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Minerals Policy Monitoring Programme

Results for 2006 on water quality and fertilisation practices within the framework of the derogation monitoring network

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Rapport in het kort

Landelijk Meetnet effecten Mestbeleid
Resultaten van de monitoring van waterkwaliteit en bemesting in meetjaar 2006 in het derogatiemeetnet

Dit rapport geeft een overzicht van de bemestingspraktijk en de waterkwaliteit in 2006 op graslandbedrijven die meer dierlijke mest mogen gebruiken dan in Europese regelgeving is aangegeven. De waterkwaliteit gemeten in 2006 is het gevolg van de bemestingspraktijk in eerdere jaren en geeft dus nog niet de gevolgen weer van de praktijk in 2006.

De Europese Nitraatrichtlijn verplicht lidstaten het gebruik van dierlijke mest te beperken tot een bepaald maximum. Een lidstaat kan de Europese Commissie vragen om onder voorwaarden van deze beperking af te wijken. Nederland heeft toestemming gekregen om van 2006 tot en met 2009 af te mogen wijken van de gestelde norm. Een van de voorwaarden is dat de Nederlandse overheid een monitoringnetwerk inricht en aan de Commissie jaarlijks rapporteert over de resultaten daarvan.

Het Rijksinstituut voor Volksgezondheid en Milieu (RIVM) en het Landbouw Economisch Instituut (LEI) hebben in 2006 in Nederland een monitoringnetwerk opgezet. Dit zogenaamde derogatiemeetnet meet de gevolgen voor de landbouwpraktijk en de waterkwaliteit als landbouwbedrijven afwijken (derogatie) van de Europese gebruiksnorm voor dierlijke mest. Het meetnet omvat driehonderd graslandbedrijven. Het derogatiemeetnet is een onderdeel van het Landelijk Meetnet effecten Mestbeleid (LMM).

In dit rapport worden de resultaten voor 2006, het eerste meetjaar, gepresenteerd. Voor 293 bedrijven waren gegevens over bemesting beschikbaar. De waterkwaliteitsmetingen zijn uitgevoerd op 202 bedrijven.

Trefwoorden: Nitraatrichtlijn, derogatiebeschikking, Europese Commissie, LMM, landbouwpraktijk, waterkwaliteit, rapportageverplichting, grondwater, nitraat, stikstof, mest

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Abstract

Minerals Policy Monitoring Programme
Results for 2006 on water quality and fertilisation practices within the framework of the derogation monitoring network

This report provides an overview of fertilisation practices and water quality in 2006 on grassland farms using more animal manure than the limit set in European legislation. Water quality measured in 2006 is related to agricultural practices in previous years, and thus the reported values do not reveal the consequences of fertilisation practices in 2006.

The European Nitrates Directive obliges Member States to limit the use of animal manure to a specified maximum. A Member State may request permission from the European Commission to deviate from this obligation under specific conditions. In December 2005 the Commission granted the Netherlands the right to derogate from the obligation from 2006 up to and including 2009. One of the underlying conditions of the derogation is that the Netherlands set up a monitoring network and report the results to the European Commission annually.

In 2006 the National Institute for Public Health and the Environment (RIVM) and the Agricultural Economics Research Institute (LEI) set up a derogation monitoring network aimed at determining the effects of allowing farmers to deviate from the European use-limit for livestock manure (derogation). The monitoring network comprises 300 grassland farms and is part of the Minerals Policy Monitoring Programme.

This report provides the monitoring results for 2006, which was the first year that the network was functional. Information on fertiliser use is available for 293 farms and water quality measurements were carried out on 202 farms.

Key words: Nitrates Directive, derogation decision, European Commission, LMM, agricultural practice, water quality, reporting obligation, ground water, nitrate, nitrogen, manure

Foreword

On behalf of the Ministry of Housing, Spatial Planning and the Environment (VROM) and the Ministry of Agriculture, Nature and Food Quality (LNV), the National Institute for Public Health and the Environment (RIVM) and the Agricultural Economics Research Institute (LEI) have compiled this report. The Ministry of LNV has asked the Expert Committee Fertilisers Act (CDM)[1] to assess the report on its content and to ensure consistency with the methodology of the scientific basis for the derogation.

In 2006, the Dutch government appointed the project group EU Monitoring to satisfy its reporting obligations to the European Commission with respect to the derogation decision of 8 December 2005. This project group, in which the Ministries of VROM and LNV are represented, has drawn up a project plan (26 October 2006). In this project plan the obligations with respect to monitoring and reporting are further detailed and the intended realisation of this is described. Five aspects have to be included in the reports to the European Commission:

A. Percentages of grassland farms, animals and agricultural land, in each municipality that falls under an individual derogation (Article 8 of the derogation decision);
B. Monitoring data from soil water, watercourses and shallow groundwater (Article 10, para 1);
C. Results of inspection and enforcement (Article 10, para 1);
D. Synthesis of trends (Article 10, para 2);
E. Report about fertilisation and yield per soil type and crop (Article 10, para 4).

This report provides an overview of the results of the water quality monitoring in 2006 on a sample of farms registered for derogation (part B). The water quality monitoring 2006 covered approximately 200 of the 300 farms participating in the monitoring network for the sampling of water quality on derogation farms (the derogation monitoring network), because at the start of the sampling in October 2005 it was not known which farms would apply for derogation. The 200 farms were already participating in the Minerals Policy Monitoring Programme (LMM) or were recruited and sampled during the sampling campaign. The results of the water quality monitoring 2006 are related to the agricultural practices prior to the derogation (2005 and the preceding years). The results of the measurements in 2007, which are related to the agricultural practices in 2006, the first derogation year, will be reported next year. However, this report does include those water quality data that are available as provisional figures. In addition to this, information is provided about the agricultural practices in 2006 for all farms in the derogation monitoring network that have made use of the derogation. This includes, for example, data about the fertilisation and the accomplished nutrient surpluses (part E, fertilisation).

The crop yields on the derogation farms (part E, yields) will be covered in a report by Aarts et al., to be published in May 2008. Parts A (June 2008), C and D (March 2008) will also be reported on separately. The Ministry of Housing, Spatial Planning and the Environment (VROM) and the Ministry of Agriculture, Nature and Food Quality (LNV) are responsible for the reports submitted to the European Commission. In June 2008, the results from the Dutch Nitrates Directive Action Programme 2002-2006 will be reported by Zwart et al. as part of the four-yearly Member State reports.

[1] The CDM is an independent scientific committee that advises the Ministry of LNV about providing scientific evidence for the regulations, standards and forfeits arising from the Fertilisers Act.

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Summary

Introduction
The Nitrates Directive obliges Member States to limit the use of animal manure to a maximum of 170 kg of nitrogen per hectare. A Member State may request the European Commission for permission to deviate from this obligation under specific conditions (derogation). In December 2005 the Commission granted the Netherlands derogation for the 2006–2009 period. Grassland farms with 70% or more grassland may, under narrowly prescribed conditions, apply 250 kg nitrogen (N) per hectare to their land in the form of manure from grazing livestock. In reciprocation, the Netherlands is obliged to set up a monitoring network in accordance with the requirements embedded in the derogation decision of the European Commission. The Netherlands also has to provide the European Commission with information –based on monitoring and model-based calculations – on the amounts of fertilisers that have been applied for the different soil types and on the evolution of water quality.

Derogation monitoring network
In 2006 a new monitoring network was designed and established to monitor the evolution in agricultural practices and water quality as a consequence of the requested derogation. This network comprises 300 farms that each benefit from the derogation. It has been set up as an expansion of the Minerals Policy Monitoring Programme (LMM), which means that all 300 selected farms also participate in the Farm Accountancy Data Network of the Netherlands Agricultural Economics Research Institute (LEI-BIN). The National Institute for Public Health and the Environment (RIVM) of the Netherlands is the designated authority responsible for monitoring nitrogen and phosphorus concentrations in groundwater and surface waters on these farms. By using a stratified random sampling method, the 300 farms are – as much as possible – evenly distributed throughout the Netherlands in terms of region (sand, loess, clay and peat region), farm type (dairy farms and other grassland farms) and economic size class. The aim of this approach is to fulfil the condition of being representative of different soil types (clay, peat, sand and loess soils), fertilisation practices and crop rotations.

Reporting results of 2006
This report describes the first monitoring results and presents data on the agricultural practices of 293 derogation farms in 2006. Of the 300 farms included in the network, seven were disregarded: four did not use the derogation in 2006, two were unable to complete the registration within the allotted time period, and for one farm the calculated nutrient flows were determined to be unreliable. Data on water quality are provided for the 202 farms that were sampled in 2006 (period November 2005 – January 2007). Only 202 farms were sampled because the sampling could only be carried out on farms that were already participating in LMM or which could be entered in the derogation monitoring network before the end of the sampling campaigns. The derogation was not yet granted to the Netherlands at the start of the sampling campaigns. The water quality data reported for 2006 relate to farm practices in 2005 and preceding years; therefore, the effects of agricultural practices on water quality in the first derogation year (2006) are not yet noticeable in these figures. The preliminary water quality data reported for the clay and peat regions in 2007 relate to farm practices in 2006 and previous years.

Characteristics of the area and the farms in the network
The agricultural area in the derogation monitoring network is 1.7% of the total area used by all derogation farms that fulfilled the criteria for participation in the network (sample population). The agricultural area of dairy farms in the derogation monitoring network in the loess region is larger and that of other grassland farms in the other regions is smaller than may have been expected based on the

areas used by these groups in the sample population. This report presents un-weighed average values. To provide averages for the sample population, future reports must contain weighed data on fertiliser use and water quality

The average area of farms in the derogation monitoring network is 48.4 ha (see Table S1), which is larger than that of farms in the sample population (40.8 ha). The percentage of the area used as grassland in the network (82%) is somewhat lower than the average percentage of grassland in the sample population (84%). The average intensity of the farms in the network, expressed in kilograms fat and protein corrected milk (FPCM) per hectare of fodder crops, is a little higher than the average intensity of the farms in the sample population because farms in the clay, peat and loess regions have a higher intensity.

Table S1 Number and characteristics of farms in the derogation monitoring network per region for 2006.

Characteristics	Region				
	Sand	Loess	Clay	Peat	All
Number of farms in the network	160	20	60	60	300
Number of farms fully registered	159	17	58	59	293
- specialised dairy farms	144	16	50	53	263
- other grassland farms	15	1	8	6	30
General characteristics of farms					
– area of agricultural land (ha)	43.8	47.8	54.1	55.1	48.4
– percentage grassland	80	77	81	89	82
– milk production (kg FPCM[1]) per hectare fodder crops	14323	11523	14745	13636	14075

[1] FPCM = Fat and Protein Corrected Milk. This is a standard used for comparing milk with different fat and protein contents (1 kg milk with 4.00% fat and 3.32% protein = 1 kg FPCM). The reported averages refer only to the 263 specialised dairy farms.

Fertiliser use and nutrient surpluses

In 2006 the average use of plant available nitrogen on grassland and on arable land (mainly silage maize) was 249 and 114 kg/ha, respectively (Table S2). Nitrogen use was lower than the 2006 nitrogen application standards on both grassland and arable land in all regions. The average use of phosphate, from animal manure and artificial fertiliser, on arable land (107 kg P_2O_5/ha) was above the 2006 phosphate application standard, while the average application of fertiliser on grassland (99 kg P_2O_5/ha) was lower than the application standard in all regions. Also on the farm level, phosphate application was below application standards in all regions.

The average application of animal manure in 2006 was calculated to be 248 kg N/ha on farm level (Table S2), with arable land receiving an average of 185 kg N/ha and grassland receiving an average of 262 kg N/ha. As the derogation granted to the Netherlands for grazing livestock manure was 250 kg N /ha, the average application of manure of 248 kg N/ha is relatively high. This high calculated value for the use of nitrogen from animal manure can be explained partly by the use of a standard calculation method for manure production on all farms while farms are allowed to use other, more farm-specific methods, to calculate manure production. When farms that make use of these other calculation methods are excluded, the nitrogen use from manure is on average 239 kg/ha instead of

248 kg/ha. To what extent the use of the standard calculation method resulted in an overestimation of manure production needs further investigation.

The average nitrogen surplus on the soil surface balance in 2006 was calculated to be 196 kg/ha (Table S2). This surplus is larger in the peat and clay regions than in the sand and loess regions. In the peat region a net nitrogen mineralization input of 80 kg N/ha was calculated as input, while in other regions this amount is negligible. In the clay region, the import of artificial fertiliser nitrogen is high compared to other regions. The average phosphate surplus on the soil surface balance was calculated to be 30 kg P_2O_5/ha and differs only slightly between regions, apart from the loess region.

Table S2 Use of fertiliser and nutrient surpluses on farms in the derogation monitoring network in 2006 per region.

Characteristics		Region				
		Sand	Loess	Clay	Peat	All
Use of fertiliser						
Plant available nitrogen	Arable land[1]	112	148	116	102	114
(kg N/ha)	Grassland	246	196	291	233	249
Phosphate	Arable land[1]	108	98	110	99	107
(kg P_2O_5/ha)	Grassland	100	75	102	103	99
Nitrogen from manure	Farm scale	248	209	251	254	248
(kg N/ha)	Arable land[1]	190	195	175	168	185
	Grassland	264	215	269	261	262
Nutrient surpluses on the soil surface balance						
Nitrogen surplus (kg N/ha)		177	142	217	242	196
Phosphorus surplus (kg P_2O_5/ha)		31	19	33	30	30

[1] Arable land on grassland farms is mainly used for green maize fodder production (on average 86%).

Water quality

Agricultural practices in the years prior to the derogation determined the water quality measured in 2006. In 2006 the nitrate concentration in water leaching from the root zone was, on average, 51 mg NO_3/l in the sand region and 88 mg/l in the loess region (Table S3). The average nitrate concentration was higher in the sand and loess regions than in the peat and clay regions where the average nitrate concentration was lower than 50 mg/l.

Table S3 Quality of water leaching from the root zone on farms in the derogation monitoring network in 2006; average concentration of nitrate, total nitrogen and phosphorus (in mg/l) and the percentage of farms with an average nitrate concentration above 50 mg/l.

Characteristic	Region			
	Sand	Loess	Clay	Peat
Number of farms	148	18	18	18
Nitrate (NO_3) (mg/l)	51	88	30	4
Nitrate % > 50 mg/l	47	83	22	6
Nitrogen (N) (mg/l)	14.9	20.1	9.2	12.2
Phosphorus (P) (mg/l)	0.10	< 0.06	0.40	0.88

Nutrient concentrations in ditch water in the clay and peat regions on farms in the derogation monitoring network were, on average, lower than those measured in water leaching from the root zone (see Table S4). The concentration levels in ditch water in the sand region were similar to those in water leaching from the root zone.

Table S4 Quality of ditch water on farms in the derogation monitoring network in 2006; average concentration of nitrate, total nitrogen and phosphorus (in mg/l) and the percentage of farms with an average nitrate concentration above 50 mg/l.

Characteristic	Region		
	Sand	Clay	Peat
Number of farms	11	18	17
Nitrate (NO_3) (mg/l)	62	12	1
Nitrate % > 50 mg/l	64	0	0
Nitrogen (N) (mg/l)	15.6	4.8	4.0
Phosphorus (P) (mg/l)	0.09	0.39	0.44

The preliminary water quality root zone leaching data for the clay region in 2007 show a somewhat higher nitrate (36 mg/l) and total nitrogen concentration (11.7 mg N/l) and a somewhat lower total phosphorus concentration (0.28 mg P/l). Data for the peat region show a similar trend – a somewhat higher nitrate and lower phosphorus concentration in 2007 compared to 2006. The total nitrogen concentration is, however, somewhat lower in 2007 than in 2006. The nutrient concentrations in ditch water show a similar trend. To what extent weather conditions influenced differences in nutrient concentrations between 2006 and 2007 can not yet be quantified. The effect of increasing the number of sampled farms in 2007 by threefold relative to 2006 on the observed differences in water quality between years would appear to be limited based on the results of a short initial analysis.

The report in 2009 will provide a complete overview of water quality on farms in the derogation monitoring network for 2007. The report in 2010 will present the results of a first analysis of the development in water quality based on measurements in the 2006–2008 period and will also include model calculations.

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Samenvatting

Aanleiding
De Nitraatrichtlijn verplicht lidstaten het stikstofgebruik via dierlijke mest te beperken tot maximaal 170 kg per hectare. Een lidstaat kan de Europese Commissie vragen hier onder bepaalde voorwaarden van af te mogen wijken (derogatie). In december 2005 heeft de Europese Commissie aan Nederland een derogatiebeschikking afgegeven voor de periode 2006-2009. Hiermee mogen graslandbedrijven, dit zijn bedrijven met een aandeel grasland van minimaal 70% van het totale areaal, onder voorwaarden, per hectare tot 250 kilogram stikstof toedienen via dierlijke mest welke afkomstig is van graasdieren. Hiertegenover staat dat de Nederlandse overheid verplicht is onder meer een monitoringnetwerk in te richten dat voldoet aan de eisen die zijn opgenomen in de derogatiebeschikking. Tevens dient jaarlijks aan de Europese Commissie te worden gerapporteerd over onder andere bemesting per gewas-bodemcombinatie en over de ontwikkeling van de waterkwaliteit op basis van zowel metingen als modelberekeningen.

Het derogatiemeetnet
In 2006 is een nieuw monitoringnetwerk ingericht voor het volgen van de ontwikkeling van de landbouwpraktijk en de waterkwaliteit als gevolg van de derogatie. Dit derogatiemeetnet omvat 300 landbouwbedrijven die zich hebben aangemeld voor derogatie. Het derogatiemeetnet is ingericht door uitbreiding van het Landelijk Meetnet effecten Mestbeleid. Dit betekent dat alle 300 geselecteerde bedrijven ook deelnemen aan het Bedrijven-Informatienet van het Landbouw Economisch Instituut (LEI-BIN). Het Rijksinstituut voor Volksgezondheid en Milieu (RIVM) draagt zorg voor de monitoring van de kwaliteit van het water dat uitspoelt uit de wortelzone en het oppervlaktewater. Via stratificatie zijn de 300 landbouwbedrijven zo goed mogelijk gespreid over regio (zand-, löss-, klei- en veenregio), bedrijfstype (melkveebedrijven versus andere graslandbedrijven) en bedrijfseconomische omvang. Op deze manier is invulling gegeven aan de eis representatief te zijn voor alle bodemtypen (klei-, veen-, zand- en lössgronden), bemestingspraktijken en bouwplannen.

Rapportage meetjaar 2006
In dit rapport worden de eerste resultaten gepresenteerd. Dit betreft de gegevens over de landbouwpraktijk in 2006 op 293 derogatiebedrijven. Van de 300 bedrijven in het derogatiemeetnet zijn van zeven bedrijven geen gegevens opgenomen: vier bedrijven hebben afgezien van derogatie in 2006, twee bedrijven konden de registratie in 2006 niet (tijdig) afronden en van een bedrijf zijn de berekende nutriëntenstromen onbetrouwbaar gebleken. Daarnaast betreft het gegevens over de waterkwaliteit op 202 derogatiebedrijven bemonsterd in 2006 (de periode november 2005 – januari 2007). Alleen die bedrijven konden worden bemonsterd die al deelnamen aan het LMM, dan wel voor afsluiting van de meetcampagne konden worden opgenomen in het derogatiemeetnet. Bij de start van het bemonsteringsprogramma begin november 2005 was de derogatie nog niet aan Nederland verleend. De gerapporteerde waterkwaliteitsgegevens voor 2006 zijn beïnvloed door de landbouwpraktijk in 2005 en de jaren ervoor. De effecten van de bedrijfsvoering in het eerste derogatiejaar (2006) op de waterkwaliteit zijn hierin nog niet zichtbaar. Voor de klei- en veenregio's zijn voorlopige resultaten van waterkwaliteitmetingen in 2007 opgenomen in dit rapport.

Karakterisering van areaal en bedrijven in het derogatiemeetnet
Het totale landbouwareaal in het meetnet is 1,7% van het areaal van alle derogatiebedrijven die voldeden aan de eisen om te worden opgenomen in het meetnet (de steekproefpopulatie). Het areaal van melkveebedrijven in de lössregio in het derogatiemeetnet is groter en dat van overige graslandbedrijven in de overige regio's kleiner dan op basis van de samenstelling van de

steekproefpopulatie verwacht mocht worden. Om een uitspraak te doen over gemiddelde waterkwaliteit en mestgebruik van het areaal van de steekproefpopulatie zal daarom in toekomstige rapporten weging moeten worden toegepast. In dit rapport worden ongewogen gemiddelden gerapporteerd.

De bedrijven in het derogatiemeetnet zijn met 48,4 ha (zie Tabel S.1) gemiddeld groter dan de bedrijven in de steekproefpopulatie (40,8 ha). Het percentage van het areaal in het derogatiemeetnet dat gebruikt wordt als grasland komt met 82% iets lager dan het gemiddelde percentage grasland in de steekproefpopulatie (84%). De gemiddelde intensiteit van de bedrijven in het derogatiemeetnet, uitgedrukt in kg meetmelk (FPCM) per ha voedergewas, is een fractie hoger dan het gemiddelde van de steekproefpopulatie omdat de bedrijven in de klei-, veen- en lössregio wat intensiever zijn.

Tabel S1 Karakterisering van de bedrijven in het derogatiemeetnet voor 2006 per regio.

Karakteristieken	Regio				
	Zand	Löss	Klei	Veen	Alle
Aantal bedrijven opgenomen in het meetnet	160	20	60	60	300
Aantal bedrijven volledig uitgewerkt	159	17	58	59	293
- waarvan gespecialiseerde melkveebedrijven	144	16	50	53	263
- waarvan overige graslandbedrijven	15	1	8	6	30
Beschrijvende kenmerken					
Oppervlakte cultuurgrond (ha)	43,8	47,8	54,1	55,1	48,4
Percentage grasland	80	77	81	89	82
Melkproductie (kg FPCM[1]) per ha voedergewas	14323	11523	14745	13636	14075

[1] FPCM = Fat and Protein Corrected Milk, dit is een vergelijkingsstandaard voor melk met verschillende vet- en eiwitgehaltes (1 kg melk met 4,00 % vet en 3,32 % eiwit = 1 kg FPCM). De gerapporteerde gemiddelden hebben alleen betrekking op de melkveebedrijven (N=263).

Mestgebruik en nutriëntenoverschotten

Het gemiddelde gebruik van landbouwkundig werkzame stikstof op grasland in 2006 was 249 kg per hectare en op bouwland (vooral maïsland) 114 kg per hectare (zie Tabel S2). Zowel op grasland als op bouwland was het gebruik in alle regio's lager dan de voor 2006 geldende gebruiksnormen. Het fosfaatgebruik op bouwland lag met gemiddeld 107 kg P_2O_5 per ha boven de voor 2006 geldende gebruiksnormen, terwijl op grasland (99 kg P_2O_5 per hectare) in alle regio's gemiddeld onder de fosfaatgebruiksnormen werd bemest. Op bedrijfsniveau lag het gebruik gemiddeld ook voor fosfaat onder de gebruiksnorm.

Het berekende dierlijke mestgebruik is gemiddeld op bedrijfsniveau 248 kg stikstof per hectare (Tabel S2). Op bouwland wordt gemiddeld 185 kg per hectare toegediend terwijl grasland gemiddeld 262 kg stikstof uit dierlijke mest ontvangt. Ten opzichte van de toegestane gift met graasdiermest van 250 kg stikstof per hectare is een gemiddeld gebruik van 248 kg stikstof uit dierlijke mest relatief hoog. Dit relatief hoge gebruik kan deels worden verklaard doordat op alle bedrijven forfaitaire berekeningsmethoden van mestproductie zijn gehanteerd, terwijl veehouders kunnen opteren voor andere, bedrijfsspecifiekere methoden voor de berekening van mestproductie. Als bedrijven die gebruik maken van deze bedrijfsspecifieke berekeningsmethoden buiten beschouwing worden gelaten, is het gebruik van stikstof uit dierlijke mest gemiddeld 239 kg in plaats van 248 kg per hectare. Nagegaan dient te worden in hoeverre het gebruik van de forfaitaire berekeningsmethodiek heeft geleid tot een overschatting van de mestproductie op de betreffende bedrijven.

Het berekende stikstofoverschot op de bodembalans in 2006 is gemiddeld 196 kg per ha (Tabel S2). Dit overschot is in de veen- en kleiregio's hoger dan in de zand- en lössregio's. In de veenregio wordt circa 80 kg netto-stikstofmineralisatie per hectare als aanvoer berekend, terwijl in de andere regio's de netto-stikstofmineralisatie verwaarloosbaar is. In de kleiregio is sprake van een hogere aanvoer van stikstof via kunstmest dan in de andere regio's. Het overschot aan fosfaat op de bodembalans is gemiddeld 30 kg P_2O_5 per hectare en verschilt, met uitzondering van de lössregio, nauwelijks tussen de regio's.

Tabel S2 Mestgebruik en nutriëntenoverschotten op bedrijven in het derogatiemeetnet voor 2006 per regio.

Karakteristieken		Regio				
		Zand	Löss	Klei	Veen	Alle
Mestgebruik						
Werkzame stikstof	Bouwland[1]	112	148	116	102	114
(kg N per hectare)	Grasland	246	196	291	233	249
Fosfaat	Bouwland[1]	108	98	110	99	107
(kg P_2O_5 per hectare)	Grasland	100	75	102	103	99
Stikstof uit dierlijke mest	Bedrijfsniveau	248	209	251	254	248
(kg N per hectare)	Bouwland[1]	190	195	175	168	185
	Grasland	264	215	269	261	262
Nutriëntenoverschotten						
Stikstofoverschot op de bodembalans (kg N /ha)		177	142	217	242	196
Fosfaatoverschot op de bodembalans (kg P_2O_5 /ha)		31	19	33	30	30

[1] Bouwland op graslandbedrijven wordt voornamelijk gebruikt voor de productie van snijmaïs (gemiddelde 86%).

Waterkwaliteit

De waterkwaliteit gemeten in 2006 is het gevolg van de landbouwpraktijk in de jaren voor de derogatie. De nitraatconcentratie in het uitspoelende water uit de wortelzone was in 2006 in de zandregio gemiddeld 51 mg NO_3 per liter en in de lössregio 88 mg/l (zie Tabel S3). De nitraatconcentratie in de zand- en lössregio's is gemiddeld hoger dan die in de andere twee regio's, waar de nitraatconcentratie gemiddeld lager is dan 50 mg/l.

Tabel S3 Kwaliteit van het water uitspoelend uit de wortelzone op bedrijven in het derogatiemeetnet in 2006; gemiddelde concentratie nitraat, totaal-stikstof en fosfor in mg/l en het percentage van de bedrijven met een gemiddelde nitraatconcentratie hoger dan 50 mg/l.

Kenmerk	Regio			
	Zand	Löss	Klei	Veen
Aantal bedrijven	148	18	18	18
Nitraat (NO_3) (mg/l)	51	88	30	4
Nitraat % > 50 mg/l	47	83	22	6
Stikstof (N) (mg/l)	14,9	20,1	9,2	12,2
Fosfor (P) (mg/l)	0,10	< 0,06	0,40	0,88

De nutriëntenconcentraties in het slootwater zijn in de klei- en veenregio gemiddeld lager dan in het water uitspoelend uit de wortelzone (zie Tabel S4). In de zandregio zijn de concentratieniveaus in het slootwater vergelijkbaar met die in het water dat uitspoelt uit de wortelzone.

Tabel S4 Kwaliteit van het slootwater op bedrijven in het derogatiemeetnet in 2006; gemiddelde concentratie nitraat, totaal-stikstof en fosfor in mg/l en het percentage van de bedrijven met een gemiddelde nitraatconcentratie hoger dan 50 mg/l.

Kenmerk	Regio		
	Zand	Klei	Veen
Aantal bedrijven	11	18	17
Nitraat (NO_3) (mg/l)	62	12	1
Nitraat % > 50 mg/l	64	0	0
Stikstof (N) (mg/l)	15,6	4,8	4,0
Fosfor (P) (mg/l)	0,09	0,39	0,44

De voorlopige gegevens over de waterkwaliteit in de kleiregio voor 2007 geven een iets hogere nitraatconcentratie (36 mg/l) en totaal-stikstofconcentratie (11,7 mg N per liter) te zien en een iets lagere totaal-fosforconcentratie (0,28 mg P per liter) dan in 2006. Voor de veenregio is het beeld hetzelfde, een iets hogere nitraatconcentratie en een lagere fosforconcentratie in 2007 dan in 2006. Alleen de stikstofconcentratie is iets lager in het laatste jaar. De concentraties in het slootwater geven eenzelfde trend. Het is nog niet aan te geven in hoeverre weersomstandigheden invloed hebben gehad op de verschillen met het voorafgaande jaar. Het effect van de verdriedubbeling van het aantal bemonsterde bedrijven in 2007 ten opzichte van 2006 op de geconstateerde verschillen tussen jaren lijkt op basis van een eerste analyse beperkt.

In de rapportage van 2009 zal een compleet overzicht worden gegeven van de waterkwaliteit in 2007 op de bedrijven in het derogatiemeetnet. In de rapportage van 2010 zal een eerste analyse gemaakt worden van de ontwikkeling van de waterkwaliteit op basis van de meetresultaten uit de periode 2006-2008 en deze rapportage zal ook modelberekeningen bevatten.

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1 Introduction

1.1 Background

The Nitrates Directive obliges Member States to limit the use of livestock manure to a maximum of 170 kg of nitrogen per hectare. A Member State can, under certain conditions, ask the European Commission if it may deviate from this obligation (derogation). In December 2005, the European Commission issued the Netherlands with a definitive derogation decision under which grassland farms, which cultivate at least 70% of their total area as grassland, were allowed to apply up to 250 kg of nitrogen per hectare in the form of livestock manure that originates from grazing livestock (EU, 2005). The derogation decision applies to the period 2006-2009. In return for this, the Dutch government is obliged to collect a wide range of data regarding the effects of the derogation and to report these to the European Commission.

One of the requirements of the derogation decision, see Appendix 1, concerns 'the formation of a monitoring network for the sampling of groundwater, soil water, drainage water and ditches on farms for which an individual derogation is permitted' (Article 8 of the decision, para 2). The monitoring network must 'provide data on the nitrate and phosphorus concentration in the water leaving the root zone and ending up in the groundwater and surface water system' (Article 8, para 4). This monitoring network, which covers at least 300 farms, should be 'representative for all types of soil (clay, peat, sandy, and sandy loessial), fertilisation practices and crop rotations' (Article 8, para 2). However, within the monitoring network, the monitoring of water quality on farms on sandy soils should be improved (Article 8, para 5). The composition of the monitoring network should remain unchanged (Article 8, para 2) during the period in which the decision applies (2006-2009). During the negotiations with the European Commission it was agreed that the design of this monitoring network would tie in with the existing Minerals Policy Monitoring Programme (LMM), under which the water quality and operational management of farms selected for this purpose has been monitored since 1992 (Fraters and Boumans, 2005). It was also agreed that participants in the LMM, who satisfy the conditions, could be regarded as participants in the monitoring network for the derogation. Accordingly, the monitoring network for the derogation (the derogation monitoring network) has become part of the LMM. For the LMM the top metre of the phreatic groundwater, the soil moisture and/or the drainage water are sampled, as this is considered to sample the water leaving the root zone (see Appendix 4).

Aside from the obligation to monitor, there is the requirement to report the evolution in the water quality. The report should be based on 'the monitoring of leaching from the root zone, the surface water quality and the groundwater quality, as well as model-based calculations' (Article 10, para 1). Furthermore, an annual report must be submitted for the different soil types and crops regarding the fertilisation and yield on grassland farms on which derogation is permitted, to provide the European Commission with an understanding of the management on these farms and the degree to which this has been optimised (Article 10, para 4). This report is intended to meet the reporting requirements.

1.2 Content of this report

This is the second of the four annual reports about the results of the derogation monitoring network. The first report (Fraters et al., 2007) was limited to a description of the monitoring network, the

progress made in 2006 in terms of setting this up, the design and content of the reports in the years 2008 to 2010, as well as a general description of the measurement and calculation methods to be used, and the models to be applied.

Contrary to that stated in the first report, this report contains no information about the crop yields of the farms in the derogation monitoring network. A detailed analysis of Dutch dairy farm crop yields will be published at a later date (Aarts et al., 2008)[2]. However, here we do report on fertilisation with nitrogen and phosphate that is related to the acreage actually used and thus is registered as such in the FADN (Farm Accountancy Data Network of the Agricultural Economics Research Institute). This acreage may deviate from the acreage recorded in the land registration system of the National Service for the Implementation of Regulations of LNV[3]. Relating the fertilisation to the actual acreage in use allows a better understanding of the relationship between agricultural practices and water quality. However, these data cannot be used to assess compliance with the legislation, since this requires the acreages as recorded by the National Service for the Implementation of Regulations. Further information about these acreages can be obtained from VROM and LNV (2008).

Apart from the water quality and fertilisation, the nutrient surpluses of the farms in the derogation monitoring network are also reported, since these surpluses determine, to a large extent, the quantity of nutrients that could potentially leach from the soil.

The annual mean measured nitrate concentration per region and outcomes from the model calculations will only be included in the reports from 2009 onwards. The calculations quantify the influence of confounding factors on the measured nitrate concentrations. In particular, nitrate concentrations in water leaching from the root zone is affected not only by fertilisation but also by variations in the precipitation surplus (Boumans et al., 1997). A statistical model has been developed for the analysis of the effect of the variations in the precipitation surplus on the nitrate concentration in the uppermost layer of groundwater (Boumans et al., 2001, 1997). This method also corrects for changes in the composition of the group of participating farms, the sample (Fraters et al., 2004)[4].

Chapter 2 contains a brief description of the design and realisation of the derogation monitoring network. The agricultural characteristics of the participating farms are also detailed and a description is given of how water quality sampling is performed.

Chapter 3 presents and discusses the measurement results of the monitoring in 2006. This concerns the agricultural practice data from 293 farms. Of the 300 farms in the derogation monitoring network, no data were included from 7 farms: four farms relinquished the right to derogation in 2006, two of the farms could not complete the registration in 2006 on time, and for one of the farms the calculated nutrient flows proved to be unreliable.

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[2] For technical reasons the analysis is limited to pure dairy farms. Therefore, not all of the 300 farms from the derogation monitoring network are included in the analysis by Aarts et al. (2008).

[3] Rephrased, land that is registered as belonging to the farm but where no manure is applied, is not registered in the FADN, but is registered in the land registration system of the National Service for the Implementation of Regulations.

[4] Occasionally, participants may be replaced during the course of the programme (see chapter 2), or changes may occur in the acreage of the participating farms. Consequently, the ratio between the soil types and/or drainage classes are subject to change over the course of the programme. The soil type (sand, loess, clay, peat) and the drainage class (poor, moderate, good drainage) affect the relationship between the nitrogen surplus and the nitrate concentration measured. If the data were not corrected, a change in the nitrate concentration could therefore be caused by a change in the composition of the group of participating farms or changes in the acreage.

The water quality data of 202 derogation farms from 2006 are presented[5]. The water quality in 2006 was determined by the agricultural practice in 2005 and the preceding years, and is therefore related to the effects of agricultural practice prior to derogation. It concerns data from farms that either previously participated in the LMM, or which were recruited during the measurement campaigns for participation in the derogation monitoring network and could still be sampled before the end of the measurement campaigns.

The water quality in 2007, in part determined by the agricultural practice in the first derogation year 2006, was, however, measured on all farms in the derogation monitoring network. The fully processed results from this will be reported in 2009. This report includes the provisional results from the measurement campaigns in the clay and peat regions (winter 2006-2007). Additional data including soil type and drainage classification are not yet available. Consequently, no conclusions can be drawn regarding possible differences in the measured water quality between the measurement years 2007 and 2006.

The relevant articles from the Dutch Derogation Decree have been included in Appendix 1. Appendix 2 provides further details about the assembly of the derogation monitoring network. The other appendices provide a detailed justification for how the data for agricultural practice and the calculation of the fertilisation and the nitrogen and phosphate surpluses are registered (Appendix 3) and how the water quality measurements are made (Appendix 4).

[5] The sampling for water quality monitoring in 2006 ran from November 2005 (start programme in Low Netherlands) to January 2007 (completion of the sampling in the loess region in High Netherlands).

2 Design of the derogation monitoring network

2.1 Introduction

The monitoring network must be designed in such a manner that it satisfies the requirements of the European Commission, as stipulated in the derogation decision of December 2005, see Appendix 1.

The setting up of the network and the reporting of the results is based on the division of the Netherlands into regions, as made for the Nitrate Directive Action Programme and the fertilisation legislation. Four regions are distinguished for this purpose: the sand region, the loess region, the clay region and the peat region. The acreage of agricultural land in the sand region constitutes about 47% of the approximately 1.95 million hectares of total agricultural land in the Netherlands. The acreage of agricultural land in the loess region constitutes approximately 1.5%, in the clay region 39% and in the peat region 12% of the total agricultural acreage.

The derogation network covers the prescribed number of 300 farms who have registered for an individual derogation (Article 8, para 2). The derogation decision deals with farms that are allowed to use the derogation. However, it is not possible to determine prior to selection, whether a farm that has registered for derogation, is permitted and is actually willing to make use of the derogation[6]. The 300 selected farms will participate in the derogation monitoring network throughout the entire period 2006-2009 (Article 8, para 2), unless they no longer satisfy the conditions. Since the farms must register for derogation each year, participants in the derogation monitoring network may cease to participate because they are no longer eligible or they no longer wish to make use of the derogation. It is also possible that participants no longer satisfy the conditions (sampling limits) for participation in the derogation monitoring network due to extreme changes in the farm set up. In either situation, new comparable farms will be selected and recruited, so that the required number of 300 participants remains constant through the entire period. In 2006, four farms refrained from making use of the derogation after being recruited to the network. This means that data on agricultural practices are available for 296 farms that actually made use of derogation in 2006.

The sampling of the water quality for the measurement year 2006 was carried out during the winter of 2005/2006 in the Low Netherlands[7] and in the summer and the rest of 2006 in the High Netherlands[7]. In 2005, when the preparations and sampling for this measurement year were started, it was not yet known which farms would apply for derogation. The group of farms that was sampled was therefore limited to the farms that already participated in the LMM and the farms that were included in the network during the measurement campaigns and could still be sampled before the campaigns were concluded. Therefore, water sampling only took place on about 200 of the 300 farms in the derogation

[6] The Fertilisers Act states that farms requesting eligibility for derogation must report to the National Service for the Implementation of Regulations of LNV each year, prior to the year for which the application is being made. This application does not necessarily mean that a derogation will be granted for these farms. The National Service for the Implementation of Regulations can only inspect the conditions attached to derogation during the year for which derogation has been requested and the year following this. The inspection takes place on the basis of data supplied by the farms and through inspections that are carried out (administrative and on the farm). VROM and LNV, 2007).

[7] The Low Netherlands covers the clay and peat regions, and those soils in the sand region that are drained via ditches, whether or not in combination with drainage pipes or channels. The High Netherlands covers the other sand and loess soils.

monitoring network. Especially in the Low Netherlands, where the measurement campaigns were concluded at the end of April 2006, the number of farms sampled was limited. In 2007, all farms for which the agricultural practice was recorded in 2006 have been sampled.

The measured water quality in 2006 is partly determined by the agricultural practice of 2005 and the preceding years, hence by agricultural practices that took place prior to derogation. The extent to which agricultural practice in a previous year affects the measured water quality depends, amongst other things, on the level of and variation in the precipitation surplus in that year. The effects of agricultural practices in 2006, the first derogation year, will not be measurable on farms – in terms of water quality – any earlier than the winter 2006/2007 (Low Netherlands) or summer and autumn of 2007 (High Netherlands). The difference between the Low and High Netherlands is caused by the difference in hydrology. This difference in hydrology is also the reason for different sampling methods used in the Low and High Netherlands.

The derogation monitoring network was set up by means of a stratified sampling method in which region, groundwater body, farm type and size of the farm operation were used as stratification variables[8] (see Appendix 2). This stratification is applied to satisfy the requirement to be representative for all soil types (clay, peat, sand, and sandy loess soils), fertilisation practices and crop rotations (Appendix 1, Article 8, para 2). The number of farms in the sand region constitutes more than half of the number of farms in the derogation monitoring network, because on the one hand, more than half of the acreage of the derogation farms is located in this region, and on the other hand, the derogation decision requires that the monitoring of agriculture on sandy soils is to be intensified (Appendix 1, Article 8, para 5).

Since certain groups could be overrepresented in the derogation monitoring network then, in principle, this should be taken into account by using a weighing factor in the calculation of means. This has not been done yet in the current report, but it will be done in the next report.

For the composition of the sample, on the one hand the four regions were subdivided in groundwater bodies, as identified by the Netherlands for the implementation of the Water Framework Directive, and on the other hand two categories of grassland farms (specialised dairy farms, other grassland farms) were distinguished. By including another group of grassland farms in the derogation monitoring network, in addition to dairy farms, an effort has been made to establish a monitoring network representative for all soil types, fertilisation practices and crop rotations, in accordance with Article 8 of the Decision. Within these categories, the farms are further classified in three different classes according to economic size based on the Netherlands Magnitude Unit (NGE)[9]. Subsequently, farms were selected that satisfied these criteria and had at least ten hectares of cultivated land in use. This last criterion is generally applied in the LMM. The selection was initially focused on farms already participating in the LMM and thus already included in the FADN as well. Then, a selection took place within the group of FADN participants who did not yet participate in the LMM, and finally farms were

[8] By recruiting participants from different strata (subpopulations of farms from the same farm type and economic size and situated in the same groundwater body), a greater reliability is obtained than would be the case if a non-stratified sample of the same size is used. Additionally, stratification helps to safeguard the representation. If a selected farm can no longer participate then it is possible to select a replacement farm that is similar to the dropped-out farm in terms of location (body of groundwater), farm type and economic size of the farm.

[9] NGE (Netherlands Magnitude Unit) is a measure for the economic size. The standard gross margins were also used (bss; De Bont et al., 2003) to determine the economic size. The total standard gross margin at farm level was converted by means of a scaling factor into the Netherlands Magnitude Unit (NGEs).

selected that did not yet participate in the FADN but who did make use of derogation, see also Appendix 2.

As stated, all data regarding the agricultural practices, relevant for the derogation, were registered for all 300 farms according to the FADN system (Poppe, 2004). These data will be used to report on fertilisation and to carry out the requested model-based calculations. This required a considerable expansion of data recording within FADN. Adjustments were also agreed with the Scientific Working Group Application Standards (WOG) of the Expert Committee Fertilisers Act (CDM)[10]. A description of the calculation methods used to describe agricultural practices can be found in Appendix 3. The water sampling on the farms was carried out in accordance with the standard LMM procedures (Fraters et al., 2004). This sampling method is explained in Appendix 4.

2.2 Design and realisation of the sample

Table 2.1 shows the planned and actual number of farms in the derogation monitoring network per region (sand region, loess region, clay region and peat region) and farm type (dairy farms versus other grassland farms). The planned numbers show the sample as drawn beforehand from records of, amongst others, The Ministry of Agriculture's National Service for the Implementation of Regulations (overviews of farms registered for derogation in 2006) and from Statistics Netherlands (CBS; overview of farms from the Agricultural census 2005). The realised numbers of farms indicate the actual sample taken. The farm type is based on data registered in the FADN for 2006.

Table 2.1 shows that with the 265 dairy and 35 other grassland farms realised, the prior intended number of 260 dairy and 40 other grassland farms has been deviated from slightly. This difference is caused by the fact that, based on the FADN data, several farms were found to belong to a different type of farm than had been assumed by the setting up of the sample[11].

Furthermore, four entrepreneurs (from the category 'other grassland farm') explicitly indicated that they would not make use of the derogation applied for in 2006. Therefore, the results of the farms concerned have not been included in the tables in this report. Figure 2.1 shows the location of the 296 farms in the derogation monitoring network that used derogation in 2006.

Furthermore, it has to be mentioned that in terms of results, the registration of the agricultural practices on two dairy farms (in the clay and loess regions respectively) was not successfully completed in 2006. For one of these two farms, the registration is continued in 2007 and the other farm has been replaced as from 2007. Moreover, it was not possible to get a complete picture of the nutrient flows of 1 of the 16 other grassland farms in the sand region. Therefore, data on the general farm characteristics (Table 2.3 in this section) and fertilisation and nutrient surpluses (section 3.1) concern 294 and 293 farms, respectively.

[10] The CDM is an independent scientific committee that advises the Ministry of LNV about providing scientific evidence for the regulations, standards and forfeits arising from the Fertilisers Act.

[11] The difference can be explained by the fact that during the selection and recruitment, use was made of the CBS Agricultural census which (a) always shows a snapshot and (b) concerns the farm data from 2005. Additionally, agricultural census farms included in the FADN following recruitment, are occasionally found to be larger (and of a different farm type) because they are only part of a farm that occurs with several farm numbers in the CBS Agricultural census.

Table 2.1 Planned (design) and realised (realisation) number of dairy and other grassland farms per region.

Farm type	Design/Realisation	Region				
		Sand	Loess	Clay	Peat	All
Dairy farms	Design	140	17	52	52	261
	Realisation	144	17	51	53	265
	(for which derogation used)	144	17	51	53	265
Other grassland farms	Design	20	3	8	8	39
	Realisation	16	3	9	7	35
	(for which derogation used)	16	1	8	6	31
Total	Design	160	20	60	60	300
	Realisation	160	20	60	60	300
	(for which derogation used)	160	18	59	59	296

The group 'other grassland farms' in the derogation monitoring network is relatively heterogeneous because it was randomly selected from all other grassland farms that had registered for derogation for the year 2006. The group of 31 monitoring network farms consists of 20 other grazing livestock farms, 10 intensive livestock farms and 1 mixed husbandry farm (Table 2.2).

Table 2.2 Further classification of the 31 realised other grassland farms with derogation per region.

	Region				
Farm type	Sand	Loess	Clay	Peat	All
Other grassland farms with mainly grazing livestock[1]	10	1	6	4	21
Other grassland farms with mainly housed animals[2]	6		2	2	10
Total	16	1	8	6	31

[1] These are grassland farms where grazing livestock other than dairy cattle form the most important production objective. This concerns the following animal species: cattle, sheep, goats or horses and ponies.

[2] These are grassland farms where housed animals such as poultry, pigs or veal calves form the most important production objective. These farms can make use of derogation because they satisfy the requirement of 70% grassland. The increased application standard of 250 kg nitrogen from livestock manure may only be used for grazing livestock manure. For indoor animal manure a standard of 170 kg nitrogen applies.

With an area of more than 14,000 ha, 1.7% of the national acreage of the total sample population has been included in the sample (see Table 2.3). The loess region is overrepresented (12.3%) for policy-related reasons. Furthermore, it can be noted that the dairy farms in all regions are more strongly represented in the acreage than the other grassland farms. This is caused by:

- the realisation of eight less 'other grassland farms' than intended and four extra 'dairy farms' due to a deviant farm type and the non-application of derogation;
- the fact that the other grassland farms in the current derogation monitoring network were on average smaller than the dairy farms in terms of the area of cultivated land whereas the sample size was based on the number of farms instead of the share in the total area of cultivated land.

Table 2.3 Area cultivated land (in ha) in the derogation monitoring network compared to the total area of cultivated land of farms with derogation in 2006 in the sample population, according to the Agricultural census 2006.

Region	Farm type	Sample population[1] Acreage in ha	Derogation monitoring network Acreage in ha	% of acreage sample
Sand region	Dairy farms	379,049	6529	1.7
	Other grassland farms	51,546	486	0.9
	Total	*430,595*	*7015*	*1.6*
Loess region	Dairy farms	5246	794	15.1
	Other grassland farms	1333	18	1.3
	Total	*6579*	*812*	*12.3*
Clay region	Dairy farms	161,073	3158	2.0
	Other grassland farms	17,426	93	0.5
	Total	*178,499*	*3251*	*1.8*
Peat region	Dairy farms	197,890	2814	1.4
	Other grassland farms	31,540	326	1.0
	Total	229,430	3139	1.4
Netherlands	Dairy farms	743,258	13,295	1.8
	Other grassland farms	101,846	923	0.9
	Total	*845,103*	*14,218*	*1.7*

[1] Estimate based on Agricultural census 2006. Further information about how the sample population was defined can be found in Appendix 2.

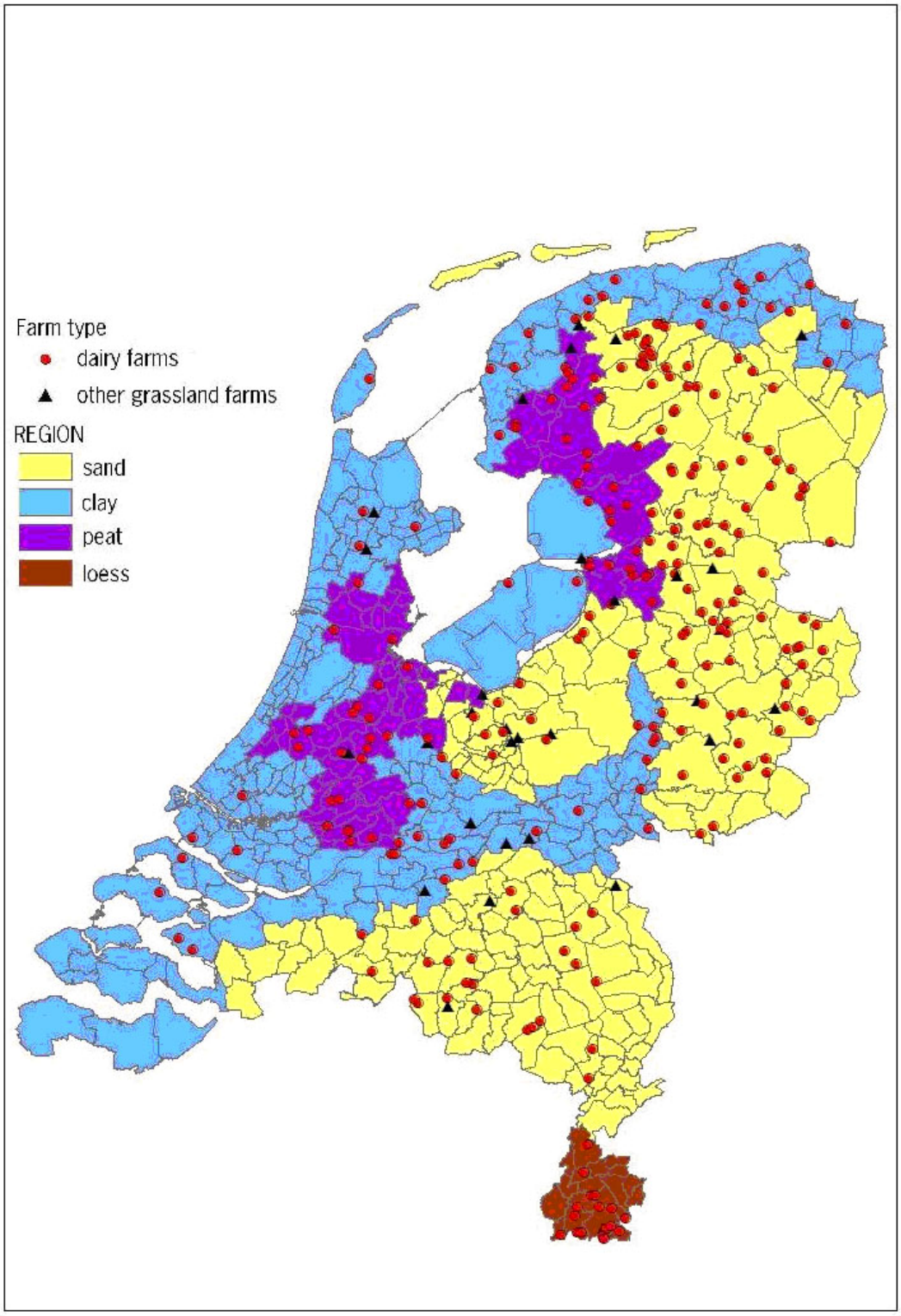

Figure 2.1 Location of the 296 grassland farms that participated in the derogation monitoring network in 2006. The four regions are: the sand region; the loess region; the clay region; and the peat region. Two types of derogation farm are distinguished, dairy farms (O) and other grassland farms (Δ).

2.3 Description of the farms in the sample

Table 2.4 contains a number of descriptive characteristics of the farms in the derogation monitoring network. This table contains data from all farms in the derogation monitoring network for which the registration in the FADN has been fully processed. For comparative purposes, the data from farms in the Agricultural census 2006 (sample population) have also been included.

Table 2.4 Description of a number of general farm characteristics of the farms in the derogation monitoring network (DM) compared to the mean of the sample population (LBT)[1].

Farm characteristic	Population[1]	Region Sand (N=160)	Loess (N=17)	Clay (N=58)	Peat (N=59)	All (N=294)
Area grassland (ha)	DM	35.0	36.9	44.0	49.4	39.8
	LBT	29.5	28.6	40.5	40.1	34.2
Area silage maize (ha)	DM	7.7	9.6	8.2	5.0	7.4
	LBT	7.1	7.0	4.7	3.2	5.8
Area other arable land[2] (ha)	DM	1.2	1.3	1.9	0.7	1.2
	LBT	0.7	2.4	1.2	0.3	0.8
Total surface cultivated land (ha)	DM	43.8	47.8	54.1	55.1	48.4
	LBT	37.4	38.0	46.5	43.6	40.8
Percentage grassland	DM	80	77	81	89	82
	LBT	79	75	87	92	84
Area natural habitat (ha)	DM	0.1	0.7	0.0	0.3	0.2
	LBT	0.3	0.4	0.4	0.2	0.3
Stocking density grazing livestock (GVE[3] per ha)	DM	2.09	1.91	2.08	1.96	2,05
	LBT	2.24	2.08	2.01	1.94	2.12
Percentage farms with housed animals	DM	15	6	12	10	13
	LBT	18	4	5	8	13
Specification livestock density derogation monitoring network (GVE[3] per ha)						
- dairy cattle (including young stock)	DM	1.98	1.82	1.87	1.80	1.92
- other grazing livestock	DM	0.10	0.09	0.21	0.15	0.13
- total housed animals	DM	1.41	0.07	0.51	0.32	0.93
- total all animals	DM	3.49	1.98	2.59	2.27	2.98

[1] DM = Farms in the Derogation monitoring network 2006, LBT = Sample population based on Agricultural census 2006 (data CBS, processed by LEI).

[2] For farms in the peat region, this primarily concerns forage crops other than silage maize. In the other regions, it chiefly concerns root crops such as sugar beet that only cover a small proportion of the area of cultivated land.

[3] GVE = Livestock Unit, this is a comparative standard for animal numbers based on the phosphate production forfeit (phosphate production forfeit dairy cow = 1 GVE).

The following conclusions can be drawn from Table 2.4:

- The mean acreage of cultivated land of the farms in the derogation monitoring network is greater than that of the farms in the sample population (48.4 versus 40.8 hectares). This also applies for all separate regions.
- Aside from the area of cultivated land, a mean of 0.2 hectares of nature conservation land is managed. This area is not included in the calculation of average fertiliser use.
- The percentage of acreage consisting of grassland is, with an average of 82% on the farms in the network, slightly lower than the mean of the sample population. For the clay and peat regions, the percentage of grassland in the monitoring network is lower, whereas in the sand and loess regions, a somewhat higher percentage of grassland is observed on the farms in the derogation monitoring network.
- Of the farms in the derogation monitoring network, a mean of 86% of the arable land is used for silage maize compared to 88% for the sample population.
- The livestock density of grazing livestock on the farms in the derogation monitoring network in the sand and loess regions is lower than the mean of the sample population, whereas in the clay and peat regions, slightly more grazing livestock per hectare are present. On average, the livestock density of grazing livestock on the farms in the derogation monitoring network is slightly lower than the mean in the sample population.
- On 15% of the farms in the derogation monitoring network, intensive livestock are present in addition to the grazing livestock. In the clay region, the percentage of farms with intensive livestock in the derogation monitoring network is clearly higher than in the sample population. This can be explained by the fact that the presence of intensive livestock was not a criterion for the stratification process.
- Dairy cattle and the associated young stock constitute almost 95% of the grazing livestock present. The other 5% is made up of beef cattle, sheep, goats, horses and ponies.
- The presence of large numbers of intensive livestock gives rise to a considerably higher mean total livestock density in the sand region compared to the other regions.

Table 2.5 provides a more detailed description of dairy farms in the derogation monitoring network. For comparative purposes, the data from the national sample (FADN) have been included (the sample population).

Table 2.5 Mean milk production and grazing on dairy farms in the derogation monitoring network (DM) compared to the weighted mean of dairy farms in the national sample (FADN)[1].

Characteristic	Population[1]	Region Sand (N=144)	Loess (N=16)	Clay (N=50)	Peat (N=53)	All (N=263)
kg FPCM[2] farm	DM	636,627	570,668	799,985	815,127	699,642
	FADN	550,139	335,574	676,206	657,478	588,219
kg FPCM per ha forage crop	DM	14,323	11,523	14,745	13,636	14,075
	FADN	14,448	10,655	13,566	12,732	13,833
kg FPCM per dairy cow	DM	8635	8033	8882	8418	8603
	FADN	8635	7412	8652	8202	8538
Percentage farms with grazing	DM	89	100	87	87	89
	FADN	86	100	88	89	87

1 DM = dairy farms in the derogation monitoring network, FADN = weighted mean of the national sample of dairy farms in the FADN

2 FPCM = Fat and Protein Corrected Milk, this is a comparative standard for milk with different fat and protein contents (1 kg milk with 4.00 % fat and 3.32 % protein = 1 kg FPCM).

The following additional conclusions can be drawn from Table 2.5:

- Just as for acreage, the dairy farms in the derogation monitoring network are also larger than the weighted national mean with respect to milk production. This applies to all regions.
- With more than 14,000 kg FPCM, the mean milk production per hectare of forage crop is slightly higher than the mean in the sample population. In the sand region, the production per hectare is slightly lower on the dairy farms in the derogation monitoring network compared to the sample population, whereas in all other regions the production per hectare is higher on the farms in the derogation monitoring network.
- The milk production per dairy cow present is also higher on the farms in the derogation monitoring network with the exception of the sand region.
- On 89% of the farms, grazing is applied and therefore lower application standards and a low coefficient for plant-availability of nitrogen from grazing livestock manure have been used in the calculations (see Appendix 3). This percentage is slightly higher on the farms in the derogation monitoring network than in the sample population.

2.4 Monitoring of water quality

2.4.1 Sampling at farms

In the measurement year 2006, water quality sampling was performed at 202 derogation farms participating in the derogation monitoring network (Figure 2.2). This concerned the sampling of groundwater, drain water or soil moisture. On the participating farms in the Low Netherlands[7], ditch water on farms was also sampled. The number of farms sampled per region in this period is stated in Table 2.6. The mean sampling frequency is also indicated. The sampling frequency continued at the normal LMM level, as the programme could only be adjusted during the course of 2006.

Table 2.6 Number of sampled farms registered for derogation per subprogramme and per region for 2006 and the sampling frequency of the leaching (L) and ditch water (DW).

Year	Sand region		Loess region	Clay region	Peat region
	All farms	Drained			
2005/2006	148	11	18	18	18
L rounds	1	3.5	1	2.3	1
DW rounds	0	2.6	0	2.3	1.5

The water quality sampling in 2006 took place in the period November 2005 to January 2007. The sampling period per region is stated in Table 2.7. Due to the prolonged drought in the autumn of 2005, the sampling in the Low Netherlands started one (clay region) to three (peat region) months later than anticipated (see Fraters et al., 2007). As a consequence of this delayed start, sampling in the peat region was only completed in May instead of April. In addition to this, the sampling in the loess region was continued until January 2007 in order to sample as many farms as possible that had registered for derogation and that could only be included in the derogation monitoring network during the measurement campaigns. A description of the sampling method per region is provided in Appendix 3.

Table 2.7 Sampling periods [1] for the water quality 2006 per region per programme in the period November 2005 to January 2007. Samples are related to the agricultural practices data of 2005.

Month	Oct	Nov[1]	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan
Sand Total																
Sand Low NL Low																
Loess																
Clay																
Peat																

[1] Light blue colour indicates that only during part of the month has been sampled.

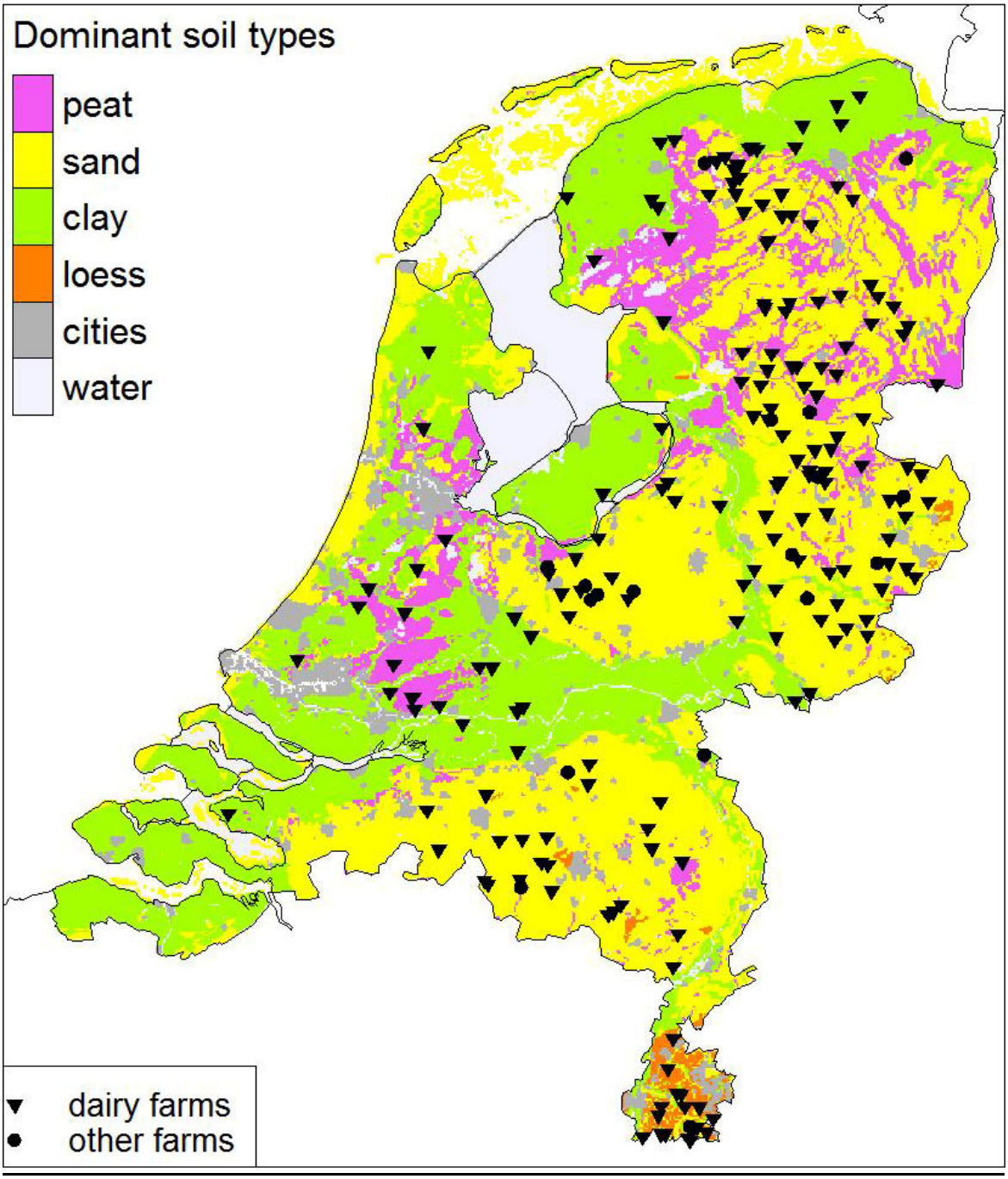

Figure 2.2 Location of the 202 grassland farms participating in the derogation monitoring network that were sampled in 2006.

The soil and drainage characteristics of the farms concerned are given per region in Table 2.8. The table reveals that within a region, soil types other than the main soil type after which the region is named occur. The loess region primarily contains naturally good draining soils and the peat region chiefly contains naturally poor draining soils.

Table 2.8 Percentages of the acreage per soil type and drainage class on derogation farms sampled in 2006.

Region	Soil types				Drainage class [1]		
	Sand	Loess	Clay	Peat	Poor	Moderate	Good
Sand region	82	0	11	7	41	48	11
Loess region	2	68	30	0	1	4	95
Clay region	16	0	81	3	38	56	6
Peat region	1	0	38	61	92	8	0

[1] The drainage classes are linked to the groundwater steps. The class of naturally poor draining contains Gt I to Gt IV, the class moderately draining Gt V, V* and VI, and the class good draining Gt VII and Gt VIII.

2.4.2 Chemical analyses and calculations

The chemical analyses of the water samples were carried out in an accredited laboratory of RIVM. Table 2.9 gives an overview of the methods used for the different components. Further details can be found in Wattel et al. (2008).

Table 2.9 Components analysed with analysis method and detection limit.

Component	Analysis method [1]	Detection limit
Nitrate (NO_3-N)	IC	0.31 mg l^{-1}
Ammonium (NH_4-N)	CFA	0.064 mg l^{-1}
Total nitrogen (N)	CFA	0.2 mg l^{-1}
Total phosphorus (P)	Q-ICP-MS	0.06 mg l^{-1}

[1] Q-ICP-MS : Quadruple inductively coupled plasma mass spectrometry.
IC : Ion chromatography.
CFA : Continuous flow analyser.

For each farm an annual mean concentration per component was calculated. For this calculation, observations with a concentration lower than the detection limit were assigned a value of 0. Consequently, farm mean concentrations lower than the detection limit can be calculated.

3 Results and discussion

3.1 Agricultural practices

3.1.1 Fertiliser use

Tables 3.1 to 3.3 provide the calculated use of plant-available nitrogen (Table 3.1), phosphate (Table 3.2) and nitrogen from livestock manure (Table 3.3) on the farms in the derogation monitoring network[12] in 2006. These tables also contain the mean application standards per hectare for arable land (mainly maize land) and grassland to allow a comparison of fertiliser use. These mean application standards are based on the acreage of cultivated crops and the soil type classifications as registered in the FADN and the statutory application standards determined for 2006 (Dienst Regelingen, 2006)[13]. The calculation of the fertiliser use is described in Appendix 3.

Table 3.1 Mean nitrogen use (in kg plant available N per ha) on farms in the derogation monitoring network in 2006. Means per region.

		Region				
		Sand	Loess	Clay	Peat	All
Description category		N=159	N=17	N=58	N=59	N=293
Plant-available nitrogen in	Livestock manure	97	73	98	101	97
	Other organic fertiliser	0	0	0	0	0
	Artificial fertiliser	120	109	158	120	127
	Total	*217*	*182*	*256*	*221*	*223*
Plant-available nitrogen on arable land[1]		112	148	116	102	114
Nitrogen application standards arable land		170	175	169	169	170
Plant-available nitrogen on grassland		246	196	291	233	249
Nitrogen application standards grassland		311	303	343	319	319

[1] Arable land on grassland farms is chiefly used for the production of silage maize (mean 86%).

The following conclusions can be drawn from Table 3.1:

- The total (plant-available) nitrogen use is relatively low in all regions. On both grassland and arable land, the quantity of plant-available nitrogen applied is significantly lower than the application standards.
- In the clay region the total (plant-available) nitrogen use is higher than in the other regions due to a higher use of artificial fertiliser. Higher application standards for nitrogen apply to clay soil than to other soil types.
- In the loess region the total (plant-available) nitrogen use is lower than in the other regions due to a lower use of both livestock manure and artificial fertiliser.

[12] Due to the 'rounding off' of figures the sum of the entries stated in the table can sometimes deviate from the totals given.

[13] This comparison provides insights into the fertilisation at crop level. The inspection by the Ministry of LNV for compliance with the application takes place, however, at farm level and not at crop or plot level.

- In all regions the nitrogen fertilisation on arable land, which mostly consists of silage maize, is considerably lower than the nitrogen fertilisation on grassland. In the loess region the fertilisation on arable land is somewhat higher than in the other regions.

Table 3.2 Mean phosphate use (in kg P_2O_5 per ha) in 2006 on farms in the derogation monitoring network. Means per region.

		Region				
		Sand	Loess	Clay	Peat	All
Description category		N=159	N=17	N=58	N=59	N=293
Phosphate in	Livestock manure	91	75	89	93	90
	Other organic fertiliser	0	0	0	0	0
	Artificial fertiliser	10	5	13	10	10
	Total	*101*	*81*	*102*	*103*	*100*
Phosphate on arable land[1]		108	98	110	99	107
Phosphate application standards arable land		95	95	96	95	95
Phosphate on grassland		100	75	102	103	99
Phosphate application standards grassland		111	112	111	112	111

[1] Arable land on grassland farms is mainly used for the production of silage maize (mean 86%).

The following conclusions can be drawn from Table 3.2:

- With the exception of the loess region, the mean phosphate use on the farms in the derogation monitoring network in all regions is just above 100 kg per hectare.
- The mean phosphate use on grassland is 99 kg and is therefore lower than the application standard of 111 kg on grassland. This is the case in all regions.
- However, at 107 kg per hectare, the use of phosphate on arable land is considerably higher than the application standard of 95 kg phosphate per hectare. This is the case in all regions.
- On average 10% of the phosphate is applied via artificial fertiliser. In the clay region slightly more phosphate in the form of artificial fertiliser is applied in both relative and absolute terms.

Table 3.3 Mean nitrogen use via livestock manure (in kg N per ha) in 2006 on farms in the derogation monitoring network. Means per region.

	Region				
	Sand	Loess	Clay	Peat	All
Description category	N=159	N=17	N=58	N=59	N=293
Use livestock manure					
– Produced on farm	267	214	274	258	263
– Stock mutation	5	8	2	-1	3
– Removal	32	15	37	14	29
– Supply	9	3	11	12	10
Total	*248*	*209*	*251*	*254*	*248*
Use on arable land[1]	190	195	175	168	185
Use on grassland	264	215	269	261	262

[1] Arable land on grassland farms is mainly used for the production of silage maize (mean 86%).

The following conclusions can be drawn from Table 3.3:

- The mean calculated use of nitrogen from all livestock manure (248 kg per hectare) is, with the exception of the loess region, at or near the derogation standard for grazing livestock manure of 250 kg N per hectare.
- The use of nitrogen from livestock manure on arable land (mainly silage maize) is, in all regions, considerably lower than the use on grassland.

In this report, use was made of a forfeit calculation method to determine manure production when calculating the fertiliser use (Appendix 2). However, for statutory purposes the manure production on farms with intensive livestock animals is determined via a farm-specific balance method. Also dairy farmers have been given the opportunity to determine the manure production in a farm-specific manner via the so-called Guidance (LNV, 2008). Figure 3.1 shows the average calculated nitrogen use according to the forfeit calculation method for three categories of farms in the derogation monitoring network that differ in the use of the statutory calculation method.

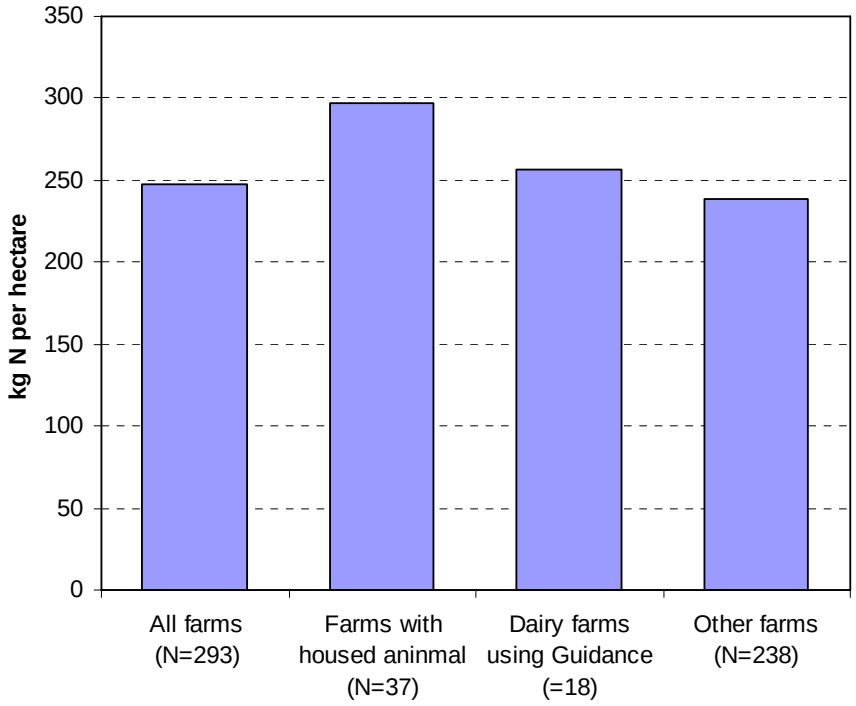

Figure 3.1 Nitrogen use from livestock manure (in kg N per ha) for categories of farms in the derogation monitoring network using different statutory calculation methods. Nitrogen use calculated using the forfeit calculation method.

The following conclusions can be drawn from Figure 3.1:

- The calculated use of nitrogen from animal manure on farms where intensive livestock animals are kept is, at 297 kg per hectare, considerably higher than the mean for farms in the derogation monitoring network. A possible explanation for this is that a forfeit fixed calculation method has led to an overestimation of the manure production compared to the farm-specific balance method. It needs to be ascertained to what extent an overestimation of the manure production on farms with intensive livestock animals has taken place.

- Eighteen of the dairy farms in the derogation monitoring network have indicated that they make use of the farm-specific calculation method (Guidance). On these farms the calculated manure production on the basis of the forfeit calculation method is also almost certainly higher than the farm-specific manure production calculated by the cattle farmer. Figure 3.1 shows that that the mean use of 257 kg nitrogen from livestock manure per hectare on these farms is indeed higher than the mean of all farms.
- On the 238 farms in the derogation monitoring network where in practice no use is made of a farm-specific calculation method for the production of the livestock manure, the average use of livestock manure is with 239 kg nitrogen per hectare (Figure 3.1) clearly under the standard of 250 kg nitrogen per hectare.

Table 3.4 provides a more detailed explanation of the input and output of livestock manure on the farms in the derogation monitoring network. The table reveals that on average, livestock manure is both imported and exported from the monitoring network farms. As the production is generally higher than the use permitted, the output of manure is on average higher than the input of manure. This applies to all regions.

Table 3.4 Percentage of farms in the derogation monitoring network that supplied and/or removed livestock manure in 2006. Means per region.

Livestock manure deliveries on farms	Region				
	Sand	Loess	Clay	Peat	All
No supply and no removal	31	35	43	49	38
Only removal	38	53	28	19	33
Only supply	27	6	19	25	24
Both supply and removal	3	6	10	7	5

The following conclusions can be drawn from Table 3.4:

- On 38% of the farms there was no transfer of manure to or from other farms.
- On 38% of the farms, manure was exported to prevent the application standard for livestock manure from being exceeded.
- On 29% of the farms livestock manure was imported. This manure import supply can be explained by the fact that the supply of nutrients via livestock manure in 2006 had a clear economic advantage compared to artificial fertiliser. The farms that imported manure ensured the complete use of the permitted application standards for livestock manure.

3.1.2 Nutrient surpluses

Tables 3.5 and 3.6 detail the nitrogen and phosphate surpluses on the soil surface balance for farms in the derogation monitoring network in 2006. This surplus indicates the calculated quantity of nutrients (nitrogen and phosphate) that are available in the soil at the end of the growing season. It is an indicator of leaching from the root zone. The surpluses are calculated using the calculation method described in Appendix 2.

Table 3.5 Composition of the nitrogen surplus of the farm and soil surface balance (in kg N per ha) of farms in the derogation monitoring network in 2006. Means per region.

Description	Category	Region				
		Sand N=159	Loess N=17	Clay N=58	Peat N=59	All N=293
Input farm	Artificial fertiliser	119	109	159	121	127
	Livestock manure	14	4	19	21	16
	Feed	180	114	190	122	167
	Other	8	3	12	6	8
	Total	*322*	*230*	*379*	*270*	*317*
Output farm	Animal products	71	53	77	60	69
	Animals	23	12	21	15	20
	Livestock manure	42	24	46	22	38
	Other	9	11	12	9	10
	Total	*145*	*100*	*156*	*105*	*136*
Nitrogen surplus farm		*177*	*130*	*223*	*165*	*181*
Input soil surface balance	+ deposition	32	36	29	29	31
	+ mineralisation	6	0	4	81	21
	+ fixation	14	17	18	16	15
Output soil surface balance	- emission housing & storage	36	23	38	27	34
	- emission application	11	11	14	16	13
	- emission grazing	5	6	4	5	5
Nitrogen surplus soil surface balance		***177***	***142***	***217***	***242***	***196***

The following conclusions can be drawn from Table 3.5:

- The mean nitrogen surplus of the soil surface balance is 196 kg per hectare. The nitrogen surplus increases in the order: loess < sand < clay < peat.
- The composition of the nitrogen surplus differs considerably between the regions:
  - The clay region is characterised by a high nitrogen surplus on the farm gate balance. The relatively high input of feed and artificial fertiliser is not entirely compensated by a higher output. The considerable variation in nitrogen input and output is probably caused by the presence of several farms in the population with a large number of intensive livestock animals (Table 2.4).
  - The sand region has a lower nitrogen surplus on the farm gate balance compared to the clay region, mainly due to the lower input of nitrogen in the form of artificial fertiliser. Since there are no large differences between the clay and sand regions in terms of the input and output of the soil surface balance, the nitrogen surplus on the soil surface balance is also considerably lower in the sand region than in the clay region.
  - In the peat region, less nitrogen is imported in the form of feed compared to the sand and clay regions. This lower input is partly caused by the lower number of intensive livestock in this region. Since removal of nitrogen via animal products and manure is also considerably lower, the nitrogen surplus on the farm gate balance is only fractionally

lower than in the sand region. In contrast, the nitrogen surplus on the soil surface balance is higher, partly due to the assumption that on average there is more than 80 kg net nitrogen mineralisation per hectare on peat. This is included as input in the soil surface balance. The calculated nitrogen emission from housing and storage is also lower because the total livestock density in this region is lower (see Table 2.4).

– The farms in the loess region are characterised by a low nitrogen surplus. Both input and output are lower on the farm gate balance than in the other regions.

Table 3.6 Composition of the phosphate surplus on the farm gate balance / soil surface balance (in kg P_2O_5 per ha) on farms in the derogation monitoring network in 2006. Means per region.

Description	Category	Region Sand N=159	Loess N=17	Clay N=58	Peat N=59	All N=293
Input farm	Artificial fertiliser	10	5	13	10	10
	Organic fertiliser	7	2	10	11	8
	Feed	70	51	74	49	65
	Other	4	2	5	3	4
	Total	*91*	*60*	*101*	*73*	*88*
Output Farm	Animal products	27	21	29	24	27
	Animals	13	7	11	9	11
	Organic fertiliser	17	8	23	8	16
	Other	3	4	5	3	3
	Total	*60*	*41*	*69*	*43*	*57*
Phosphate surplus farm = Phosphate surplus soil surface balance		***31***	***19***	***33***	***30***	***30***

The following conclusions can be drawn from Table 3.6:

- The average phosphate surplus on the soil surface balance is 30 kg per hectare.
- With the exception of the loess region, there is scarcely any difference in the phosphate surplus between regions. The higher phosphate input in the clay region, especially through feed, compared to the peat region is almost completely compensated by a higher output via livestock manure in particular. The sand region lies in between these two regions.

3.2 Water quality

3.2.1 Leaching from the root zone, measured in 2006

The concentrations measured in 2006 in water leaching from the root zone are related to the agricultural practices on the farms in 2005 and the years prior to this. Therefore, the water quality reported does not yet bear any relationship with the agricultural practices during the year in which derogation was applied. In 2006, two farms making no use of derogation were sampled in the loess region. The results of these samplings have not been included in the tables below.

The nitrate concentrations in the sand and loess regions are on average higher than 50 mg NO_3 per litre. In the clay and peat regions the nitrate concentrations are on average lower than 50 mg NO_3 per litre (see Table 3.7). Although the nitrate concentration in the peat region is lower than in the clay region, the total nitrogen concentration is higher. This is caused by the higher ammonium concentrations in the groundwater. The average ammonia nitrogen concentration in the peat region is 8.1 mg N per litre. In the clay, sand, and loess regions the concentration is on average lower than 1 mg/l. The higher ammonium concentration is probably the consequence of nutrient rich peat layers (Van Beek et al., 2004). The groundwater that is, or has been, in contact with nutrient rich peat layers often has a similarly high phosphate concentration (Van Beek et al., 2004) and these nutrient rich peat layers are probably also the cause of the measured higher mean phosphorus concentration in the peat and clay regions compared with the sand and loess regions.

Table 3.7 Nutrient concentration (in mg per litre) in water that leached from the root zone in 2006 on farms in the derogation monitoring network. Mean concentrations per region.

Characteristic	Region			
	Sand	Loess	Clay	Peat
Total number of farms	148	18	18	18
Nitrate (NO_3-N)	51	88	30	4
Nitrogen (N)	14.9[a]	20.1	9.2	12.2
Phosphorus (P)[b]	0.10 (53%)	< 0.06 (78%)	0.40 (17%)	0.88 (0%)

[a] Four missing observations.
[b] The percentage of the mean farm concentrations that are lower than the detection limit of 0.06 mg/l is indicated between brackets.

In the sand region, 53% of the farms have a nitrogen concentration lower than 50 mg/l and in the loess region this is 17% (see Table 3.8). In the clay and the peat regions, the percentage of farms with a concentration lower than 50 mg/l, is 78% and 94%, respectively.

Table 3.8 Frequency distribution of the mean farm nitrate concentrations (in mg NO_3 per litre) in water that leached from the root zone on farms in the derogation monitoring network per region in 2006, expressed as percentages per class.

Concentration class	Region			
(mg NO_3 / L)	Sand	Loess	Clay	Peat
< 15	20	0	39	94
15-25	11	6	17	0
25-40	14	0	17	0
40-50	8	11	6	0
> 50	47	83	22	6[a]
Total number of farms	148	18	18	18
Missing	0	0	0	0

[a] Concerns a farm with a deviating value for 2006 in a series of measurements since 2000, previously always < 25 mg/l.

Fifty percent of the farms in the sand region have a nitrogen concentration between 8.3 and 19.2 mg N per litre (see Table 3.9). For the peat region the figures are virtually comparable. For the clay region the values are lower and for the loess region higher.

Table 3.9 Nitrogen concentrations (in mg N per litre) in water that leached out from the root zone in 2006 on farms in the derogation monitoring network. First quartile, median and third quartile per region.

Characteristic	Region			
	Sand	Loess	Clay	Peat
Total number of farms	144	18	18	18
First quartile (25%)	8.3	12.2	3.7	7.3
Median (50%)	14.2	16.6	8.0	10.0
Third quartile (75%)	19.2	24.7	13.6	19.4

The phosphorus concentration in the leaching water on 75% of the farms is lower than the detection limit of 0.06 mg P per litre in the loess region and is lower than 0.11 mg/l in the sand region (see Table 3.10). In the clay region, the phosphorus concentrations for 50% of the farms lie between 0.09 and 0.73 mg/l. In the peat region the concentrations are higher.

Table 3.10 Phosphorus concentrations (in mg P per litre) in water leaching out of the root zone in 2006 on farms in the derogation monitoring network. First quartile, median and third quartile per region.

Characteristic	Region			
	Sand	Loess	Clay	Peat
Total number of farms	148	18	18	18
First quartile (25%)	< 0.06	< 0.06	0.09	0.60
Median (50%)	< 0.06	< 0.06	0.25	0.75
Third quartile (75%)	0.11	< 0.06	0.73	1.17

3.2.2 Ditch water quality, measured in 2006

The quality of the ditch water in the winter of 2005-2006 that is reported here, reflects the agricultural practices in 2005 and the years prior to this and, therefore, bears no relation to the derogation granted in 2006[14].

There are clear interregional differences in the nitrate concentration in the ditch water on the farms in the derogation monitoring network. With a mean of 62 mg NO_3, the nitrate concentration is highest in the sand region and with a mean of less than 2 mg/l, is lowest in the peat region (see Table 3.11). This also applies to the nitrogen concentration, although the difference between the clay and peat regions is not significant. The phosphorus concentration in the ditch water is highest in the peat region and lowest in the sand region. In the loess region there were no farms represented, in the derogation monitoring network, which had ditches.

[14] It is assumed that the derogation has exerted no effect on the possible (direct) nutrient displacement to ditches via surface run-off in the period between 1 January and 1 May 2006.

Table 3.11 Nutrient concentration (in mg per litre) in ditch water in the winter of 2005-2006 on farms in the derogation monitoring network. Mean concentrations per region.

Characteristic	Region			
	Sand	Loess	Clay	Peat
Total number of farms	11	-	18	17
Nitrate (NO_3-N)	62	-	12	1
Nitrogen (N)	15.6	-	4.8	4.0
Phosphorus (P)[b]	0.09	-	0.39	0.44

In the sand region four of the eleven farms (36%) have a nitrate concentration lower than 50 mg/l (see Table 3.12). In the clay and peat regions all of the farms sampled have a ditch water nitrate concentration lower than 50 mg/l.

Table 3.12 Frequency distributions of the farm mean nitrate concentrations (in mg NO_3 per litre) in ditch water on farms in the derogation monitoring network per region in the winter of 2005-2006, expressed in percentages per class.

Concentration class	Region			
(mg NO_3 / L)	Sand	Loess	Clay	Peat
< 15	0	-	61	100
15-25	18	-	22	00
25-40	9	-	11	00
40-50	9	-	6	0
> 50	64	-	0	0
Total number of farms	11	-	18	17
Missing	0	-	0	0

Approximately 50% of the farms in the sand region have a ditch water nitrogen concentration of between 10 and 20 mg N per litre (see Table 3.13). In the clay and peat regions at least 75% of the farms have a ditch water nitrogen concentration lower than 6.2 mg/l.

Table 3.13 Ditch water nitrogen concentrations (in mg N per litre) in the winter of 2005-2006 on farms in the derogation monitoring network. First quartile, median and third quartile per region.

Characteristic	Region			
	Sand	Loess	Clay	Peat
Total number of farms	11	-	18	17
First quartile (25%)	10.3	-	2.5	2.6
Median (50%)	14.0	-	4.0	3.8
Third quartile (75%)	20.3	-	6.2	4.6

On 50% of the farms in the sand region, the ditch water phosphorus concentration is lower than the detection limit of 0.06 mg P per litre (see Table 3.14). In the peat region, 50% of the farms have a phosphorus concentration between 0.24 and 0.62 mg/l. In the clay region the concentrations are lower than in the peat region, but higher than in the sand region.

Table 3.14 Ditch water phosphorus concentrations (in mg P per litre) in the winter of 2005-2006 on farms in the derogation monitoring network. First quartile, median and third quartile per region.

Characteristic	Region			
	Sand	Loess	Clay	Peat
Total number of farms	11	-	18	17
First quartile (25%)	< 0.06	-	0.07	0.24
Median (50%)	< 0.06	-	0.35	0.39
Third quartile (75%)	0.17	-	0.50	0.62

3.2.3 Provisional figures for the measurement year 2007

For the second measurement year (2007), provisional results are available only for the measurements in the clay and peat regions; 'provisional' means that the results have not yet been processed for a limited number of farms[15] and additional data such as soil type and drainage classification, for example, are not yet available. Consequently, no conclusions can be drawn about possible differences in the measured water quality between the measurement years 2007 and 2006.

In both the clay and peat regions, one farm was sampled that did not use derogation in the end. The results of these samplings have not been included in the tables below.

The mean nitrate concentration in 2007 for the clay region was 36 mg NO_3 per litre in the water that leached from the root zone. This is slightly higher than the 30 mg/l in 2006. Of the participating farms, 76% had a nitrate concentration lower than 50 mg/l (see Table 3.15). In addition, the nitrate concentration on farms in the peat region is higher than in 2006, with a mean of 21 mg/l measured in 2007.

The mean nitrate concentration in the clay region ditch water in 2007 is with 15 mg/l, slightly higher than the 12 mg/l in 2006. In the peat region as well, the average nitrate concentration of 6 mg/l in 2007 is higher than that measured in 2006. Of the participating farms in the clay region, 96% had a nitrate concentration lower than 50 mg/l and in the peat region this figure was 98% (see Table 3.15).

Table 3.15 Frequency distributions for the farm mean nitrate concentrations (in mg NO_3 per litre) in water leaching out of the root zone (left) and in the ditch water (right) on farms in the derogation monitoring network per region in 2007, expressed in percentages per class. The figures given are provisional (see text).

Concentration class (mg NO_3 / L)	Water type			
	Leaching out root zone		Ditch water	
	Clay region	Peat region	Clay region	Peat region
< 15	36	68	60	93
15-25	23	9	18	4
25-40	5	4	15	2
40-50	9	4	4	0
> 50	27	16	4	2
Total number of farms	56	57	55	56
Missing	3	2	4	3

[15] The number of farms for which the results have not yet been processed is stated in the table under the heading 'missing'.

The mean total nitrogen concentration in the leaching water for the clay region is 11.7 mg N per litre in 2007 (Table 3.16); this is higher than in the previous year (9.2 mg/l). In the peat region the average concentration in 2007 was 11.3 mg/l and thus comparable with the clay region and slightly lower than in 2006 (12.2 mg/l). The ditch water nitrogen concentrations are clearly lower than in leaching water but exhibit the same trend. The differences between years are small.

Table 3.16 Nitrogen concentrations (in mg N per litre) in the water that leaches from the root zone (left) and in the ditch water (right) in 2007 (provisional figures) on farms in the derogation monitoring network. First quartile, median and third quartile per region.

Characteristic	Water type			
	Leaching		Ditch water	
	Clay region	Peat region	Clay region	Peat region
Total number of farms	56	57	55	56
Mean	11,7	11.3	5.1	3.3
First quartile (25%)	3.7	5.1	2.3	1.8
Median (50%)	6.4	9.1	3.8	2.6
Third quartile (75%)	14.1	13.7	7.4	4.0

The average phosphorus concentration in leaching water in the clay region is 0.28 mg P per litre in 2007 (Table 3.17); this is lower than 2006 (0.40 mg/l). The same holds for the peat region, with a mean of 0.52 mg/l in 2007 and 0.88 mg/l in 2006. Like nitrogen, the phosphorus concentrations in ditch water are lower than in leaching water. The ditch water nutrient concentrations exhibit a difference between 2006 and 2007 comparable to that of the concentrations in the water leaching from the root zone.

Table 3.17 Phosphorus concentrations (in mg P per litre) in the water leaching from the root zone (left) and in the ditch water (right) in 2007 (provisional figures) on farms in the derogation monitoring network. First quartile, median and third quartile per region.

Characteristic	Water type			
	Leaching		Ditch water	
	Clay region	Peat region	Clay region	Peat region
Total number of farms	56	57	55	56
Mean	0.28	0.52	0.33	0.23
First quartile (25%)	0.10	0.10	< 0.06	0.08
Median (50%)	0.20	0.20	0.19	0.15
Third quartile (75%)	0.43	0.73	0.50	0.27

The extent to which weather conditions have affected the differences in the measured concentrations between 2006 and 2007 cannot yet be stated. The differences observed between the two measurement years do not appear to have been caused by an increase in the sample size. For example, fifteen farms in the clay region, for which measurement data are available from both years, reveal a comparable increase in the nitrate concentration in the leaching water (8 mg NO_3 per litre) and total nitrogen concentration (3.9 mg N per litre). Also, the decrease in the total phosphorus concentration (0.11 mg P per litre) is comparable with that of the entire group. For the ditch water a comparable

increase can also be seen in terms of the nitrate concentration (7 mg/l) and total nitrogen concentration (1.0 mg N /l). Moreover, the decrease in the total phosphorus concentration (0.05 mg P /l) is comparable with that of the entire group.

For the sixteen farms in the peat region, where measurements from both years are available, the picture scarcely differs from that of the entire group. Only the nitrate concentration is lower in this group compared to the entire group, and the total nitrogen concentration in the leached water shows a small increase between 2006 and 2007.

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Appendix 1 The derogation decision, relevant articles about monitoring and reporting

Article 8 Monitoring

1. Maps showing the percentage of grassland farms, percentage of livestock and percentage of agricultural land covered by individual derogation in each municipality, shall be drawn by the competent authority and shall be updated every year. Those maps shall be submitted to the Commission annually and for the first time in the second quarter of 2006.
2. A monitoring network for sampling of soil water, streams and shallow groundwater shall be established and maintained as derogation monitoring sites. The monitoring network, corresponding to at least 300 farms benefiting from individual derogations, shall be representative of each soil type (clay, peat, sandy and sandy loessial soils), fertilisation practices and crop rotation. The composition of the monitoring network shall not be modified during the period of applicability of this Decision.
3. Survey and continuous nutrient analysis shall provide data on local land use, crop rotations and agricultural practices on farms benefiting from individual derogations. Those data can be used for model-based calculations of the magnitude of nitrate leaching and phosphorus losses from fields where up to 250 kg nitrogen per hectare per year in manure from grazing livestock is applied.
4. Shallow groundwater, soil water, drainage water and streams in farms belonging to the monitoring network shall provide data on nitrate and phosphorus concentration in water leaving the root zone and entering the groundwater and surface water system.
5. A reinforced water monitoring shall address agricultural catchments in sandy soils.

Article 9 Controls

1. The competent national authority shall carry out administrative controls in respect of all farms benefiting from an individual derogation for the assessment of compliance with the maximum amount of 250 kg nitrogen per hectare per year from grazing livestock manure, with total nitrogen and phosphate application standards and conditions on land use.
2. A programme of inspections shall be established based on risk analysis, results of controls of the previous years and results of general random controls of legislation implementing Directive 91/676/EEC. Specific inspections shall address at least 5 % of farms benefiting from an individual derogation with regard to land use, livestock number and manure production. Field inspections shall be carried out in at least 3 % of farms in respect to the conditions set out in Article 5 and 6.

Article 10 Reporting

1. The competent authority shall submit the results of the monitoring, every year, to the Commission, with a concise report on evaluation practice (controls at farm level, including information on non compliant farms based on results of administrative and field inspections) and water quality evolution (based on root zone leaching monitoring, surface/ground water quality and model-based calculations). The first report shall be transmitted by March 2007, and subsequently every year by March in 2008, 2009 and 2010.
2. In addition to the data referred to in paragraph 1 the report shall include the following:
   (a) data related to fertilisation in all farms which benefit from an individual derogation;
   (b) trends in livestock numbers for each livestock category in the Netherlands and in derogation farms;

(c) trends in national manure production as far as nitrogen and phosphate in manure are concerned;

(d) a summary of the results of controls related to excretion coefficients for pig and poultry manure at country level.

3. The results thus obtained will be taken into consideration by the Commission with regard to an eventual new request for derogation by the Dutch authorities.

4. In order to provide elements regarding management in grassland farms, for which a derogation applies, and the achieved level of optimisation of management, a report on fertilisation and yield shall be prepared annually for the different soil types and crops by the competent authority and submitted to the Commission.

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Appendix 2 Selection and recruitment of participants for the derogation monitoring network

Introduction

In this appendix the selection and recruitment of the 300 farms in the derogation monitoring network is explained in detail. As indicated previously in the main text, the derogation monitoring network has become part of the Minerals Policy Monitoring Programme (LMM). The selection and recruitment of farms for the derogation monitoring network is comparable to that of participants in other parts of the LMM. Based on the most recent Agricultural census data (2005), a sample population was defined for each of the four regions. The sample populations were then divided into groups of farms (the strata) having the same groundwater body, farm type and economic size. From this distribution, the desired number of farms for the sample was derived per stratum, which not only considered the proportion of the total surface area of cultivated land in a given stratum (the greater the area of cultivated land, the greater the number of farms required in the random sample) but also a minimum representation per groundwater body.

The recruitment of farms was initially targeted at farms in the Farm Accountancy Data Network (FADN; report year 2006). For this, all suitable FADN farms were approached that had applied for derogation in 2006. Once the recruitment under FADN farms had been completed, it was determined which strata needed additional farms. Additional farms were selected from a database, compiled by the National Service for the Implementation of Regulations of the Ministry of Agriculture, Nature and Food Quality, which contains all farms that had applied for derogation in 2006. Of the additional participants chosen, fifteen are also participating in the research project Koeien & Kansen [Cows and opportunities] (www.koeienenkansen.nl).

Definition of the sample population

Just like the LMM, a limited number of farms that had registered for derogation were not considered for the random sample. This concerns either very small (economic size smaller than 16 NGE, see the next section for an explanation) or extremely large farms (larger than 800 NGE in size) as well as farms that use less than ten hectares of cultivated land.

Furthermore, during the supplementary selection based on the overviews of National Service for the Implementation of Regulations, a further three groups of farms were excluded. Firstly, farms for which the BRS numbers[16] on which derogation was registered did not appear in the Agricultural censuses of 2004 or 2005. It was not possible to ascertain which strata these farms were situated in. Secondly, farms were excluded that (according to the Agricultural Census of that year) had less than sixty percent grassland in 2005. There was a risk that this would include participants who applied for derogation, yet who upon further reflection may decide not to proceed due to the consequences of having to (sometimes considerably) increase the proportion of grassland on the farm. Thirdly, farms using

[16] Basic Registration System number, this is the relation number used by the National Service for the Implementation of Regulations.

organic practices were filtered from the National Service for the Implementation of Regulations database. By definition, organic farms (irrespective of the type of grassland or fertiliser) may not use more than 170 kg N livestock manure per hectare. The final sample population used for the selection contained almost 21,000 farms.

Explanation per stratification variable

The derogation decision demands a monitoring network that is not only representative for all soil types but also for all fertilisation practices and crop rotations (Article 8 of the derogation decision). Accordingly, the stratification was made not only per region but also per farm type, economic size (size class) and groundwater body. These variables are explained in this section.

Classification according to farm type
For the classification of farms according to farm type, use was made of the classification based on the Netherlands Magnitude Unit (NEG classification; De Bont et al., 2003). The NEG profile of a farm is determined by the extent to which the farm produces specific types of crops and/or animals. For this all crop areas and numbers of animals per animal species present are converted into so-called standard gross margins (SGM). A farm is characterised as 'specialised' when a significant proportion (often at least two-thirds) of the total farm volume comes from a certain type of production (for example, dairy, arable or pigs). Within the NEG profile, eight main farm types can be distinguished of which five are pure and three combined. The five pure, main farm types are: arable, horticulture, permanent cultivation (fruit growing and tree nurseries), grassland animals and housed animals (intensive livestock farming). Combined farms are classified according to crop combinations, mixed husbandry and mixed crop and husbandry. Each main farm type is further divided into several subtypes. For example, within the grazing animal farms, specialised dairy farms are distinguished.

Within the group of farms that applied for derogation in 2006, dairy farms form a large homogenous group (that use almost 90% of the cultivated land). A good 10% of the acreage is situated on farms of a different type. These farms were also included in the network so as to gain as representative a sample as possible in terms of crop rotations and fertilisation practices.

Classification according to economic size
Other than farm type, farms were also classified according to economic size, for which four size classes were distinguished. This prevented farms of a smaller or larger economic size from being overrepresented.

For the determination of the economic size, the standard gross margins were also used. The total standard gross margins at farm level was converted by means of a scaling factor into Netherlands Magnitude Unit (NGEs).

Classification according to groundwater body per main soil type region
For the Framework Directive Water, a total of twenty groundwater bodies are distinguished in the Netherlands (Verhagen et al., 2006). During the setting up of the derogation monitoring network, a fair distribution (and minimal representation) was strived for in each region to cover, measured in terms of cultivated land area, the most important groundwater bodies. The basis for determining the groundwater body per farm was the municipality in which the farm receives post. In municipalities where several groundwater bodies are found, all farms were attributed to the largest groundwater body.

Within the sand region, five groundwater bodies were distinguished as subregions, namely: Eems, Maas, Rhine Central, Rhine North and Rhine East. The other farms (in other groundwater bodies within the region) were attributed to the sixth subregion termed ‘other’. The loess region only contains the ‘Krijt’ [Chalk] groundwater body and was therefore not classified further. The peat region was divided into four subregions, namely the groundwater bodies Rhine North, Rhine East, Rhine West and ‘other’. Five subregions were eventually distinguished in the clay region. As several groundwater bodies are situated in the Southwestern sea clay area (without clear domination) this entire clay area was classified as a separate subregion. A further three groundwater bodies were distinguished as separate subregions: Eems, Rhine North and Rhine West (in so far as this is located outside of the South-western sea clay area). The fifth subregion concerned the farms in other, not further classified, municipalities.

In Tables A2.1 to A2.4 the numbers of dairy and other grassland farms recruited per main soil type region and within this, per subregion are stated. Figure A2.1 shows the farms and subregions.

Table A2.1 Number of farms realised in the sand region in 2006, per subregion.

Groundwater body	Total number of farms	Number of dairy farms	Number of other grassland farms
EEMS sand	9	8	1
MAAS sand	27	24	3
RHINE CENTRAL sand	17	12	5
RHINE NORTH sand	29	28	1
RHINE EAST sand	74	68	6
OTHER within sand region	4	4	0
TOTAL SAND REGION	160	144	16

Table A2.2 Number of farms realised in the clay region in 2006, per subregion.

Groundwater body	Total number of farms	Number of dairy farms	Number of other grassland farms
EEMS clay	5	5	0
RHINE NORTH clay	16	15	1
RHINE WEST clay *	18	13	5
Western sea clay area	7	7	0
OTHER within clay region	13	11	2
TOTAL CLAY REGION	59	51	8

Table A2.3 Number of farms realised in the peat region in 2006, per subregion.

Groundwater body	Total number of farms	Number of dairy farms	Number of other grassland farms
RHINE NORTH peat	13	11	2
RHINE EAST peat	15	14	1
RHINE WEST peat	25	24	1
OTHER within peat region	6	4	2
TOTAL PEAT REGION	59	53	6

Table A2.4 Number of farms realised in the loess region in 2006.

Groundwater body	Total number of farms	Number of dairy farms	Number of other grassland farms
TOTAL LOESS REGION	18	17	1

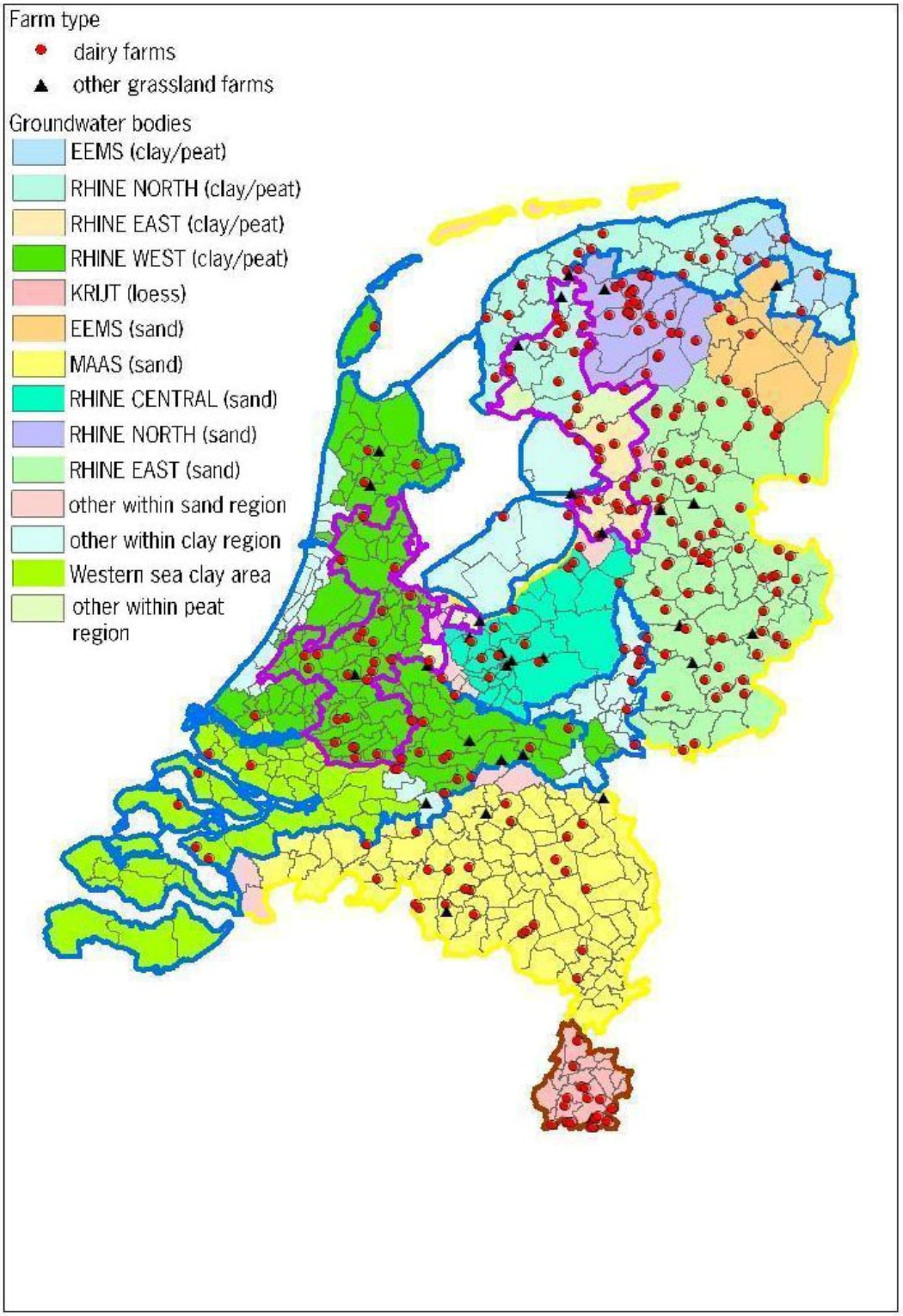

Figure A2.1 Location of dairy farms (o) and other grassland farms (Δ) participating in the derogation monitoring network in 2006 per subregion.

Appendix 3 Monitoring of agricultural characteristics

Introduction

The LEI is responsible for monitoring the data on agricultural practices as part of the FADN. The FADN is a stratified sample of approximately 1500 farms and horticultural enterprises for which a detailed set of financial-economic and environmental data are maintained. The FADN represents almost 95% of the total agricultural production in the Netherlands (Poppe, 2004). Approximately 45 fulltime LEI staff are responsible for collecting and recording the operational data in FADN. They process all the invoices of the participating farms. They also stock take initial and end supplies and additional data such as the crop rotation, grazing system and the composition of the livestock population. Participants receive a report from LEI, largely containing annual totals (such as profit and loss accounts and a balance). Inconsistencies in the processing of data by researchers or participants are checked, of course, since apart from financial flows, many physical flows are also registered. As stated in Section 2.1, the set of operational data that LEI records from participants in the monitoring network has been considerably extended.

Most of the data in the FADN are converted into annual totals corrected for stock adjustments. The feed concentrate use per year, therefore, emerges from the sum of all purchases between two balance dates, minus all sales, plus the starting stock, minus the end stock. The use of fertilisers is known not just on an annual basis but also on a growing season basis running from the moment that the prior fruit was harvested until the harvest of the crop.

Calculation of the fertiliser use

According to the derogation decision (EU, 2005) the report should include details regarding the fertilisation and crop yield (Article 10, para 4). This article states (see Appendix 1): ‘In order to provide elements regarding management in grassland farms, for which a derogation applies, and the achieved level of optimisation of management, a report on fertilisation and yield shall be prepared annually for the different soil types and crops by the competent authority and submitted to the Commission’. A detailed analysis of crop yields is provided in Aarts et al. (2008). This report will also examine whether permitted quantities of manure produced, as used in this report, are consistent with the quantities calculated from the difference between feed on the one hand, and the sum of animal products and possible gaseous losses on the other. In the report concerning fertilisation, four regions are distinguished (the clay region, the peat region, the sand region and the loess region). Fertilisation at farm level is reported, but a distinction is also made between fertilisation on arable land and grassland.

For the calculation of fertiliser use, first the production of manure on the farm is calculated. Concerning nitrogen, this is the net production after subtraction of gaseous nitrogen losses from housing and storage. The manure production for grazing livestock is calculated by multiplying the mean number of animals present by the statutory excretion forfeits (Dienst Regelingen, 2006). With regards to manure production of intensive livestock animals, the number of animals concerned is multiplied by the

national excretion forfeits, as stipulated by the Working Group Uniformisation Manure Figures (Van Bruggen, 2007)[17].

Furthermore, the quantity of nutrients is registered for all fertilisers and stock (artificial fertiliser, livestock manure and other organic fertilisers) imported and exported. In principle, the quantity of nitrogen and phosphate in all imported and exported fertilisers is calculated by means of sampling. If sampling has not taken place, estimated levels per fertiliser type are used (Dienst Regelingen, 2006). Nutrients in initial and final stocks are always calculated using estimates of nutrient contents (Dienst Regelingen, 2006).

The total quantity of fertiliser used at farm level is subsequently calculated as:

Fertiliser use farm = Manure production + Initial stock – Final stock + Input – Output

The quantity of fertilisers used on arable land are directly registered within the FADN.
Besides the type and quantity, the time of application is also recorded. The fertiliser use on grassland is subsequently calculated as:

Fertiliser use on grassland = Fertiliser use farm – Fertiliser use on arable land

This use on grassland consists of manure that is spread and manure that is directly excreted onto the grassland by grazing livestock (grassland manure). The quantity of nutrients directly excreted on grassland is calculated per animal type by multiplying the percentage of time on an annual basis that the animals graze, by the excretion estimates (Dienst Regelingen, 2006).

Nitrogen use

The total nitrogen use is expressed in kg plant-available nitrogen. The quantity of plant-available nitrogen is calculated by multiplying the total quantity of nitrogen in organic fertilisers by the availability coefficient as stated in Table A3.1.

The availability coefficient for all livestock manure is lower if grazing is applied on the farm (35% instead of 60%). In the case of fertilisation of arable land during the autumn on clay and peat soil, a lower availability coefficient is calculated. In all other cases, the availability coefficient depends solely on the type of fertiliser.

Phosphate use

Phosphate use is expressed in kg phosphate. The calculation of the use includes all fertilisers with the exception of a part of the phosphate applied via compost and defecation scum.

[17] This is in contrast to the statutory calculation for manure production on intensive livestock farms where use is made of a housing balance method in which the manure production is calculated as supply of feed for animals minus removal of animals and animal products.

Table A3.1 Availability coefficient (in %) used to determine nitrogen use (Dienst Regelingen, 2006).

Type fertiliser	Condition	Availability coefficient
Autumn application livestock manure on arable land on clay or peat soil	Liquid manure	30
	Solid manure	25
Manure produced on own farm from grazing livestock	Farm with grazing	35
	Farm without grazing	60
Other fertilisers and conditions	Thin fraction and slurry	80
	Liquid manure	60
	Solid manure from pigs, poultry and minks	55
	Solid manure other animal species	40
	Mushroom compost	25
	Compost	10
	Sewage sludge	40
	Other organic fertilisers	50

Calculation of nutrient surpluses

In addition to fertilisation, a report is also given concerning the surplus of nitrogen and phosphate on the soil surface balance (in kg N per ha and phosphate in kg P_2O_5 per ha). These surplus amounts are used as an indicator of the quantity of nitrogen and phosphate available for leaching from the root zone and are calculated with the help of a procedure derived from the method used and described by Schröder et al. (2007, 2004). This means that in addition to the quantities of nitrogen and phosphate in inorganic and artificial fertilisers, and the quantities of nitrogen and phosphate removed in crops, consideration is also given to other supply categories such as net mineralisation of organic matter in the soil, nitrogen fixation by legumes and atmospheric deposition. The calculation of nutrient surpluses on the soil surface balance assumes an equilibrium situation. It is assumed that in the longer term, the import of organic nitrogen, in the form of crop residues and organic fertiliser, is equal to the annual breakdown. An exception is made to this rule for peat and reclaimed soils for which the supply post for mineralisation used in the calculations is 160 kg N per ha for grassland on peat and 20 kg N per ha for grassland on reclaimed soil and other crops on peat and reclaimed soil. For these soils it is known that net mineralisation occurs as a consequence of the groundwater level management that is necessary to be able to use these soils for agricultural purposes. Schröder et al. (2007, 2004) calculated the surplus on the soil surface balance by taking the supply of nutrients to the soil as the starting point. In this study, a balance method is used to calculate the surplus on the soil surface balance from the farm data.

The calculation method used for the nitrogen surplus is summarised in Table A3.2. Initially, the surplus on the farm gate balance is calculated by adding the supply and removal of nutrients registered in the bookkeeping. This surplus is calculated with the inclusion of stock mutations. Regarding nitrogen, the surplus calculated on the farm gate balance is then corrected for input and output categories on the soil surface balance. Similarly, for phosphate the surplus on the soil surface balance is the same as the surplus on the farm gate balance. A more detailed explanation of the calculation methods can be found in the footnotes below the tables.

Table A3.2 Calculation method used for the nitrogen surplus on the soil surface balance (kg N ha^{-1} year^{-1}).

Description categories		Calculation method
Input farm	Artificial fertiliser	Quantity[a] * level[e]
	Animal manure and other organic fertiliser	Quantity[a] * level[e]
	Feed	Quantity[a] * level[f]
	Animals	Quantity[a] * level[g]
	Plant products (sowing seed, young plants and seed potatoes)	Quantity[b] * level[h]
	Other	Quantity[b] * level[I]
Output farm	Animal products (milk, wool, eggs)	Quantity[c] * level[j]
	Animals	Quantity[d] * level[I]
	Animal manure and other organic fertiliser	
	Crops and other plant products	Quantity[d] * level[h]
	Other	Quantity[c] * level[g]
N surplus on the farm gate balance	Input farm – Output farm	
Input soil surface balance	+ Mineralisation	160 kg N for peat soil and 20 kg for reclaimed soil[l]
	+ Atmospheric deposition	Differentiated per province[m]
	+ N fixation by legumes.	All legumes[n]
Output soil surface balance	- Volatilisation from housing and storage	For example animal species, housing system and grazing system[o]
	- Volatilisation application and grazing	Artificial fertiliser and livestock manure such as actual manure production, grazing and application method[p]
N surplus on the soil surface balance	N surplus farm + input soil surface balance – output soil surface balance	

a) Purchase – sale + initial stock – final stock.
b) Purchase + stock decrease.
c) Sale – purchase + final stock – initial stock.
d) Sale + stock increase.
e) N levels artificial fertiliser, feed concentrate and single feeds via quarterly overviews.
f) N levels for roughage via quarterly overviews or estimated standards (CVB, 2003).
g) N levels crops and plant products according to Van Dijk (2003).
h) N levels livestock manure and compost according to Dienst Regelingen (2006).
i) N levels animals according to Beukeboom (1996).
j) The N level of milk is calculated as the farm-specific protein level/6.38. Other N level animal products according to Beukeboom (1996).
k) For grass on peat: 160 kg N per ha per year, other crops on peat as equally reclaimed soil (irrespective of crop): 20 kg N per ha per year, all other soil types: 0 kg. For FADN farms the areas are established according to the four soil types used by the National Service for the Implementation of Regulations (sand/clay/peat/loess). For the estimations of mineralisation for

reclaimed soil use is made of global soil classifications (based on postcode) according to De Vries and Denneboom (1992).

l) The atmospheric deposition is differentiated each year per province and in 2006 varied between 23-40 kg N per ha per year (MNP/CBS/WUR, 2007).

m) N fixation in kg N per ha per year (Schröder, 2006).
   - for grass clover: in the case of clover proportion < 5%: 10 kg, in the case of clover proportion between 5 and 15%: 50 kg, in the case of clover proportion > 15% 100 kg, proportion of clover according to figures submitted by the participant;
   - for alfalfa: 160 kg;
   - for peas, broad beans, kidney beans and snap peas 40 kg;
   - for other legumes 80 kg.

n) Emissions from housing and storage is calculated as a function of the livestock species, housing system and grazing system (see, for example, Oenema et al., (2000)).

o) Volatilisation in the case of grazing: 8% of the N-total excreted on grassland (Schröder et al., 2005). In the case of mechanical application on grassland: trailing foot spreader, 10% of N total; trussed beam plough, 6.5% of N total; shallow grassland injector 3% van N total; aboveground spreading of solid manure, 14,5%. On arable land, incorporating 8.5% van N total; injection, 1% of N total, aboveground spreading of solid manure 14.5% (Van Dijk et al., 2004, Table 1).

Appendix 4 Sampling of water on farms

Introduction

The derogation decision (EU, 2005) states that a report must be produced concerning the evolution of water quality based on, for example, regular monitoring of leaching from the root zone and checking of surface and groundwater quality (Article 10, para 1). For this, the monitoring of the quality of the 'shallow groundwater layers, soil water, drainage water and watercourses on farms that are part of the monitoring network' must provide data about the nitrate and phosphorus concentration in the water leaving the root zone and ending up in the groundwater and surface water system (Article 8, para 4).

Water sampling
In the Netherlands, the groundwater level is often present just beneath the root zone; the mean groundwater level in the sand region is approximately 1.5 metres below the surface. In the clay and peat region, the groundwater levels are, on average, even shallower. Only on the push-moraines of the sand region and in the loess region is the groundwater level mostly deeper than 5 metres beneath the surface. Therefore, in the majority of situations, leaching from the root zone or leaching into groundwater can be measured by sampling the uppermost metre of groundwater. In situations where the groundwater level is deeper (more than five metres below the surface) and the soil retains sufficient moisture (loess region), the soil water below the root zone is sampled. There is little agriculture on the push-moraines in the sand region. Where this does occur, the soil water below the root zone is also sampled if possible.

The loading of surface water with nitrogen (N) and phosphorus (P) takes place via run-off and groundwater, in which the travel times are usually long. In the High Netherlands, only leaching from the root zone is monitored by sampling the uppermost metre of groundwater or of soil water under the root zone. In the Low Netherlands, in areas drained via ditches, whether or not in combination with pipe drainage, the travel times are shorter. Here, the loading of surface water is visualised by sampling ditch water in combination with sampling of the uppermost metre of groundwater or water from the drainage pipes (drain water).

Number of measurements per farm
Per individual farm, groundwater is sampled at sixteen measurement locations, drain water at sixteen locations, soil moisture at sixteen locations and ditch water at eight locations. The number of measurement locations is based on the results of previous research carried out in the sand region (Fraters et al., 1998; Boumans et al., 1997), in the clay region (Meinardi and Van den Eertwegh, 1997, 1995; Rozemeijer et al., 2006) and in the peat region (Van den Eertwegh and Van Beek, 2004; Van Beek et al., 2004; Fraters et al., 2002).

The measurement period and measurement frequency
Sampling takes place in the winter in the Low Netherlands. During the winter here, precipitation surplus is largely transported via shallow groundwater flow to surface water. In the summer, especially in the peat region, water from a the main rivers is often let into the ditches. Sampling from sand and loess soils in the High Netherlands can take place in both the summer and the winter. As the available sampling capacity must be spread over the year, the sand region is sampled in the summer and the loess region in the autumn. The measurement period (see section 3.1) has been chosen in such a manner that

the measurements represent leaching from the root zone, whereby the measurements give as good a picture as possible of the agricultural practices in the previous year.

Soil moisture and groundwater are measured at least once per year on each farm. The annual precipitation surplus in the Netherlands is approximately 300 mm per year. This quantity of water spreads itself in a soil with a porosity of 0.3 (typical for sandy soil) over a layer of around 1 metre in the soil (saturated soil). Therefore, the quality of the uppermost metre gives a good picture of the annual leaching from the root zone and the loading of groundwater. Other types of soil (clay, peat, loess) generally have a greater porosity. In other words, a sample from the uppermost metre will contain, on average, water from more than just the previous 1 year. A measuring frequency of once per year is therefore sufficient. Previous research has demonstrated that the variation in the nitrate concentration within one year, as well as the variation between previous years, disappears if dilution effects and variations in the groundwater level are taken into account (Fraters et al., 1997).

From the start of the new sampling season, the frequency of the sampling of drain water and ditch water will be increased for the Low Netherlands (1 October 2006) from two to three rounds per winter (current realised LMM sampling frequency) to approximately four rounds per winter (intended LMM sampling frequency) to achieve a better spread over the leaching season. In the winter 2005-2006 the measurement frequency was thus less than four times. In the winter of 2006-2007, the measurement frequency of four times per season was not achieved on all farms, as a large number of new farms were included in the derogation monitoring network and the first sampling, in which the sample locations are selected, needed to be performed by specialist staff. The intended LMM sampling frequency was based on research carried out by Meinardi and Van den Eertwegh in the early 1990s (Meinardi and Van den Eertwegh, 1997, 1995; Van den Eertwegh, 2002). The evaluation of the LMM programme in the clay areas, in the period 1996–2002, led to the conclusion that there was no reason to change the existing relationship between the number of sampling rounds per farm (realised sampling frequency) and year, and the number of drains sampled per farm and per sampling round (Rozemeijer et al., 2006). The intensification emerges from the European Commission’s request for an increased sampling frequency. A frequency of four times per year is equivalent to the proposed sampling frequency for operational monitoring of vulnerable phreatic groundwater that has a relatively fast and shallow run-off (EU, 2006).

Besides the compulsory components of nitrate, total nitrogen and total phosphorus, the chemical analysis of the water samples also included the determination of other water characteristics. This was performed to clarify the data for the measurements of the compulsory components. These additional components were ammonium nitrogen, ortho-phosphorus and several general characteristics such as conductivity, pH and dissolved organic carbon. The results of these measurements are only given in this report where relevant.

The following sections describe the sampling per region in greater detail.

The sand and the loess regions

Standard sampling
Groundwater sampling of the derogation farms in the sand region took place in the period 7 May 2006 to 8 November 2006, and in the loess region in the period 5 October 2006 to 11 January 2007 (see Figure A4.1). In these periods each farm was sampled once. This was performed according to the standard working method. This is as follows: on each farm, samples are taken from bore holes made at

16 locations. The number of locations per plot depends on the size of the plot. Within the plot the locations are chosen randomly. Selection and positioning take place according to a protocol[18]. The uppermost metre of groundwater is sampled using the open bore hole method[19]. In the field, the groundwater level and nitrate concentration (Nitrachek-method[20]) are determined. The water samples are filtered[21], conserved[22] and stored in a cool, dark place for transport to the laboratory[23]. In the laboratory, two mixed samples are prepared (eight samples per mixed sample) and analysed for nitrate, total nitrogen and total phosphorus.

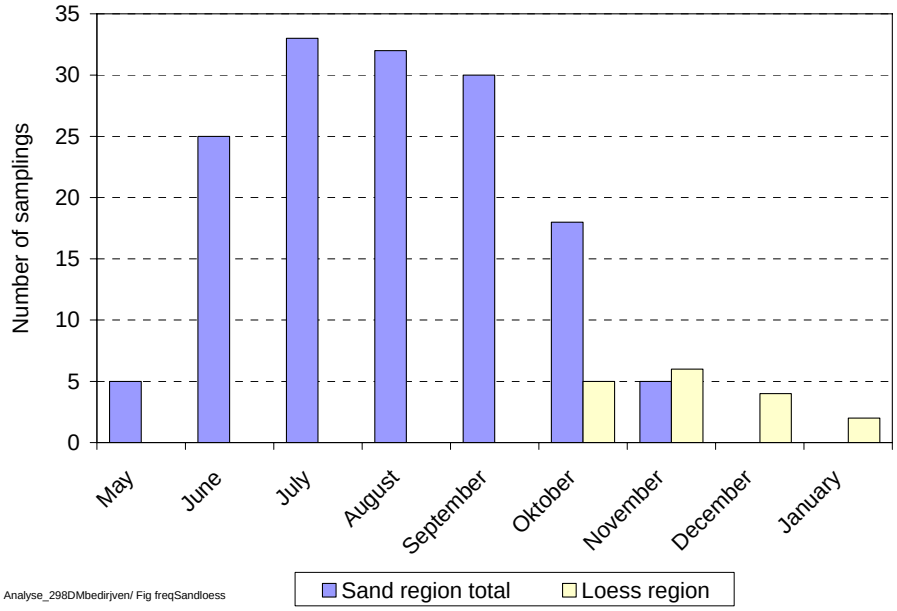

Figure A4.1 Number of samples for groundwater and soil moisture in the sand and loess region per month during the period May 2006 to January 2007.

The additional sampling in the low-lying areas

Of those farms with drains and ditches in the sand region, additional drain and ditch water was sampled during the period 13 December 2005 to 4 April 2006 (see Figure A4.2). This was performed according

[18] Determination of the location of the sampling points. SOP number LVM-BW-P618. National Institute for Public Health and the Environment (RIVM)

[19] Grondwaterbemonstering met een bemonsteringslans en slangenpomp op zand-, klei- of veengronden [Groundwater sampling with a sampling lance and hose pump on sandy, clay or peat soils]. SOP number LVM-BW-P435. National Institute for Public Health and the Environment (RIVM)

[20] Het meten van de nitraatconcentratie in een waterige oplossing m.b.v. een nitrachek-reflectometer (type 404) [The measurement of the nitrate concentration in an aqueous solution with the aid of a nitracheck-reflectometer (type 404)]. SOP number LVM-BW-P110. National Institute for Public Health and the Environment (RIVM)

[21] Filtreren van grond- of slootwater met behulp van een filterbedhouder en een 0,45 µm membraanfilter [Filtering of groundwater or ditch water using a filter bed holder and a 0.45 µm membrane filter]. SOP number LVM-BW-P434. National Institute for Public Health and the Environment (RIVM)

[22] Methode voor het conserveren van watermonsters door het toevoegen van een zuur [Method for conserving water samples by adding an acid]. SOP number LVM-BW-P416. National Institute for Public Health and the Environment (RIVM)

[23] Het tijdelijk opslaan en transporteren van monsters [The temporary storage and transport of samples]. SOP number LVM-BW-P414. National Institute for Public Health and the Environment (RIVM)

to the standard method. On each farm, 16 drainage pipes were selected for sampling. The number of drainage pipes to be sampled per plot depends on the size of the plot. Within the plot the drains are selected according to the protocol[18].

At each farm two types of ditch sample are distinguished. In principle, there are two ditch types, farm ditches and local ditches. Farm ditches only discharge water originating from the farm. Local ditches discharge water from elsewhere; the water leaving the farm is therefore a mixture. If farm ditches are present, samples are taken downstream (where the water leaves the farm or the ditches) in four of these ditches. Furthermore, in four local ditches, samples are taken downstream to gain an impression of the local ditch water quality. If there are no farm ditches then samples are taken both upstream and downstream from four local ditches. This provides an impression of the local water quality and the effect of the farm on this. The ditch water sampling types are therefore farm ditch, local ditch upstream and local ditch downstream. The selection of locations for the ditch water sampling is protocolled[18]. The selection is aimed at gaining an impression of the effect of the farm on ditch water quality and excluding effects external to the farm as much as possible.

In the winter 2005-2006 drain and ditch water was sampled two or three times on the farms. A total of 29 samplings were performed. This means that on average 2.6 samplings per farm were performed. Water samples originating from drainage pipes that discharge above ditch water level are obtained by capturing the flowing water in a measuring beaker. In the case of drainage pipes discharging under the water, a hose or shortened sampling lance is stuck into the drainage pipe, and after a rest period, the water is pumped out of the pipe[24]. The ditch water samples are taken with a measuring beaker attached to a stick or 'fishing rod'[25]. The sampling is spread over the winter (see Figure A4.2).

Water samples are stored in a cool, dry place for transport to the laboratory[22]. In the laboratory, a mixed sample is prepared on the following day for the drain water samples, and two of the ditch water samples (one per type of ditch sampled). The individual drain and ditch water samples are analysed for nitrate and additionally, that from the mixed samples for total nitrogen and total phosphorus.

Further, a groundwater sampling was performed on these farms in the period 2 January to 5 April 2006. The start of the sampling season is partly determined by the moment at which the drains start to flow and periods in which the sampling of the basic programme is carried out in the sand region. The sampling strategy and method are identical to that carried out in the summer.

[24] Monsterneming van drain water [Sampling of drain water]. SOP number LVM-BW-P432. National Institute for Public Health and the Environment (RIVM)

[25] Monsterneming van oppervlakte-/slootwater met een maatbeker [Taking samples from surface water or ditch water with a measuring beaker]. SOP number LVM-BW-P431. National Institute for Public Health and the Environment (RIVM)

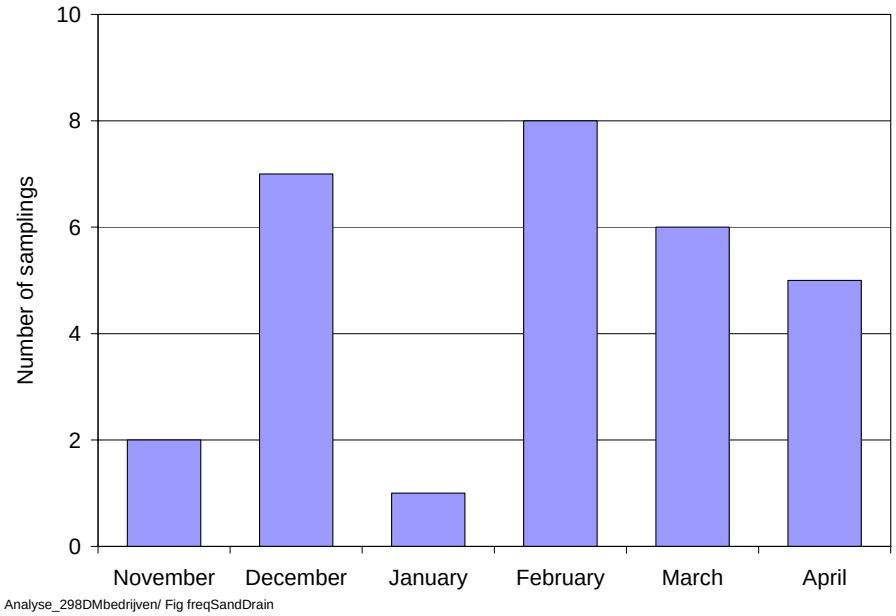

Figure A4.2 Number of samplings of drain water and ditch water in the sand region per month during the period November 2005 to April 2006.

The clay region

In the clay region, a distinction is made between farms on which the soil is drained with drainage pipes and farms where that is not the case. If less than 25% of a farm's acreage is drained with drainage pipes, or if less than 16 drains can be sampled, then the farm is considered not to be drained. The sampling strategy on drained farms differs from that on non-drained farms.

Drained farms
On the drained farms, drain water and ditch water were sampled in the period 15 November to 5 April[24,25] (see Figure A4.3). A total of 38 samplings were performed. In other words, an average of 2.4 per farm. On each farm, drainage pipes are selected for sampling. The number of drainage pipes to be sampled per plot depends on the size of the plot. Within the plot the drains are selected on the basis of a protocol[18]. On each farm two types of ditch sample are distinguished. For each type of ditch sample, four sampling locations are selected. The selection is protocolled[18] and is aimed at gaining an impression of the effect of the farm on ditch water quality and excluding effects external to the farm as much as possible.

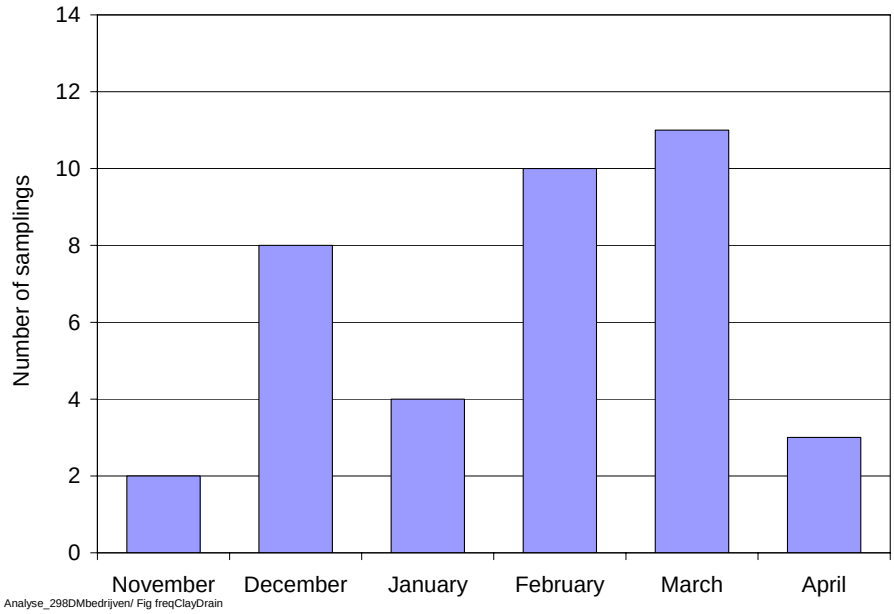

Figure A4.3 Number of samplings of drain and ditch water in the clay region per month during the period November 2005 to April 2006.

During this winter the drain water and ditch water was sampled between one and four times as described in the previous section[24,25]. The sampling was spread over the winter.

Water samples were stored in a cool, dry place for transport to the laboratory[22]. In the laboratory, a mixed sample was prepared on the following day for the drain water samples, and two of the ditch water samples (one per type of ditch sampled). The individual drain water and ditch water samples were analysed for nitrate and also that from the mixed samples for total nitrogen and total phosphorus.

Non-drained farms

On non-drained farms, the uppermost metre of the groundwater and ditch water was sampled in the period 15 November to 5 April[19,26] (see Figure A4.4). On two farms the sampling was performed twice. On the other farms the sampling was only performed once this year.

The sampling of the groundwater is similar to that in the sand region. However, instead of the open bore hole method, the closed bore hole method is normally used[19]. In the field, the nitrate concentration (Nitrachek method) is determined at each of the 16 locations[20]. The water samples were filtered[21], conserved[22] and stored in a cool, dark place for transport to the laboratory[23]. In the laboratory, two mixed samples were prepared (eight samples per mixed sample) and analysed for nitrate, total nitrogen and total phosphorus.

[26] Slootwater- of oppervlaktewaterbemonstering met een aangepaste bemonsteringslans en slangenpomp [Sampling ditch water or surface water with a modified sampling lance or hose pump]. SOP number LVM-BW-P430. National Institute for Public Health and the Environment (RIVM)

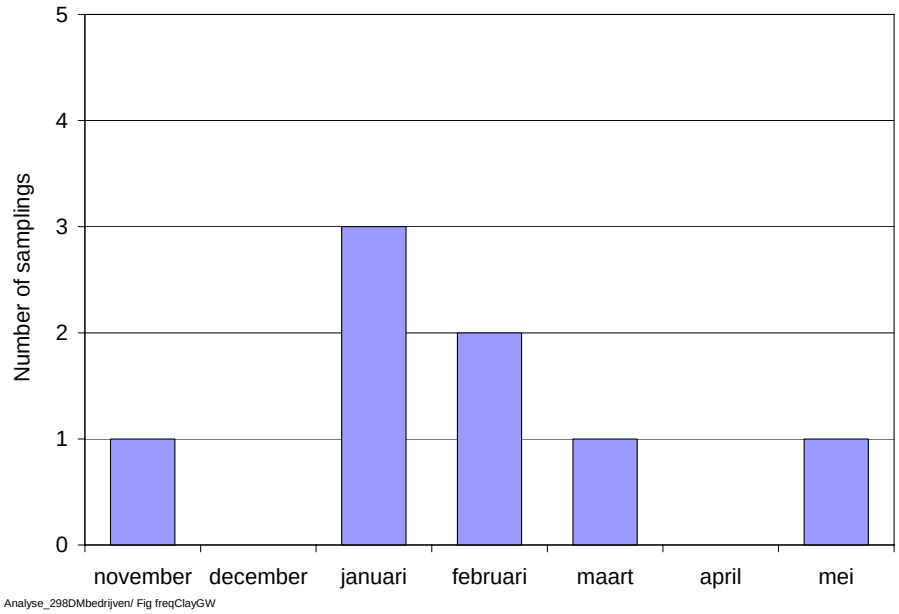

Figure A4.4 Number of samplings of groundwater and ditch water in the clay region per month during the period November 2005 to March 2006. The sampling in November and May concerned a farm that was previously classified in the sand region and so was sampled in the winter and the summer.

The ditch water sampling is similar to that of the drained farms, two types of ditch samples each with four locations. However, the sampling takes place with a filter lance[26] and water samples are filtered directly in the field[21] and analysed for nitrate (Nitrachek-method[20]). In addition to being filtered, the individual samples are also conserved[22] and stored in a cool, dark place for transport to the laboratory[23]. In the laboratory, two mixed samples are prepared from these ditch water samples (one per ditch sample type). The mixed samples are analysed for nitrate, total nitrogen and total phosphorus.

The peat region

In the peat region the uppermost metre of groundwater was sampled once on all farms in the period 16 January to 3 May 2006 (see Figure A4.5). During this sampling, the ditch water was also sampled. In this first measurement year, no extra group-wide ditch water samplings had yet been performed since the old working method was still in use during this winter. An extra investigation took place on three farms during this period. On two of these farms, the ditch water was sampled five times and on the third farm the ditch water was sampled on two occasions. One farm belonged originally to the sand region, but upon the reclassification of the areas, was attributed to the peat region. On this farm, the uppermost groundwater was sampled in mid-June. No ditch water sampling took place on this farm.

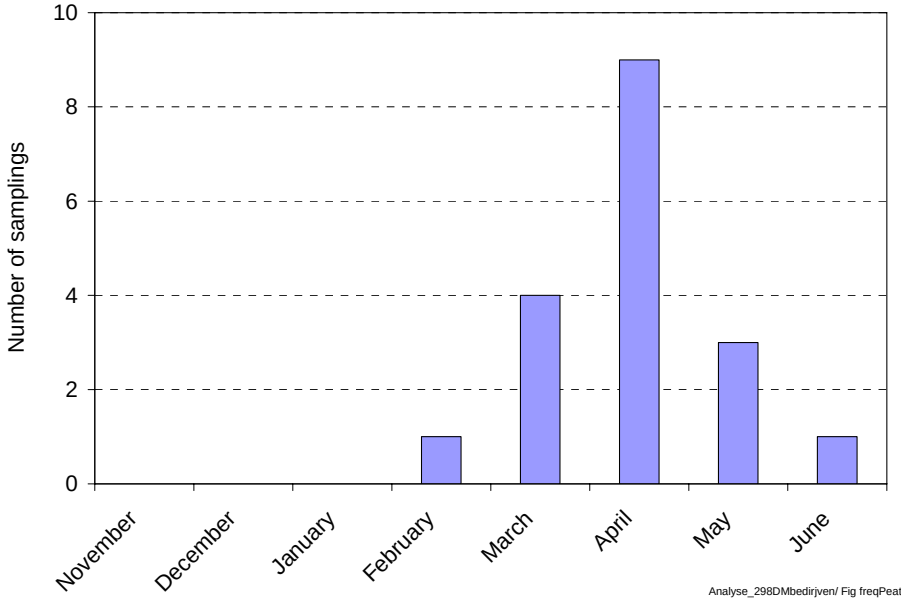

Figure A4.5 Number of samples from groundwater and ditch water in the peat region per month during the period November 2005 to May 2006. The sampling in June concerned a farm that was previously classified in the sand region.

The sampling of groundwater is similar to that in the sand and clay regions. However, instead of an open or closed bore hole method, a reservoir tube method is usually used[19]. In the field, the nitrate concentration (Nitrachek method[20]) is determined at each of the 16 locations. The water samples were filtered[21], conserved[22] and stored in a cool, dark place for transport to the laboratory[23]. In the laboratory, two mixed samples are prepared (eight samples per mixed sample) and analysed for nitrate, total nitrogen and total phosphorus.

Ditch water sampling, carried out at the same time as groundwater sampling, is similar to that of non-drained farms in the clay region. Sampling, therefore, takes place with a filter lance[26]. There are always two types of ditch samples, each with four locations. Water samples are analysed for nitrate directly in the field (Nitrachek method[20]). The individual samples are filtered[21], conserved[22] and stored in a cool, dark place for transport to the laboratory[23]. In the laboratory, two mixed samples are prepared from these ditch water samples (one per ditch sample type). The mixed samples are analysed for nitrate, total nitrogen and total phosphorus.

The additional ditch water samples are taken at the same locations and at the same time as those for groundwater sampling. However, the sampling method is not the same, but rather the method used on drained farms in the clay region. Sampling is therefore done with a fishing rod and measuring beaker[25]. No analyses take place in the field and the samples are stored in a cool, dry place for transport to the laboratory[23] but not filtered and conserved. In the laboratory, two mixed samples are prepared on the following day (eight samples per mixed sample) and analysed for nitrate, total nitrogen and total phosphorus.

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