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The EU Nitrate Directive - Experiences and Necessity of Further Action

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Abstract

The awareness of ecological problems caused by agriculture was considerably increased in the last decade. Consequently, legislative activities at the EU and the national level have been launched as a reaction to public pressure which demands the protection of environmental goods. The EU Nitrate Directive is targeted at a reduction of nitrate in water. As a point of entry the use of animal manure has been chosen. Whether law enforcement on a national level will be effective enough in order to meet the overall objectives of the Nitrate Directive is still questionable at the moment, considering the necessary scope of farm adjustment in the specific problem regions. In addition, the question arises if the measures launched under the Nitrate Directive will be effective enough to restrict nutrient supluses to a level which might be tolerated by society in the long run. This question involves the interaction of the common agricultural policy in general and specific environmental issues.

The experiences from the 1992 CAP reform lead to the conclusion that the change of economic frame conditions in the near future will not induce a significant reduction of environmental problems caused by agriculture. Especially livestock farming and overall livestock densities in the EU will only be affected indirectly or to a limited extent by further deregulations of agricultural markets. It can be concluded that the ecological requirements and the public pressure to introduce targeted environmental instruments aiming towards a change of agricultural production systems will not only remain, but even increase. This applies to the reduction of nutrient emissions from agricultural production in particular. In spite of the introduction of measures, which are in line with the objectives of already existing regulations like the EU Nitrate Directive, further-reaching instruments however could be considered. Such policy interventions to reduce nutrient emissions from agricultural sources will probably be targeted at the N-balance surplus and not only at the N-fertilization from organic sources as it is prescribed by the Nitrate Directive. At the present time the average N-output from livestock production equals the average N-balance surplus at the EU level. This figure highlights that nutrient surpluses can only be reduced substantially by policy measures that induce structural changes in the livestock sector.

Introduction

In the last two decades, environmental concerns have influenced political decisions more and more at the EU and national levels. In this context, agriculture has been identified as a main polluter. This refers especially to nutrient emissions. The interrelation between agricultural production and the environment and the relating problems have been discussed intensively. The general need for political intervention has reached broad consensus in recent years, but

the scope and the detailed implementation is still a matter of discourse between different groups in society, especially between farmers and farm input industry on the one side and environmentalists and consumers on the other side.

According to the pressure of the different groups, policy interventions at the EU and national levels have concentrated up to now on taggling specific problems of ‚agriculture and the environment' by detailed measures and have not implemented more general economic measures for example taxing polluting inputs. As a result, agriculture in Europe is confronted with regulatory ‚command-and-control' as well as ‚incentive-and-control' policies at the EU, national and regional levels (BONDE 1994, TUNNEY 1994, WILLIAMS 1994). These policies are accompanied by extension efforts aiming at a reduction of negative environmental effects of agriculture for example by ‚integrated production' or production in accordance with ‚Codes of Good Farming Practice'. Production systems causing severe pollution such as intensive livestock production have been confronted with more or less restrictive environmental regulations such as manure directives. An approach towards more market based policy interventions can be observed in Denmark (AGRA-EUROPE 50/95), where pesticide taxes have been introduced for selected products and nitrogen levies are seriously being discussed at the moment. In spite of the present policy framework law enforcement is often not efficient so that the real impact of environmental policies on agricultural production has been quite limited up to now, at least because monitoring and control measures tend to be unsatisfactory (VON MEYER 1991, BROUWER & VAN BERKUM 1996). Therefore, the claim for further involvement of policy interventions will remain.

The question as to whether this applies in particular to the EU Nitrate Directive is analysed in this paper. First, the implementation of the Nitrate Directive is described and the present impact on agricultural production systems and the environment is assessed. In a second step the necessity of policy changes is analysed, in case N-emissions in general have to be reduced substantially in future.

EU-Nitrate Directive - Implemenation and Experiences

In the last decade, the EU has given an increasing emphasis on environmental issues, e. g. in the Single European Act in 1986, which introduced explicit environmental law-making powers by introducing a number of new articles (130r, 130s, 130t). They provide the justification for environmental protection laws even where there is no direct link to the economic aims of the EU (REEVE 1993). Furthermore the Fifth Action Programme on the Environment of the EU ‚Towards Sustainability' (1996 - 2000) sets out objectives for the reduction of environmental problems caused by agriculture. At the present time, the implementation of the EU-Nitrate Directive (91/676) is of high practical relevance for agriculture in all EU member states

Beside other issues, water pollution had gained extraordinary importance in the public discourse about environmental problems. Agriculture has been identified as a main source of emissions which lead to water pollution. Apart from pesticide residues or phosphates the contribution of agriculture to nitrate emissions is of great relevance (DE HAEN 1982, HANLEY 1990; SHORTLE & DUNN 1991). Agriculture holds a share of about 60 % of the total nitrate loss to water (TUNNEY 1994). A main reason for this has been the increase of intensive livestock production systems in Europe which provide a high output of animal manure resulting in a nutrient supply on the utilized agricultural area (UAA) additional to the

mineral fertilizers applied. As a consequence in many regions and production systems, the nitrogen supply exceeds the nitrogen uptake by plants resulting in a nutrient surplus in the soil system. Through leaching, this surplus turns into an immission polluting groundwater and surface water.

To prevent nitrate leaching in several EU member states, measures have been launched. For example manure regulations have been enacted in Germany in some northern Federal States in order to reduce nitrate emissions by prescribing the amount and timing of animal manure application. Because the problem of increasing nitrate concentrations in water still remained and the single actions of some member states resulted in competition distorsions, a common approach was launched by the EU. In 1991 the Nitrate Directive (91/676/EEC) was adopted as the first legislative activity relating to water and agriculture at the EU level.

Objectives of the nitrate directive

The main objective of the Nitrate Directive aims at the reduction of water pollution by nitrates from agricultural sources. In accordance with the EU Drinking Water Directive (80/778/EEC), which fixes the Maximum Admissible Concentration (MAC) for nitrate in drinking water to 50 mg/l, the same value is applied to groundwater. Apart from this main objective, which clearly is a matter of public health, secondary objectives are also persued by the Nitrate Directive. These are purely environmental objectives aiming at the negative ecological effects of excessive nitrogen use like the decreasing number of species in intensively used agro-ecological systems or the eutrophication of coastal and marine waters (REEVE 1993).

Implementation of the nitrate directive

In order to comply with the objectives of the Nitrate Directive, the EU member states have to fullfill a set of requirements at the national level. They consist of three main topics, i. e. the monitoring of polluted waters and identification of vulnerable zones, the introduction of codes of good agricultural practice and the establishment of action programmes referring to the vulnerable zones. These requirements of the Directive have to be enforced by passing national laws, regulations and administrative provisions.

- Monitoring of polluted waters and identification of vulnerable zones

  The member states have to identify all water which is effected by nitrate pollution or might be affected in the future. The Directive defines all water that contains or might contain more than 50 mg of nitrate per litre, as polluted. On the basis of the polluted waters identified member states have to designate the catchment areas that contribute to the nitrate immission as vulnerable zones (TUNNEY 1994). This part of implementation had to be finished by the end of 1993.

- Introduction of codes of good agricultural practice

  To provide a general level of preventive protection for all waters, member states are required to establish codes of good agricultural practice. Farming according to these codes should minimize the nitrate pollution of waters. The contents of theses codes therefore, should refer to performance rules about mineral fertilizer and manure application as well as to cropping patterns or manure storage. The transfer of the contents has to be accompanied by training and information activities for farmers.

Farming according these codes is voluntary throughout the whole EU but legally binding in the vulneralbe zones defined by the Nitrate Directive.

- Establishment of action programmes referring to the vulnerable zones

  The member states have to establish action programmes which entirely refer to the designated vulnerable zones. This had to be done by the end of 1995. The implementation has to be finished by the end of 1999. Mandatory measures shall be introduced by the action programmes. The specific contents may vary according to the location specific conditions like climate, soils and farming system. In the member states, a legal framework has to be developed definig the responsibilities as well as the measures and contents at the national, regional or local levels. In general, the contents are prohibitions on (organic!) fertilizer application at certain times of the year (winter!) or regulations on storage vessels for livestock manure. If necessary, the member states are even allowed to implement measures, that go beyond the framework of the EU Directive, in case it is likely that the objectives outlined in the Directive cannot be reached otherwise (TUNNEY 1994). At least the Directive provides only one quantitative restriction that is legally binding in vulnerable zones throughout the whole EU: The application of animal manure is limited to 170 kg nitrogen per hectare at the farm level by 1999. In the intermediate time up to 1999 a limit of 210 kg of nitrogen per hectare is allowed on grassland.

To ensure a sustainable implementation of the Nitrate Directive, member states have to review the designition of vulnerable zones every four years if they have not defined the entire national territory as a vulnerable zone. Furthermore, they have to report to the Commission a summary of the action programmes and the monitoring results obtained in the vulnerable zones (TUNNEY 1994).

Impact on production systems

The actual impact of the Nitrate Directive on the agricultural production systems in the EU can only be estimated roughly at the present time because the implementation has not been finished yet and reliable information about farm adjustment has not been available up to now. Nevertheless, it can be assumed that there will be far reaching consequences (WILLIAMS 1994) especially for livestock farms, because the limit of 170 kg of nitrogen from animal manure equals a livestock density of about 2 livestock units (LU) per hectare UAA, which is extremely exceeded in many regions within the EU.

The possible impact of the EU Directive at the national level depends on the measures implemented by the member states on one side and the characteristics of the agricultural production systems on the other side. Under the assumption that instruments such as the treatment of animal manure are not applied, the impact on agriculture then depends on the share of vulnerable zones in percent of the UAA and the contents of the national regulations as well as the share of farms exceeding the limit of 170 kg of nitrogen from animal manure per hectare UAA.

In the EU member states the political decision process about the details of the national regulations (Codes of Good Farming Practice; contents of action programmes in vulnerable zones) has not been finished completely as yet. Nevertheless, in Germany a fertilizer regulation has been enacted for example in 1996 in order to fulfill the requirements of the Directive. This regulation is legally binding for the whole territory. It replaces the manure

regulations in those Federal States which had introduced such measures before. In the Netherlands, due to highly intensive livestock production a public discourse about the needs to cut livestock numbers and/or to tax nutrient surpluses accompanied the introduction of nutrient regulations (REEVE 1993, DLG-MITTEILUNGEN 12/95, AGRA-EUROPE 19/96). At least nitrogen levies are seriously discussed in Denmark at the moment.

Table 1. Number of farms represented by FADN [1)] statistics and farms with production levels of animal manure exceeding 170 kgN/ha, by member state in 1990/91

Country	all farms represented by FADN		farms with nitrogen from manure > 170 kgN/ha			
	number of	average	share of total (%)		average	manure
	farms represented (*1,000)	production of animal manure (kg N/ha)	number of farms represented	UAA	production (kg N/ha)	production (% of total)
Belgium	51.9	196	47	42	327	71
Denmark	81.0	109	26	25	285	59
Germany	373.9	98	12	10	207	21
Greece	498.3	64	15	9	557	68
Spain	690.6	40	19	3	723	64
France	556.7	62	6	4	309	18
Ireland	140.2	93	8	7	225	17
Italy	1,369.8	55	6	7	361	49
Luxemburg	2.3	128	11	10	197	15
Netherlands	94.0	343	63	66	501	99
Portugal	448.5	40	18	5	357	35
UK	141.6	68	17	7	258	27
EU 12	4,448.9	73	13	8	352	40

[1)] FADN: Farm Accountary Data Network of the European Commission
Source: BROUWER et al. (1995)

To estimate the adjustment pressure for livestock farming in the EU and the member states, the share of farms exceeding 170 kg of nitrogen from animal manure per hectare UAA and the respective UAA has to be considered. In the following, this is done using figures published by BROUWER et al. (1995). These computations are based on the Farm Accountary Data Network of the European Commission (FADN) and provide detailed information about farm characteristics. For reasons of data availability the reference period is 1990/91, but the general results can be transferred to the current situation. The concentration process outlined for livestock production systems in the study by BROUWER et al (1995) is likely to have continued in the meantime so that the conclusions drawn from the figures in Table 1 are even more valid.

The FADN sample represents about 4.5 million farms in the EU 12. From this a total number of about 60.000 holdings (=13 %) have a manure output of more than 170 kg of nitrogen per hectare UAA. The share of UAA affected by this amounts to 8 %. This group of farms produces about 40 % of the total manure in the EU with an average value of 352 kg of nitrogen production per hectare UAA. These figures show the high degree of regional concentration in livestock production.

The scope of possible impact on agriculture varies widely among member states and regions. The adjustment pressure is extremely high in the Netherlands, Belgium and to a minor extent in Denmark. In these countries, the share of farms (UAA) above the limit of 170 kg of nitrogen from animal manure amounts to 63 % (66 %), 47 % (42%) and 26 % (25 %) respectively. In terms of the share of farms, this group of member states is followed by Germany, Greece, Spain, Luxembourg and Portugal with 10 % - 20 %. The pressure at the national level is lowest in France, Ireland and Italy, where only 6 % - 8 % of the farms are above the limit value. Nevertheless, even the national levels are still not detailed enough to demonstrate the degree of concentration in livestock production. This especially applies to bigger countries like France, Italy, Spain or Germany. Within these countries the regional concentration in areas like Bretagne, Lombardia, Galicia/Asturias and North-West-Germany is comparable to the Netherlands or Belgium (BROUWER et al. 1995).

For the time remaining left for total implementation of the Nitrate Directive up to 1999, major adjustments are still necessary in farming practice throughout the EU. Apart from manure treatment there are only two general options to meet the application limit of 170 kg of nitrogen from manure per hectare: decreasing livestock density at the farm level and/or transfer of nutrients to other farms, which keep no livestock or which have less than about 2 LU per hectare UAA. It is likely that a combination of both options at the regional level is more or less likely to occur. The experience with manure regulations in some Federal States in Germany shows that livestock farmers had arranged contracts with other farmers to transfer manure surpluses to them in order to meet the limit of maximum application levels. But in recently, the risks of transmitting epidemics restrict the transfer of nutrients especially to those farms which have livestock, but less than about 2 LU per hectare UAA. Consequently, the transaction and transport costs for discharging manure increase for those farms with more than about 2 LU per hectare UAA. In some regions, the marginal rate of return in pig production equals nearly the costs of discharing surplus nutrients if the stocking rate is increased and at the same time all environmental regulations are met. Nevertheless, in the past control mechanisms have been and are still quite weak. So the impact of the further implemenation of the Nitrate Directive on the livestock sector depends on the effectiveness of control mechanisms and the costs of transferring surplus nutrients.

Implications for Further Policy Interventions

Interaction between Common Agricultural Policy (CAP) and environmental issues

In order to assess the impact of environmental policy interventions on agriculture those CAP adjustments have to be taken into account which can be expected for the near future in order to face the next WTO negotiations and the EU enlargement towards Middle and Eastern Europe. It is quite likely that respective CAP adjustments, recently expressed by the Commission in the *Agenda 2000*, will lead to a higher degree of liberalization for European agriculture and to product prices to world market level accordingly. In most cases this implies

decreasing product prices (milk, beef, cereals). Assuming a decreasing price level for such important agricultural commodities in the future, the question arises if this might affect agricultural production systems and the intensity of input use in particular. Consequently, the corresponding negative environmental side effects of agriculture could be reduced this way. In order to estimate the possible scope of intensity reductions, some effects of the CAP reform of 1992 will be described and conclusions will be drawn, to which extent further price cuts might affect the input use in agriculture, the profile of plant production systems or even animal stocking rates.

In spite of the fact that the CAP reform of 1992 has lead to a 30 % reduction in grain prices and to a 50 % reduction in oil seed prices respectively, the effects on input use as well as on agricultural pollution in general have been regarded to be quite limited (BAUER 1994; VAN DER WEIJDEN 1995). A main reason for this is that livestock production (apart from beef) has not been affected by the CAP reform significantly (BROUWER & VAN BERKUM 1996). Already during the implementation of the CAP reform, such qualitative estimations have been supported by quantitative results which were obtained by modell calculations (DOLUSCHITZ 1992, LIAPIS 1994). These estimates are confirmed by empirical results obtained after the implementation of CAP reform. For Germany it is reported that the effects of the CAP reform on crop rotation as well as on fertilizer and pesticide use are clearly limited, considering the conventionally farmed UAA without set-aside (ZIMMERMANN & ZEDDIES 1995, STOYKE 1995, STOYKE & WAIBEL 1997). No remarkable adaptations were observed for land use patterns (STOYKE & WAIBEL 1997). So it can be concluded that the CAP reform of 1992 has not lead to significant positive environmental effects, yet.

The experience from the 1992 CAP reform allows the conclusion that the change of economic frame conditions in the near future will not induce a significant change towards production systems, which have a considerably better ecological performance. This is in particular the case because (1) input decisions in response to changing price relations are quite inelastic, (2) in arable farming the relations between product prices and input prices (N-fertilizers, pesticides) have stayed nearly constant in the last 10 years and will probably do the same in the near future and (3) livestock densities in the EU will only be affected indirectly or to a limited extent by further deregulations of agricultural markets. So it can be concluded that the ecological requirements and the public pressure to introduce targeted environmental instruments aiming towards a change of agricultural production systems will not only remain, but even increase.

Restricting the fertilizer use or limiting the nutrient balance surplus?

The reduction of nutrient emissions from agricultural production will remain one of the most urgent issues of environmental protection in future (BONDE 1994; SRU 1996). In spite of the introduction of measures, which are in line with the objectives of already existing regulations like the EU Nitrate Directive, further-reaching instruments could be considered therefore. The main reason for this assumption is the fact that existing instruments have had only a limited impact up to now. For example, the Nitrate Directive only sets a quantitative limit for nutrient application from livestock production (170 kgN/ha). This means the restriction of organic nutrient use is only an approximation in order to reduce water pollution by nutrient emissions from agricultural sources. Mineral fertilizers are excluded, but in the long run it is quite likely that the total potential nutrient emission might be used as an approximation for the nutrient immission into eco-systems. Consequently, the reduction of nutrient balance surpluses at the farm or regional level would be a more general and appropriate objective. This objective

would contribute to both, water and atmosphere protection. Then the total balance surplus (i. e. without substraction of mineral losses of ammonia) should be considered as an environmental pressure indicator.

Possible approaches to reducing surpluses of nutrient balances might be a command-and-control strategy or imposing a tax on the surplus that exceeds a defined limit. Comparable to the actual Nitrate Directive, livestock production would be affected much more than arable farming. For example, in the Netherlands levies on exceeding nutrient surpluses have been implemented in the meantime in order to meet the objectives of the Nitrate Directive (AGRA-EUROPE 51/95, 19/96 and 32/96). If measures to restrict nutrient surpluses could be implemented successfully, the impact on agriculture would depend on the level of surpluses as well as on their distribution among regions and farming types. In the following section, nutrient balances in the EU are presented and possible approaches and consequences of surplus restrictions are discussed. Because of its outstanding importance only nitrogen balances are considered. Nevertheless, the general conclusions also apply to phosphate and potassium, too.

Level of nitrogen balances in the EU

In Table 2 nitrogen balances are presented for EU member states and the EU 12 in order to give an impression of the pollution potential from agricultural nutrient sources. The N-balance gross surplus is calculated as the average ‚farm gate' difference in kgN/ha UAA between the production-related input (purchase of fertilizer + manure production) and the uptake by crops. Because the data base refers to 1990/91 the figures for fertilizer purchase might be over-estimated whereas those for nitrogen from manure might be under-estimated under current conditions. Nevertheless, the N-balance surpluses probably still have the same level assuming the uptake by crops has not significantly changed since 1991. The fact that only the EU 12 is considered creates no problems because the three missing countries (Austria, Finland and Sweden) do not have significant problems with nitrogen surpluses (BONDE 1994). These new member states will be quite capable to compete with possible future restrictions on nutrient surpluses.

At the EU level the average nitrogen balance surplus amounts to 78 kgN/ha, resulting from a production related input of 159 kgN/ha (86 kgN/ha mineral fertilizer plus 73 kgN/ha from animal production) and 82 kgN/ha as uptake by crops. These average figures at the EU level are quite misleading considering the variation between member states: The production related input varies between 71 kgN/ha (Portugal) and 561 kgN/ha (Netherlands). Considering the uptake by crops, the respective N-surpluses amount to 14 kgN/ha and 388 kgN/ha in Portugal and the Netherlands respectively (table 2). Especially countries with a surplus of more than 100 kgN/ha, i. e. Belgium, Denmark, Germany, Luxemburg and the Netherlands will have severe problems facing future environmental measures targeted at the reduction of nutrient surpluses from agricultural sources.

Table 2. Nitrogen balances by member state and EU average farm in 1990/91 (FADN)

Country	production related input			uptake by	nitrogen balance surplus	
	purchase of fertilizer	manure production	Total	crops		
	(kg N/ha)	(kg N/ha)	(kg N/ha)	(kg N/ha)	(kg N/ha)	(% of manure production)
Belgium	163	196	359	163	196	100
Denmark	142	109	252	123	129	118
Germany	128	98	226	106	119	121
Greece	46	64	111	53	58	91
Spain	38	40	77	53	25	63
France	98	62	160	85	75	121
Ireland	60	93	152	72	81	87
Italy	46	55	101	78	23	42
Luxemburg	128	128	256	124	132	103
Netherlands	218	343	561	173	388	113
Portugal	32	40	71	57	14	35
UK	92	68	160	96	64	94
EU 12	86	73	159	82	78	107

1) Gross surplus without consideration of mineral losses of ammonia, i. e. total pollution potential to water and atmosphere. The difference due to mineral losses of ammonia amounts to 7 kg N/ha at EU level with a minimum value of 2 kg N/ha in France and Germany respectively and 67 kg N/ha in the Netherlands.
Source: BROUWER et al. (1995) and own calculations

It obviously turns out that the level of the N-balance surplus is strongly determined by the level of animal manure production. Apart from a few member states with quite low average livestock densities (Italy, Portugal and Spain) in all other countries the N-balance surplus shows roughly the same level (kgN/ha) as the nitrogen from animal production. This applies not only to high levels but also to medium levels of livestock densities. Expressed in percent of the nitrogen from animal production, the N-balance surplus varies in these cases between 87 % (Ireland) and 121 % (France and Germany). At the EU level the N-balance surplus amounts to 107 % of the nitrogen from livestock production (table 2 and figure 1). Consequently, a nutrient amount which is roughly equivalent to the whole nitrogen output from livestock production becomes an emmission into soil, water and atmosphere.

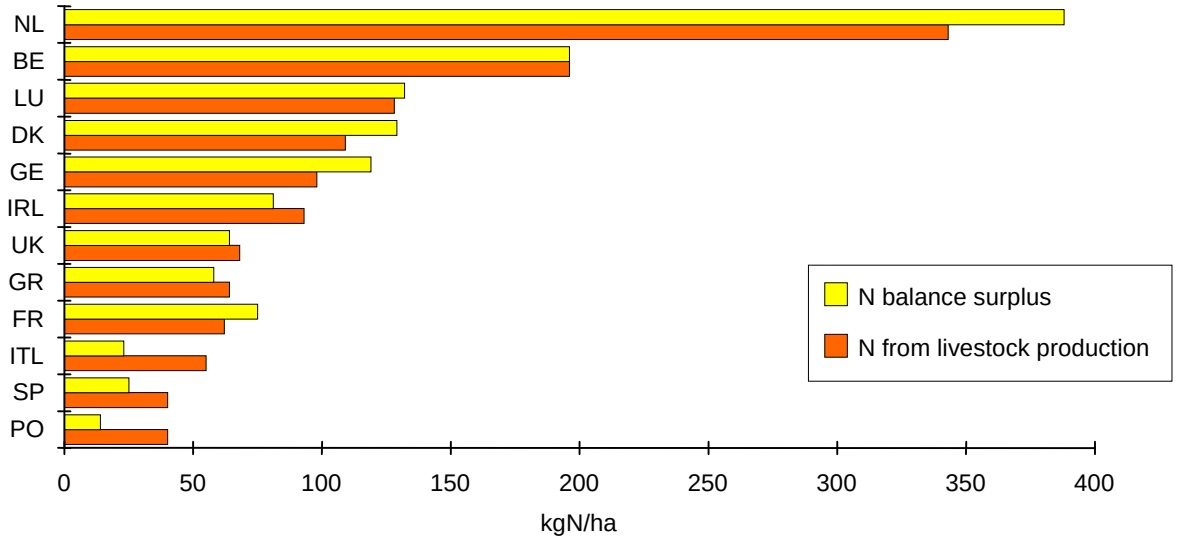

Figure 1. Nitrogen balance surplus and nitrogen from livestock production in kg N/ha, EU average farm in 1990/91 (FADN)

Source: own compilation according to BROUWER et al. (1995)

These findings are supported by data which have been reported by DE BOO (1991, cit. in WILLIAMS 1994). According to calculations of this author only 40 % (i. e. about 3.6 million tons N) of the total nitrogen production from livestock in the EU 12 (i. e. about 9 million te) is available for spreading. Only 20 % of this organic N-fertilization is effectively utilized by crops (i. e. 0.7 million tons N or 8 % of the total nitrogen production from livestock). Consequently, one can draw the conclusion that nitrogen from animal production is only utilized by crops to a minimum share. This is a matter of both the availability for spreading as well as the fact that organic fertilizers normally are taken less into account than mineral fertilizers, i. e. that the nutrient content is often underestimated in arable farming. Especially in regions and farming systems with high livestock densities, animal manure is even more or less treated as ‚waste' and not as a production input. In economic terms, the decision as to how to handle manure is not a question of efficient input use but of minimizing costs of waste mangement.

Because of the latter aspect the variation of the average N-surpluses is even higher within some member states than the variation among member states. At least the variation is determined by the distribution of farming types. According to FADN-data in cereal farms, the average N-balance surplus is quite low (about 30 kgN/ha), showing a small variation among farms and between member states. The N-balance surpluses are high in dairy farms (in average about 110 kgN/ha) and they show extremely high levels in granivore farms (in average about 700 kgN/ha). In both cases, diverse patterns and a high variation among farms and between member states can be observed (BROUWER et al. 1995).

Options for policy measures and possibilities of farm adjustment

In order to reduce nutrient surpluses from agricultural sources, different measures could be implemented in the future, but in any case livestock production will be the entry point. Three

options for targeted measures to reduce nutrient surpluses will probably be most important (listed according to the degree of restriction):

1. increasing the nutrient efficiency in livestock production by using specially adapted feeding stuff, i.e. reducing the manure production per unit output of meat, milk or eggs
2. transfer of nutrients from problem regions into regions with low livestock densities, i.e. regions where arable farming allows a more efficient use of nutrients from animal manure
3. reducing livestock densities in problem regions, i. e. in regions with significant nutrient surpluses

The necessary adjustments at the farm level could be induced by ´command-and-control‘ strategies or by economic incentives like taxing nutrient surpluses which exceed a defined limit.

The three options mentioned could have different implications for the interaction with arable farming, i. e. the substitution of mineral fertilizers. Options (1) and/or (3) are quite unlikely to have implications for mineral fertilizer use, because the reduction of nutrient output from livestock means a reduction of ‚waste output‘ and not of ‚nutrient supply‘ in regions with high livestock densities. In the case of approach (2) nutrient substitution could be possible in nutrient importing regions.

The question, if a regional transfer of nutrients (option 2) might be a realistic approach to meeting the ecological objectives depends on the price of mineral fertilizers as well as on the transaction and transport costs per nutrient unit, given that all other determining factors are constant. At the present time no reliable quantitative forecasts are possible, but for two reasons it is quite unlikely that a regional nutrient transfer of significant quantities is going to happen in the future without strict regulations or effective economic incentives. The first reason is the high degree of concentration in livestock production (pigs, poultry) which in return causes high costs to shift manure over long distances. The second reason is the low price level for mineral nutrients compared to the costs of an efficient use of organic nutrients.

Assuming that in the future in spite of the facts mentioned above some nutrient quantities will be transfered from ‚surplus regions‘ to ‚deficit regions‘, it is still questionable whether significant quantities of mineral fertilizer nutrients will be substituted by organic nutrients to a large extent. For agronomic reasons this applies in particular to nitrogen and not to phosphate and potassium. The nutrient importing farmers will charge the nutrient exporting farmers for the manure they use in arable farming, but nevertheless it is unlikely that they will adjust their use of mineral fertilizer to the same extent that they will import organic nitrogen. This input decision is probably a matter of risk assessment (SHORTLE & DUNN 1986; HALBERG et al. 1994): Given low mineral fertilizer prices the use of organic N is taken into account only very hesitantly. Consequently, balance surpluses remain high.

Lastly it turns out that nutrient surpluses can only be reduced substantially by policy measures that lead to a structural change in the livestock sector. Even a significant decentralization could be necessary for some problem regions. This strategy should be supported by other policy options like subsidising technical progress that is targeted at an increase of feeding stuff efficiency and imposing a tax on mineral nitrogen. Anyway, the crucial question remains if policy makers are really convinced of the necessity ‚to change something‘ or in case they are if they are willing to get through the conflicts with the respective interest groups.

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