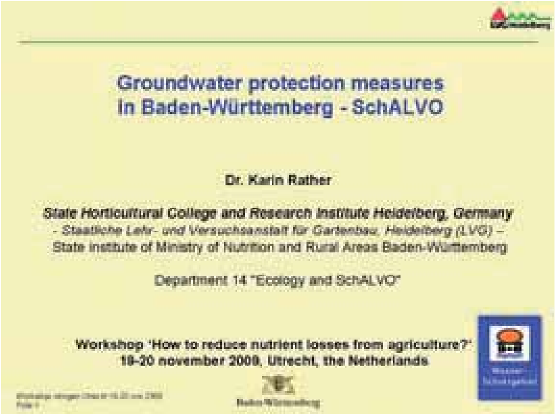
Nutrient balances: conclusions

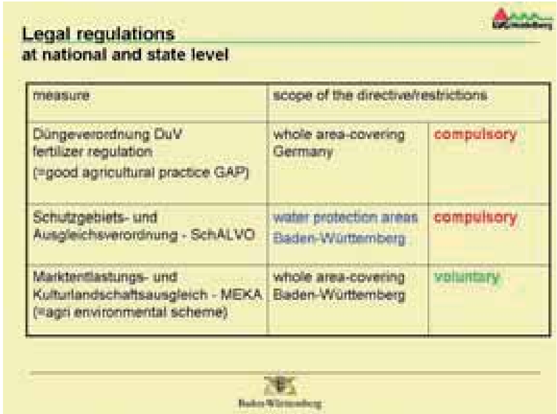
Nutrient balances highly complex

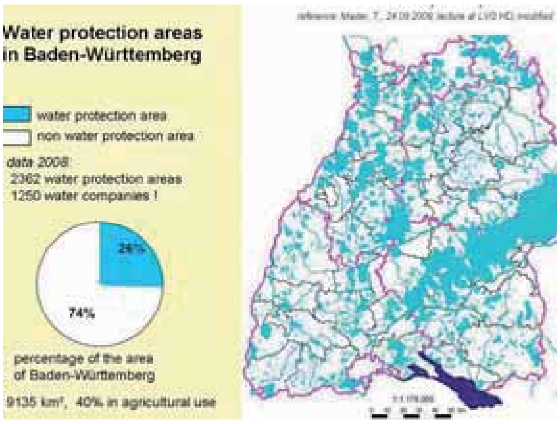
Possibility of comparison between countries and longer time periods difficult

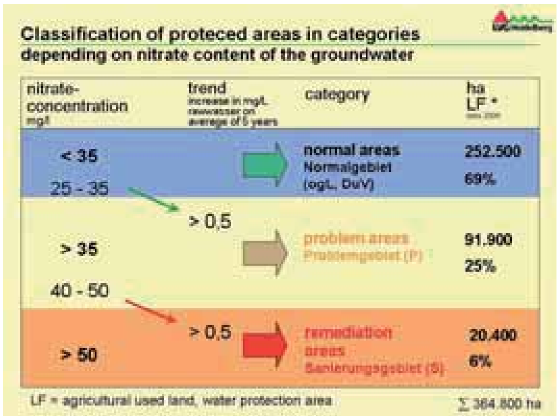
Other/better agri-environmental indicators?

Presentation by Karin Rather









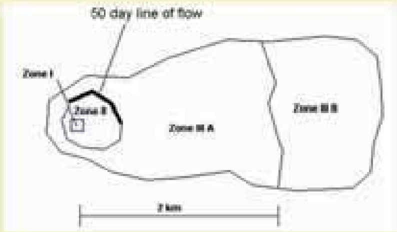
Restrictions in all water protected areas

zone	normal areas -ogL	problem areas - P	remediation area - S
I water catchment *	- only grassland, no grazing (Weidenutzung)		
II close and further protection zone	- ban on application liquid manure (Gülleverbot) - limited application of solid manure (eingeschränkte Mistausbringung) - limited use of pasture land (eingeschränkte Weidenutzung) - no pen (keine Tierpferche)		
I, II, III	- compliance with codes of good agricultural practice (DuV, Düngeverordnung) - avoid entry of nitrate - no ploughing up of permanent grassland - no application of fungizides terbuthylazin or tolylfluanid		

*spring

Design and classification of water protection areas

water protection area is divided in several protection zones due to following criteria:



Baden-Württemberg

Special regulations

zone	normal areas ogL	problem areas P	remediation area S
I water catchment *	no further regulations	→	→
II, III close and further protection zone	no further regulations	•nitrogen fertilization •farmyard manure •periods for growing and ploughing catch/cover crops •soil treatment •irrigation •adjust crop rotation •when indicated: official directive of the water authority	•additional requirements •remediation plan specific for the area •if necessary contracts e.g. crop rotation cultivation of lambs lettuce outside of the S-area

*spring

⇒ give examples

Farmyard Manure application

detailed requirements

- amount of application depends on manure type, P- or S-area, crop
- time of application
  - according to the manure type
  - depending on
    - crop type (e.g. winterrape, winterbarley)
    - soil type (A, B)
    - preceding crop
    - season and
    - time of harvest
  - close periods depending on P- or S-area
- application technique

⇒ see leaflet SchALVO on OLAT, editors: LTZ Karlsruhe 2008

Baden-Württemberg

Mineral fertilizers - vegetable and arable crops

measuring of soil mineral N (Nmin method)

taking into account for calculation of N demand (fertilizer recommendation system)

P area ⇒ for each cultivar at least on 30% of fields at planting and top dressing

S area ⇒ at each fertilizer application during cultivation of each crop

repeat the soil sampling for mineral nitrogen, in case no fertilizer was applied in between two weeks after getting the result of the analysis

monitoring: documentation of soil-management and fertilization

Baden-Württemberg

Mineral fertilizers

N fertilizer recommendation system - vegetables

	N-demand vegetable crop based on target values	kg N/ha	calculation
-	soil mineral N-content in rooting zone	kg N/ha	analysis
-	mineralization of soil organic matter	kg N/ha	tabular values
-	carry over of N from crop residues	kg N/ha	tabular values
-	carry over of N from manure application	kg N/ha	tabular values/ analysis
-	carry over of N from greenmanure	kg N/ha	tabular values
=	N- fertilizer demand	kg N/ha	calculation

Baden-Württemberg

Mineral fertilizers

fixed application rates of mineral nitrogen / split application (kg/ha)

	in P- and S-areas	fertilizer type: slow acting N fertilizer	fertilizer type: highly soluble N fertilizer
generally	A-soils (e.g. S, Sl, lS, SL)	80	50
	B-soils (z.B. sL, L, LT, T)	100	80
early cultivars covered	A-soils (z.B. S, Sl, lS, SL)	120 (150 solid organic fertilizer)	50
	B-soils (z.B. sL, L, LT, T)		80
shallow rooting crops in autumn (e.g. lamb lettuce)	A-soils (z.B. S, Sl, lS, SL)	80	none
	B-soils (z.B. sL, L, LT, T)	100	

fixed period of two weeks between fertilizer application rates

Soil types A- and B-soils

depending on risk of leaching

soil depth	Ackerschätzungsrahmen: Bodenart	Entstehung	Zustands-stufe	Boden-/ Ackerzahl	soil type
< 60 cm	alle	alle	alle	alle	A-Boden
> 60 cm	S, Sl	alle	alle	alle	A-Boden
	lS, SL	alle (außer Löß)	alle	alle	A-Boden
	lS, SL	loess	alle	alle	B-Boden
	alle	Dg, Vg, Alg	4 - 7	alle	A-Boden
	sL, L, LT, T	D, V, Al	4 - 7	alle	B-Boden
	sL, L, LT, T	alle	1 - 3	alle	B-Boden
	Mo, Anmoor, Moor	alle	alle	alle	A-Boden

Mineral fertilizers
slow acting N-fertilizer

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

e.g.:
ammonium sufate
ammonium gas
calcium cyanamide
urea
ammmonium nitrate urea solution
nitrogen stabilized fertilizers with less than 30% nitrate

Baden-Württemberg

Post harvest measures
growing catch/cover crops in P- and S- area

site characteristics		Jul	Aug	Sep	Okt	Nov	Dez	Jan	Feb	Mär
no following crop in autumn "Stilllegung im Folgejahr": fallow (no crop follows)	altitude > 500 m			latest sowing 1.9.						
	altitude < 500 m			latest sowing 15.9.						

special regulations for asparagus, row crops e.g. nursery plants

requirements to cover/catch crops
- fast growing cultivars
- large nitrogen uptake capacity
- sowing later than 15.8. forces cultivars adapted to late sowing
- no legumes
- sowing technique ⇒ closed rich vegetation

Post harvest measures
Soil management and destruction of cover/catch crops – e.g. vegetables

Earliest date for soil management/ tillage depends on
- **cultivation**
  planted or sowing vegetables,
  asparagus, late cabbage
  frost susceptible or winter resistent cover/catch crops
- **altitude**
  <300 m, 300-500 m, >500 m
- **category water protection area**
  in S-areas stricter constraints

Baden-Württemberg

Post harvest measures
Soil management: ploughing and destruction of cover/catch crops / P-areas

site characteristics			Jul	Aug	Sept	Okt	Nov	Dez	Jan	Feb	Mär
vegetables field grown	altitude >300 m	all soils						from 1.12.			
frost susceptible cover crops/ fallow (no following crops)	altitude < 300 m	B-soils						from 1.12.			
		heavy A-soils							from 1.1.		
		A-soils								from 1.2.	
sown vegetables		all soils							from 15.1.		
frost resistent cover crops	all altitudes	all soils								from 1.2.	

Post harvest measures
Soil management: ploughing and destruction of catch/cover crops / S-areas

site characteristics			Jul	Aug	Sept	Okt	Nov	Dez	Jan	Feb	Mär
frost susceptible cover crops/ fallow (no following crops)	altitude > 500 m	previous crops: - vegetables (N-rich crop residue) - potatoes farmyard manure after harvest								from 1.2. early sowing	from 1.3. late sowing
		other previous crops no farmyard manure						from 1.12.			
	altitude < 500 m	all previous crops								from 1.2. early sowing	
frost resistent cover crops	all altitudes	all previous crops									from 1.3. late sowing
>10 % vegetables	all altitudes	not before succeeding crop in the following year									

Implementation of SchALVO requirements into practice

Advisors for water protection areas at the rural district offices
- advice and information of farmers/gardeners
- support the farmers to meet the constraints
- harvest control (site selection, organization of soil sampling etc.)
- calculation of supplement for additional work of the farmers with a special computer application

professional support from experts at

horticulture: LVG, Lehr- und Versuchsanstalt für Gartenbau, Heidelberg
agriculture: LTZ, Landwirtschaftliches Technologiezentrum Karlsruhe

Baden-Württemberg

Monitoring nitrate-N content of soil
according to SchALVO §12 – harvest monitoring

- **emission control – monitoring for**
  - compliance with the requirements
  - soil nitrate thresholds
- **period**
  october 15th to november 15th *
- **soil sampling nitrate-N**
  0-30/ 30-60/ 60-90 cm depth
- **number of sites sampled 2008**

Baden Württemberg	P+S areas
all sites	16.458 **
horticulture	324

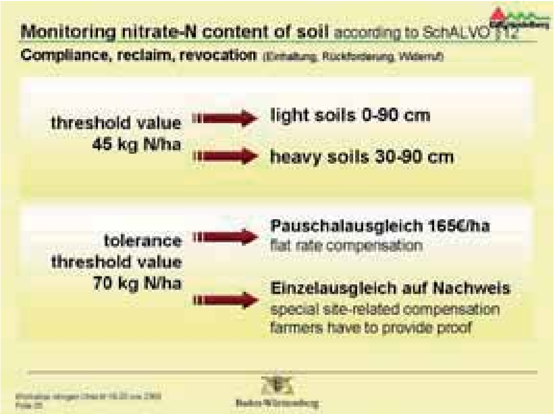
* with later harvest sampling period is extended to December 15th
** before the amendment of SchALVO in 2001: all sites: 80.000/ horticulture 1.000

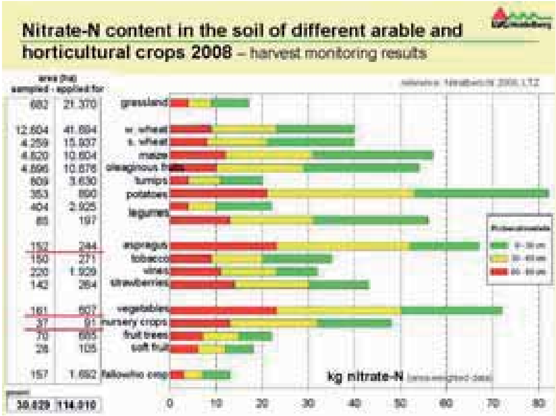
Monitoring nitrate-N content of soil
according to SchALVO §12 – threshold values in P- and S- area

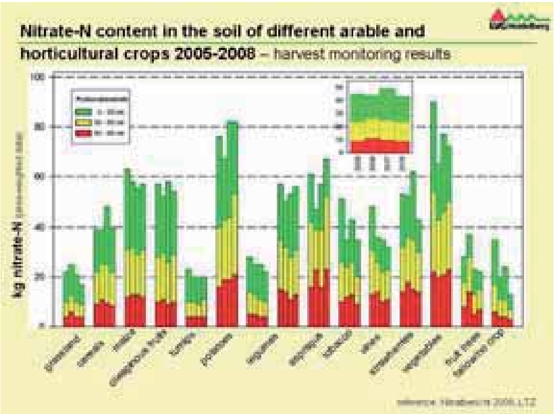
threshold values (kg N/ha)
soil type and soil leaching category

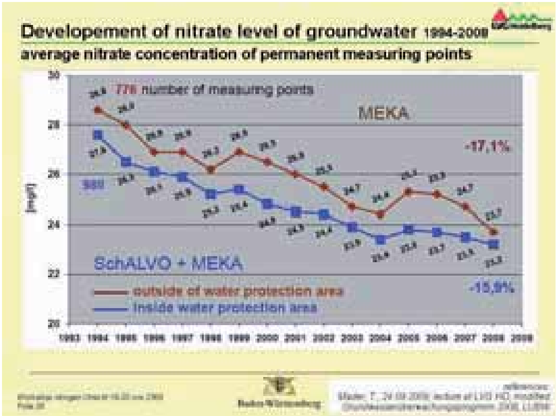
maximum possible sampling depth (cm)	A (S, Sl, lS, SU) without bog soils (ohne Moor und Anmoorböden)	B (sL, L, LT, T)	bog soil (Moor- und Anmoorböden)
0-90	45	45 in 30-90 45 in 0-30	90 in 30-90 90 in 0-30
0-60	30	45	90
0-30	20	-	-

Baden-Württemberg

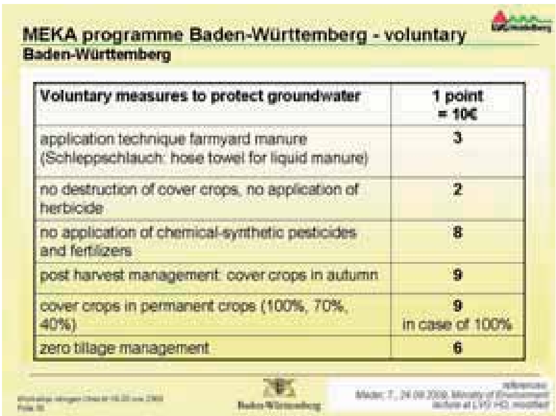

Monitoring nitrate-N content of soil according to SchALVO §12
Compliance, reclaim, revocation (Einhaltung, Rückforderung, Widerruf)
threshold value 45 kg N/ha
light soils 0-90 cm
heavy soils 30-90 cm
tolerance threshold value 70 kg N/ha
Pauschalausgleich 165€/ha
flat rate compensation
Einzelausgleich auf Nachweis
special site-related compensation
farmers have to provide proof


Nitrate-N content in the soil of different arable and horticultural crops 2008 – harvest monitoring results
grassland
w. wheat
s. wheat
maize
oleaginous fruits
turnips
potatoes
legumes
asparagus
tobacco
vines
strawberries
vegetables
nursery crops
fruit trees
soft fruit
fallow/no crop
kg nitrate-N
30.029
114.010


Nitrate-N content in the soil of different arable and horticultural crops 2005-2008 – harvest monitoring results
kg nitrate-N
grassland
cereals
maize
oleaginous fruits
turnips
potatoes
legumes
asparagus
tobacco
vines
strawberries
vegetables
fruit trees
fallow/no crop

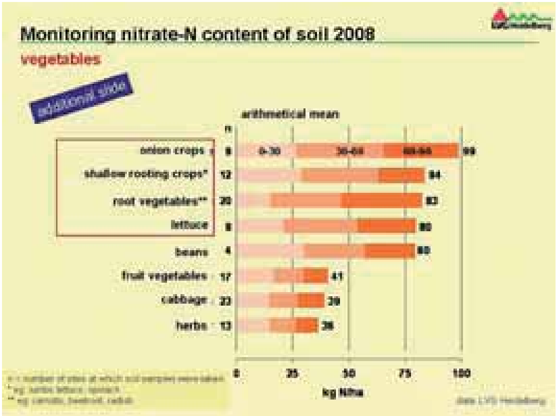

Developement of nitrate level of groundwater 1994-2008
average nitrate concentration of permanent measuring points
776 number of measuring points
MEKA
-17,1%
580
[mg/l]
SchALVO + MEKA
outside of water protection area
inside water protection area
-15,9%

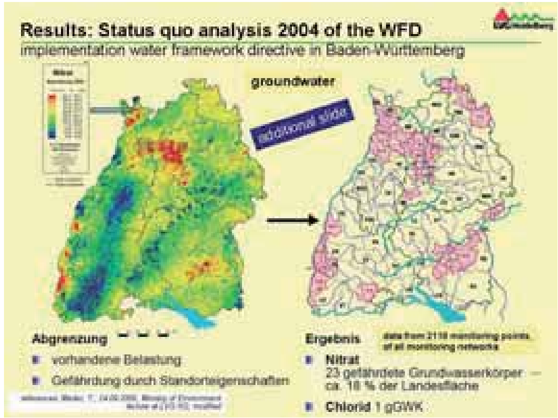

MEKA programme
Baden-Württemberg - voluntary
Marktentlastungs- und Kulturlandschaftsausgleich
agri environmental scheme, since 1992, EU notified
objectives
- care and conservation of the agricultural landscape
- environmental-friendly cultivation and extensive land use
- unload of agricultural market
programme
- participation is volontary
- participants enrol in the programme for five years
- according to a modular design principle
- calculation of compensation based on a point-score system


MEKA programme Baden-Württemberg - voluntary
Baden-Württemberg
Voluntary measures to protect groundwater
1 point = 10€
application technique farmyard manure (Schleppschlauch: hose towel for liquid manure)
3
no destruction of cover crops, no application of herbicide
2
no application of chemical-synthetic pesticides and fertilizers
8
post harvest management: cover crops in autumn
9
cover crops in permanent crops (100%, 70%, 40%)
9 in case of 100%
zero tillage management
6

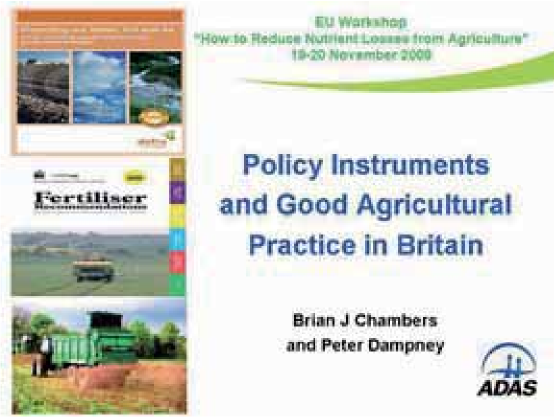

Financial expenses for groundwater protection measures
SchALVO and MEKA
MEKA groundwater protection measures ~ 75 Mio. €
SchALVO compensation payments ~ 22 Mio. €
SchALVO consultancy/harvest monitoring ~ 7 Mio. € (2004)

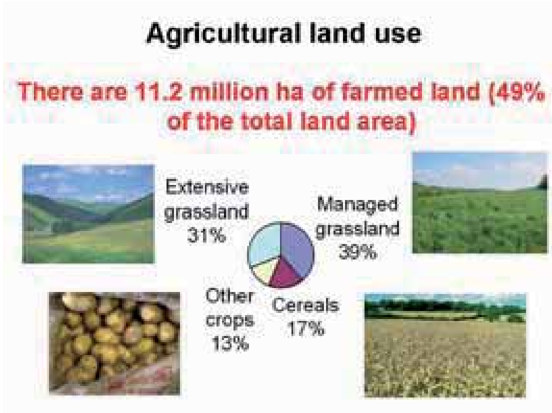

thank you for your attention

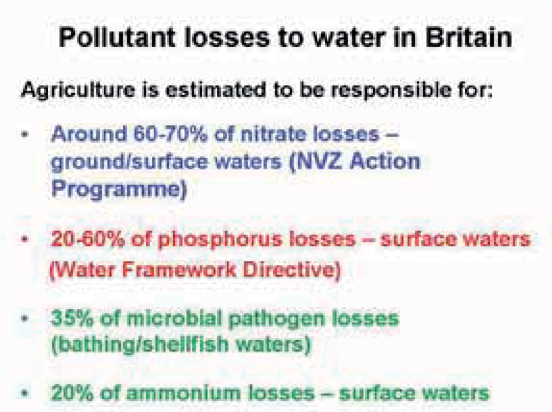

Monitoring nitrate-N content of soil 2008
vegetables
additional slide
arithmetical mean
n
onion crops
8
0-30
30-60
60-90
99
shallow rooting crops*
12
84
root vegetables**
20
83
lettuce
8
80
beans
4
80
fruit vegetables
17
41
cabbage
23
39
herbs
13
36
0
25
50
75
100
kg N/ha
data LVG Heidelberg

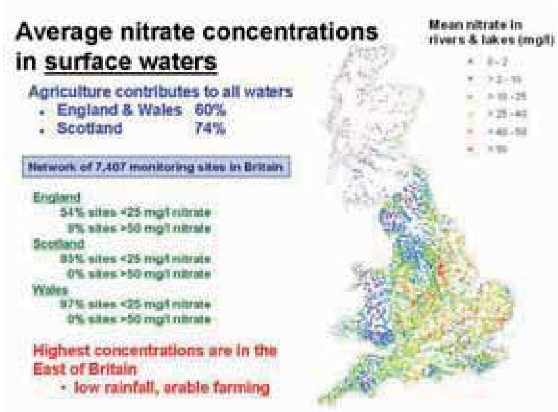

Results: Status quo analysis 2004 of the WFD
implementation water framework directive in Baden-Württemberg
groundwater
additional slide
Abgrenzung
vorhandene Belastung
Gefährdung durch Standorteigenschaften
Ergebnis
data from 2118 monitoring points of all monitoring networks
Nitrat
23 gefährdete Grundwasserkörper — ca. 18 % der Landesfläche
Chlorid 1 gGWK

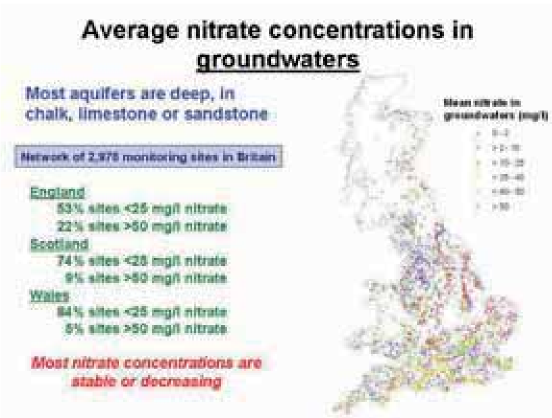
Presentation by Brian Chambers

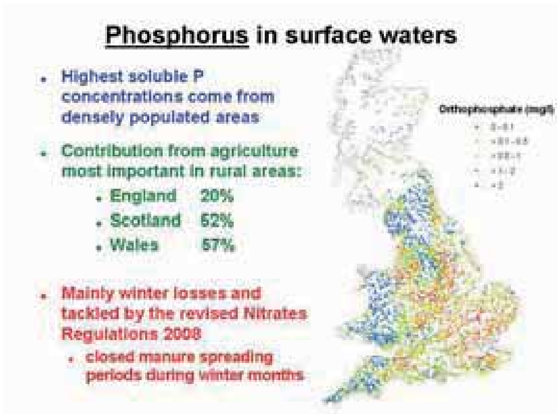


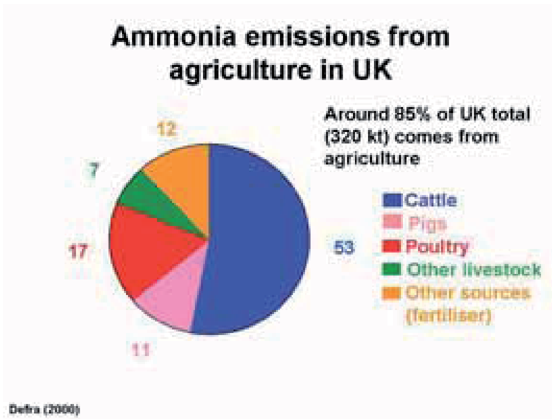




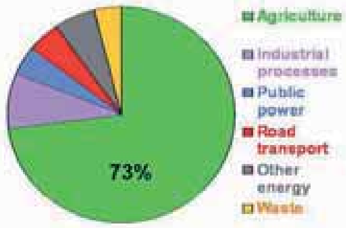








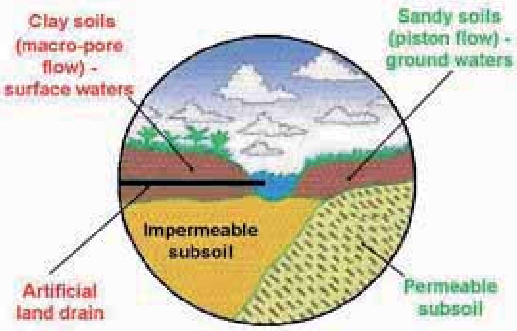
Nitrous oxide emissions in UK



From: 2007 UK National Greenhouse Gas Inventory

Soil types in England and Wales

Nutrient loss pathways

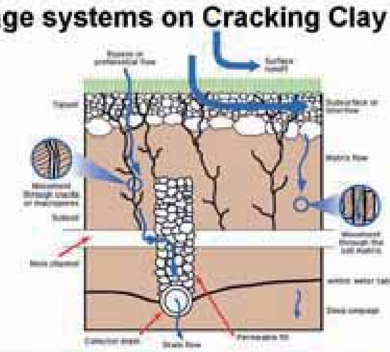


Cracking Clay soils

6.4 million ha of drained soils in England and Wales

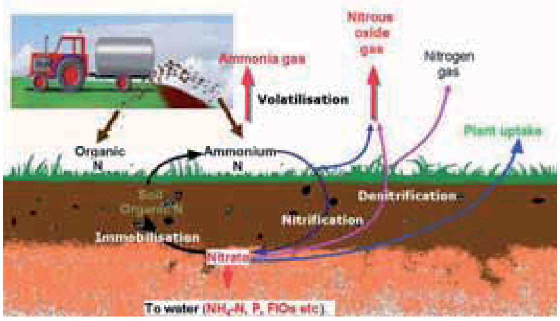
(70% of agricultural land area)

Drainage systems on Cracking Clay soils



Following rainfall events (>5mm) 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
    - agri-environment schemes:
    - decision support tools (e.g. PLANET)
    - nutrients advice programme

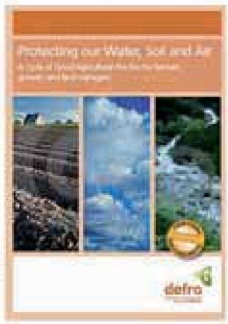
- Industry and farmer action:
  - Fertiliser Advisers Certification and Training Scheme (FACTS)
    - accreditation of nutrient management advisers
  - Professional Nutrient Management Initiative
    - practical help to farmers

FACTS

Code of Good Agricultural Practice

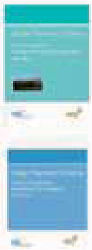
- Soil fertility and plant nutrients
- Management Plans (soil, nutrient, manure)
- Farm buildings and structures
- Field work
- Specialised horticulture
- Wastes
- Water supplies

Note: NVZ 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 license)

defra · Environment Agency · Agriculture and Rural Development · ADAS

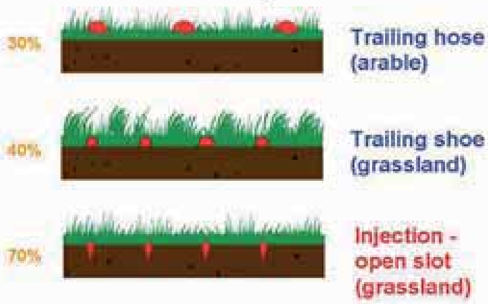
PLANET User Survey - 'key' feedback

- 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

Use slurry bandspreading / shallow injection equipment to minimise ammonia losses and odour nuisance

New slurry application techniques - lower emitting surface area



Trailing hose *vs.* surface broadcast slurry application

Trailing hose   Surface broadcast

IPPC – Integrated Pollution Prevention and Control Directive

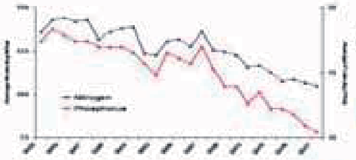
('large' pig and poultry units)

- 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

Use is decreasing ...... and farm output is stable or increasing, a result of improved efficiency of fertiliser use by farmers



Since 1985 .... 27% less chemical N
.... 43% less chemical P

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…

Presentation by Peter Dampney

EU Workshop
"How to Reduce Nutrient Losses from Agriculture"
19-20 November 2009

NVZ Regulations in Britain

Peter Dampney, ADAS

www.adas.co.uk

Designated NVZs in the UK

Different regulations in each country

England	68%
Wales	4%
Scotland	14%
N Ireland	100%
UK	42.5%

Designation methodology (England and Wales)

Polluted water sampling points identified using
- monthly water analysis data for nitrate
  - 7,407 surface water sites
  - 2,978 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

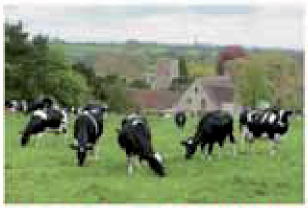
The crop N requirement limits (Nmax)

Field application of organic manures

Field application of manufactured nitrogen fertiliser

Records

The Livestock Manure N Farm Limit (170N)



Approximately 40% of dairy farms in England may not comply

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 2007

250 kg N/ha per year on eligible farms
- at least 80% 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

Livestock type	Age, milk yield (litres) or weight (kg)	N produced (kg N/year)
1 Dairy cow	>9000 litres 6000-9000 litres <6000 litres	115 101 77
1 Dairy heifer	13 months to first calf	61
1 Beef suckler (large)	25 months and over, over 500kg	83
1 Beef cow or steer	13-25 months	50

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

Storage of organic manures

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 fouled concrete yards or from the dairy/parlour that is collected separately from slurry'

Standard livestock excreta values

Excreta standards – some cattle examples

Livestock type	Age, milk yield (litres) or weight (kg)	Excreta (m^3/month)
1 Dairy cow	>9000 litres 6000-9000 litres <6000 litres	1.92 1.59 1.26
1 Dairy heifer	13 months to first calf	1.20
1 Beef suckler (large)	25 months and over, over 500kg	1.35
1 Beef cow or steer	13-25 months	0.78

See Defra NVZ Guidance leaflet 3 for all standards

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 and Crop N requirement limits

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

The Crop N Requirement limits (N max)

Standard limits for the major crop types (94% 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

	N max (kg N/ha)	Standard yield (t/ha)
Wheat, autumn and early winter sown	220	8.0
Wheat, spring sown	180	7.0
Winter barley	180	6.5
Spring barley	150	5.5

- 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 milling wheat varieties

N max rate - other arable crops

	N max (kg N/ha)	Standard yield (t/ha)
Winter oilseed rape	30 (autumn) 220 (spring)	3.5
Sugar beet	120	n/a
Potatoes	270	n/a
Forage maize	150	n/a
Field beans	0	n/a
Peas	0	n/a

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

	N max (kg N/ha)	
		from Jan 2012
Grass	330	300

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

Minimum manure N availability coefficients

	Crop available N (% of total N) in year of application	
	from 1 January 2009	from 1 January 2012
Cattle slurry	20	35
Pig slurry	25	45
Poultry manure/litter	20	30
Other livestock manures	10	10

Field application of N

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

Grassland	
Sandy or shallow soils	All other soils
1 Sept – 31 Dec (4 months)	15 Oct – 15 Jan (3 months)

Organic manure closed periods: tillage land

Organic manures with a high readily available N content (>30% of total N)

e.g. slurry, poultry manure, liquid digested sludge

Tillage land	
Sandy or shallow soils	All other soils
1 Aug – 31 Dec* (5 months)	1 Oct – 15 Jan (3.5 months)

*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 fertiliser closed periods

Grassland	Tillage land
15 September to 15 January	1 September to 15 January

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

Manufactured nitrogen fertiliser allowed during the closed period

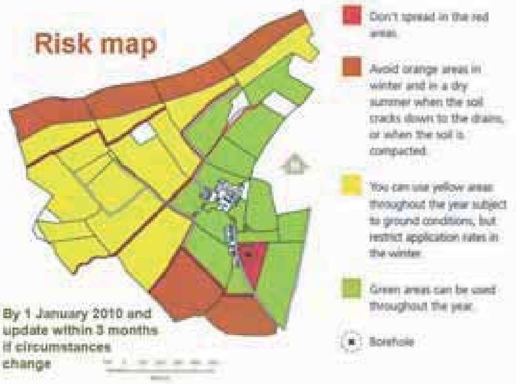
	kg N/ha (maximum)
Winter oilseed rape	30 (not after 31 October)
Asparagus	50
Brassica	100 (plus an extra 50 kg N/ha every 4 weeks during closed period up to date of harvest)
Bulb onions	40
Overwintered salad onions	40
Parsley	40
Grass	80 (max 40 kg N/ha per application, not after 31 October)

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



By 1 January 2010 and update within 3 months if circumstances change

Risk map must show

All fields (show area in ha)	Land within 10m surface water
Surface waters	Land within 50m spring, well or borehole
Springs, wells & boreholes (and those on neighbouring 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 2m 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

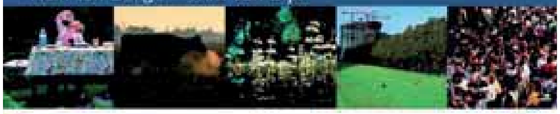
Must not spread if the soil is:

- waterlogged, flooded, snow covered, or frozen for more than 12 hrs in previous 24 hours

Presentation by Hein ten Berge

Legislation on Nitrogen Use –
kick-off for discussion

Hein ten Berge - Wim van Dijk



This session................

- 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 all sources
- **Denmark**
  - Upper bound: National N-quotum, distributed over crops
  - in 2009 about 85% of recommended N rate
  - "cheese-sliced" reductions
- **Netherlands**
  - lower bound: max allowable N surplus (postponed to 5th AP?)
  - Upper bound: recommended N rate
  - 'leaching sensitive crops' 90-95% of recommended (2009) (80-95% in 4th AP , 2010-2013)

Structure of N application standards

Denmark	Netherlands	Flanders
Effective N = fertiliser equivalents		Total N Plus extra limit for fertiliser-N
Specific per soil		Soil only in cereals (incl. maize)
Specific per crop		6 crop groups
- Yield level - Previous crop	No such differentiation (but first attempts now in NL)	

N-application standards **Flanders**

Crop	Total N	N manures	N other organic	N fertiliser
Grass	350	250/170	170	250
Maize	275	250/170	170	150
Sugar beet	220	200/170	170	150
Low-N crops	125	125	125	70
Leguminous	0	0	0	0
other	275	170	170	175

Values of N application standards 2009 (kg N/ha) as effective N

	Flanders		Denmark	Netherlands
	Manure-N 100	Manure-N 170		
Maize	210	205	140-165	150-185
potato	235	205		
- ware			135-155	215-275
- starch			170-190	230
Sugar beet	150	180	105-130	145-150
Winter wheat	235	205		160-220
- feed			150-180	
- baking			190-230	
Spring barley	235	205	115-135	80
Onions	85	-	140-165	120

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Derogations for manure-N

	condition	max	domain
Flanders	Grass Grass + maize	250	- crop area - cattle, horse, goat, sheep, liquid fraction pig manure
	Wheat + green manure Beets (sugar; fodder)	200	
Denmark	> 70% grass + feed crops	230	- whole farm - ruminant manures
Germany	Gras (≥ 4 cuts; or ≥ 3 cuts + grazing)	230	- crop area - cattle manures
Netherlands	> 70% gras	250	- whole farm - manures from cattle, horse, goat, sheep

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N fertiliser value of manures (on arable land)

	Statutory value (%)		in recommendations (%)	
	Denmark	Netherlands	Denmark	Netherlands
Cattle slurry	70	60	55-70	50-55
Pig slurry	75	60-65 (70% in 4th AP)	70-75	70-75
Poultry manure	65	55	65	50-55
Farm yard manure (cattle)	65	40	45	30

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N legislation Germany

Whole country:

- Good Agricultural Practice
- Nutrient management plan
- N-surplus (field level)
  - Past 3 years
  - 90 kg N/ha (2006-2008)
  - 60 kg N/ha (2009-2011)
  - Vegetable crops: extra 'sink-term' of 50-120 kg N/ha

special case:
Schalvo system
Baden-Wurttemberg

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N legislation France

- No general limits on N
- Nor in NVZ (such as entire Brittany district)
- Strict in ZAC (Zones d'Action Complementair)
  - Zones for 'drinking water' production, with high nitrate (> 50 mg/l in surface water)
    - Total N max 210 kg N/ha
    - Arable, pig, poultry farms: total N max 140 (of which 40 as fertiliser-N)
    - Cattle farms total N max 170 (of which 70 as fertiliser-N)

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Max. Soil Nitrate-N in autumn

- **Flanders**
  - Sampling October 1st – November 15th
  - Max. allowed 90 kg nitrate-N/ha (0-90 cm depth)
- **Germany**
  - In groundwater protection areas (NRW, BW)
  - Sampling October 15th – November 15th
  - Max. allowed
    - 45 kg nitrate-N/ha sensitive (Type A) soils (0-90 cm)
    - 90 kg nitrate-N/ha peat soils (0-60 cm)
    - 45 kg nitrate-N/ha other soils (0-60)

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In summary

Considerable differences between countries

- Type of constraints (input; surplus; GAP balance)
- Level of constraints
- Degree of differentiation (crops, soils, yield-level, ...)
- Fertiliser value of manures:
  - implicit or explicit
  - statutory versus recommended values
  - in-/exclusive of long term effect
- additional 'targets' : soil nitrate-N

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Possible research issues

- First try only............
- Any – not only shared - issues

PLANT RESEARCH INTERNATIONAL WAGENINGEN UR

- 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 ?????

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Policy Instruments

- Structure: limits on input / surplus / residual N?
- Need to compare instruments?
- Need to compare values ?
  - yield levels
  - attainable efficiencies
- Enforcement – administrative pressure ?

PLANT RESEARCH INTERNATIONAL

Translating 50 mg/l 'back' into input/surplus limits ?

(final constraints, as opposed to transitional)

- By trial and error (DK approach) ?
- Calculus ('NL scheme')
- Pain partitioning, € or kg N
- Compliance: scale issues, averaging
- Exemption of (vegetable / ornamental) crops
- Requirement for growth (Flanders) vs offtake (Germany) ...

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Internalize environmental costs

- Taxation on fertilisers ?
- Tradable N quota ? (input; surplus)
- Other ....?

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Technology development

- Reduce farmer uncertainty on N requirement
  - account for soil-N
  - tools 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 ???

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Differentiation of N input constraints

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

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Issues for uniform approaches (???)

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Uniformity – why ?

- Would help judgement of AP's by EC
- More efficient negotiations ?
- 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 NAS's ?
- Other ....

PLANT RESEARCH INTERNATIONAL

'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 ND targets

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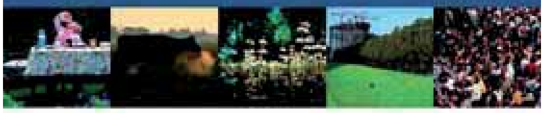
That's for a start only.....



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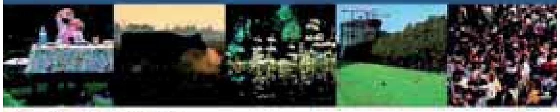
Presentation by Wim van Dijk

N fertilizer recommendations

Kick-off for discussion

Wim van Dijk
Hein ten Berge



PRAKTIJKONDERZOEK PLANT & OMGEVING WAGENINGEN UR

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
  - $N_{fert} = N_{upt}/N_{rec} - N_{soil}$
  - 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

- $N_{fert} = N_{upt}/N_{rec} - N_{soil}$
- Differentiation more easily applicable
- Dependency of parameters
  - E.g. higher recovery at higher yield/Nuptake 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)
    - Area crop
    - Status of current recommendation
  - Trial design
    - Number of N rates
  - Analysis data
    - N response method
    - N balance
    - Difference method (new level > current level)

Fertilization Committees NL

- Main task: assessing fertilizer recommendations
- Representatives
  - Farmers organization (chair)
  - Research institutes
  - Laboratories
  - Extension service
  - Ministry of Agriculture
- Sectors
  - Forage crops
  - Arable and horticultural crops
- Since 2006 also governmental committee
  - Status FC becomes less clear

Corrections

- Yield level
- N sources
  - Initial soil mineral N
  - Soil N mineralization
  - Long term effects of manure
  - Previous crops

Correction for yield level

	DK	FR	GE	NL
	Kg N/ton	Kg N/ton	Kg N/ha	Kg N/ha
Silage maize		14	-20/+20	
Potatoes	2		-10/+20	
Sugar beets	1		-20/+20	
Winter wheat	13-17	30	-20/+10	-20

N-mineralisation soil

FL	- Depending on om-content (arable land: 60-110 kg N/ha) - Fixed values based on frequency of used organic materials
DK	Fixed values based on N-content soil, manure history en crop rotation - Corrections -40 t/m 10 kg N per ha
GE	Correction at om-content < 1.5% (+20 kg N/ha)
FR	Fixed values (no measurements) - Arable land: 40-100 kg N/ha
UK	SNS-system, corrections based on excess winter rainfall, soil type and previous crop/rotation
NL	Grassland: based on total N-content soil Arable land: No appropriate indicator available

Long term effects manure

FL/DK /UK	Taken into account in correction for soil N mineralisation
GE	Fixed values related to live stock rates - 10 kg N/ha per LSU
FR	Fixed values for grassland - Depending on type and frequency of manure inputs
NL	Grassland: via soil N delivery Arable land - Maize: N recommendation 25 kg N/ha lower when manure is used regularly - Via higher N fertilizer value manure

First year and long term N fertilizer value (% of total N)

	1st year NFV	Long term NFV
Pig slurry	75	85
Cattle slurry	55	75
Poultry manure	55	70
Farmyard manure	30	55

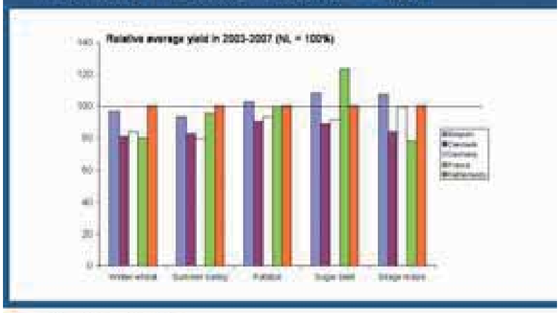
Correction for previous crop

Previous crop	FL	DK	GE	FR	NL
Sugar beet	20-30	15	30	20	30
Grassland		30-100	20-40	110-140	100
Green manure crops	30		20-30		30-40

Recommended levels (kg N/ha)

	FL	DK	GE	FR	NL
Maize	150-175	160-190	150-160	150	160-185
Potato - Ware - Starch	200-225	160-180 200-225	130 130	160 190	265-250 240
Sugar beet	125-150	125-150	110-150	150	150
Winter wheat - Fodder - Bread	175-225	180-210 220-270	130-180	190	190-230 270
Spring barley	100	130-155	60-110	60	80-90

Yield levels in EU-countries (NL = 100)



1e year N fertilizer value animal manure (%)

Application on arable land before sowing/planting

	FL	DK	GE	FR	NL
Cattle slurry	55	55-70	50	55	50-55
Pig slurry	65	70-75	60	60-75	70-75
Solid poultry manure	55	65	50	45-65	50-55
Solid cattle manure	30	45	25	15-30	30

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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.

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Issues to address for discussion (and joint actions)

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

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Methodology for deriving recommendations

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

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Differentiation of recommendations

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

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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?
- …………………………………………

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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)
- …………………………………………

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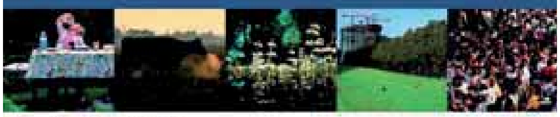
Now it's up to you……..



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