COMPARISON AT DAIRY FARM LEVEL OF DIFFERENT POLICIES TO DECREASE NUTRIENT LOSSES TO GROUND AND SURFACE WATERS IN THE NETHERLANDS

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ABSTRACT

This paper describes and compares two governmental policies that aim to decrease nutrient losses from farming to ground and surface waters in the Netherlands. The mineral bookkeeping system (MINAS) is the first policy. It is applied in the Netherlands since 1998 and it is based on a farm gate balance approach. This national policy was definitely rejected on October 2, 2003 by the EU Court of Justice as it was considered not to comply fully with the EU Nitrate Directive. Consequently, the Netherlands developed the Application Standards Policy (ASP) based on a soil balance approach which will replace MINAS starting 2006. Especially for dairy farming, that combines plant and animal production, nutrient input and output at soil level are hard to determine as nutrient input via manure and nutrient output via grass and forage is not measured. ASP, therefore, works with standards leaving less incentives for individual farmers to improve their nutrient use efficiency through farm management.

Comparison of the policies by means of modeling at farm level shows partial removal of manure and replacement of the nutrients in this manure by fertilizer for an intensive dairy farm when changing from MINAS to ASP. This leads to a decreased cost-effectiveness as nutrient losses remain roughly the same while the farm income decreases substantially. Also the income of an extensive dairy farm decreases, but there nutrient losses also decrease. The value of this last decrease is questionable, however, as the nutrient surpluses on the extensive farm are below the surpluses that are considered acceptable given the buffering capacity of the environment. The partial removal of manure from intensive farms will definitely lead to problems on the manure market in the Netherlands as it is already difficult in the current situation to place all the surplus manure in a responsible way on arable farms.

Key words: dairy farming, nutrient losses, environmental policy, nitrate directive, cost-effectiveness

INTRODUCTION

Governmental intervention in agriculture in the Netherlands based on environmental concerns has a history that goes back till 1984. Henkens and van Keulen (2001) distinguish roughly three phases in the so-called manure policy in the Netherlands. The first phase (1984 to 1990) focused on stopping the increase of animal production. In the second phase (1990-1998) stepwise decrease of the manure burden was the main focus. Balancing inputs and outputs with regard to N and P so far is the last phase (1998 to present). The subsequent phases show that the policy focus has turned more and more towards the actual problem, an imbalance between input and output of nutrients (Schröder et al, 2004a).

The introduction of the Mineral Accounting System (MINAS) in 1998 marked the beginning of the third phase of the manure policy. MINAS is a farm gate balance approach and it was the answer of the Netherlands to the EU Nitrate Directive that was approved in 1991. After a long pe-

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riod of discussion between the EU and the Netherlands, on October 2, 2003, the European Court of Justice decided that MINAS does not comply fully with the EU Nitrate Directive and therefore it shall be replaced by a policy that fully complies with the Nitrate directive. Since then, a lot of work has been done by governmental servants, scientists and representatives of farmers organizations to develop a new policy aiming at decreasing nutrient losses to ground and surface waters. This has resulted in a system of application standards for the use of N and P on agricultural land, based on a soil balance approach, which will replace MINAS from 2006 onwards.

The change from a farm gate balance approach to a soil balance approach has the advantage that the focus is shifted to the compartment where the unwanted losses arise, namely the soil. For farming systems that combine animal and plant production like dairy farming, however, it adds uncertainty, as most of the nutrient inputs and outputs at soil level are part of the internal nutrient cycle of the farm and are therefore not measured. This refers to manure as a soil input and roughage as a soil output in dairy farming. The disadvantage brought about by this uncertainty for these types of farm is twofold. As monitoring of nutrient production via manure is hard it will be difficult to give incentives to farmers to minimize nutrient content of manure by exact feeding. Second, reliable determination of nutrient surpluses at soil level and of consequential harmful losses is difficult.

The objective of this paper is first to give the policy background by describing the different policies. The second goal is to determine possible consequences of this policy change for dairy farms by using an environmental-economic model of a dairy farm.

POLICY BACKGROUND

The ultimate goal of the EU Nitrate Directive is the decrease of nitrate from agricultural sources to ground water and surface waters (91/676/EEC). This has been translated in a maximum allowable nitrate content of ground and surface water of 50 mg per liter (75/440/EEC). The core of the Directive is that a balance should be reached at soil level between nutrient input and output. Important for the Netherlands in this respect is the statement in the annex that member states have to guarantee that application of N from animal manure does not exceed 170 kg per ha per year. A higher application rate can be allowed based on objective criteria and provided that the objectives of the Nitrate Directive are achieved in time (Oenema and Berentsen, 2005).

MINAS, the answer of the Netherlands to the Nitrate Directive, is a farm gate balance approach (Berentsen and Tiessink, 2003). Farmers are required to account for nutrient flows that enter and leave the farm through the farm gate. The difference between input and output is the nutrient surplus. As MINAS aims to decrease losses to the soil, the N surplus is corrected using standards for gaseous losses like ammonia emission from stables. The final surplus is expressed per hectare and compared to standards expressing surpluses per hectare that are considered acceptable. The amounts of N and P2O5 exceeding the acceptable sur-

Table 1. Acceptable nutrient surpluses and levies within MINAS for 2003-2005

	P_2O_5	N	
		all soils	vulnerable sandy soils
Acceptable surpluses (kg/ha):			
- grassland	20	180	140
- arable land	20	100	60
- conservation areas	10	50	50
Levies €/kg	9	2.30	2.30

pluses are penalized with a levy per kg of N and P2O5 respectively. As from the introduction of MINAS in 1998, acceptable surpluses and levies were gradually tightened. Table 1 shows the final standards that were and are used from 2003-2005. As can be seen from table 1, acceptable surpluses differ depending on the use of the land and for N also on the vulnerability of the land concerning leaching. MINAS has a number of shortcomings like not including atmospheric N deposition, biological fixation of N and P2O5 fertilizer as an input to the system. Next to the correction for gaseous losses, this makes a MINAS balance different from an actual nutrient balance.

The first action plan of the Netherlands including MINAS was delivered to the EU Commission in 1997. This plan was criticized immediately by the EU as it was considered not to comply with the Nitrate Directive. Years of discussion and adaptations followed. The EU commission, however, could not be convinced and they went to the EU Court of Justice. On October 2, 2003, the EU Court of Justice concluded that the Netherlands did not fulfill the obligations following from the Nitrate Directive. Concerning the scope of MINAS, the Court concluded that:

- no application standards for the use of animal manure were introduced (170 kg of nitrogen per ha);
- no application standards were introduced for the supply of nutrients via fertilizers and manure aiming at a balance between nutrient supply and nutrient uptake at soil level.

With this conclusion, the concept of surplus standards in general and MINAS in particular is considered as being in contradiction with the Nitrate Directive. This means that MINAS had to be replaced by a new policy that does comply with the Nitrate Directive (Van Bavel et al, 2004).

Following the conclusions of the Court, the Netherlands developed a new policy to replace MINAS. This Application Standards Policy (ASP) consists of three types of application standards (Ministry of Agriculture, 2004):

1.A standard for the application of N from animal manure of 170 kg/ha. Foreseeable is an allowance of 250 kg/ha for farms that have more than 70% grassland (the so-called derogation);

2.A standard for the application of available mineral N per ha from fertilizer and manure depending on soil type and crop;

3.A standard for the application of P2O5 per ha from fertilizer and animal manure depending on soil type and crop.

Standards for the application of available mineral N are based on acceptable losses per ha given the 50 mg nitrate maximum and on known input/output relations for N per crop. The same line of reasoning counts for the application standards for P2O5 (Schröder et al, 2004b). For dairy farming, measurement of N and P2O5-supply (also indicated as –production) via animal manure is hardly possible, so standards for N and P2O5-excretion per animal have been developed based on an average Dutch situation concerning the ration of cows and young stock (Tamminga et al, 2004). N-production per animal is determined by decreasing N-excretion with standard amounts for gaseous N losses. Available mineral N from animal manure is determined by correcting N-production using a working coefficient for animal manure. This working coefficient differs between systems that do apply grazing and systems that do not, as manure excreted during grazing is badly distributed and is therefore considered not to contribute to available mineral N. The resulting higher N losses in the grazing situation are captured by a lower standard for the use of available mineral N on grassland in case of grazing. Table 2 gives an overview of the standards that will be used for dairy farming in 2006.

Table 2. ***Standards that will be used in the Application Standards Policy (ASP) for 2006***

		N	P_2O_5
Application standards for sandy soil (kg/ha/year)			
- N from animal manure		170 (250)	
- available nutrients:			
grassland:	with grazing	300	110
	without grazing	355	110
maizeland		155	95
Nutrient production in manure (kg/year)			
- per cow		114.6	36.8
- per heifer (1-2 year)		70.2	20.4
- per calf (<1 year)		32.8	9.1
Working coefficient for N in manure (%):			
- with grazing		35	
- without grazing		60	

MODEL

The model that is used to determine the effects of the environmental policies is a whole farm linear programming model. The objective function maximizes labour income (i.e. the remuneration for family labour and management that is left after all other costs have been paid). The initial farm situation is specified by the right-hand side values for land, milk quota and family labour and by farm-specific coefficients representing milk production per cow and grass production per hectare.

The central element in the model is a dairy cow with a fixed milk production, which is assumed to calve in February. A minimal ratio is required between the number of young stock and the number of dairy cows to guarantee replacement of dairy cows. The feeding part of the model consists of four parts. The dairy cows and young stock are fed separately, and a division is made between summer, when cows and young stock can graze, and winter, when livestock is kept indoors. For dairy cows, feeding constraints reflect demand and supply of energy and protein, dry matter intake capacity, and demand for fibre in the ration. Feed for dairy cows and young stock consists of grazed and conserved grass and maize silage produced on the farm, three types of purchased concentrates that differ in protein content, dried beet pulp, and purchased maize silage.

The land can be used for growing grass and maize silage. Grass can be produced in the model at five rates of mineral nitrogen (Nmin) from fertilizer and manure (100, 200, 300, 400 and 500 kg/ha year) to include decreasing marginal production with increasing Nmin rates. Modelling of maize production is less complex. Above an optimal nutrient rate, production response to nutrients is low so that only one nutrient rate is used. A surplus of silage maize can be sold.

Nutrients for plant production can be supplied by fertilizer or by manure. The model estimates nutrient balances for N and P2O5 at the farm level based on nutrient inputs and outputs. Surplus manure can be removed from the farm to be used by other farms at a price of 8 Euro/m3. For a more detailed description of the model see Berentsen and Giesen (1995).

To compare MINAS with ASP two versions of the model were made, one including MINAS and one including ASP.

RESULTS

As environmental problems are related to animal density, the comparison of MINAS and ASP is done for two farming situations differing in intensity. Both farms have the same milk quota of 400,000 kg, but the intensive farm has 25 ha of land and the extensive farm has 40 ha of land. This results in an intensity of production of 16,000 and 10,000 kg/ha respectively. On average the production intensity in the Netherlands is approximately 13,000 kg/ha. Yearly milk production per cow is assumed to be 8000 kg with 4.45% fat and 3.5% protein, which resembles the average production level in the Netherlands.

Results are shown in tables 3 and 4. In all situations the numbers of animals are the same. These numbers follow directly from the assumptions and amount 50 dairy cows, 19 calves and 18 heifers. In the situation under MINAS the intensive farm uses 22.6 ha as grass land at an Nmin fertilization level of 256 kg/ha (table 3). The rest of the land is used for growing silage maize. In general, use of the land and the Nmin level of grassland is detemined by the feeding requirements of the dairy cattle. In the summer ration intake of grass by means of grazing is maximized given the feed intake capacity of the cows, as grass for grazing is cheap feed. In the winter ration roughage consists for the greater part of maize silage, with a smaller amount of grass silage and concentrates to fulfill protein requirements. As silage maize has to be harvested only once, it is cheaper roughage than grass silage which has to be harvested several times. In the situation under MINAS, the Nmin level on grassland is restricted by MINAS. This can be seen from table 4 where the N MINAS surplus of this farm equals the acceptable surplus. Feed production on the intensive farm is by far not enough to fulfill the feed requirements. The amounts of concentrates and maize silage that are purchased cover some 40% of the total feed requirements. All animal manure produced on the farm is supplied on the farm. The real nutrient balances in table 4 indicate an environmental load of 229 kg/ha for N and 14 kg/ha for P2O5. Labour income of this farm amounts to € 26,281.

Table 3. Farm production results of the intensive and extensive farm for MINAS and ASP

	Intensive		Extensive	
	MINAS	ASP	MINAS	ASP
Cropping plan (ha)				
- grass	22.6	20.3	20.9	28.0
- silage maize	2.4	4.7	19.1	12.0
Nmin level grassland (kg Nmin/ha)	256.2	318.9	325.2	247.3
Feed purchases (1000 MJ NEL[1])				
- concentrates	500	500	500	468
- maize silage	604	492	0	0
Fertilizer purchase (kg/ha)				
- N grasland	143	245	255	169
- P2O5 grasland	0	25	30	28
Animal manure (m^3)				
- total production in the stable	957	957	957	957
- removed from the farm	0	332	0	0

[1] NEL = Net Energy for Lactation

Table 4. Environmental and economic results of the intensive and extensive farm for MINAS and ASP

	intensive		extensive	
	MINAS	ASP	MINAS	ASP
MINAS N balance (kg/ha):				
- surplus	152		109	
- acceptable surplus	152		122	
MINAS P2O5 (kg/ha)				
- surplus	14		-13	
- acceptable surplus	20		22	
Real N balance (kg/ha)				
- farm input	322	386	272	231
- farm output	93	155	94	79
- surplus	229	230	178	152
Real P2O5-balance:				
- farm input	53	71	56	48
- farm output	39	60	36	31
- surplus	14	11	20	17
Labour income of the farm (€)	26,281	24,674	30,417	28,978

Replacement of MINAS by ASP results in removal of approximately one third of the manure produced on the intensive farm. This takes place because of the application standard for N from animal manure. This is already 250 kg/ha because of having more than 70% grassland. The removal of manure and the application standard for available mineral N from manure and fertilizer give the possibility to drastically increase the N fertilizer use on grassland. The Nmin level on grassland increases by 63 kg/ha. This leads to a higher grass production per ha and consequently to a lower area of grassland and a higher area of silage maize. Consequently the amount of purchased silage maize is lower. The N balance shows a much higher farm input (fertilizer), but also a much higher farm output (manure removal). The resulting surplus remains the same (table 4). For P2O5 the surlus decreases by 3 kg/ha. The economic results change because of lower costs for purchase of silage maize and higher costs for fertilizer purchase and manure removal. The consequence is a decrease of labour income by € 1607.

For the extensive farm changes are quite different. In the situation with MINAS the farm sells some 9 ha of the silage maize that is produced. MINAS is not a restriction as the surpluses are below the acceptable levels (table 4). Under ASP the farm increases the area of grassland to reach the 70% grassland which is required to get the application standard for N from animal manure of 250 kg/ha (table 3). The 170 kg/ha would also for this farm result in obligatory removal of manure. Productivity levels of grassland in the Netherlands are that high that the extensive farm has trouble to feed all the grass produced, so the Nmin level on grassland is decreased substantially. Nutrient surpluses are decreased further although they were already low. Labour income decreases by € 1440 mainly due to the loss of returns from selling silage maize.

DISCUSSION

Results show that the policy change from MINAS to ASP leads to quite different changes at farm level. For the intensive farm ASP is less cost-effective than MINAS as the income decreases while environmental results remain at the same level. There is a slight decrease of phosphate surplus, but this surplus is already way below the surplus that is considered acceptable given the buffering capacity of the environment. The extensive farm has surpluses below the acceptable surpluses in all situations. This questions the value of the further decrease of the surpluses by ASP. In any case, also on the extensive farm economic results are worsened. Looking at the results from a sector or a national point of view, an additional effect of the policy change arises. The total supply of manure on the manure market will drastically increase as many dairy farms will have to remove manure from their farm. This can be considered an absolute problem since already in the current situation with MINAS there is difficulty in convincing all arable farmers to use substantial amounts of animal manure, next to the fact that also arable farmers are faced with environmental legislation that limits the amount of manure they can apply. In that sense the change from MINAS to ASP can be considered negative for the Netherlands.

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