CHAPTER 22. EVALUATION OF THE DUTCH MANURE AND FERTILISER POLICY, 1998-2002

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Abstract

In 2003/04 five instruments of Dutch manure and fertiliser policy were evaluated: the Minerals Accounting System (MINAS, the core of Dutch manure policy), the Manure Transfer Contracts system, the Production Quota system, the Buying Up Scheme and the Nitrate Projects Action Scheme. A great number of data sources and research and evaluation tools were used. The evaluation showed that MINAS was for important sectors within agriculture both an effective and efficient instrument. The system of Manure Transfer Contracts did not add to the effect of the Production Quota system and therefore was not efficient. MINAS has contributed to a reduction in the use of chemical nitrogen fertilisers by 25% and phosphate fertilisers by 10-20%. Since 1998 nitrogen surpluses in dairy farming have steadily reduced by 15-30 kg ha^{-1} yr^{-1} and present surpluses average about 150 kg ha^{-1} yr^{-1}. Nitrate concentrations in upper groundwater have decreased substantially since 1990, but the target value of 50 mg L^{-1} is exceeded on at least 60% of all farms on sandy soils in the Netherlands.

Introduction

Agriculture in the Netherlands is highly productive and intensive (Westhoek, *et al.,* 2004). However, intensity decreased from 2.9 Livestock Unit (LU) per hectare in 1995 to 2.4 LU per hectare of agricultural land in 2003 (CBS, 2004a). About 25% of total animal manure nitrogen is produced on pig and poultry farms belonging to operators who own only a few hectares of agricultural land. From the 1980s onward, the Dutch government has developed legislation to restrict the pollution of soils, groundwater and surface waters caused by animal manure. In 1984, legislation was implemented to stabilise the number of pigs and poultry. In 1986, the Fertilisers Act was introduced. This was followed by legislation to control the quantity (in 1987), timing and method (in 1988-95) of manure application. Application standards were based on the amount of phosphate (P_2O_5) in animal manure. The application standards were steadily lowered. These measures led to a more even spreading of the manure across the country and a reduction of the amount of phosphate in animal manure.

After it became evident that a reduction in nitrogen fertilisation had not been achieved at the same rate as phosphate fertilisation and because of the fact that chemical fertilisers were not included in the regulations, the Minerals Accounting System (MINAS) was introduced in 1998 as part of the Fertilisers Act. MINAS was one of the instruments intended to implement the European Union

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Nitrates Directive (91/676/EEC)[4] in Dutch legislation. MINAS regulates the use of both fertiliser and manure nitrogen and manure phosphate. In 2002, Manure Transfer Contracts were introduced in the Fertilisers Act. Manure Transfer Contracts limit the total production of animal manure in the Netherlands by obliging farmers to plan manure transfer before it is produced.

In this evaluation project, five policy instruments were evaluated which the Netherlands has implemented to reduce the nutrient surplus (the surplus of nitrogen and phosphate from agricultural sources) in order to prevent and reduce the diffuse pollution of ground and surface water by nitrogen and phosphate from agricultural sources.[5]

Policy measures and evaluation

The five policy instruments that were evaluated are the three of the core instruments of the Fertilisers Act:

1. the Minerals Accounting System (MINAS) – introduced in 1998 for farms with the highest environmental risk, from 2001 on compulsory for all farms;

2. the system of Manure Transfer Contracts (mestafzetovereenkomsten), MAO – since 2002;

3. the system of Production Quota (or Livestock Quota[6]) – introduced in the 1990s;

and two additional instruments in Dutch manure policy:

4. the Buying Up Scheme for Production Quota (or Voluntary Farm Closure Scheme) – executed in 2000 and 2001;

5. Nitrate Projects Action Scheme – a set of research projects and communication tools, implemented from 2001 until 2004.

The evaluation was conducted by three co-operating groups of research institutes: the Netherlands Environmental Assessment Agency (MNP-RIVM), the lead agency; the Agricultural Economics Research Institute (LEI); and the Centre of Expertise of the Ministry of Agriculture, Nature and Food Quality (EC-LNV). MNP-RIVM focused on the environmental effects of the instruments; LEI focused on the behavioural effects on farmers of the first three instruments; and EC-LNV focused on the effects of the last two instruments. The project started in April 2003 and was finished in April 2004.

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4. The European Union Nitrates Directive came into force in 1991. The objective of the Nitrates Directive is to prevent and reduce the diffuse pollution of groundwater, surface water and coastal waters by nitrates from agricultural sources. The Nitrates Directive requires an equilibrium between nitrogen supply and nitrogen withdrawal by crops; at the same time it restricts the nitrogen fertilisation from animal manure to 170 kg ha^{-1}.

5. The Fertilisers Act also contains regulations on the trade and transport of manure. The Steering Committee decided not to evaluate these regulations in this project.

6. Legally, there are three systems of production rights: a system of manure production rights, a system of pig production rights and a system of poultry production rights. The pig production rights are not incorporated in the Fertilisers Act, but in separate legislation. To get an overall picture of the functioning of the systems of production rights in total, all three systems have been evaluated in this project.

The evaluation was carried out under the direction of a Steering Committee comprised of the ministries responsible for the Fertilisers Act and environmental quality (the Ministry of Agriculture, Nature and Food Quality; The Ministry of Housing, Spatial Planning and Environment; and the Ministry of Transport, Public Works and Water Management) and representatives of the provinces, the Water Boards, the agricultural sector and the environmental movement. A governmental project group was responsible for the correct and timely execution of the evaluation.

In October 2003 the European Court of Justice (ECJ) ruled that the Netherlands had not properly implemented the Nitrates Directive. One important reason for the ruling was that the MINAS loss standards did not enforce the Directive application standard of 170 kg ha^{-1} nitrogen. A second reason was that loss standards are not sufficient to limit the total application of fertilisers. A third reason was that MINAS allowed farmers to exceed the loss standards and be charged a levy. On the basis of this ruling, the Dutch government decided to replace the system of MINAS by a system based on application standards beginning in 2006.

This judgement and the subsequent decision of Dutch Government to abolish MINAS occurred halfway this evaluation project. It led to a sudden shift in (political) focus, and as a consequence the *ex post* evaluation lost part of its importance. An *ex ante* evaluation of the new policy was started, to answer many of the questions which rose out of the necessity to design and implement a new fertiliser and manure policy. This paper reviews the ex post evaluation of the policy instruments. The ex ante evaluation is not discussed in this paper.

Objectives of the Fertilisers Act and its instruments

The main objective of the Fertilisers Act is to improve the quality of groundwater and surface water by reducing and more efficiently using nutrients within the agricultural sector. This evaluation of the Fertilisers Act looks at whether this objective has been achieved and particularly at the contribution of the MINAS, the system of Manure Transfer Contracts and the system of production quotas in the period of 1998-2002. To assist the introduction of MINAS, two stimulation measures were also implemented: the Buying Up Scheme and the Nitrate Projects Action Scheme.

The objective of *MINAS* is to realise a balance between input and output of both nitrogen and phosphate (equilibrium fertilisation) at the farm level. Inputs for MINAS include all the nutrients in concentrate feed, livestock, by-products, roughage, livestock manure, organic manure, nitrogen fertilisers and nitrogen fixation. Outputs for MINAS include livestock, all products of animal origin, arable crops, roughage and livestock manure. Some loss of nutrients, termed "loss standards", is allowed for because they are unavoidable and at an acceptable level. The loss standards depend, among others, on the type of soil and the crop grown; *e.g.* the loss standards for grass on sandy soils are stricter than those for grass on peat or clay. The loss standards have been gradually tightened and stricter standards were introduced for dry soils prone to nitrate leaching (presently set at 7% of the agricultural area) (Table 1).

Under MINAS, farmers must keep an accurate record of the input and output of nutrients on their farm. The nutrients return forms, stating real phosphate and nitrogen surpluses, must be submitted to the (Agricultural) Levies Office annually. The Levies Office audits the nutrient return forms. When the difference between inputs and outputs (*i.e.* a nutrient surplus) is higher than the loss standard, a levy is imposed. The levies to be paid have been increased through the years to make them prohibitive.

At its start in 1998, MINAS was only compulsory for farms with the highest environmental risks: intensive livestock farms with more than 2.5 LUs per hectare. In practice, this encompassed nearly all Dutch pig and poultry producers and the more intensive cattle holdings. In 2001, MINAS became

compulsory for all Dutch farmers. A political condition for the introduction of MINAS was that a socio-economic vital agricultural sector could be maintained.

Table 1. MINAS loss standards from 1998 to 2005

	1998	1999	2000	2001	2002	2003	2004	2005
	Nitrogen (kg ha^{-1})							
Grassland other	300	300	275	250	220	220	180	180
Grassland dry sand				250	190	190	160	140
Arable land clay/peat	175	175	150	150	150	150	135	125
Arable land dry sand			150	125	100	100	80	80
Arable land other			150	125	110	110	100	100
	Phosphate (kg ha^{-1})							
Grassland	40	40	35	35	25	25	20	20
Arable land	40	40	35	35	30	30	25	20

The objective of both the *Production Quota* system and of the system of *Manure Transfer Contracts (MAO)* is to limit the total amount of nutrients produced in Dutch agriculture. This would diminish the risk for fraudulent bookkeeping in the system of MINAS as a lower level of manure production in the Netherlands would make it easier (and cheaper) for individual farmers to comply with MINAS.

Under the system of Manure Transfer Contracts, farmers are obliged to arrange manure transfer contracts for their manure surpluses a year in advance. Farmers can apply manure on their own land provided they do not exceed the MINAS loss standards. Surplus manure can be transferred to arable farmers or livestock farmers with sufficient land for extra manure application, or to manure processors. A farmer unable to contract sufficient buyers for their surplus manure must reduce the number of livestock on the farm.

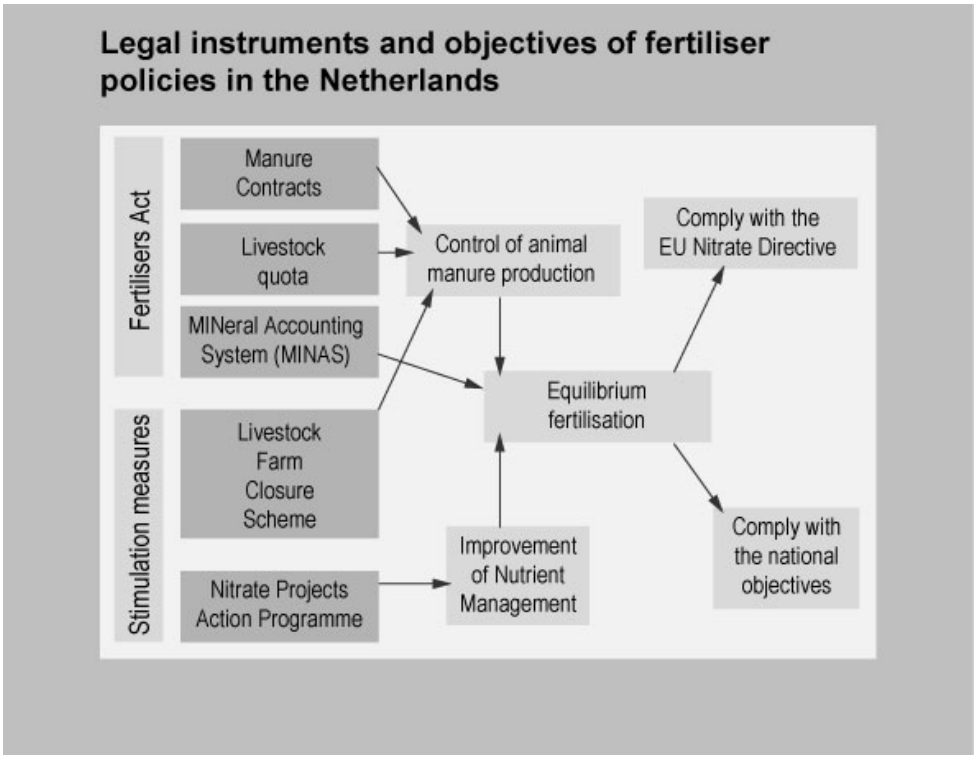
Manure Production Quotas (in P_2O_5 terms) are required for cattle and sheep farms. Animal Production Quotas (animal units) are necessary for pig and poultry holdings. The maximum number of animals on a farm is determined by the farm's quota holding. When the animal Production Quotas were introduced in 1998 for pig farms, a compulsory generic reduction of ten percent of the pig population was carried out.

Through the *Buying Up scheme for Production Quota*, the Dutch government spent more than EUR 264 million on buying quota from pig farmers in spring 2000 and autumn 2001.[7] The primary environmental objective of the scheme was to decrease the number of livestock, and in doing so reduce the amount of nutrients produced in the Netherlands. In addition, the instrument had the objective of giving farmers the opportunity of ending their farm in a socially acceptable way, and the objective of improving spatial quality in the Netherlands by decreasing the number of stables in the countryside. For this last reason, the so-called "space for space" regulation was designed where the provinces provided subsidies for the demolition of farm buildings for holding livestock to the farmers who had joined in the Farm Closure Scheme, in return for the vacant lots. This regulation cost the participating provinces around EUR 355 million, although this sum is expected to be earned back by selling the vacant lots for building business and private dwellings (Vliet and Ogink, 2004).

7. The Dutch government has used similar instruments to decrease the number of production quota in previous years.

The *Nitrate Projects Action Scheme* is a cluster of research and communication projects which aim at achieving a more efficient nutrient management by farmers through developing and dispersing know-how and management tools. This was done using a wide scale and great diversity of communicative instruments: study groups, publications, seminars and individual expert advice. Total expenditure for this scheme was EUR 60 million (Table 7). Figure 1 summarises the policy instruments and their objectives.

Figure 1. Policy instruments and their objectives



Evaluation criteria

A biannual evaluation of the Fertilisers Act is compulsory under article 68 of that Act, which states that the Minister of Agriculture, Nature and Food Quality has to inform parliament every two years about the effects of the Act. In addition, the regulation on performance indicators and evaluation research *(Regeling Prestatiegegevens en Evaluatieonderzoek Rijksoverheid [RPE])* of the Dutch Ministry of Finance (FIN, 2002) determines when and how to conduct policy evaluations like the evaluation of the Fertilisers Act. This regulation contains rules on the use, frequency, quality (evaluation research should be valid, reliable and accurate, and useful) and reporting of policy evaluation research.

An *ex post* policy evaluation should make a judgement possible of the implemented policy on the following seven aspects. In this paper we focus on the questions with respect to the first five aspects.

1. the merits of the policy objectives in itself;

2. the degree to which the objectives of the policy have been fulfilled;

3. the degree to which the policy has led to the fulfilment of the objectives (the effectiveness of the policy instruments);

4. the degree to which the objectives could have been realised, with the employment of less means, or the degree to which the objectives could have been better realised with the employment of the same means (general efficiency of the instrument);

5. the general suitability or merits of the chosen policy instruments;

6. the costs and quality of the development, implementation and evaluation of the policy (administrative and compliance costs);

7. the input of resources (money and apparatus).

On the basis of detailed "objectives maps" showing the relationships between policy instruments, objectives, sub-objectives and goals (see below), these main aspects have been elaborated by the governmental project group into a large number of detailed questions on the functioning, effectiveness and efficiency of the five policy instruments and the organisations that are responsible for the implementation of these instruments: the Agricultural Levies Office (for the Minerals Accounting System, Manure Transfer Contracts and the systems of Production Quota), LASER[8] for the buying up schemes for Production Quota, and the Nitrate Bureau for the Nitrate Projects Action Scheme. The General Inspection Service (AID) is responsible for the enforcement of the regulations. These organisations are all part of the Ministry of Agriculture, Nature and Food Quality.

The evaluation project had to deal with several issues with a lot of political attention. Some of these issues were related to the environmental impact of (over) fertilisation and how to measure that impact; others had to do with the functioning of the policy instruments.

Tools and methods of evaluation

The starting point of the evaluation is a conceptual model of the causal relations between the policy instruments and their intended objectives (Figure 2). These relations in the case of manure and fertiliser policy prove to be complex both because of the number of "steps" between the point of impact of the policy instruments and the ultimate goals, and because of the complex physical environment, and social and political context.

This multitude of influences and complexity of objectives complicates the task of evaluating the effect of policy instruments on the environment. Based on the impact schemes in Figures 1 and 2, Table 2 gives examples of variables that influence the effect of manure policy instruments on environmental quality.

To deal with this complexity, the evaluators have used a number of data sources, and research and evaluation techniques. The main data sources for evaluating the relation between farmer behaviour and environmental effects were the National Monitoring Programme for the effectiveness of the Minerals Policy (LMM) (nitrate concentration in shallow groundwater on farms), water quality measurements in regional surface waters, the Farm Accountancy Data Network (FADN), the Agricultural Census and Environmental Cost Statistics.

8. LASER and the Agricultural Levies Office have by now been merged into the National Regulation Agency.

- The LMM has combined water quality data and farm management data from FADN (see below) for more than ten years (Fraters, *et al.,* 2004). The number of farms sampled increased from 93 farms in 1992 to 225 farms in 2002. Policy measures aim at improving water quality through changing farm management practices. Therefore, to exclude as far as possible other sources of water quality pollution, on-farm waters were monitored, such as the upper metre of groundwater or soil moisture within 5 metres of the soil surface, tile drain water or ditch water. These types of waters reflect the effects of recent farm management practices (less than 4 years ago). Standardised concentrations were estimated adjusting for the effects of differences in weather and changes in number and location of sample points.

Figure 2. The impact scheme for nutrient policies in agriculture

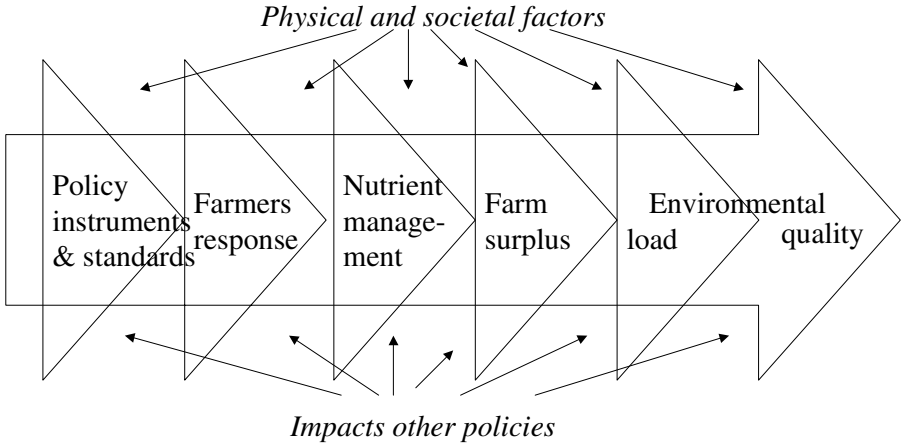


Table 2. Examples of relevant variables that influence the causality chain for the Dutch manure policy

Impact aspect	Variables (examples)
Policy instruments and standards	Amendments to facilitate implementation; compromises on setting standards
Farmers' response	Policy acceptance; knowledge; fraud
Nutrient management	Number of animals; acceptance of non-farm manure; grazing schemes; manure application procedures
Farm surplus	Fertiliser purchase; feed purchase; manure disposal; production efficiency; farm gate balance
Environmental load	Ammonia policy; denitrification
Environmental quality	Other sources of N and P; buffer capacity of soils for N and P; resistance and resilience of ecosystems
Impact other policies	Common Agricultural Policy; ammonia policy; effect-oriented measures to mitigate the effects of eutrophication
Physical environment	Weather effects; background concentrations of N and P
Socio-economic context	Economics; environmental awareness; image of agricultural sector

- Data on surface water quality are collected by the regional Water Boards (Portielje, *et al.,* 2004). Sample locations (about 200) are selected where water quality is mainly influenced by agriculture. The frequency of sampling is usually once every four weeks. Averages of winter measurements were estimated because the water sampled then is mainly from local origin whereas in summertime there may be an influence of inflow of water from elsewhere.
- Annual statistics on the costs incurred by the agricultural sector in reducing environmental damage are made by Statistics Netherlands (CBS, 2004a). Costs include investments (annualised over the economic lifetime of the measure) and operational costs minus the possible savings. Adding environmental levies (as far as they are earmarked for environmental objectives) to these costs and subtracting from them subsidies received, results in what is referred to as environmental burden (VROM, 1999).
- The Farm Accountancy Data Network (FADN) is a stratified sample of all Dutch farms (Hubeek and Hoop, 2004a). Farms are stratified on the basis of agricultural sector, region/soil type and size. Data is collected on, among other things, productivity and profitability of the farm, nutrient surpluses and manure management. In FADN, data from the annual agricultural statistics and the European FADN are integrated.

To evaluate the effectiveness and efficiency of MINAS, the system of Manure Transfer Contracts the Production Quota system, and the Nitrate Projects Action Scheme in terms of farmer behavioural response to these instruments, LEI has used, in addition to the FADN and the annual agricultural statistics (Hubeek and Hoop, 2004a):

- Data from an extensive research and communication projects on dairy farms, called *Praktijkcijfers* ("data from practice", which started in 1997, and includes about 300 farms), and which has as its goal to show farmers that it is possible to manage nutrients more efficiently and that it is possible to realise equilibrium fertilisation, even with the most strict MINAS loss standards;

- Data on MINAS (number and content of nutrient returns, levies imposed, levies paid, costs of implementation and enforcement), the system of Manure Transfer Contracts and the systems of Production Quota gathered by the Levies Office and the National Regulation Agency (CBS, 2004b);

- Data from interviews with staff members of the executive organisations (Levies Office and General Inspection Office) and representatives, scientific and field experts of interested parties;

- A survey among 300 farmers (in the FADN), with a response of 56% on the systems of MINAS, Manure Transfer Contracts and Production Quota and on the Nitrate Action Programme.

EC-LNV has used quantitative data of LASER and the Levies Office to evaluate the effects of the buying up schemes for Production Quota.

Representatives from non-governmental organisations representing farmers, agro-industry and environment interests, as well as representatives from local governments were invited to act as a "sounding board" for this evaluation. This sounding board commented on the evaluation questions and the results, in a total number of three sessions (one organised by the governmental project group with the intention of giving the opportunity to comment on the questions asked in this evaluation; the other sessions by MNP-RIVM to give the opportunity to remark on the tentative results).

A scientific review committee was installed by the Director of the MNP-RIVM to judge the state-of–the-art of the methods and data used for this evaluation. Furthermore they were asked to verify whether the conclusions were scientifically sound and uncertainties were properly addressed.

Reference situation

To study the effect of MINAS in general, comparison is made in time: what changes are visible in terms of farmers' behaviour and environmental outcomes? As MINAS was introduced gradually, there was, to some extent, the opportunity to compare the behaviour of those farmers that had to deal with MINAS and those that had not. Further, concerning the question as to whether MINAS had an effect on the use of chemical fertilisers, comparison is possible because chemical nitrogen fertilisers are included in the input factors of MINAS and phosphate chemical fertilisers are not.

The effects of Production Quotas, the Manure Transfer Contracts and the Buying Up Scheme can be studied by comparing the situation before and after their introduction. These instruments both create and limit a market for manure and gave the government a tool to lower the ceiling by cutting the quota, as done when the pig Production Quota was introduced or through the Buying Up Scheme.

The system of Production Quota and the system of Manure Transfer Contracts have the same goal. They could be compared in the effectiveness and efficiency with which they realise that goal. The fact that the Production Quota in general turned out to be more limiting than the Manure Transfer Contracts led to the conclusion that the Manure Transfer Contracts in the present setting were not very effective and efficient (for more results, see below).

Finally, to study the effect of some of the tools of the Nitrate Projects Action Scheme, it was possible to compare those farmers that were counselled and those that were not. The effectiveness of all five instruments was judged by a quantitative analysis of the environmental effects of the policy instruments used.

Strengths and limitations

Before presenting the results, it is important to discuss the strengths and limitations of this evaluation. The ***strengths*** include:

- The availability of (monitoring) data: large datasets (*e.g.* the dataset of the Levies Office) and long time series (*e.g.* the datasets of LMM and FADN) for the most aspects of the impact chain. A lot of factual data was available for the evaluators.

- Not only a lot of data was available, but there were also different data sources for key aspects of the impact chain; in particular with respect to nutrient management, farm gate balances, and the loading of the soil with nutrients.

- The evaluation was carried out by a large consortium of research institutes which interacted openly and frequently with each other, and with policy makers and stakeholders. The evaluation was in this respect very multidisciplinary; combining knowledge and information on the relationship between public policy, farmer behaviour and environmental effects from social and natural sciences.

- The combined use of empirical data and simulation models to assessment the national effects of manure policy on manure and fertiliser use, and the environment.

Limitations, in part as observed by the scientific review committee, include:

- Separation of the effects of autonomous developments (like developments in trade of agricultural products, the reforms of the EU Common Agricultural Policy) and incidental occurrences (like epidemic outbreaks of animal diseases) from the effects of the policy instrument under evaluation is problematic. These incidents and developments do have an impact on farmer behaviour and it is difficult to disentangle the exact influence of these incidents and developments. LEI has tried to disentangle the effects using interviews with experts and representatives of interest groups, and a survey among farmers, combined with the use of firm empirical data, model analysis and reasoning. An example is trying to determine the causes of the impressive reduction of nitrogen losses in dairy farming (Figure 7) which can be empirically related to the tightening of the loss standard but in most cases goes beyond legal requirements. An explanation for this distinct decrease in farm nutrient losses is that the obligatory MINAS farm gate balances triggered a focus on nutrient efficiency, which was cost-effective for the producer and therefore more or less "self-propelling" (Hubeek and Hoop, 2004b).

- The fact that monitoring data as a rule become available one to two years after implementation of policy measures and, moreover, the manifestation of environmental effects is delayed causes uncertainties in the relationship between policies, the response of farmers to these policies and the environmental effects of these measures.

- Limited information on ecological impacts and uncertainties associated with disentangling contributions of effects of various manure policy instruments from autonomic effects, effect based measures and, above all, natural processes.

- Regional aspects of the manure and fertiliser problem are not and cannot yet be properly addressed. Both the nature and the extent of problems associated with manure production and excess fertilisation show a strong regional variation. However, the available data do not allow accurate evaluation of the effectiveness of the manure and fertiliser policy on a regional scale.

- Insufficient knowledge about the sorption/desorption process of phosphorus and denitrification. These processes occur in soil and sediment, and are critical for the response of surface waters and deep groundwater to reduced soil loading. For example, the net loading of Dutch agriculture soils with phosphate reduced by more than 50% since 1985. However, the diffuse loading of phosphate from agricultural soils to surface waters, which is a very small fraction of the soil surplus of phosphate, hardly decreased. The massive accumulation of phosphate in agricultural soils due to past over-fertilisation is the evident cause of the strong delay in a surface water response to MINAS.

- Outdated soil maps. The groundwater depth is a key factor determining nitrate leaching to groundwater. Present maps are out-of-date, and results form new nation-wide surveys are still not available.

Results

Achievement of environmental goals

Table 3 summarises the quality objectives for nutrients in ground and surface waters. Two sets of quality standards for water are defined: the MTR (Maximum Tolerable Risk) value and the target value. The target value for nitrate applies to deeper groundwater in groundwater protection areas.

Table 3. Quality objectives for nutrients in groundwater and surface water

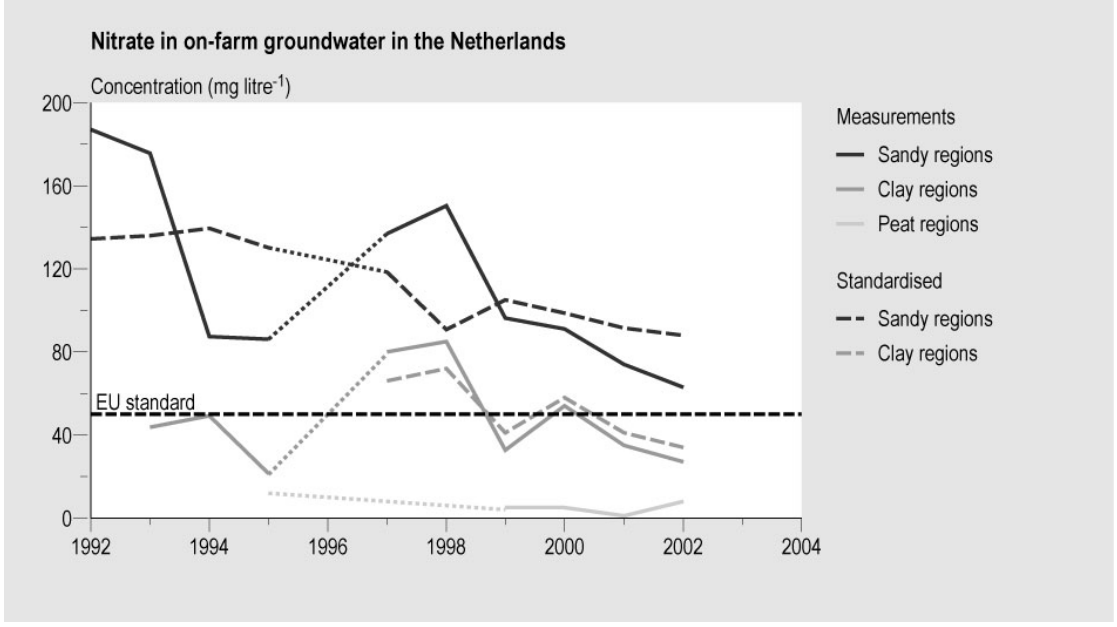
Parameter	Groundwater		Surface water (fresh)	
	MTR value (mg Ll^{-1})	Target value (mg L^{-1})	MTR value [1] (mg L^{-1})	Target value (mg L^{-1})
Total N	-	-	2.2	1
Total P	-	0.4 or 3 [2]	0.15	0.05
Nitrate	50	25	-	-
Ammonium-N	-	2 or 10 [2]	-	-

Notes:
1. Values used as summer-average values for stagnant surface waters sensitive to eutrophication, that serve as guiding values for other waters.
2. The low value is valid for sandy soils; the higher value applies to clay and peat. Higher concentrations of ammonia may be found in areas with brackish/salt groundwater.
Source: MNP-RIVM (2004).

The nitrate concentrations in the upper metre of groundwater have steadily decreased (Figure 3). In the case of farms with sandy soils, the nitrate concentration declined from an average of 134 mg L^{-1} in 1992-95 to 76 mg L^{-1} in 2000-02. On peat soils, nitrate concentrations were lower than 10 mg L^{-1}. Drainage water from clay soils showed a decrease in nitrate concentrations to decrease from 60 mg L^{-1} to 30 mg L^{-1}. The conclusion is that in sandy areas, which are prone to leaching, the MTR value was on average not attained in the 2000-02 period.

Figure 3. Nitrate concentration in the upper metre of groundwater

(annual average of measured concentration and computed standardised concentration within 5m of the soil surface [peat, sand] or tile drain water [clay of farms)



For dairy farms with sandy soils, a distinct relationship was found between the MINAS calculated nitrogen losses and the groundwater nitrate concentration (Figure 4). To meet the MTR value for these farms, the nitrogen loss standards will have to diminish by 50 to 70 kg ha^{-1}, depending on the proneness to nitrate leaching.

The percentage of farms meeting the 50 mg L^{-1} nitrate standard increased from 5-10% to 20-40% in sandy areas, and from 55-70% to 60-75% in clay areas (Tables 4 and 5). Dairy farms attained the highest percentages: 40% on sand and 75% on clay. In peat areas, the 50 mg L^{-1} standard was never exceeded. These percentages are based on non-standardised nitrate concentrations. Nitrate concentrations in individual years strongly depend on the precipitation surplus. When corrected for this the sample population shows smoother trends but also suggests a larger distance to the target MTR value of 50 mg L^{-1} in 2003 than uncorrected concentrations.

Figure 4. Nitrogen losses according to MINAS on dairy farms on sandy soils in relation to the continuous decrease of the loss standards under MINAS

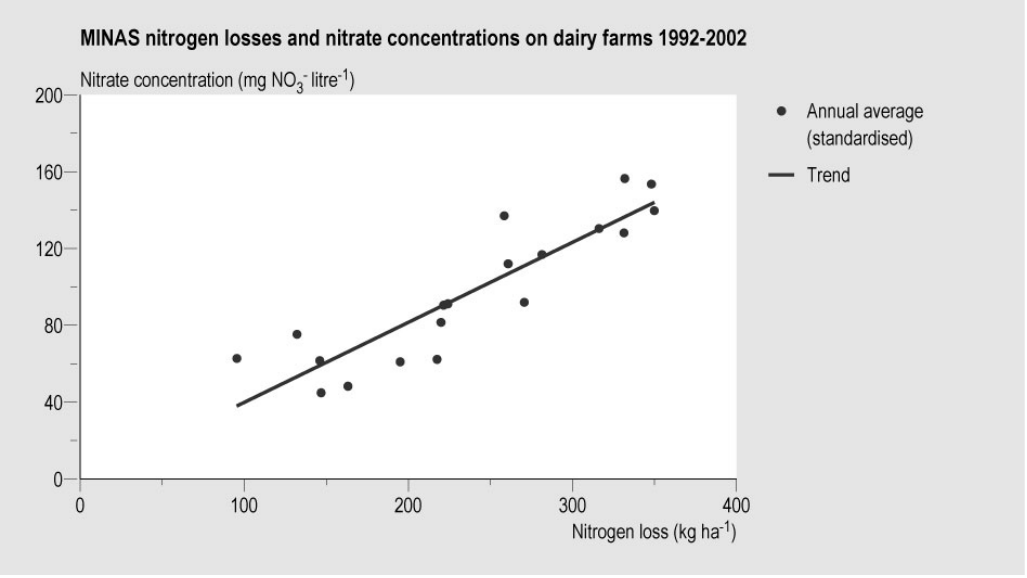


Table 4. Percentage of farms in sandy areas with nitrate concentrations of 50 mg L^{-1} or less in upper groundwater

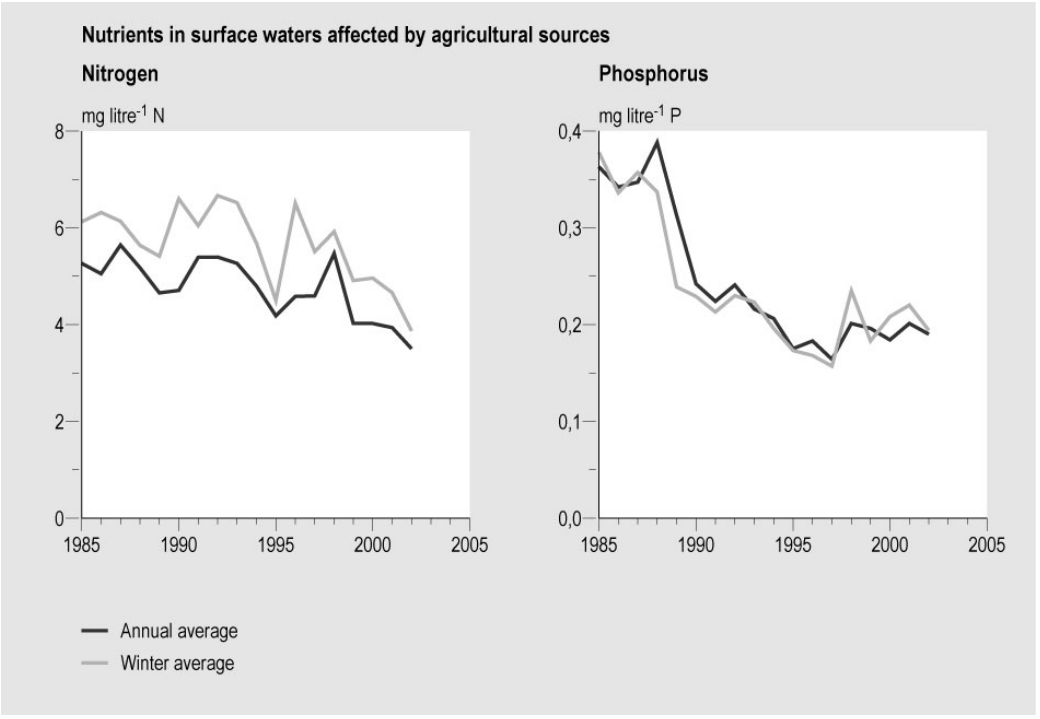
Sandy areas	1992-95	1997-99	2000-02
Arable farms	10%	30%	30%
Dairy farms	5%	25%	40%
Other farms	-	10%	20%

Table 5. Percentage of farms in clay areas with nitrate concentrations of 50 mg L^{-1} or less in drainage waters

Clay areas	1992-95	1997-99	2000-02
Arable farms	-	55%	60%
Dairy farms	-	70%	75%

Despite a clear country-wide fall since 1997 in total nitrogen concentrations in surface waters affected by agricultural sources, the MTR value has, on average, not yet been achieved (Figure 5). The larger decrease in wintertime compared to the annual average indicates that the decrease in concentration is caused by reduced runoff and leaching from agricultural land. The number of locations where the average total nitrogen concentration is below the 2.2 mg L^{-1} standard has grown slightly but is still very low. These locations are mainly in the vicinity of the main Dutch rivers Rhine, Meuse and IJssel. High concentrations of total nitrogen (more than three times the 2.2 mg L^{-1} standard) are found particularly in the Westland region (near the west coast of the Netherlands) and at many locations in the sandy areas of the country. The concentrations at these locations are largely attributable to local agricultural and horticultural activities, such as the glasshouse horticulture in Westland and intensive livestock farming in some sandy areas (Portielje, *et al.,* 2004).

Figure 5. National annual averages and winter averages of monthly median concentrations of total phosphorus and total nitrogen in surface waters affected by agricultural sources



Source: Portielje, *et al*. (2004).

Total phosphorus concentrations in waters affected by agricultural pollution decreased sharply over the period 1985-2002. This decrease largely took place between 1988 and 1991. It is probably an effect of reduced emissions from point sources. The effect of the more stringent manure application regulations (prohibition in autumn/winter, low ammonia emission) introduced between 1988 and 1995 is not certain. These restrictions on manure application will particularly affect the surface runoff of phosphates. This may be an explanation why no similar trend was observed for nitrogen during the period in question.

The manure and fertiliser policy since 1998 has not resulted in any appreciable decrease in the phosphorus concentration in these surface waters. On the contrary, there is an increase in the number

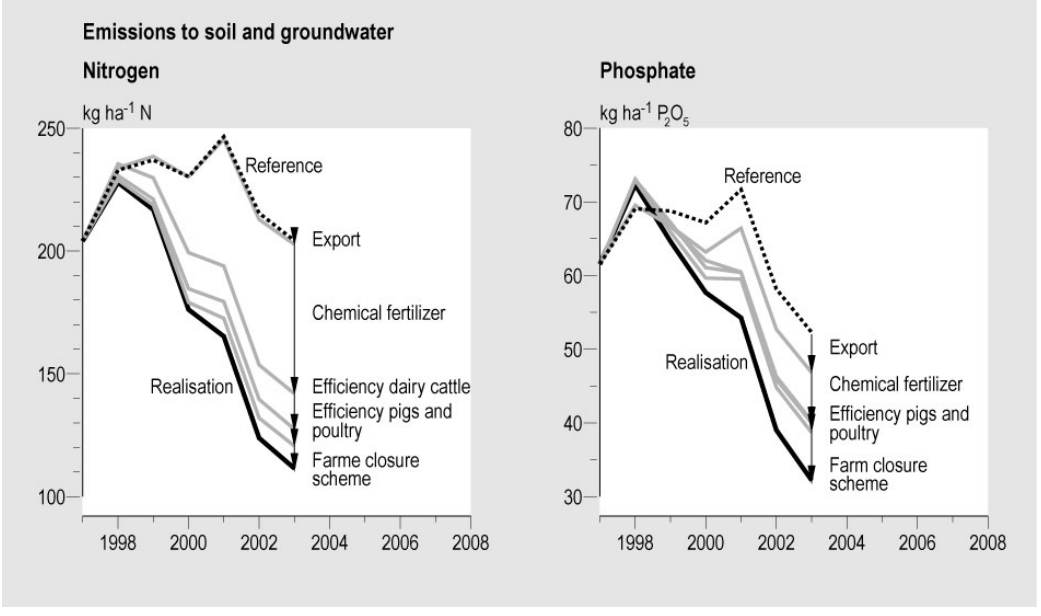
of locations where total phosphorus concentration has risen. It is unclear whether this is due to a gradual breakthrough effect of phosphate-saturated soils.

Comparison of the monitoring results for different landscape regions shows clear differences in phosphorus concentrations in surface waters. Over 1997-2002, the average total phosphorus concentration was below the 0.15 mg L^{-1} standard at very many locations in the east of the Netherlands, the southern and central sandy areas and river areas. Contrary to this, total phosphorus concentrations were considerably higher in the west and north of the Netherlands. In the coastal region, which includes almost all the marine clay areas, the average phosphorus concentrations generally exceeded 1 mg L^{-1}. For these marine clay areas it is not known how much agriculture and other human factors contribute, compared with the background load from phosphorus-rich seepage from marine groundwater bodies. This question needs to be answered, particularly with a view to future objectives to be formulated in connection with the European Water Framework Directive.

Effectiveness of policy instruments

One of the two main questions of this evaluation was whether the policy instruments used by the Dutch government have led to the fulfilment of the environmental goals. MINAS has proven to be an effective instrument in the sense that it led to a substantial reduction of the use of nitrogen and phosphorus fertilisation in Dutch agriculture, although, as discussed above, the environmental objectives have not yet been fulfilled everywhere. It is the main reason why over the period 1998-2002, the amount of chemical nitrogen fertilisers purchased by the agricultural sector has fallen by almost 30% (about 110 Gg) and chemical phosphate fertilisers by over 20% (about Gg 15). While the nutrient input to soils was reduced, crop production remained about the same and overall withdrawal of nitrogen fell only slightly. Consequently, there was a decrease in nutrient emissions (emission = input minus withdrawal) to the soil of more than 30%. Figure 6 indicates the part of this decrease that can be attributed to the more stringent manure and fertiliser policy from 1998 onwards.

Figure 6. Decrease of nitrogen and phosphate emissions, 1998-2003[1]



Note:
1. 2003 figure is provisional.

The reference line in Figure 6 indicates what the emission would have been without any measures taken by farmers to comply with the manure and fertiliser policy. The reference line was estimated starting from the actual emissions and subsequently adding the effect of the Farm Closure Scheme and of measures that were mainly brought about by MINAS: more efficient nutrient feeding of the farm animals, decrease of chemical fertiliser use and export of manure. It was assumed that without manure and fertiliser policy, farm management with respect to these items would have been the same as in 1997 before MINAS got into force.

MINAS on dairy farms

MINAS has been an effective and efficient instrument for dairy farming. While dairy farming accounts for about 50% of agricultural land use, it contributed most to the decrease in the use of nitrogen and phosphorus chemical fertilisers in the agricultural sector since 1997 (Table 6).

Table 6. Nitrogen fertilisation on farms participating in LMM groundwater monitoring programme

(kg per hectare)

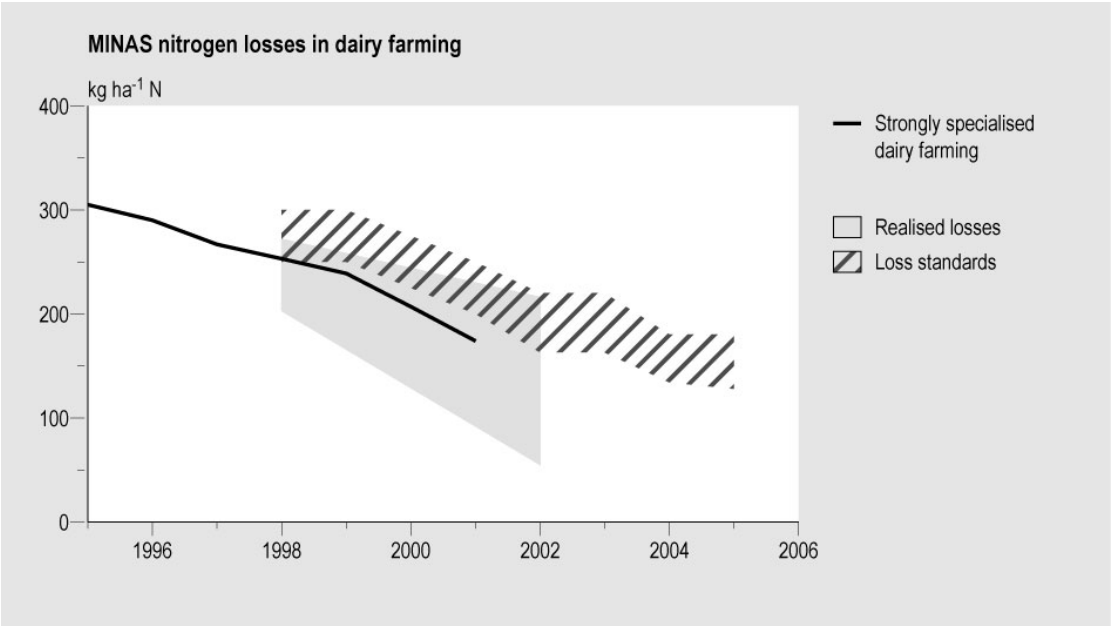
	Sand regions			Clay regions	
	1991-94	1996-98	1999-2001	1996-98	1999-2001
Manure					
Dairy farms	358	284	288	263[2]	263
Arable farms	135	142	120	89	119[3]
Other farms[1]	394	308	277	169	145
Fertiliser					
Dairy farms	253	211	162	345[2]	295
Arable farms	119	98	85	169	150
Other farms[1]	148	120	65	237	194

Notes:
1. For example, combinations of livestock husbandry and arable farming.
2. Average for the 1997-98 period.
3. Average for the 1999-2000 period.

Registrations of nutrient book-keeping and results of pilot farms show a decrease of the MINAS nitrogen losses by 15-30 kg ha^{-1} per year from 250 kg ha^{-1} in 1997 to around 150kg ha^{-1} in 2002 (Figure 7). The large variation between the achieved reductions and the loss standards is caused by differences in intensity in the use of nutrients, the innovative capacity of the farmer and the degree in which counselling was received.

Unfortunately no data were available for the FADN specialised dairy farms after 2001. MINAS has improved nutrient management because it has increased awareness of the input and output of nitrogen and phosphate on the farm. The effect of MINAS levies appears less important because nitrogen losses for most farms were far below the MINAS loss standards. The 25% decrease in the use of phosphate chemical fertilisers was a major side-effect of MINAS. In fact, MINAS sets no limits on the use of phosphate chemical fertilisers. MINAS was also an efficient instrument for very many dairy farmers because few costs were involved and the reduced use of chemical fertilisers lowered milk production costs.

Figure 7. Average nitrogen losses according to MINAS on dairy farms in relation to the continuous decrease of the loss standards under MINAS



MINAS on intensive livestock farms

MINAS is intended to ensure the safe disposal of all manure that cannot be used in accordance with loss standards on the intensive livestock farm that produced it. Safe disposal includes transfers to other farms, manure processing or manure export. Since the average intensive livestock farm consists of 10 hectares of land and the average amount of phosphate in manure is over 400 kg ha^{-1}, by far the majority of the manure must be removed from the farm. A secondary goal of MINAS is to cut down nutrient production per animal, as this will lower national manure production and thus also the national manure surplus. Conditions for achieving these MINAS goals are that input and output items are determined correctly, levies have a controlling effect and that there is no large-scale fraud.

Major inaccuracies (around 40%) in the determination of input and output amounts of manure by intensive livestock farms were one reason for the switch to MINAS in 1998. However, MINAS did not take into account statistical errors in manure analyses and consequently some farmers had to pay high levies despite the fact that they had disposed of their entire manure production. This problem is referred to as the MINAS gap. In spite of these problems, MINAS is more accurate than the previous accounting system and hence, a great improvement. MINAS levies have been high enough to enforce manure disposal, even though manure transfer prices were relatively high. MINAS has had little effect on reducing excretion per animal. One reason being that this has little effect on the volume of manure that must be transferred, which was calculated on the basis of set excretion rates. Another being that the nitrogen and phosphorus content of the pulp feed mixtures used in pig holdings are difficult to control.

MINAS on arable farms

Over 90% of the arable farmers could comply with the MINAS loss standards for nitrogen and phosphates in 2002. The level of nitrogen and phosphate fertilising on arable farms has barely diminished since 1997. There was a decrease in the sandy regions but most of the arable farms are in the clay regions where, due to the policy of spreading the surpluses, the use of animal manure

increased. The effectiveness of MINAS for arable farming was therefore limited. But it should be noted that the MINAS system did not become compulsory for arable farms until 2001. Another important reason for the limited effectiveness of MINAS in arable farming were the high nominal permitted outputs (*forfaits*) for crops, *viz.* 165 kg ha^{-1} N and 65 kg ha^{-1} P_20_5.

Conclusions on MINAS

In 2002 all sub-sectors, on average, easily met the MINAS loss standards for that year. Farms have managed, on average, to reduce their MINAS surpluses annually, and to keep pace with the tightening of the MINAS loss standards. So, the policy goal of MINAS, "a balanced fertilisation" in agreement with the loss standards, has been achieved. However, it could be expected from the outset that meeting the MINAS loss standards would not lead to the realisation of the underlying environmental objectives. There are several reasons for this:

- The MINAS loss standards for nitrogen, certainly in the first years of the period mentioned, were set at the upper end of the range needed to attain the MTR values for nitrate in groundwater (50 mg L^{-1}) and for nitrogen in surface waters (2.2 mg L^{-1}).

- The MINAS levies were initially not high enough to provide an incentive to meet the loss standards.

- The nominal amounts (*forfaits*) used for the permitted output of nitrogen and phosphates *via* crops and in gaseous nitrogen compounds were high compared to empirical data.

- Some inputs, such as phosphate chemical fertilisers, biological nitrogen fixation, atmospheric deposition and compost, were not included in the MINAS bookkeeping system.

The extent to which the MINAS loss standards were attained gives an over-optimistic picture of the extent in which a balance is achieved between fertilisation and crop withdrawal. Nevertheless, MINAS has sharply reduced nitrogen and phosphate losses at both the farm level and the national level, which has also enhanced environmental quality.

Restriction of manure production

Production Quotas were effective because they halted the growth of national manure production. In particular, larger intensive livestock farms with potential for growth did not increase their livestock because they judged costs for obtaining necessary quota from other smaller farms too high.

The Manure Transfer Contracts hardly posed any restriction on the production of manure as there proved to be sufficient demand from, in particular, arable farmers. Farm surpluses of nitrogen had to be contracted a year in advance. Surpluses were estimated with nominal amounts based on averages for excretion per animal. The farmers who managed to lower their excretion rates beyond the average had to enter into hypothetical contracts. Farmers saw the Manure Transfer Contracts as merely paperwork while MINAS limited fertilisation. After this evaluation the government decided to abolish the system of Manure Transfer Contracts.

Livestock Farm Closure Scheme

Under the Livestock Farm Closure Scheme and other, previous schemes to buy-up livestock quota, around 15% of pigs and poultry livestock quota were bought by government. This means that the "manure production capacity" in the Netherlands has decreased clearly.

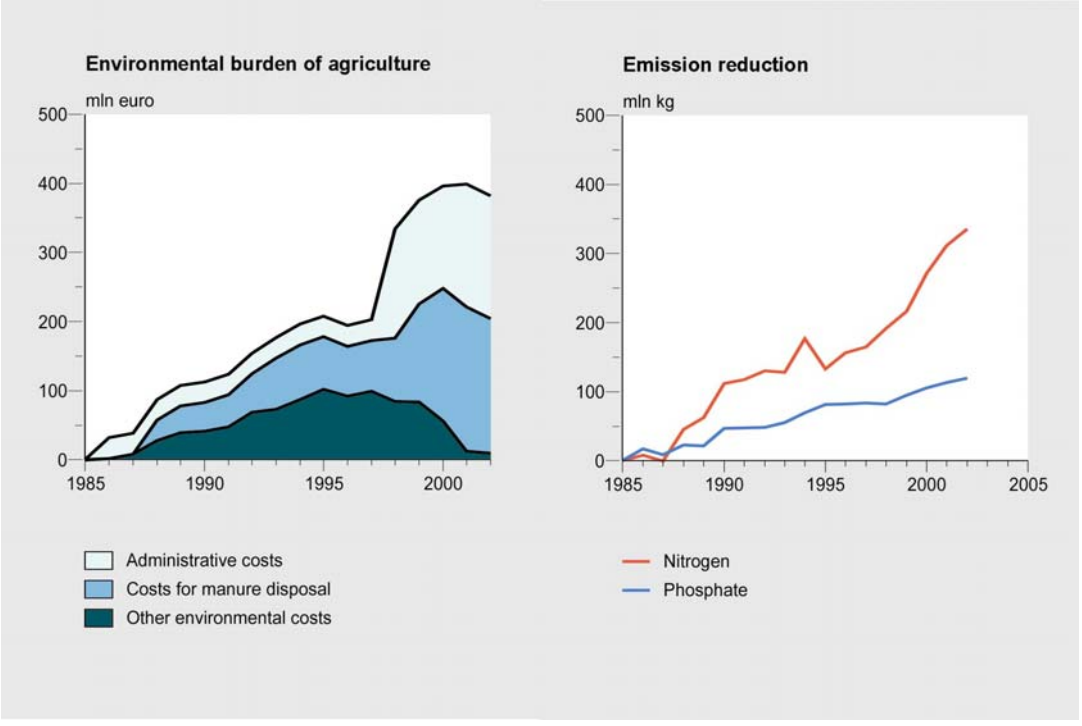
Nitrate Projects Action Scheme

The Nitrate Projects Action Scheme aimed at improving farm nutrient management. The knowledge imparted by the programme has made farmers more interested in the nutrient flows on their land or made them aware of the environmental and economic benefits of limiting nutrient losses. The programme showed farmers that the objectives of MINAS were attainable and offered them methods and tools to do so. As there were no explicit objectives laid down for the Nitrate projects, it was difficult, if not impossible for the evaluators to provide quantitative answers to the question whether the programme had been effective and efficient.

Efficiency of policy instruments

Before 1998, the storage and disposal of manure were the largest items of expenditure for agriculture. After the tightening of the manure policy in 1998, the environmental costs for agriculture rose sharply in the 1998-2002 period to twice as much as what they were in the 1995-97 period (Figure 8) (MNP-RIVM, 2004). The increase was, in particular, caused by increased costs of manure disposal (an average of EUR 90 million per year) and administrative costs (an average of EUR 125 million per year). The reduced use of fertilisers, on the other hand, led to cost savings of about EUR 35 million per year, which nearly compensated the "Other environmental costs" in 2002. Although not relevant for the cost analysis for the agricultural sector as a whole, implementation of the Fertiliser Act also generated revenues for arable farmers accepting manure and for entrepreneurs involved in transport, storage and application of manure.

Figure 8. Development of environmental costs for the agricultural sector and emission reduction for nitrogen and phosphate



The direct public spending on buying-up livestock quota in the 1998-2003 period came to a total of EUR 710 million (Table 7).[9] In total 23 million kg of nitrogen and 13 million kg of phosphate was bought up. In total, the extra costs imposed on the agricultural sector compared to 1997 as a result of the manure and fertiliser policy came to EUR 1 000 million for the period 1998-2003 and led to an emission reduction of 162 million kg of nitrogen and 29 million kg of phosphate.

Table 7. Costs for tightening manure and fertiliser policy – 1998-2002/2003

	(EUR million)
Environmental burden for agriculture 1998-2002	1 000
Public spending 1998-2003 including:	1 080
- Farm Closure Schemes	710
- Nitrate Projects Action Programme	60
- Implementation and enforcement of the fertiliser policy	310

The effectiveness of the government expenditure is hardly comparable to the cost-effectiveness attained by the agricultural sector. Costs of buying up livestock quota are once-only expenses leading to structural emission reductions, while the costs of agriculture have to be paid every year to maintain emission reduction.

The annual public expenditure cost of implementing the Fertilisers Act rose from EUR 20 million in 1998 to over EUR 85 million in 2002. The highest expenditure items are MINAS and the System of Manure Transfer Contracts. Since MINAS is a tax system, all of the MINAS returns have to be checked and farmers have to be informed on the decision of paying a levy or not. This has to be done regardless whether there is a risk of over-fertilisation. The problem of the MINAS gap, delays in processing MINAS returns and high manure disposal prices decreased support for MINAS among livestock farmers. Legal appeals and increasing administration costs were the result. The costs for the System of Manure Transfer Contracts include a geographical information system that contains a regularly updated registration of size and usage of all farm fields.

Overall, despite the substantial increase in costs, Dutch manure and fertiliser policy in 1998-2002 was efficient since costs per emission reduction in nitrogen and phosphates did not rise compared with the previous period. In fact, in recent years (after 1999), these costs per emission reduction even declined. However, unit costs are likely to increase with advancing emission reductions.

Discussion

Despite the great efforts and improvements made, the MTR values for nitrate in groundwater and nitrogen in surface waters were on average not attained in 2002. From this point of view the environmental problem was not solved. Pollution of groundwater and surface waters by nitrogen was reduced but not prevented.

MINAS was a cost-effective measure in dairy farming but not in intensive livestock farming and arable farming. It was successful in dairy farming because efficient nutrient management was stimulated. In the intensive livestock farming sector MINAS acted as an enforcement instrument for obligatory manure disposal. In arable farming, nominal amounts for crop withdrawal were so high that on average little effort was needed to comply with MINAS.

9. This is the sum of all buying-up schemes, not only the Farm Closure Scheme.

The Manure Transfer Contracts system was neither effective nor efficient for livestock farming. The additional effect on controlling manure production and regulating disposal was nil, while the costs were considerable. The system of Production Quotas was effective in restricting growth in the intensive livestock farming at a national level.

In general the support of farmers for policy instruments in the Fertiliser Act was not very strong. Farmers judged policy instruments and objectives to be too changeable, and the government too unreliable, to justify major investments in adjusting their farm management

The *ex post* evaluation was carried out under great pressure of time, as the completion date was fixed by the time schedule for passing new legislation through parliament, and because of the additionally required *ex ante* evaluation research after the ruling of the European Court of Justice. This somewhat hampered the ex post analysis of the most recent empirical data on farmers behaviour and nutrient management, and the subsequent synthesis of socio-economic and environmental results.

The *ex post* evaluation was primarily intended to support the decision-making process of government on the necessary adaptation of the manure and fertiliser policies, and secondarily for other stakeholders. The evaluation report received a fair amount of attention, particularly in agricultural periodicals and newspapers. The tenor of most articles was that the policy apparently had proven to be insufficient to attain environmental targets as set by the EU, but that farmers had reached an economical and psychological limit as to further adopting new and stricter policies. However, the suggestion that reduction of livestock was the inevitable solution was rejected strongly. Instead the farmer associations stated that the Dutch government had poorly negotiated with the European Commission from the onset of the national implementation of the Nitrates Directive.

As to the impact of the evaluation on the decision making process for the new manure and fertiliser policy by government, there were not many explicit references. The decision to abolish MINAS was taken before the results of the evaluation were available. The government's decision to abolish the system of Manure Transfer Contracts in favour of the system of manure Production Quota was partly based on the outcomes of this evaluation.

The main impact of this evaluation probably was that it strengthened the conviction that future application standards for manure and fertiliser had to be stricter in order to attain the environmental objectives. However, there is a widely accepted view among almost all stakeholders, that a policy based on nutrient losses is superior to a system based on application standards. Two important arguments to prefer a system based on nutrient losses are that it gives stronger incentives for more efficient livestock feeding, and that it more directly controls the environmental loading. Dairy farms with high livestock density will have to dispose of part of their manure, generating extra costs. To maintain sufficient grass production, farmers will have to replace some of the disposed manure with chemical fertiliser. Despite the fact that the new system is stricter for farmers it is not certain that it will be more beneficial to the environment and to animal welfare.

The next evaluation, which is provisionally planned in 2007, is going to be very interesting as it will include the first effects of the policy change. One intriguing question is whether the robust decrease of the nitrogen surplus as observed since 1995 will continue.

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(http://www9.minlnv.nl/servlet/page?_pageid=306&_dad=portal30&_schema=PORTAL30).

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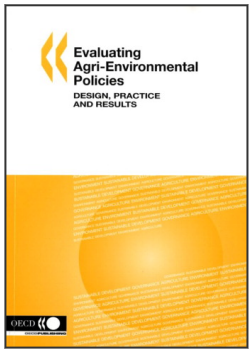

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