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MINERAL BALANCES AT FARM LEVEL IN THE EUROPEAN UNION

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Agricultural Economics Research Institute (LEI-DLO)

ABSTRACT

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Mineral balances are assessed at farm level in the European Union. In addition, an assessment is made of the distribution of nitrogen surpluses among farms in EUR 12. They are based on the 1990/91 sample of the Farm Accountancy Data Network (FADN) of the European Commission. Additional data have been obtained from experts in Member States. Nitrogen surplus increases with the intensity of agricultural production. Mineral surpluses vary largely across groups of farms in the European Union because of the differences in farm structure and input use. Stocking density of livestock population and the intensity of crop production are crucial elements to be considered.

The supply of animal manure in EUR 12 exceeds 170 kg N per ha on approximately 13% of the number of holdings represented by FADN. This is the equivalent of almost 600,000 holdings. An improvement needs to be achieved in the treatment of animal manure at holdings with a supply of animal manure which exceeds 170 kg of nitrogen per ha. Manure production at the group of holdings that exceed standards on the application of animal manure, as formulated in the Nitrate Directive, is about five times that of the average of all farms across EUR 12.

A series of recommendations is formulated in order to contribute to the objectives of the Nitrate Directive. This series focuses on keeping records of critical indicators in the framework of existing databases. Also, suggestions are made for improvements in the tools available to quantify mineral balances at farm level.

Mineral balance/Agriculture/Environment/Nitrogen/Nitrate Directive/Farm level

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CONTENTS

PREFACE

The present report is a contribution to the study 'Standards on nitrate in the European Community: Processes of change in policy instruments and agriculture'. The overall objective of the study is to identify (i) policy instruments to reduce nitrate levels in drinking water, such that standards on the quality of drinking water are met; and (ii) processes of change in the agricultural sector of the European Community in response to policies. The study is partly funded by the Directorate-General for Science, Research and Development (DG XII) of the Commission of the European Communities (Environment Programme, Area III: Socio-economic Research) under contract EV5V-CT92-0155. This support is gratefully acknowledged.

The project is a joint collaboration of the (i) Landbouw-Economisch Instituut (LEI-IEA), Brussels, Belgium; (ii) Statens Jordbrugsøkonomiske Institut, Copenhagen, Denmark; (iii) Bundesforschungsanstalt für Landwirtschaft, Institut für Betriebswirtschaft (FAL), Braunschweig, Germany; (iv) Institut National de la Recherche Agronomique, Station d'Économie et Sociologie Rurales (INRA), Rennes, France; (v) Landbouw-Economisch Instituut (LEI-DLO), The Hague, the Netherlands; and (vi) University of Stirling, Economics Department, Scotland, United Kingdom. It started in 1993 and is scheduled for completion by Mid 1995. A supplementary agreement was also signed between the European Economic Community and LEI-DLO for the participation of Central and Eastern European institutions in this effort. Contributions from the Soil Fertility Research Institute (Slovakia), the Agricultural University Plovdiv (Plovdiv, Bulgaria), the National Food and Nutrition Institute (Warsaw, Poland) and the University of Ljubljana (Ljubljana, Slovenia) will be published as separate documents.

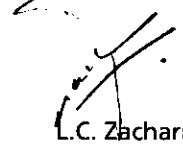
The present report first focuses on the quantification at farm level of mineral inputs to agriculture and the amount of mineral surpluses which result from farming. Also an assessment is made of structural characteristics of farms that are close to meeting the standards of nitrate in drinking water.

Comments on a draft version of the report were obtained by the partners in the study, including B.S. Frederiksen, W. Kleinhanss, L. Lauwers, D. Parsisson, P. Rainelli, S. Rude, K.-H. Schleef and C. Spash. The numerous comments received and useful suggestions made, are gratefully acknowledged.

Comments on a draft version of the report were also received from W.H.M. Baltussen and K.J. Poppe (both from LEI-DLO). These comments are acknowledged as well. A draft version of the report was also reviewed by D. Leuck (United States Department of Agriculture, Economic Research Service, Washington) and A.J. Oskam (Department of Agricultural Economics,

Wageningen Agricultural University, the Netherlands). We highly appreciate the important remarks made on the report and the many suggestions given.

The Director,



The Hague, September 1995

L.C. Zachariasse

SUMMARY

Objective of the study

The report is to investigate to what extent nitrogen surplus varies across groups of farms. This is based on the hypothesis that nitrogen surplus increases with the intensity of agricultural production. Stocking density of livestock population as well as the intensity of crop production are considered to be crucial in the identification of farm characteristics which affect levels of nitrogen surplus. Various farming types as well as structural characteristics of farms therefore need to be considered in an assessment of the distribution of nitrogen surplus among farms. The farming types considered include cereal farms, general cropping farms, dairy farms, drystock farms, granivore farms and mixed farms.

The availability of information

Mineral balances at farm level are based on the 1990/91 sample of the Farm Accountancy Data Network (FADN) of the European Commission. The sample includes 58,450 farms which in total represent 4.4 million farms in the EU. Mineral balances are available for all farms of the sample, and are based on individual FADN data. It should be mentioned that the report only provides results of averages of at least fifteen farms. Results are not presented in the report in case the size of the sample was insufficient (less than fifteen farms) to provide reliable estimations. Manure production estimates are derived from coefficients on the excretion of minerals from livestock. These coefficients are obtained from experts in various Member States. Data on mineral requirements and mineral uptake to grow crops also are obtained from experts in the European Union.

Approach used

Mineral balances in the report are based on the so-called surface balance approach. It reflects the application and treatment of minerals on the field. Another approach would have been the farm gate balance approach. This approach reflects the amount of minerals which enter or leave the farm.

Both methods should provide the same results if measured at a regional level. Differences mainly arise in case transport of animal manure is considered. This happens to be the case primarily in granivore farms. The surface balance approach was chosen because no detailed information is

available at farm level on the treatment of animal manure in the European Union, nor that of the amount of minerals in feed concentrates.

A distinction is made in the report between so-called gross nitrogen surpluses and net nitrogen surpluses. Gross nitrogen surplus equals the total input of nitrogen available for crop growth from fertilizers and manure, minus the uptake by crops. The input component is limited to minerals from agricultural sources. Losses of minerals by the emissions of ammonia are not taken into account. The calculation of net nitrogen surpluses includes all nitrogen available and also assumes that part of animal manure is emitted to the air by emissions of ammonia. It is recommended to assess net nitrogen surpluses because they are more appropriate towards the identification of the potential of leaching to soils than gross nitrogen surpluses do.

Mineral surplus across the EU

Net nitrogen surplus in the European Union varies across Member States between 6 kg/ha (Portugal) and 321 kg/ha (the Netherlands). Net nitrogen surplus in EUR 12 is 71 kg/ha. Relative differences among countries regarding the production of animal manure are bigger than those regarding the input from inorganic fertilizers. The input of fertilizers varies between 32 (Portugal) and 218 kg/ha (the Netherlands). The supply of nitrogen from animal manure shows a larger variation and varies between 40 (Spain and Portugal) and 343 kg/ha (the Netherlands). Manure production levels exceed the purchase of nitrogen fertilizers in Belgium, Greece, Spain, Ireland, Italy, the Netherlands and Portugal. Purchase of fertilizers of the average of all farms in EUR 12 (86 kg/ha) is slightly above the production of nitrogen from manure (73 kg/ha).

Net nitrogen surplus across Member States exceeds the average of EUR 12 in Belgium, Denmark, Germany, France, Luxembourg and the Netherlands. Phosphate surplus in these countries also exceeds the average of EUR 12, with the exception of Denmark.

Mineral surplus across farming types

Nitrogen surpluses differ largely among farming types identified. Differences across Member States are also large for the six farming types distinguished. Major determinants of such differences are livestock composition and cropping plan as well as the intensity of farming practice. The stocking rate of animals (number of livestock units per ha UAA) and the yields of crop production reflect the intensity of farming. Such differences also explain to a large extent the differences among Member States for specific farming types. Management characteristics of individual farms (i.e. ways of treating animal manure) are likely to be important as well, but these cannot be identified in the approach used. Net nitrogen surplus in EUR 12 at cereal farms, general cropping farms and drystock farms is below the average of all farms represented by the sample (70 kg/ha). Surplus is highest at granivore farms (690 kg/ha). Net nitrogen surplus of dairy farms and mixed farms on

Table 1 Nitrogen balance (kg N/ha) of the average farm in 1990/91

Country/region	Nitrogen balance					
	deposition from the atmosphere	production-related input			uptake by crops	net surplus
		purchase of fertilizer	manure production	total		
Belgium	33	163	196	359	163	170
Denmark	18	142	109	252	123	114
Germany	31	128	98	226	106	121
Nordrhein-Westfalen	38	132	113	244	107	141
Rheinland-Pfalz	26	119	61	180	94	94
Greece	7	46	64	111	53	46
Spain	6	38	40	77	53	19
Galicia	7	57	166	223	112	68
Extremadura	7	37	16	53	51	4
France	17	98	62	160	85	73
Bretagne	17	108	149	257	97	133
Limousin	11	19	76	95	73	10
Ireland	10	60	93	152	72	63
Italy	12	46	55	101	78	18
Lombardia	23	87	137	224	114	92
Sicilia	4	25	25	49	66	-20
Luxembourg	27	128	128	256	124	121
Netherlands	36	218	343	561	173	321
Portugal	4	32	40	71	57	6
United Kingdom	16	92	68	160	96	59
England West	20	93	98	191	100	81
Scotland	7	58	39	97	65	27
EUR 12 a)	16	86	73	159	82	71

a) Average of all represented farms in the EU.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

average is slightly above the average of all farms in EUR 12. Net nitrogen surplus at granivore farms on average is more than tenfold that of the average of cereal farms, general cropping farms and drystock farms in EUR 12.

Production of animal manure

According to the EC Nitrate Directive the application of animal manure should not exceed 170 kg/ha (including manure from grazing livestock). This is to be achieved under the Nitrate Directive in zones which are identified to be vulnerable for leaching of nitrate. Supply of animal manure in EUR 12 exceeds 170 kg N per ha on approximately 13% of the number of holdings represented by the FADN. This is the equivalent of almost 600,000 holdings.

Table 2 Number of farms represented by FADN and farms with production levels of animal manure exceeding 170 kg of nitrogen per ha, by Member State in 1990/91

Country	Number of farms represented (x 1,000)	Average production of animal manure (kg N/ha)	Farms with nitrogen from manure > 170 kg/ha	
			share of total number of farms (%)	average production (kg N/ha)
Belgium	51.9	196	47	327
Denmark	81.0	109	26	258
Germany	373.9	98	12	207
Greece	498.3	64	15	557
Spain	690.6	40	19	723
France	556.7	62	6	309
Ireland	140.2	93	8	225
Italy	1,369.8	55	6	361
Luxembourg	2.3	128	11	197
Netherlands	94.0	343	63	501
Portugal	448.5	40	18	357
United Kingdom	141.6	68	17	258
EUR 12	4,448.9	73	13	352

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

The production of animal manure in EUR 12 at the group of holdings with an excess of nitrogen from animal manure on average amounts to 350 kg per ha. This is about five times of the average of all farms across EUR 12.

Differences among Member States are large on the number of farms that produce more than 170 kg N/ha. The share of the number of farms with excess of nitrogen from animal manure in total number of farms is lowest in France, Ireland and Italy (less than 10%) and highest in Belgium (47%) and the Netherlands (63%). Important phenomena in this respect are differences in animal density and the large share of livestock production in total agricultural output. The production of manure on the group of farms which produce more than 170 kg/ha, on average is more than double their national averages in all Member States except Belgium, Luxembourg and the Netherlands. The production of nitrogen from animal manure at Member State level exceeds 170 kg/ha in Belgium and the Netherlands. This means that these countries are unable to meet the Directive according to present farming practice (e.g. inputs used, cropping plan and livestock population).

Several responses are to be expected by farmers to meet the requirements of the Nitrate Directive:

- farming practice needs to be adjusted at farms with a production of animal manure which exceeds 170 kg N/ha. Such farms have to treat animal manure in a more efficient way. The application of animal manure at other farms will most likely gain importance. Costs of transport

of animal manure will become increasingly important as a production factor;

- arable farms may play an important role under this Directive through the substitution of inorganic fertilizers by organic manure. Substitution rates used are considered to reflect actual farmers' behaviour. They may increase by allowing for higher application levels of animal manure at the expense of mineral fertilizers. The treatment of animal manure could be improved by application during the period of crop growth.

Recommendations

Nitrate levels in groundwater need to be reduced in the European Union, and a strict application of the Nitrate Directive (Council Directive 676/91) is one of the actions to achieve that. A major target up to the year 2000 formulated in the Fifth Environmental Action Programme 'Towards Sustainability' is to achieve a standstill or reduction of nitrate levels in groundwater. Some recommendations are formulated to contribute to the objectives of the Nitrate Directive. Several of them focus on keeping records of critical indicators in the framework of existing databases.

Knowledge on the amount of minerals in animal manure is not sufficient for an assessment of leaching losses to the environment. Mineral balances are more appropriate in that respect, including both inflow and outflow elements. It is therefore recommended to assess net nitrogen surplus at farm level because this indicator is more appropriate towards the identification of the potential of leaching to soils than gross nitrogen surplus is.

Differences across Member States are large regarding the mineral content of animal manure. It is recommended to harmonize these coefficients to allow for assessments of manure production levels and their mineral content, according to harmonized procedures and accounting rules. This is required to support monitoring of progress by the agricultural sector in meeting requirements of the Nitrate Directive.

1. INTRODUCTION

1.1 Statement of concern

The notion of deterioration of the environment due to leaching losses of minerals is gaining increasing public concern. The agricultural sector is one of the main contributors to the pollution of water, primarily from pesticides and nitrate (CEC, 1992). The quality of water is one of the most important environmental issues in areas with a high density of livestock population. Nitrate levels of 50 mg/l (EU drinking water standard) and more may be expected in about 25% of the agricultural soils in the EU, particularly in the Netherlands, Denmark, Belgium, Germany, the southern part of the United Kingdom, the Po Valley area in Italy and western France (RIVM and RIZA, 1991). This is due to either the high surplus of nitrogen from agriculture or due to vulnerability of the soil to leaching, or a combination of these two phenomena. Major adjustment processes are required in EU agriculture to reduce leaching of minerals and meet the standards of nitrate. A Directive concerning the protection of waters against pollution caused by nitrates from agricultural sources was issued by the Council in December 1991 (91/676/EEC). Policies are being formulated in several Member States in order to reduce pollution of groundwater (nitrates), surface water (eutrophication by excessive use of nitrogen and phosphate fertilizers) and the atmosphere (emissions of ammonia) (see also Rude and Frederiksen, 1994 for a review of nitrate policies in 7 Member States).

The report investigates to what extent nitrogen surplus varies across groups of farms. This is based on the hypothesis that nitrogen surplus increases with the intensity of agricultural production. Stocking density of livestock population as well as the intensity of crop production are considered to be crucial in the identification of farm characteristics which affect levels of nitrogen surplus. Various farming types as well as structural characteristics of farms therefore need to be considered in an assessment of the distribution of nitrogen surplus among farms.

Nitrogen surplus may affect the environment by denitrification or by leaching losses to water. The relationship between nitrogen surplus and the actual leaching of nitrate is not direct, but also depends on climatic and soil conditions. The balances are identified at farm level since the available options to contribute to a reduction of mineral surpluses primarily remain there.

1.2 Objective of the report

The objective of the present report is firstly to assess mineral flows at farm level in the European Union (EU). Mineral balances in agriculture include input (e.g. manure and fertilizers) as well as output components (e.g. uptake by crops). They are also linked to structural characteristics of farms (including livestock density and livestock composition, as well as cropping plan) since such factors are considered to largely affect mineral surpluses. The report is therefore also aimed at investigating links between mineral surpluses and structural characteristics of farms and the use of inputs at farm level across the European Union. This kind of information will provide insight in the kind of adjustment processes which may contribute to a reduction of nitrogen surplus at farm level and a subsequent reduction of nitrate leaching. Information on structural characteristics will likely provide insights into adjustment processes at farms with a considerable size of utilized agricultural area (e.g. general cropping farms and dairy farms). This approach might be less suitable for making conclusions on adjustment processes at granivore farms because of manure disposal outside the farm and different feeding systems. Links are made with indicators of farm output to examine the efficiency of treating minerals in agriculture across the EU.

The report mainly focuses on surplus of nitrogen, its input and output components, and to a limited extent on surpluses of phosphate. Nitrogen is the principal indicator for action to be taken at farm level to reduce leaching of nitrate. The separate components of nitrogen balances are identified as well. Surplus of phosphate is described because of possible interdependencies which might arise in the environmental issues concerned. Phosphate surpluses in agriculture are assessed since policies to reduce nitrate in drinking water might have unfavourable or beneficial effects on other environmental issues. The separate components of the phosphate balance are not presented in the report.

1.3 Outline of the report

Mineral balances of so-called average farms are given in chapter 2 of the report. They reflect balances according to regional averages of the use of fertilizers, cropping pattern and livestock population. It allows a comparison of the mineral balances at regional level, according to the Farm Accountancy Data Network (FADN), with those presented in Schleef and Kleinhanss (1994). The information provided in this chapter is primarily limited to national averages. Nitrogen surplus for regions with highest and lowest surplus of nitrogen are also given for the relatively large Member States.

Mineral surpluses are considered to differ largely across farms in the European Union (EU), among others due to differences in farm structure and input use. Mineral balances of the major farming types are presented in chapter 3 of the report. These balances are averages of the balances of individual farms, weighted by the number of farms (including their area) repre-

sented by the sample. The farming types considered include cereal farms, general cropping farms, dairy farms, drystock farms, granivore farms and mixed farms (see also appendix 2 for a classification of the major farming types according to FADN). These six farming types include most of arable crops and livestock products. No assessments are presented for horticultural holdings, vineyards and permanent-crops holdings. These farming types are excluded because of the wide variety in crops on these farms. Mineral requirements of these crops have therefore not been quantified within the framework of the project. Some characteristics of farm structure are presented in chapter 3 to identify main determinants of mineral surplus at farm level.

Mineral surpluses may also differ largely across individual farms within the farming types considered. This is to be considered because of differences in stocking density and in intensity of crop production. The distribution among farms in their mineral surplus is given by farming type in chapter 4 of the report. Nitrogen surplus of a group of farms with lowest surplus is compared with that of a group of farms with highest nitrogen surplus. Data are presented by Member State as well as for regions with high surpluses.

Some characteristics of farm structure and farm output of groups of farms with high and those with low surpluses of nitrogen are given in chapters 5 to 7 of the report. These chapters successively focus on general cropping farms (chapter 5), dairy farms (chapter 6) and granivore farms (chapter 7). The structure (i.e. animal density, cropping plan) and output achieved (from crop and/or livestock) of farms with a high surplus of nitrogen is compared to those with a low surplus of nitrogen. The information presented provides the basic elements of farm characteristics which are critical to the identification of mineral surpluses. Correlation coefficients between net nitrogen surplus and general variables of farms are presented.

The identification of mineral surpluses and its major determinants is aimed at contributing to the understanding of options to reduce leaching of nitrate at farm level, and subsequently at meeting the objectives of the Nitrate Directive. One of the main elements of the Nitrate Directive is a standard on the application of animal manure in zones identified as vulnerable to leaching of nitrate. The number of farms with a production of animal manure exceeding 170 kg of nitrogen per ha is assessed in chapter 8 of the report. Some characteristics of these farms are also examined in that chapter.

Some concluding remarks with major findings of the study on mineral balances at farm level in the European Union are presented in chapter 9.

1.4 Method used

The concept of mineral balances at farm level, used in the report, is based on the so-called surface balance approach. The input factors of surface balances of nitrogen include production-related input of nitrogen and deposition from the atmosphere. Production-related input of minerals in-

cludes (i) minerals provided by purchase of fertilizers and manure and (ii) minerals from production of animal manure. The output factor includes uptake of nitrogen from harvested crops. The assessments are based on the elaborations by FAL to assess mineral balances at the regional level (Schleef and Kleinhanss, 1994). The model used to quantify mineral balances is described in appendix 4 of the report.

Another approach to calculate mineral balances would have been the so-called farm gate balance. The criterion for the identification of input and output factors of that approach is minerals entering or leaving the farm. The input of nitrogen includes deposition from the atmosphere, purchase of fertilizers, organic manure, (young) animals and feedingstuffs. The output of nitrogen includes livestock, livestock products and crop products sold, as well as animal manure that is transported and treated or applied elsewhere. The surface balance approach was chosen since the available data are more suitable to calculate this type of balance rather than farm gate balances. No detailed information is available yet on the treatment at farm level of animal manure in the European Union, nor that of the amount of minerals in feed concentrate. The coefficients used in the calculation of the nitrogen and phosphate balances are presented in appendix 5 of the report.

The surface balance approach reflects the application and treatment of minerals on the field. Contrary to this, the farm gate approach reflects the minerals which enter or leave the gate of a farm. Both methods to assess nitrogen surpluses should provide the same results, if measured at a regional level. Differences arise in case transport of animal manure is considered. Differences are also likely to arise in case the mineral content of animal manure, feed concentrate, crop production and livestock production are based on normative figures.

Table 1.1 Nitrogen balance in the Netherlands in 1990 (in million kg N)

Farm gate balance approach		Surface balance approach	
Input		Input	
- Mineral fertilizers	443	- Mineral fertilizers	443
- Feed concentrates	484	- Animal manure	617
- Deposition	71	- Deposition	71
Total input	998	Total input	1,131
Output		Uptake	
- Arable crops	94	- Arable crops	94
- Livestock production	186	- Forage crops	318
Total output	280	Total uptake	412
Surplus (input - output)	718	Surplus (input - uptake)	719

Source: Brouwer and Veenendaal, 1992.

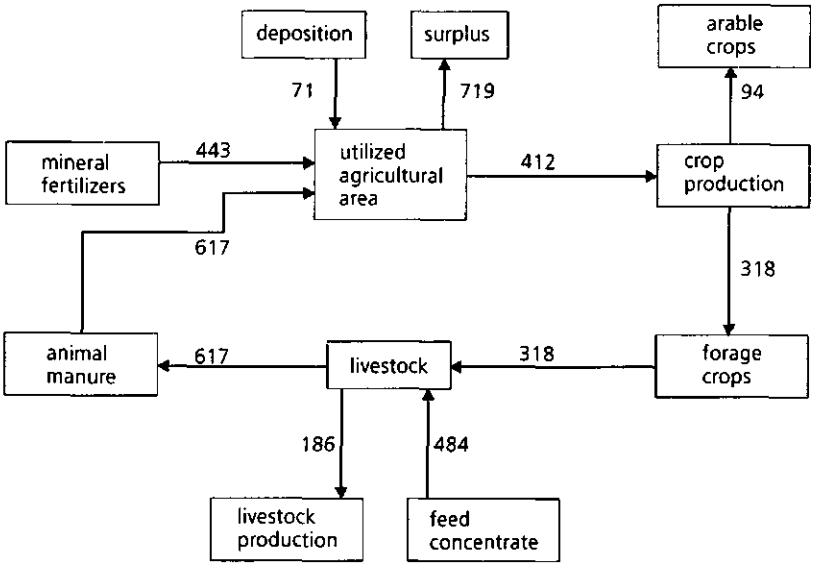


Figure 1.1 Nitrogen flows in the agricultural sector in the Netherlands in 1990 (in million kg N)
Source: Brouwer and Veenendaal, 1992.

A simplified version of nitrogen flows through the agricultural sector in the Netherlands is provided in figure 1.1. This figure also allows for the assessment of nitrogen surplus, based on the surface balance approach as well as the farm gate balance approach (table 1.1). Surpluses do not differ among the two approaches, because all animal manure is considered to be applied on the total of utilized agricultural area.

A distinction will be made in this report among two types of nitrogen balances:

1. gross nitrogen surplus. It is defined as the production-related input of nitrogen (manure production and purchase of fertilizers and manure) minus the uptake by crops. This balance reflects surplus of nitrogen from agricultural production;
2. net nitrogen surplus. It is defined as the total supply of nitrogen from inorganic fertilizers, production of manure and deposition from the atmosphere, reduced by the uptake of harvested crops and ammonia losses to the atmosphere. Losses of ammonia occur during storage and spreading. These are assumed to be 30% of total nitrogen from manure production. Net nitrogen surplus therefore equals the total of nitrogen by deposition from the atmosphere, purchase of fertilizers and manure, 70% of animal manure produced, minus uptake by harvested crops (see also Schleef and Kleinhanss, 1994; and appendix 4 of

the report for an investigation of the model to quantify the individual components of mineral balances).

Phosphate surplus is defined in a way similar to the gross nitrogen surplus.

The report focuses on the average of balances of individual farms, with the exception of chapter 2 of the report. A regional perspective of mineral balances is presented in that chapter to identify regions with high surpluses. Regional balances reflect the average farm in that area.

A difference exists regarding the definition of mineral inputs at the regional and farm level, which is due to transport of animal manure between farms. This is considered to be important for the interpretation of results. Production-related input at the regional level does only include purchase of inorganic fertilizers and production of manure. Transport of manure among the regions considered in the analysis is likely to be of marginal importance, if at all. However, if balances are identified at farm level, the production-related input of nitrogen does likely include purchase of fertilizers as well as purchase of manure. Cereal farms for example, may apply a combination of fertilizers and manure. Both components of production related input originate from outside the farm. Total production-related input of nitrogen at farm level therefore is composed of the purchase of fertilizers and manure, and of manure produced at the farm. A large share of manure produced on mainly granivore farms is applied elsewhere. The notion of manure which is applied elsewhere implies that the regional average of nitrogen surplus among all farms represented by the sample is higher than nitrogen surplus at the average farm in a region. This phenomenon can be explained by an investigation of the treatment of animal manure at granivore farms and at general cropping farms. The supply of animal manure at granivore farms contributes to mineral surpluses, irrespective of the fact that part of it may be applied at general cropping farms. Purchases of fertilizers at that farming type also contribute to mineral surpluses.

Mineral balances and their components are presented in the report in kg per ha unless otherwise stated. The denominator is based on the area of arable crops and grass. This area is considered to be available for the application of manure. The area does not include permanent crops. The mineral balance components may reach very high values in case the area of arable crops and grass is small (or might even be zero for some farms) 1). The assumption was made that the area of fodder maize equals 0.001 ha in case the area of arable crops and grass is zero. The total utilized agricultural area (UAA), including arable crops, permanent grass and permanent crops, is only used in the report if it is explicitly stated.

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1) The area of arable crops and permanent grass includes field crops, market gardening and flowers, forage crops and other arable crops (see also appendix 4 of the report for the definition of variables used in the model).

1.5 Data source used

Mineral balances at farm level are based on the 1990/91 sample of the Farm Accountancy Data Network (FADN) of the European Commission. The sample includes 58,450 farms which in total represent 4.4 million farms in the EU. Mineral balances at farm level are available for all six farming types selected from the sample, and are based on individual FADN data. It should be mentioned that the report only provides results of averages of at least fifteen farms. Results are not presented in the report in case the size of the sample was insufficient (less than fifteen farms) to provide reliable estimations.

FADN contains farm level data on the structure of the farm (economic size, agricultural area and livestock population), total output, intermediate consumption, a balance sheet account and a profit and loss account. The coefficients used to convert species and classes of livestock to livestock units (LU) are described in appendix 3 of the report. FADN is based on the annual accounting results for a sample of commercial farms in the EU Member States. Commercial farms refer to farms which are large enough to provide a main activity for the farmer and a level of income sufficient to support the farmer's family (CEC, 1989: 4). Farms are classified as 'commercial' when they exceed a minimum economic size, measured in European Size Units (ESU). Because of the different farm structures in the Union, the thresholds applied for the economic size of farms vary among Member States. The farms in the sample are rather heterogeneous. FADN stratifies farms according to region, economic size and farming type to reflect this heterogeneity adequately. FADN distinguishes 91 regions in the EU. In this study a division of the EU into 87 regions has been used 1). This division is more or less equal to the FADN division and is given in appendix 1 of the report. It needs to be mentioned that the Neue Bundesländer in Germany have not been included in the analysis, nor Member States which entered the Union in 1995.

Yields of field crops are available in FADN, which allows to use this type of information to assess mineral balances at farm level. Yields have been used from FADN to quantify mineral requirements at farm level for the most important field crops. Regional averages of yields of field crops however have been used in case this information was not available on farm level. Yields of forage crops originate from external sources, and are described in Schleef and Kleinhanss (1994) (see also appendix 7). This was done because of the difficulties which might arise on the interpretation of yields of forage crops, provided by FADN. FADN does not provide yields of forage crops in the northern Member States and extreme differences arise with yields of forage crops in several of the southern Member States.

Manure production estimates have been derived from coefficients on the excretion of minerals from livestock. These coefficients have been ob-

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1) English translation is used to identify Member States and regions are named according to their NUTS nomenclature.

tained from experts in various Member States. Data on mineral requirements and mineral uptake to grow crops also are obtained from experts in he European Union (see also appendix 5).

1.6 Representativeness of FADN data

To assess to what extent FADN is representative for all EU farms, a comparison between the population of farms in FADN and the Farm Structure Survey (FSS) has been made. Although farms below a certain limit, which differs among Member States, are not included in the FSS, it is nevertheless the most complete statistical source on agricultural structures at EU level. In 1990/91 4.4 million agricultural holdings in the EU were represented in FADN, 58,000 of which are in the sample. These 4.4 million farms match about half of the number of farms which participate in the FSS of 1987 (see table 1.2). Among Member States there are large differences in the representativeness of FADN. It varies from 93% in Denmark to 39% in Spain. Representativeness in the Netherlands, Portugal and Ireland is about 70%.

Table 1.2 Number of farms, utilized agricultural area and area arable crops and grass in FADN (1990/91), FSS (1987) and REGIO (1987-1989), by Member State

	Number of farms (x 1,000)		Utilized agricultural area (x mln ha)			Area arable crops and permanent grass (x mln ha)		
	repre-sented in FADN	in FSS	FADN	FSS	REGIO	FADN	FSS	REGIO
Belgium	52	93	1.3	1.4	1.4	1.3	1.4	1.4
Denmark	81	87	2.8	2.8	2.8	2.8	2.8	2.8
Germany	374	705	10.8	11.8	11.9	10.7	11.6	11.7
Greece	498	953	3.2	3.8	3.9	2.3	2.8	.
Spain	691	1,792	15.2	24.8	27.1	12.8	20.4	22.3
France	557	982	25.0	28.1	31.0	23.8	26.8	29.7
Ireland	140	217	4.9	4.9	5.7	4.9	4.9	5.7
Italy	1,370	2,784	12.7	15.5	17.6	10.4	12.6	13.9
Luxembourg	2	4	0.1	0.1	0.1	0.1	0.1	0.1
Netherlands	94	132	2.1	2.0	2.0	2.0	2.0	2.0
Portugal	449	636	5.3	3.3	4.9	4.5	2.5	3.9
United Kingdom	142	260	15.5	16.7	18.0	15.4	16.7	17.9
EUR 12	4,449	8,644	98.8	115.4	126.9	91.0	104.6	116.4

Sources: FADN-CCE-DG VI/A-3; adaptation LEI-DLO, Eurostat.

In all EU Member States the representation of the smaller farms in FADN is much lower than that of the larger farms. The 3.4 million farms which are smaller than 2 ESU, are hardly represented in FADN. This is one of the explanations of the low representativeness of Spain in the sample in

FADN. But apart from the fact that the representation of the farms in the small size classes is very small, it is also possible that the representation within the size classes in FADN diverges from the FSS.

The representativeness of the utilized agricultural area (UAA), the area arable crops and grass and the livestock population in FADN is much higher than the representativeness of number of farms. About 86% of the utilized agricultural area in FSS is represented in FADN (table 1.2). The representativeness is in the range between 61% in Spain and 159% in Portugal. In Italy and Greece it is about 80%, while it is between 90 and 100% in the other Member States. For the area arable crops and grass representativeness is like UAA.

Because in the regional mineral balances in the other part of this study (Schleef and Kleinhanss, 1994) data from the Eurostat databank REGIO were used, the representativeness of FADN is also related to REGIO for UAA, the area arable crops and grass and the livestock population. The area UAA in REGIO is some 10% larger than in FSS. Especially in Spain, France and Italy the utilized agricultural area in REGIO exceeds that in FSS.

The livestock population in FADN represents about 90% of the population in FSS (table 1.3). In Spain representativeness is much lower (65%), while it is about 80% in Greece and Italy. In the other Member States representativeness is more than 90%. In the composition of the livestock population there are remarkable differences between FADN and FSS in Greece, Italy and Portugal. In FADN the share of grazing livestock in the total livestock population is much larger than in FSS in these countries. In the total livestock population and its composition there hardly are any differences between REGIO and FSS.

Table 1.3 Livestock population in livestock units (LU) in FADN (1990/91), FSS (1987) and REGIO (1987-1989), by Member State

	Livestock population (in million LU)			Grazing livestock (%)			Pigs and poultry (%)		
	FADN	FSS	REGIO	FADN	FSS	REGIO	FADN	FSS	REGIO
Belgium	3.5	3.8	3.9	56	55	56	44	44	45
Denmark	4.2	3.9	4.0	39	40	.	60	60	58
Germany	16.1	17.3	17.5	62	60	60	38	39	36
Greece	1.9	2.4	2.8	94	72	78	5	22	21
Spain	7.4	11.3	11.8	57	55	55	42	42	47
France	21.2	22.6	22.3	74	72	75	26	27	23
Ireland	5.7	5.6	5.0	94	93	.	6	6	7
Italy	8.9	11.1	12.0	70	62	64	30	38	32
Luxembourg	0.2	0.2	0.2	91	89	88	9	10	10
Netherlands	7.6	8.0	8.0	48	45	46	52	55	51
Portugal	2.5	2.3	2.3	76	56	60	22	40	41
United Kingdom	14.4	15.6	14.7	81	77	78	19	23	22
EUR 12	93.5	104.2	104.5	69	65	67	31	34	33

Sources: FADN-CCE-DG VI/A-3; adaptation LEI-DLO, Eurostat.

2. MINERAL BALANCE AT REGIONAL LEVEL

2.1 Introduction

In this chapter, mineral balances are presented at the regional level (section 2.2). This allows for comparison with the regional averages based on REGIO, presented in Schleef and Kleinhanss (1994). The separate components of the nitrogen balance are published, as well as the surplus of phosphate. The results shown in this chapter are limited to national averages. Balances are also presented at regional level of the regions with high and low net nitrogen surpluses in the relatively large Member States. Some characteristics of the structure of farms represented by the sample of FADN are described (section 2.3). Animal density, livestock composition and cropping plan are given by Member State. Linkages among such characteristics and the mineral balances of the regions are made.

2.2 Mineral surplus across the EU

Net nitrogen surplus in the European Union varies across Member States between 6 kg/ha (Portugal) and 321 kg/ha (the Netherlands) (table 2.1) 1). Net nitrogen surplus in EUR 12 is 71 kg/ha. The two main input components of nitrogen in all Member States include nitrogen from purchase of fertilizers and nitrogen available from production of animal manure. Relative differences among countries regarding the production of animal manure are bigger than those regarding the input from inorganic fertilizers. The input of fertilizers varies between 32 (Portugal) and 218 kg/ha (the Netherlands). The supply of nitrogen from animal manure shows a larger variation and varies between 40 (Spain and Portugal) and 343 kg/ha (the Netherlands). Manure production levels exceed the purchase of nitrogen fertilizers in Belgium, Greece, Spain, Ireland, Italy, the Netherlands and Portugal. Purchase of fertilizers of the average of all farms in EUR 12 (86 kg/ha) is slightly above the production of nitrogen from manure (73 kg/ha).

Gross nitrogen surplus might be higher than net nitrogen surplus, depending on mineral losses of ammonia. It exceeds net nitrogen surplus in

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1) The assessments do not allow a quantification of mineral balances in EUR 12 in a way similar to the computation of national balances. This is due to the fact that the coefficients in the equations to assess excretion of minerals from livestock, mineral requirements and mineral uptake by crops are country specific. Nitrogen balance and phosphate surplus in EUR 12 are computed as the average of all represented farms in the EU.

Member States in which nitrogen losses from manure during storage and spreading exceed deposition levels from the atmosphere. Gross nitrogen surplus exceeds net nitrogen surplus in all Member States except Germany, as manure production is relatively low in that country compared to the rather high deposition of nitrogen from the atmosphere.

Table 2.1 Nitrogen balance (kg N/ha) and phosphate surplus (kg P_2O_5/ha) of the average farm in 1990/91

Country/region	Nitrogen balance							Phosphate surplus
	deposition from the atmosphere	production-related input			uptake by crops	surplus		
		purchase of fertilizer	manure production	total		gross	net	
Belgium	33	163	196	359	163	196	170	82
Denmark	18	142	109	252	123	129	114	18
Germany	31	128	98	226	106	119	121	47
Nordrhein-Westfalen	38	132	113	244	107	137	141	50
Rheinland-Pfalz	26	119	61	180	94	86	94	44
Greece	7	46	64	111	53	58	46	35
Spain	6	38	40	77	53	25	19	28
Galicia	7	57	166	223	112	111	68	46
Extremadura	7	37	16	53	51	2	4	23
France	17	98	62	160	85	75	73	65
Bretagne	17	108	149	257	97	160	133	84
Limousin	11	19	76	95	73	22	10	30
Ireland	10	60	93	152	72	81	63	34
Italy	12	46	55	101	78	23	18	29
Lombardia	23	87	137	224	114	110	92	71
Sicilia	4	25	25	49	66	-17	-20	5
Luxembourg	27	128	128	256	124	132	121	57
Netherlands	36	218	343	561	173	388	321	92
Portugal	4	32	40	71	57	14	6	8
United Kingdom	16	92	68	160	96	64	59	13
England West	20	93	98	191	100	91	81	19
Scotland	7	58	39	97	65	31	27	6
EUR 12 a)	16	86	73	159	82	78	71	44

a) Average of all represented farms in the EU, see also section 1.4.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Net nitrogen surplus across Member States exceeds the average of EUR 12 in Belgium, Denmark, Germany, France, Luxembourg and the Netherlands. Phosphate surplus in these countries also exceeds the average of EUR 12, with the exception of Denmark. Purchase of phosphate and the production of phosphate from manure both are relatively low in Denmark. Phosphate surpluses in Denmark might be relatively low compared to other

countries because of the low excretion levels considered for several animal types (e.g. grazing livestock except dairy cows, and pigs) (see also appendix 5, table A5.5).

Surplus levels of phosphate across Member States are highest in Belgium and the Netherlands (over 80 kg P_2O_5 per ha) and lowest in Denmark, Portugal and the United Kingdom (less than 15 kg P_2O_5 per ha).

Regional differences in net nitrogen surplus are largest in Germany, Spain, France and Italy, and relatively small in Greece, Portugal and the United Kingdom (figure 2.1). In France for example, net nitrogen surplus is in the range between 10 kg/ha (Limousin) and 133 kg/ha (Bretagne). This is mainly due to differences between these regions on the level of nitrogen input from fertilizers (respectively 19 and 108 kg/ha). Manure production in Bretagne (149 kg N/ha) is about double that of Limousin.

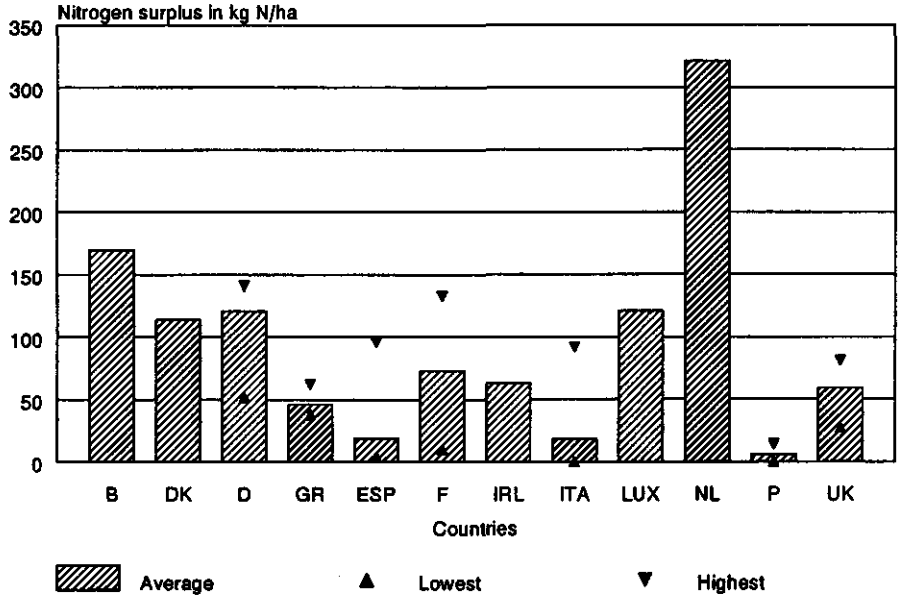

Figure 2.1 Net nitrogen surplus for the EU Member States with average, lowest and highest regional level in 1990/91

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Production of nitrogen from manure in France varies between 3 kg/ha (Île de France) and 149 kg/ha (Bretagne). Net nitrogen surplus in Sicilia (Italy) is negative since the uptake of nitrogen by harvested crops is assessed to exceed the input levels that are available for plant growth. It is highest in

Lombardia (92 kg/ha), primarily due to the production of animal manure which exceeds the average level of Sicilia by some 110 kg/ha. Negative values of nitrogen surplus remain relatively small in the assessments and depletion of soils does not necessarily result in such cases.

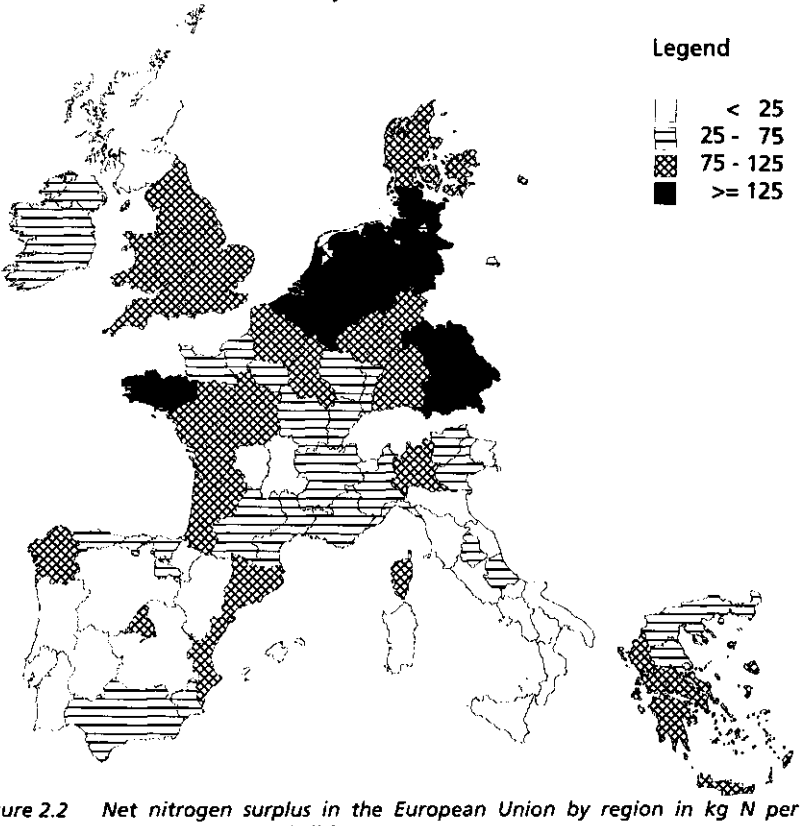

Figure 2.2 Net nitrogen surplus in the European Union by region in kg N per ha in 1990/91 (average of all farms)
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Net nitrogen surplus in the European Union of the average of all farms exceeds 125 kg/ha in Belgium, large areas of Germany (Schleswig-Holstein, Niedersachsen, Nordrhein-Westfalen, Bayern), France (Bretagne), and the Netherlands (figure 2.2). Surplus of phosphate of the average of all farms in EUR 12 is highest in Belgium, France (Bretagne), Italy (Lombardia), Spain (Cataluna and Madrid) and the Netherlands (figure 2.3).

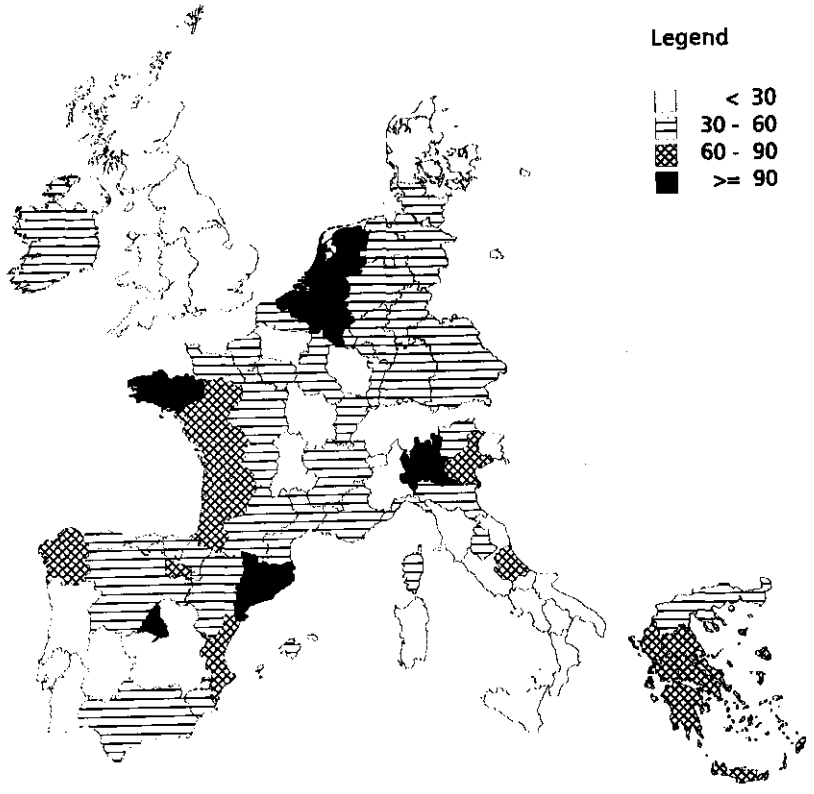

Figure 2.3 Phosphate surplus in the European Union by region in kg P_2O_5 per ha in 1990/91 (average of all farms)
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

2.3 Mineral surplus and farm structure

The 1990/91 FADN sample includes 58,450 farms, which in total represent around 4.4 million farms in the EU (table 2.2). Utilized agricultural area (UAA) per farm is in the range between 6 ha in Greece and almost 110 ha in the United Kingdom. Utilized agricultural area per farm in EUR 12 is 22 ha. Cereals and grass in total cover more than half of the utilized agricultural area in all Member States considered, except for Greece and Portugal. The utilization of land to grow other forage crops exceeds grass in these two countries. More than half of UAA in Denmark is used to grow cereals. More than half of utilized agricultural area in Ireland, Luxembourg, Netherlands and United Kingdom is used to grow grass. Density of livestock population exceeds two livestock units per ha of utilized agricultural area (LU/ha UAA) in Belgium, Galicia (Spain), Bretagne (France), Lombardia (Italy) and the Netherlands. The share of pigs and poultry in total livestock population is

relatively high (i.e. more than 40%) in the regions with a high density, except for Galicia where grazing livestock includes 80% of total livestock population. It is highest in Denmark (60%).

Net nitrogen surplus is relatively high in regions with a high density of animal population and their subsequent high supply of nitrogen from animal manure. The latter exceeds 125 kg/ha in regions with animal density of at least 2 LU/ha utilized agricultural area.

Table 2.2 Farm structure of the average farm in 1990/91

Country/region	Number of farms represented (x 1,000)	Number of farms in sample	Utilized agricultural area (UAA)			Livestock density (LU/ha UAA)	Share in livestock population (%)	
			total (ha)	of which in %			grazing livestock	pigs and poultry
				cereals	grass			
Belgium	51.9	1,195	25.5	24	44	2.6	56	44
Denmark	81.0	2,274	34.1	56	7	1.5	39	60
Germany	373.9	5,176	28.9	37	37	1.5	62	38
Nordrhein-Westfalen	51.0	719	29.7	46	30	2.0	42	58
Rheinland-Pfalz	30.2	559	22.6	41	32	0.8	76	24
Greece	498.3	5,987	6.4	45	2	0.6	94	5
Spain	690.6	7,941	22.0	42	13	0.5	57	42
Galicia	94.2	887	4.9	12	33	2.2	80	19
Extremadura	36.0	390	36.2	20	40	0.2	97	2
France	556.7	7,531	44.8	33	27	0.8	74	26
Bretagne	57.5	631	28.8	22	8	2.4	48	52
Limousin	14.5	211	50.1	11	42	1.0	96	3
Ireland	140.2	1,259	34.7	7	83	1.2	94	6
Italy	1,369.8	19,527	9.3	32	20	0.7	70	30
Lombardia	66.3	1,185	16.5	39	19	2.3	51	49
Sicilia	160.4	929	8.6	34	14	0.2	97	3
Luxembourg	2.3	316	50.0	22	57	1.4	91	9
Netherlands	94.0	1,580	22.0	9	53	3.7	48	52
Portugal	448.5	2,627	11.8	19	15	0.5	76	22
United Kingdom	141.6	3,037	109.6	26	53	0.9	81	19
England West	30.6	524	83.7	27	46	1.3	84	16
Scotland	18.0	412	251.2	12	73	0.5	97	3
EUR 12	4,448.9	58,450	22.2	32	31	0.9	69	31

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

3. MINERAL BALANCE BY FARMING TYPE

3.1 Introduction

Mineral balances differ largely among farms because of differences in farm structure, cropping plan, livestock composition and management factors. Balances at farm level therefore are presented by farming type. The information provided includes national averages of the balances of individual farms, weighted by the number of farms (including their area) represented by the sample. Regional averages are only presented in case the net nitrogen surplus is considerably higher than the national average. The information is presented successively for cereal farms (section 3.2), general cropping farms (section 3.3), dairy farms (section 3.4), drystock farms (section 3.5), granivore farms (section 3.6) and mixed farms (section 3.7). The assessments include six types which are regrouped from the principal farming types identified in FADN according to their technical and economic characteristics (CEC, 1989) (see also appendix 2). Horticultural holdings, vineyards and permanent crop holdings are not examined because the knowledge available of mineral requirements and mineral uptake for horticultural and permanent crops is rather limited. Some concluding remarks are presented in section 3.8.

3.2 Cereal farms

Net nitrogen surplus of cereal farms across Member States ranges between less than 10 kg/ha and almost 100 kg/ha. It is less than 10 kg/ha in Spain, Italy and Portugal and highest (96 kg/ha) in Germany (table 3.1). The average net nitrogen surplus of all cereal farms in EUR 12 is 32 kg/ha. Differences among countries on net nitrogen surplus are mainly due to the purchase of fertilizers and manure rather than the supply of nitrogen from home-produced manure. The supply of nitrogen from manure at cereal farms on average is below 10 kg/ha because livestock production at such farms is very small.

The purchase of minerals (in fertilizers or manure) across Member States is in the range between 23 kg/ha (Portugal) and 160 kg/ha (France). Net nitrogen surplus in Lombardia (56 kg/ha) is considerably higher than the national average. Such a difference in Italy between national and regional averages is mainly due to the relatively high purchase level in Lombardia of nitrogen in fertilizers and manure (126 kg/ha). The uptake of nitrogen by crops is lowest in regions with relatively low yields of arable crops (e.g. Greece, Spain and Portugal).

Table 3.1 Nitrogen balance (kg N/ha) and phosphate surplus (kg P_2O_5/ha) of cereal farms in 1990/91

Country/region	Nitrogen balance							Phosphate surplus
	deposition from the atmosphere	production-related input			uptake by crops	surplus		
		purchase of fertilizer and manure	manure production	total		gross	net	
Denmark	18	149	9	158	105	53	68	0
Germany	31	152	11	163	94	68	96	49
Greece	8	72	6	78	56	21	27	37
Spain	6	36	2	39	39	0	6	25
France	18	160	5	165	102	63	79	57
Ireland	10	149	14	163	118	45	51	108
Italy	11	52	4	56	61	-5	4	22
Lombardia	23	126	6	132	98	34	56	103
Portugal	4	23	5	28	31	-3	0	1
United Kingdom	20	133	16	149	110	40	55	2
EUR 12	12	84	6	90	68	22	32	28

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Table 3.2 Structure of cereal farms in 1990/91

Country/region	Number of farms represented (x 1,000)	Number of farms in sample	Utilized agricultural area (UAA)			
			total (ha)	of which in %		
				cereals	oil seeds	sugar beet
Denmark	12.3	236	25.4	81	11	0
Germany	7.1	129	30.6	77	11	1
Greece	31.4	437	13.1	89	1	1
Spain	101.9	1,118	50.5	74	5	0
France	35.3	462	68.5	75	14	1
Ireland	3.7	29	34.7	74	-	1
Italy	101.8	988	14.8	82	1	0
Lombardia	6.5	117	21.8	94	1	0
Portugal	10.3	86	40.3	53	4	-
United Kingdom	15.3	261	122.9	71	6	1
EUR 12	319.1	3,748	39.0	75	6	1

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Differences among countries regarding the phosphate surplus of cereal farms also arise mainly due to the input of minerals through purchase of fertilizers and manure, and to a limited extent to the production of ma-

nure. About 7% of the total number of farms in EUR 12 are cereal farms. The FADN represents around 320,000 cereal farms, about two thirds of them are located in Spain and Italy (table 3.2). Net nitrogen surplus per farm in these two countries on average is low compared to the average of all cereal farms in EUR 12. This is due to a combination of low input levels of minerals and low uptake by crops. Utilized agricultural area per farm is in the range between 13 ha (Greece) and 123 ha (United Kingdom). The share of oil seeds in total UAA exceeds 10% at cereals farms in Denmark, Germany and France. The share of sugar beet in total UAA is of marginal importance at this farming type.

3.3 General cropping farms

Net nitrogen surplus of general cropping farms across Member States ranges between less than 10 kg/ha in Spain, Italy and Portugal and over 100 kg/ha in Belgium, Germany and the Netherlands (table 3.3) 1). It was also less than 10 kg/ha at cereal farms in Spain, Italy and Portugal. Net nitrogen surplus of general cropping farms in EUR 12 (57 kg/ha) is higher than that of cereal farms (32 kg/ha). This also holds at the level of Member States, except for France, Ireland and Italy where net nitrogen surplus at general cropping farms is slightly below that of cereal farms. Net nitrogen surplus at general cropping farms exceeds that of cereal farms primarily because of the production of animal manure at such farms.

Manure production at general cropping farms in EUR 12 (18 kg/ha) is threefold that of cereal farms in EUR 12. Manure production at this farming type is highest (55 kg/ha) in Belgium. Purchase of nitrogen from fertilizers and manure at general cropping farms in EUR 12 is about 30 kg/ha above the average level of cereal farms in EUR 12. Phosphate surplus at general cropping farms also exceeds that at cereal farms, except for France and Ireland where phosphate surplus at general cropping farms is slightly below that of cereal farms.

General cropping farms are far more important in EUR 12 than cereal farms. The number of general cropping farms represented by FADN is almost 1.3 million (or 28% of the total number of farms), compared to almost 320,000 cereal farms. Cereals cover about half the utilized agricultural area of all general cropping farms in EUR 12 represented by FADN. Growing oil

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1) The input of minerals by purchase of fertilizers and manure is very high in the Netherlands. This is due to the high share of potatoes and sugar beet in the cropping plan of farms. The total use of nitrogen from organic and inorganic sources is assessed to be 495 kg/ha (potatoes) and 370 kg/ha (sugar beet) (Janssens, 1993; personal communication) (see also appendix 5 for an investigation of mineral requirements and mineral uptake by crops). An important element which also needs to be considered here is the relatively low input level of nitrogen to grow grass, compared to assessments from other sources in the Netherlands (Poppe et al., 1994).

seeds and sugar beet is also an important part of the cropping plan of general cropping farms (table 3.4).

Table 3.3 Nitrogen balance (kg N/ha) and phosphate surplus (kg P_2O_5/ha) of general cropping farms in 1990/91

Country/region	Nitrogen balance							Phosphate surplus
	deposition from the atmosphere	production-related input			uptake by crops	surplus		
		purchase of fertilizer and manure	manure production	total		gross	net	
Belgium	33	163	55	219	133	86	103	113
Denmark	18	160	25	186	114	72	83	4
Germany	31	168	32	200	107	94	115	59
Niedersachsen	35	178	25	203	112	91	118	65
Greece	7	70	15	85	58	27	30	41
Spain	6	46	5	51	47	5	9	30
France	18	147	15	161	101	61	74	56
Northern cereal area a)	20	165	13	177	117	60	76	38
Ireland	10	104	32	136	87	49	50	85
Italy	12	62	10	71	79	-8	1	26
Lombardia	23	140	11	150	122	28	48	114
Netherlands	36	430	11	441	140	301	333	216
Portugal	4	29	23	52	45	7	4	7
United Kingdom	20	142	30	172	115	57	68	6
England East	22	150	24	174	118	56	71	5
EUR 12	16	117	18	135	89	46	57	40

a) See appendix 1.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Net nitrogen surplus at general cropping farms on average is assessed to be higher than at cereal farms. The share of other field crops in the cropping plan of general cropping farms exceeds that at cereal farms. These crops normally require higher nitrogen input than cereals do.

The share of oil seeds in total UAA exceeds 10% in Denmark, Germany, Spain and France. The share of sugar beet in total UAA is highest in Belgium (22%) and the Netherlands (19%). The three arable crops distinguished in table 3.4 cover less than half the UAA in Ireland, the Netherlands and Portugal. This is partly due to the share of potatoes in total UAA of general cropping farms which is high in some countries (e.g. about 25% in the Netherlands).

The replacement of mineral fertilizers by organic manure is based on actual farmers' behaviour and varies between crops and countries (appendix

5, table A5.3). In most countries up to some 15-20% of nitrogen required can be achieved from organic manure. A modest utilisation of organic manure at farms with a relatively high supply of organic manure implies that fertilizers need to be purchased, which results in a high surplus. In the Netherlands for example, mineral fertilizers cannot be replaced by organic manure on acreage under cereals, while on other crops (e.g. potatoes and sugar beet) the replacement rate is around 50%.

Table 3.4 Structure of general cropping farms in 1990/91

Country/region	Number of farms re presented (x 1,000)	Number of farms in sample	Utilized agricultural area (UAA)			
			total (ha)	of which in %		
				cereals	oil seeds	sugar beet
Belgium	8.0	165	37.5	47	2	22
Denmark	24.6	523	37.5	58	14	5
Germany	57.2	1,119	39.2	56	12	11
Niedersachsen	13.0	280	50.2	55	6	18
Greece	210.1	2,576	6.7	52	1	4
Spain	151.8	2,049	23.9	44	14	5
France	113.8	1,702	55.8	51	17	4
Northern cereal area a)	38.3	689	75.0	54	12	8
Ireland	3.0	41	48.8	39	-	10
Italy	482.8	5,519	8.5	42	6	5
Lombardia	18.5	239	15.4	45	14	9
Netherlands	14.0	334	40.9	27	1	19
Portugal	166.1	455	10.5	25	2	-
United Kingdom	21.4	480	154.8	54	8	6
England East	10.9	281	179.4	55	8	9
EUR 12	1,253.0	14,965	19.7	47	11	6

a) See appendix 1.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Replacement rates are high for grain maize, fodder crops, fodder maize and grass in Greece, Spain, France, Italy and Portugal. In Spain, Italy and Portugal these crops have a considerable share in the cropping plan (the share of cereals is less than 45%). Small amounts of fertilizers need to be purchased and the surplus is low. An increase in replacement rates may be technically feasible. This will result in a better utilisation of organic manure, a lower input of fertilizers and hence lower surpluses.

3.4 Dairy farms

The average net nitrogen surplus of all dairy farms in EUR 12 is 114 kg/ha (table 3.5), which is double that of general cropping farms and more than threefold that of cereal farms. Net nitrogen surplus exceeds 150 kg/ha in Belgium, Denmark, Greece and the Netherlands. The supply of nitrogen from animal manure at this farming type is higher than purchase levels of fertilizers and manure for all regions except Bretagne. It exceeds 170 kg/ha (manure application levels under the Nitrate Directive, see also chapter 8) in Belgium, Denmark, Greece, Lombardia and the Netherlands, and is only 115 kg/ha in Bretagne. Mineral input by purchase of fertilizer and animal manure is also above the average of EUR 12 in these regions with the exception of Greece (26 kg/ha) and Lombardia (62 kg/ha). Phosphate surplus at dairy farms exceeds 100 kg/ha in Bretagne and the Netherlands.

Table 3.5 Nitrogen balance (kg N/ha) and phosphate surplus (kg P_2O_5/ha) of dairy farms in 1990/91

Country/region	Nitrogen balance							Phosphate surplus
	deposition from the atmosphere	production-related input			uptake by crops	surplus		
		purchase of fertilizer and manure	manure production	total		gross	net	
Belgium	33	175	197	372	184	188	162	87
Denmark	18	159	201	360	152	207	165	26
Germany	30	121	129	250	113	138	129	43
Nordrhein-Westfalen	38	130	131	262	120	142	140	45
Greece a)	8	26	247	272	46	227	161	86
Spain	7	62	169	231	111	120	76	55
France	17	66	101	167	78	89	76	68
Bretagne	17	125	115	239	98	141	124	210
Ireland	10	54	119	173	68	104	79	35
Italy	18	47	150	198	99	98	72	47
Lombardia	23	62	204	266	105	160	122	73
Luxembourg	27	129	132	261	126	135	123	58
Netherlands	36	221	383	604	188	416	337	113
Portugal	4	34	120	154	82	73	40	22
United Kingdom	18	70	153	223	86	137	108	33
England West	20	85	156	241	100	141	114	32
EUR 12	21	92	146	238	101	137	114	54

a) The area of arable crops and grass is less than 1 ha on more than 5% of the number of farms represented. The interpretation of figures per ha is difficult at these farms with a small area. Figures can reach extreme values. See also Section 1.4. Mineral surpluses are not presented in the report in case they exceed 10,000 kg/ha. They are depicted as ∞ in such cases.

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

In total there are almost 600,000 dairy farms in EUR 12 which are represented by the sample of FADN. Utilized agricultural area at dairy farms in Greece, Spain and Portugal is less than half that of the average in EUR 12 (28 ha). The area arable crops and grass is less than 1 ha on more than 5% of the dairy farms represented in Greece (see footnote in table 3.5). Figures on a per ha basis can reach extreme values on such farms. Animal density of dairy farms exceeds 2 LU/ha UAA in Belgium, Greece, Spain, Lombardia and the Netherlands (table 3.6). Net nitrogen surplus is also relatively high in these regions with the exception of Spain. The use of fertilizers is relatively low in Spain compared to other Member States. The density of grazing livestock per ha of forage crops in the Netherlands is smaller than the density of total livestock population per ha of utilized agricultural area. This pattern is contrary to that of other Member States and is due to the presence of granivores (mainly pigs) at dairy farms in the Netherlands.

Table 3.6 Structure of dairy farms in 1990/91

Country/region	Number of farms represented (x 1,000)	Number of farms in sample	Utilized agricultural area (UAA)			Livestock density	
			total (ha)	of which in %		total LU per ha UAA	grazing livestock (LU per ha forage crops)
				grass	other forage crops		
Belgium	13.4	191	28.9	71	22	2.2	2.2
Denmark	15.3	430	35.9	14	48	1.9	2.9
Germany	132.6	1,329	29.3	67	15	1.6	1.9
Nordrhein-Westfalen	11.9	160	31.8	74	10	1.6	1.8
Greece	2.4	24	6.3	25	37	3.2	5.1
Spain	64.9	1,378	7.3	52	40	2.1	2.2
France	125.9	1,426	38.4	45	41	1.2	1.4
Bretagne	30.7	248	30.0	9	75	1.4	1.6
Ireland	55.7	455	33.5	86	12	1.5	1.5
Italy	78.4	2,461	14.2	51	39	1.8	2.0
Lombardia	14.6	390	19.6	45	42	2.5	2.8
Luxembourg	1.3	209	52.3	59	19	1.4	1.7
Netherlands	37.9	487	29.0	84	13	3.1	2.7
Portugal	26.5	346	9.0	37	54	1.5	1.6
United Kingdom	35.2	721	61.5	67	26	1.8	2.0
England West	11.1	171	61.1	59	31	1.9	2.0
EUR 12	589.7	9,457	28.3	60	28	1.7	1.8

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

3.5 Drystock farms

The average net nitrogen surplus of all drystock farms in EUR 12 is 48 kg/ha (table 3.7), which is less than half the net nitrogen surplus on dairy farms in EUR 12. Total production-related input of nitrogen (i.e. from purchase of fertilizers and manure, and from production of manure) on drystock farms in EUR 12 is about half of that of dairy farms in EUR 12. Average net nitrogen surplus of drystock farms in Greece and the Netherlands is considerably higher than on dairy farms. This is mainly due to the high supply of nitrogen from manure production. Net nitrogen surplus is 400 kg/ha in the St. Ellas N. Egae. Kriti region of Greece. Phosphate surplus of drystock farms in Greece is very high (300 kg/ha). This is more than threefold the phosphate surplus of dairy farms in that country.

Table 3.7 Nitrogen balance (kg N/ha) and phosphate surplus (kg P_2O_5/ha) of drystock farms in 1990/91

Country/region	Nitrogen balance							Phosphate surplus
	deposition from the atmosphere	production-related input			uptake by crops	surplus		
		purchase of fertilizer and manure	manure production	total		gross	net	
Belgium	33	175	218	393	183	211	178	95
Germany	30	121	119	240	108	131	126	45
Greece a)	6	18	451	469	31	438	308	298
St.Ellas N.Egae. Kriti a)	4	11	586	597	25	572	400	415
Spain a)	6	49	89	138	75	64	43	61
Galicia	7	76	139	214	120	94	60	56
France	15	44	75	120	65	55	47	37
Pays de la Loire	17	76	102	178	73	105	91	57
Ireland	10	55	78	133	68	65	52	36
Italy	9	26	80	106	66	40	25	27
Lombardia	23	60	172	232	94	138	110	66
Luxembourg	27	132	129	261	128	133	121	57
Netherlands a)	36	220	540	759	179	581	455	183
Portugal	4	42	40	82	71	11	3	4
United Kingdom	12	44	57	101	61	40	35	11
England West	20	84	103	187	99	88	77	18
EUR 12 a)	12	48	79	127	68	59	48	32

a) Note: See table 3.5.

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Animal density of livestock population at drystock farms is very high in Greece and the Netherlands (over 5 LU/ha UAA) compared to elsewhere in the EU (table 3.8). Utilized agricultural area of drystock farms in Greece is only 4 ha which is much smaller than the average of EUR 12 of 39 ha. The small size of utilized agricultural area and the subsequent high density of animal population is an important indicator for the large mineral surpluses of drystock farms in Greece, and to a lesser extent also in the Netherlands. The area arable crops and grass is less than 1 ha on more than 5% of the number of drystock farms represented in Greece, Spain and the Netherlands. It is less than 1 ha on more than 5% of the drystock farms represented in EUR 12. Utilized agricultural area is also rather small in Galicia. Animal density and net nitrogen surplus in that region however are only slightly above the average of EUR 12. Livestock population at drystock farms in Galicia is relatively small compared to other regions in EU.

Table 3.8 Structure of drystock farms in 1990/91

Country/region	Number of farms represented (x 1,000)	Number of farms in sample	Utilized agricultural area (UAA)			Livestock density	
			total (ha)	of which in %		total LU per ha UAA	grazing livestock (LU per ha forage crops)
				grass	other forage crops		
Belgium	5.5	134	34.0	65	22	2.4	2.5
Germany	19.9	290	30.2	47	23	1.7	2.1
Greece	48.7	714	4.1	7	44	5.1	10.3
St.Ellas N.Egae. Kriti	16.4	223	3.6	3	47	5.9	11.7
Spain	97.0	1,137	19.6	72	22	1.2	1.2
Galicia	24.1	271	5.4	37	52	1.9	1.9
France	92.5	1,148	55.1	53	34	1.0	1.1
Pays de la Loire	13.7	121	44.2	29	53	1.3	1.6
Ireland	71.0	635	34.1	92	6	1.0	1.0
Italy	76.7	1,885	25.5	66	22	1.0	1.1
Lombardia	7.7	127	19.5	42	40	2.2	2.7
Luxembourg	0.3	36	60.6	66	13	1.4	1.6
Netherlands	4.7	45	19.1	69	26	5.1	4.7
Portugal	42.1	364	21.7	18	75	0.5	0.5
United Kingdom	43.9	996	143.2	91	7	0.7	0.7
England West	7.0	125	81.7	80	15	1.3	1.4
EUR 12	502.7	7,397	39.1	71	21	1.0	1.1

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Stocking density of grazing livestock per ha of forage crops presented in this report differs from the assessments published by the European Com-

mission. There are two main reasons that explain that difference. First, calves for fattening do not belong to the group of grazing livestock, according to the definition used by the Commission. This group of animals however is included in the present report because of their contribution to manure production. Second, the definition of stocking density of grazing livestock per ha of forage crops in this report differs from the one used by the Commission. In the present report it is based on the total area of forage crops at drystock farms as well as on all grazing livestock at drystock farms. However, the Commission defines stocking density according to the group of farms with both grazing livestock and forage crops. Stocking density of drystock farms in the Netherlands exceeds that of the estimates provided by the European Commission. This is due to the production of calves for fattening in the Netherlands. Density of grazing livestock per hectare of forage crops in Greece is high as well. The use of common grazing land might be important in that country, although it is not included in a definition of utilized agricultural area. This notion would imply that density of grazing livestock population would be lower than in the statistics presented.

3.6 Granivore farms

Purchase of fertilizers and manure is a major component of total input of minerals for plant growth in most of the farming types considered before. Granivore farms however are characterized by the fact that the production of manure largely exceeds the purchase of fertilizers and manure (table 3.9). This is mainly due to the high purchases of feed concentrates at that farming type. On the other hand, the supply of nitrogen from animal manure is only double the purchase of fertilizers in Denmark and Germany. Total input of nitrogen is below 500 kg/ha in these countries, which is less than half the average of all granivore farms in EUR 12. Net nitrogen surplus exceeds 1,000 kg/ha in Belgium, Greece, Spain (also including Aragon and Cataluna), Italy, the Netherlands and England East. Phosphate surplus exceeds 800 kg/ha in these regions. Gross nitrogen surplus at granivore farms by far exceed net nitrogen surplus at such farms due to the high losses of ammonia.

The area of arable crops and grass is less than 1 ha on more than 5% of the granivore farms represented in EUR 12. The figures of manure production, on a per ha basis, can reach extreme values in among others Belgium, Greece and the Netherlands.

The relatively small size of utilized agricultural area per farm, and the high density of livestock population are major determinants of the high rates of mineral surplus at granivore farms compared to that of the other farming types presented before. UAA in those regions with net nitrogen surplus over 1000 kg/ha is below the average of EUR 12 (11 ha) (table 3.10). UAA is below 5 ha in Belgium, Greece and the Netherlands. It is only 1 ha in Greece. UAA at granivore farms is relatively high in Denmark (32 ha), Ger-

many (16 ha) and France (21 ha). Net nitrogen surplus in these countries is far below that of the other Member States.

Animal density in the regions with net nitrogen surplus over 1,000 kg/ha is more than 20 livestock units per ha of utilized agricultural area. It is highest in Greece (87 LU/ha UAA), Italy (61 LU/ha UAA), the Netherlands (58 LU/ha UAA) and Belgium (46 LU/ha UAA).

Table 3.9 Nitrogen balance (kg N/ha) and phosphate surplus (kg P_2O_5/ha) of granivore farms in 1990/91

Country/region	Nitrogen balance							Phosphate surplus
	deposition from the atmosphere	production-related input			uptake by crops	surplus		
		purchase of fertilizer and manure	manure production	total		gross	net	
Belgium a)	33	142	2,211	2,353	132	2,221	1,591	1,372
Denmark	18	135	330	465	111	354	273	108
Germany	35	104	234	338	79	259	224	111
Greece a)	6	19	8,999	9,018	43	8,975	6,282	6,970
Spain a)	6	36	1,486	1,522	59	1,463	1,024	1,146
Aragon and Cataluna a)	6	40	1,526	1,566	79	1,487	1,035	1,149
France a)	17	94	577	671	88	583	427	445
Pays de la Loire a)	17	84	852	936	77	859	621	647
Bretagne a)	17	111	512	623	94	528	392	406
Italy	20	51	1,859	1,911	133	1,777	1,239	1,430
Netherlands a)	36	196	3,223	3,419	152	3,266	2,335	1,816
Portugal a)	4	49	732	781	95	686	470	520
United Kingdom a)	20	92	1,282	1,374	100	1,274	909	716
England East a)	22	117	1,545	1,662	114	1,548	1,107	884
EUR 12 a)	19	101	950	1,051	97	954	688	617

a) Note: See table 3.5.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

The share of poultry in total livestock population of granivore farms is less than 10% in Denmark and Germany. More than half the total livestock population at granivore farms is based on poultry in Pays de la Loire (81%) and Italy (66%).

Table 3.10 Structure of granivore farms in 1990/91

Country/region	Number of farms represented (x 1,000)	Number of farms in sample	Utilized agricultural area (UAA)			Livestock density (LU/ha UAA)	Share in livestock population (%)	
			total (ha)	of which in %			pigs	poultry
				cereals	other forage crops			
Belgium	3.6	141	4.8	42	15	45.9	73	25
Denmark	4.7	204	31.6	72	3	6.5	97	2
Germany	4.3	43	16.4	70	15	5.5	92	8
Greece	0.9	24	1.0	30	10	86.9	66	34
Spain	15.9	197	5.6	55	27	23.5	60	40
Aragon and Cataluna	6.9	84	6.2	42	39	23.1	77	23
France	8.8	178	20.7	52	24	13.6	54	44
Pays de la Loire	0.9	20	20.6	33	44	24.6	16	81
Bretagne	5.2	115	22.2	60	21	11.1	76	22
Italy	4.9	43	7.7	79	9	60.8	34	66
Netherlands	9.7	178	4.6	9	37	57.6	63	36
Portugal	3.2	67	6.8	1	75	12.5	74	24
United Kingdom	4.3	79	10.8	30	23	31.1	66	30
England East	1.6	21	6.5	48	25	37.9	84	16
EUR 12	60.7	1,161	10.9	54	19	20.5	61	38

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

3.7 Mixed farms

This farming type includes farms with a wide variety of cropping patterns and livestock combinations. It includes mixed livestock, mainly grazing livestock (farming type 71), mixed livestock, mainly granivores (farming type 72), field crops and grazing livestock combined (farming type 81) and various crops and livestock combined (farming type 82). (see also appendix 2). This wide variety of farms with crops and/or livestock combinations is also reflected by the wide range among countries of the production of nitrogen from manure. It is in the range between around 50 kg/ha (Portugal and Spain) and over 500 kg/ha (the Netherlands). Although manure production at mixed farms in Portugal on average is only 50 kg N/ha, the area arable crops and grass is below 1 ha on at least 5% of the mixed farms represented by FADN in that country. At least 5% of the mixed farms in Greece and in Aragon and Cataluna do also belong to that group of farms.

Differences among countries regarding mineral input by purchase of fertilizers and manure are much smaller than that of manure production (table 3.11). It is in the range from about 30 kg/ha in Greece, Spain and Portugal and about 260 kg/ha in the Netherlands.

Phosphate surplus exceeds 100 kg/ha in Belgium, Aragon and Cataluna, Bretagne, and the Netherlands.

Table 3.11 Nitrogen balance (kg N/ha) and phosphate surplus (kg P_2O_5/ha) of mixed farms in 1990/91

Country/region	Nitrogen balance							Phosphate surplus
	deposition from the atmosphere	production-related input			uptake by crops	surplus		
		purchase of fertilizer and manure	manure production	total		gross	net	
Belgium	33	159	209	368	154	213	184	115
Denmark	18	141	144	285	121	164	139	27
Germany	31	126	106	233	100	133	132	50
Nordrhein-Westfalen	38	128	141	268	102	167	163	56
Greece a)	7	32	111	143	38	105	78	61
Spain	6	31	59	90	42	48	36	43
Aragon and Cataluna a)	6	44	138	182	60	122	87	101
France	17	91	82	173	84	89	82	63
Bretagne	17	122	152	274	95	179	151	203
Ireland	10	80	85	165	82	84	69	59
Italy	11	41	76	117	75	42	30	29
Lombardia	23	76	138	214	99	116	97	82
Luxembourg	27	126	113	239	115	124	117	59
Netherlands	36	257	510	767	162	606	488	236
Portugal a)	4	30	50	80	54	25	14	14
United Kingdom	17	85	96	180	90	91	79	21
EUR 12	18	85	93	178	83	95	85	47

a) Note: See table 3.5.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

More than half of UAA at mixed farms includes cereals in Denmark, Nordrhein-Westfalen, Greece and Lombardia (table 3.12). Density of animal population at mixed farms exceeds 2 LU/ha UAA in Belgium, Denmark, Nordrhein-Westfalen, Bretagne, Lombardia and the Netherlands. It is highest in Belgium (3.0 LU/ha UAA) and the Netherlands (6.5 LU/ha UAA). At least two thirds of total livestock units includes pigs and poultry in Denmark, Nordrhein-Westfalen, Aragon and Cataluna, and the Netherlands.

Table 3.12 Structure of mixed farms in 1990/91

Country/region	Number of farms represented (x 1,000)	Number of farms in sample	Utilized agricultural area (UAA)				Livestock density (LU/ha UAA)	Share in livestock population (%)	
			total (ha)	of which in %				grazing livestock	pigs and poultry
				cereals	grass	other forage crops			
Belgium	14.3	387	28.1	29	36	15	3.0	50	50
Denmark	20.9	592	37.8	60	7	15	2.2	27	73
Germany	121.8	1,821	29.5	48	26	15	1.9	39	60
Nordrhein-Westfalen	22.4	301	28.4	56	20	16	2.8	27	72
Greece	37.7	592	8.6	53	3	24	1.3	98	2
Spain	79.5	388	25.2	32	8	54	0.8	54	46
Aragon and Cataluna	13.7	86	28.9	46	15	25	2.0	28	72
France	95.4	1,282	50.0	34	26	28	1.2	61	39
Bretagne	12.9	153	33.1	31	7	50	2.6	35	65
Ireland	6.4	90	45.9	32	46	19	1.2	79	21
Italy	137.9	2,908	14.6	34	24	32	1.0	88	12
Lombardia	7.2	157	23.2	54	5	33	2.1	68	32
Luxembourg	0.5	50	52.1	30	45	17	1.3	73	27
Netherlands	8.3	88	20.0	7	47	24	6.5	29	71
Portugal	144.2	429	10.0	19	21	50	0.6	77	21
United Kingdom	15.3	394	113.8	35	33	26	1.4	73	27
EUR 12	682.2	9,021	25.8	36	23	29	1.4	55	45

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

3.8 Concluding remarks

1. Net nitrogen surplus differs largely among farming types identified. Differences across Member States are also large for the six farming types distinguished. Major determinants of such differences are livestock composition and cropping plan as well as the intensity of farming practice. The stocking rate of animals (number of livestock units per ha UAA) and the yields of crop production reflect the intensity of farming. Such differences also explain to a large extent the differences among Member States for specific farming types. Management characteristics of individual farms (i.e. ways of treating animal manure) are likely to be important as well, but these cannot be identified in the approach used.
2. Net nitrogen surplus in EUR 12 at cereal farms, general cropping farms and drystock farms is below the average of all farms represented by the sample (70 kg/ha). Surplus is highest at granivore farms (690 kg/ha). Net nitrogen surplus of dairy farms and mixed farms on ave-

rage is slightly above the average of all farms in EUR 12. Net nitrogen surplus at granivore farms on average is more than tenfold that of the average of cereal farms, general cropping farms and drystock farms in EUR 12.

3. Net nitrogen surplus in EUR 12 is lowest at cereal farms, primarily because of small levels of manure production. Differences across Member States on mineral surplus at cereal and general cropping farms are mainly due to the variation in purchase levels of fertilizer and animal manure, rather than to manure production. Net nitrogen surplus at general cropping farms is assessed to be higher than at cereal farms. This is due to the high share of root crops in the cropping plan, as well as to the production of animal manure being higher than at cereal farms.
4. Net nitrogen surplus at dairy farms exceeds 150 kg/ha in Belgium, Denmark, Greece and the Netherlands. Net nitrogen surplus at dairy farms in the Netherlands (335 kg/ha) is about threefold that of the average in EUR 12. Production of nitrogen from animal manure at dairy farms exceeds the average of EUR 12 (145 kg/ha) in Belgium, Denmark, Greece, Spain, Italy, the Netherlands and United Kingdom. Net nitrogen surplus in these countries also exceeds the average of EUR 12, with the exception of Spain, Italy and the United Kingdom. Animal density at this farming type is highest (over 3 livestock units per ha UAA) in Greece and the Netherlands.
5. Net nitrogen surplus of drystock farms in Greece and the Netherlands is considerably higher than that of dairy farms. This is mainly due to the fact that utilized agricultural area of drystock farms in these countries is below that of dairy farms. Net nitrogen surplus of drystock farms is well below that of dairy farms in Spain, France, Ireland, Italy, Portugal and the United Kingdom. This is mainly due to the fact that UAA of drystock farms in these countries exceeds that of dairy farms.
6. Net nitrogen surplus across the EU is highest at granivore farms. On average it is around 700 kg/ha on granivore farms. It is below the average of all represented granivore farms of EUR 12 in Denmark, Germany, France and Portugal. Animal density at granivore farms in these countries is also below the average of EUR 12 (i.e. 20 LU/ha UAA). The four countries with highest net nitrogen surplus in descending order are Greece, the Netherlands, Belgium and Italy. Density of livestock population at granivore farms exceeds 45 LU/ha UAA in these countries.
7. The production of nitrogen from animal manure at mixed farms is in the range between 50 kg/ha (Portugal) and 510 kg/ha (the Netherlands); animal density in the Netherlands (6.5 LU/ha UAA) is also tenfold that of Portugal. Mineral surpluses vary across countries according to the stocking density of livestock population. Net nitrogen surplus ranges between 14 kg/ha (Portugal) and 488 kg/ha (the Netherlands).

4. DISTRIBUTION OF NITROGEN SURPLUS AMONG FARMS

4.1 Introduction

Net nitrogen surplus may differ largely across individual farms within the farming types considered. Average surplus might be high for a specific farming type, but the distribution of mineral surplus within that group of farms might be large as well. The objective of this chapter therefore is to assess the distribution of nitrogen surplus among farms. This allows the examination of whether groups of farms of some farming type would already be able to meet relatively low surpluses compared to the average surplus. Farm structure characteristics and use of inputs are important phenomena in this respect which will be examined for three farming types in chapters 5 (general cropping farms), 6 (dairy farms) and 7 (granivore farms).

The distribution among farms of net nitrogen surplus and phosphate surplus is presented in this chapter for all six farming types considered in the report. We will distinguish between average surplus of the group of farms with lowest net nitrogen surplus, the group of farms with highest net nitrogen surplus and the group in between. This kind of information is considered to provide insight into the reduction of nitrogen surplus which already might be achieved with current farming practice. Phosphate surplus of these farms is also presented because farms with a high net nitrogen surplus do not necessarily have a high phosphate surplus.

4.2 Cereal farms

Net nitrogen surplus across cereal farms in EUR 12 ranges between -40 and 160 kg/ha. It is less than 10 kg/ha on more than half of all cereal farms in EUR 12, and it exceeds 50 kg/ha at some 25% of the cereal farms (figure 4.1). Especially cereal farms in Spain, Italy and Portugal are represented in the group of farms below 10 kg/ha (Section 3.2).

Net nitrogen surplus in EUR 12 in the group of 25% of cereal farms with smallest surplus (category 'low') is negative (table 4.1). Uptake of nitrogen from the soils in that group of farms exceeds the supply of nitrogen. Net nitrogen surplus of categories 'low' and 'medium' is negative or zero in Italy and Portugal. The average per farm of the 25% percent of farms with highest surplus in EUR 12 (category 'high') is 75 kg/ha. Nitrogen surplus of category 'high' is considerably higher than nitrogen surplus in the other categories. This is mainly due to the relatively high surplus of a group of cereal farms in Germany and France, and to a lesser extent also in Denmark

and Lombardia. Phosphate surplus in these regions is also above the average of EUR 12, except Denmark.

Table 4.1 *Distribution of average surplus of N and P_2O_5 on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on cereal farms*

Country/region	Category	Number of farms represented (x 1,000)	Number of farms in sample	Net nitrogen surplus kg N/ha	Phosphate surplus kg P_2O_5/ha
Denmark	low	3.0	48	51	1
	medium	6.2	114	65	1
	high	3.1	74	80	-1
Germany	low	1.8	34	73	36
	medium	3.6	64	94	48
	high	1.8	31	115	60
Greece	low	7.8	139	11	19
	medium	15.8	166	29	38
	high	7.8	132	72	86
Spain	low	25.5	255	1	30
	medium	50.9	597	5	23
	high	25.4	266	13	30
France	low	8.8	120	41	37
	medium	17.7	243	77	46
	high	8.8	99	126	111
Ireland	low	.	.	.	.
	medium	.	.	.	.
	high	0.9	15	60	133
Italy	low	25.4	151	-28	9
	medium	50.9	507	-1	12
	high	25.5	330	30	45
Lombardia	low	1.6	48	37	54
	medium	3.2	53	65	131
	high	1.7	16	80	156
Portugal	low	2.6	16	-12	-6
	medium	4.6	35	0	1
	high	3.1	35	8	6
United Kingdom	low	3.8	47	39	2
	medium	7.6	131	54	2
	high	3.9	83	67	1
EUR 12	low	79.8	618	-9	15
	medium	159.6	1,897	11	23
	high	79.8	1,233	75	39

Note: In the table categories have been calculated on weighting factors on the farm (including their area) and a minimum threshold of 15 farms has been used for the sample size. When this threshold is not reached for one or more of the categories, no data are given for these categories.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Phosphate surplus increases with rising net nitrogen surplus in most of the countries with the exception of cereal farms in Denmark, Spain and the United Kingdom. Phosphate surplus of cereal farms in Denmark, Portugal and the United Kingdom is very small.

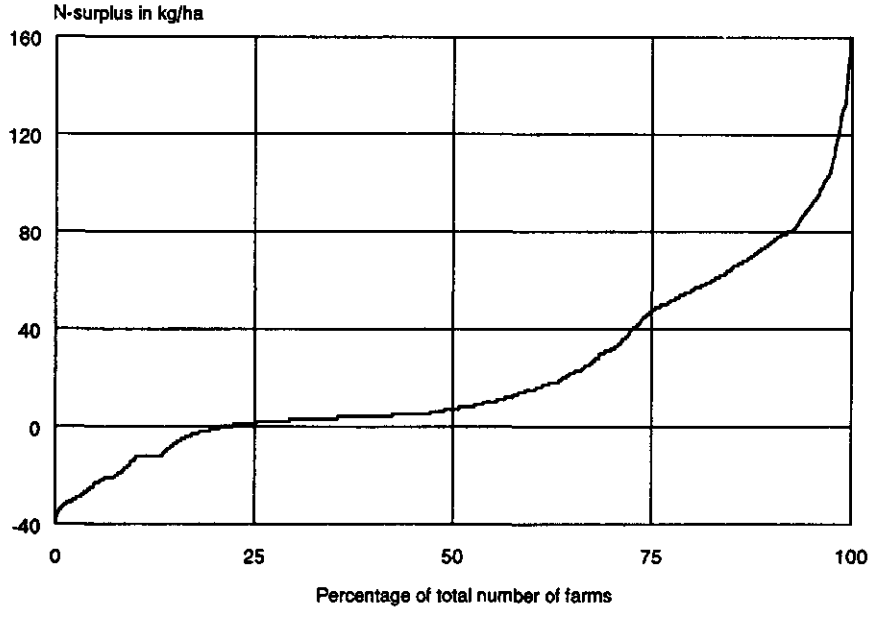

Figure 4.1 Net nitrogen surplus of cereal farms across the European Union in 1990/91 (farms ranked by net nitrogen surplus)
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

4.3 General cropping farms

Net nitrogen surplus of about half of the general cropping farms is less than 25 kg/ha; it is between 25 and 50 kg/ha for the next 25% of farms and exceeds 100 kg/ha for 10% of the farms with highest nitrogen surplus (figure 4.2). Net nitrogen surplus in Spain, Italy and Portugal is below 10 kg/ha (section 3.3) and around 60% of the total number of general cropping farms in EUR 12 is located in these three countries.

Net nitrogen surplus across groups of farms in EUR 12 is negative at 25% of the farms with lowest surplus and around 100 kg/ha at the group with highest surplus. Net nitrogen surplus of 25% of the general cropping farms with highest surplus exceeds that of cereal farms in all Member States except Greece and France. Mineral surpluses at cereal farms and general cropping farms show only small differences in Greece and France. In cate-

gory 'high' it exceeds 100 kg/ha in Belgium, Denmark, Germany, France and the Netherlands (table 4.2). Phosphate surplus increases with increasing net nitrogen surplus in all Member States with the exception of Belgium and Spain. Phosphate surplus in Belgium and Spain in category 'low' does not differ very much from that in category 'high'. Phosphate surplus across groups of farms in the Netherlands is equal for all nitrogen categories.

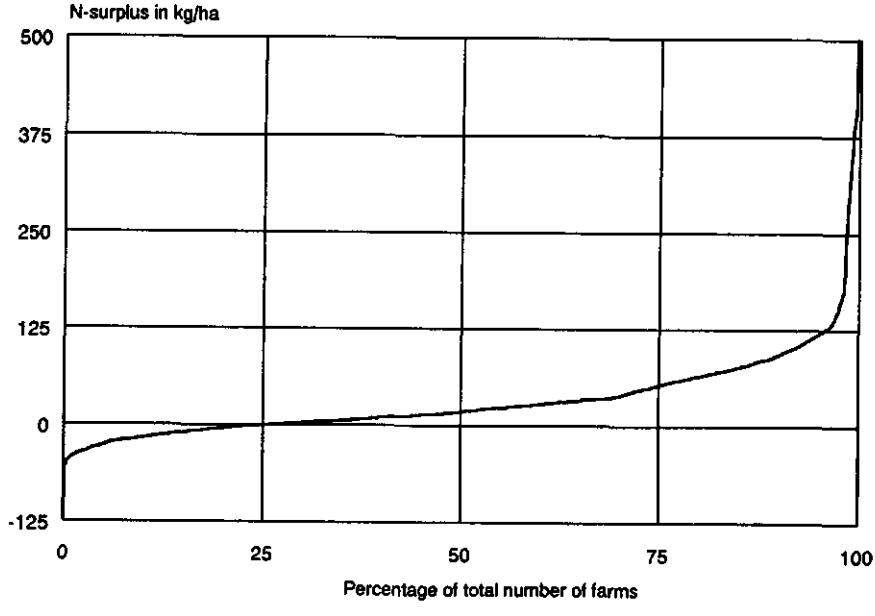

Figure 4.2 *Net nitrogen surplus of general cropping farms across the European Union in 1990/91 (farms ranked by net nitrogen surplus)*
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

Table 4.2 *Distribution of average surplus of N and P_2O_5 on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on general cropping farms*

Country/region	Category	Number of farms represented (x 1,000)	Number of farms in sample	Net nitrogen surplus kg N/ha	Phosphate surplus kg P_2O_5/ha
Belgium	low	2.0	46	82	117
	medium	4.0	71	100	113
	high	2.0	48	130	107
Denmark	low	6.2	123	64	1
	medium	12.3	264	80	3
	high	6.2	136	108	11
Germany	low	14.3	259	88	46
	medium	28.6	562	113	60
	high	14.3	298	138	65
Nieder-	low	3.2	66	98	47
sachsen	medium	6.5	142	118	70
	high	3.2	72	137	72
Greece	low	52.5	643	11	21
	medium	105.0	1,301	25	39
	high	52.6	632	68	74
Spain	low	37.9	592	-2	41
	medium	76.1	978	8	27
	high	37.9	479	33	33
France	low	28.4	421	37	37
	medium	56.9	862	72	47
	high	28.5	419	110	92
Northern	low	9.6	146	52	29
cereal area	medium	19.1	361	73	35
	high	9.6	182	94	48
Ireland	low	.	.	.	.
	medium	1.5	21	50	81
	high	0.8	17	66	111
Italy	low	120.7	1,039	-29	10
	medium	241.4	2,913	0	18
	high	120.7	1,567	41	64
Lombardia	low	4.6	33	22	67
	medium	9.1	136	39	110
	high	4.8	70	74	141
Netherlands	low	3.5	83	256	215
	medium	7.0	166	335	216
	high	3.6	85	424	217
Portugal	low	41.8	141	-13	-3
	medium	83.1	249	9	8
	high	41.2	65	97	72
United Kingdom	low	5.4	84	48	4
	medium	10.7	269	65	4
	high	5.3	127	86	11
England East	low	2.7	51	55	3
	medium	5.5	157	68	3
	high	2.7	73	87	11
EUR 12	low	313.3	3,023	-15	15
	medium	626.4	7,140	19	28
	high	313.3	4,802	98	54

Notes and source: See table 4.1.

4.4 Dairy farms

Net nitrogen surplus on about half the number of dairy farms in the EU is less than 100 kg/ha; it exceeds 150 kg/ha for 25% of the farms with highest surplus and even 300 kg/ha for about 10% of the farms with highest net nitrogen surplus (figure 4.3). Net nitrogen surplus increases rapidly within the group of dairy farms with highest surplus level. The distribution among farms of net nitrogen surplus is large; the average of all dairy farms in EUR 12 is 114 kg/ha (table 3.5).

Net nitrogen surplus of dairy farms across EUR 12 shows a rather diverse pattern. In EUR 12 the surplus in category 'high' (220 kg/ha) is about sixfold that of category 'low' (40 kg/ha) (table 4.3). Differences between both categories are at least 100 kg in Belgium, Denmark, Spain, Italy, the Netherlands and Portugal. In Belgium, Denmark, Spain, Lombardia and the Netherlands net nitrogen surplus in category 'high' exceeds that of EUR 12 in that category. Net nitrogen surplus at category 'low' in the Netherlands (286 kg/ha) exceeds that of the average of category 'high' in EUR 12. Differences in Bretagne among farms with low and high net nitrogen balances are rather small (112 and 137 kg/ha) compared to other regions. This is also the case to a lesser extent in Germany and Luxembourg.

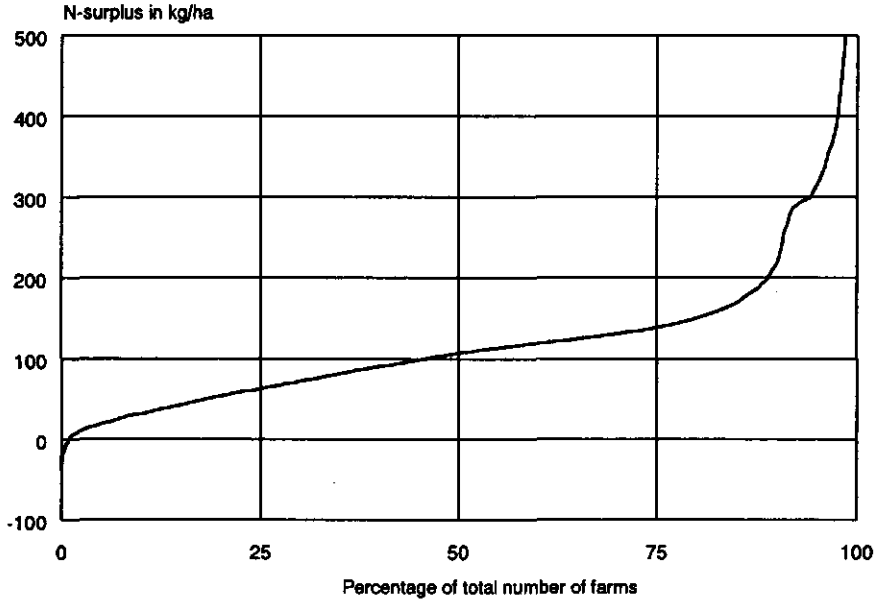

Figure 4.3 *Net nitrogen surplus of dairy farms across the European Union in 1990/91 (farms ranked by net nitrogen surplus). (Source: FADN-CCE-DG VII/A-3; adaptation LEI-DLO)*

Table 4.3 Distribution of average surplus of N and P_2O_5 on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on dairy farms

Country/region	Category	Number of farms represented (x 1,000)	Number of farms in sample	Net nitrogen surplus kg N/ha	Phosphate surplus kg P_2O_5/ha
Belgium	low	3.3	38	122	94
	medium	6.8	98	158	86
	high	3.3	55	225	81
Denmark	low	3.8	92	123	16
	medium	7.6	235	163	25
	high	3.8	103	245	44
Germany	low	33.0	339	101	40
	medium	66.5	653	127	43
	high	33.1	337	163	46
Nordrhein-Westfalen	low	3.0	24	111	42
	medium	6.0	82	134	44
	high	3.0	54	183	49
Spain	low	16.3	290	27	38
	medium	32.4	812	73	46
	high a)	16.3	276	305	181
France	low	31.5	413	35	26
	medium	63.0	737	80	47
	high	31.5	276	126	187
Bretagne	low	7.7	54	112	232
	medium	15.3	131	124	203
	high	7.7	63	137	199
Ireland	low	14.0	67	36	37
	medium	27.9	215	76	27
	high	13.9	173	120	46
Italy	low	19.5	385	6	21
	medium	39.3	1,245	64	40
	high	19.6	831	186	100
Lombardia	low	3.8	15	44	44
	medium	7.1	217	120	65
	high	3.7	158	247	137
Luxembourg	low	0.3	39	100	59
	medium	0.7	109	121	58
	high	0.3	61	149	55
Netherlands	low	9.5	112	286	122
	medium	18.9	248	319	99
	high	9.5	127	461	139
Portugal	low	6.8	59	-2	-2
	medium	13.1	182	53	28
	high a)	6.7	105	187	108
United Kingdom	low	8.8	173	69	19
	medium	17.6	370	109	31
	high	8.8	178	158	56
England West	low	2.8	37	79	18
	medium	5.5	89	114	29
	high	2.8	45	170	60
EUR 12	low	147.4	2,358	37	28
	medium	294.9	4,463	104	55
	high	147.4	2,636	221	77

a) Note: See table 3.5.
Notes and source: See table 4.1.

4.5 Drystock farms

The distribution of net nitrogen surplus of 75% of the drystock farms in EUR 12 with smallest surplus level (figure 4.4) is about equivalent to the distribution of the same group of dairy farms. Net nitrogen surplus of the group of drystock farms with highest surplus per ha is however much higher than with that of dairy farms. Net nitrogen surplus of about 10% of drystock farms exceeds 500 kg/ha; such high surplus levels are only assessed on about 2% of the number of dairy farms in EUR 12. This is due to the fact that animal density in livestock units per ha of utilized agricultural area at drystock farms in some Member States (e.g. Greece and the Netherlands) is considerably higher than on dairy farms. Utilized agricultural area per drystock farm in Greece and the Netherlands on average is 4 and 19 ha, which is less than on dairy farms (respectively 6 and 29 ha).

The distribution of net nitrogen surplus among drystock farms in EUR 12 shows a wide range. The averages of the categories 'low' and 'high' range between 4 and 254 kg/ha (table 4.4). Net nitrogen surplus in category 'low' is negative in Spain, Italy and Portugal. Average net surplus of the farms within group 'high' are very large in Greece (St. Ellas N. Egae. Kriti) and Spain. Animal density at the group of drystock farms with high nitrogen surpluses therefore is much larger than the average of all drystock farms in Greece (5 LU per ha of UAA). Net nitrogen surplus of group 'high' in the Netherlands is high as well and exceeds 1,800 kg/ha.

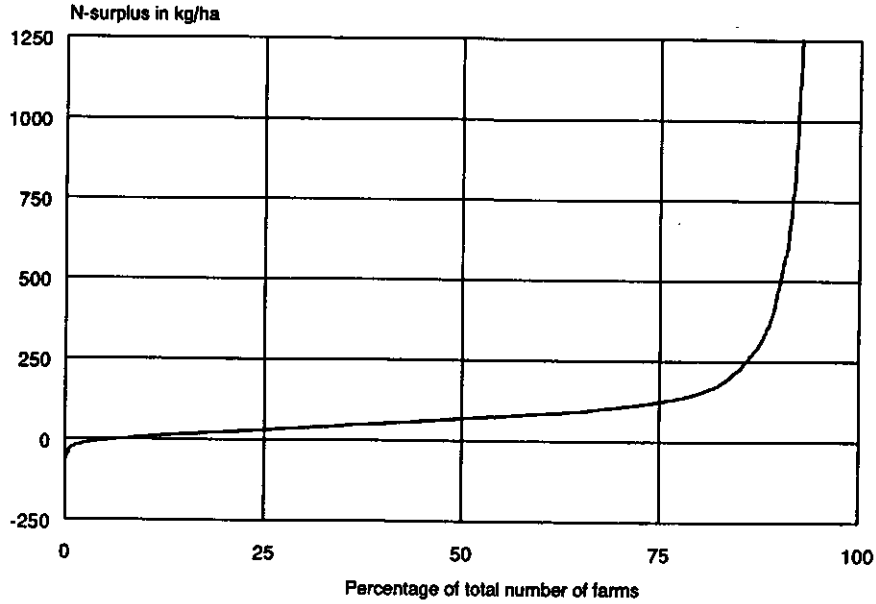

Figure 4.4 *Net nitrogen surplus of drystock farms across the European Union in 1990/91 (farms ranked by net nitrogen surplus). (Source: FADN-CCE-DG VIIA-3; adaptation LEI-DLO)*

Table 4.4 *Distribution of average surplus of N and P_2O_5 on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on drystock farms*

Country/region	Category	Number of farms represented (x 1,000)	Number of farms in sample	Net nitrogen surplus kg N/ha	Phosphate surplus kg P_2O_5/ha
Belgium	low	1.4	26	123	91
	medium	2.7	71	163	85
	high	1.4	37	317	132
Germany	low	4.9	65	96	42
	medium	10.0	142	122	45
	high	4.9	83	168	49
Greece	low	12.2	156	95	89
	medium	24.4	363	338	323
	high a)	12.2	195	4,768	4,749
St.Ellas N.Egae.	low	4.1	51	114	116
Kriti	medium a)	8.3	108	721	748
	high a)	4.0	64	∞	∞
Spain	low	24.1	357	-1	27
	medium	48.7	530	93	75
	high a)	24.2	250	∞	∞
Galicia	low	6.0	68	19	43
	medium	12.0	138	68	51
	high a)	6.1	65	238	153
France	low	23.0	327	11	25
	medium	46.4	576	48	29
	high	23.1	245	101	76
Pays de la	low	3.5	26	76	57
Loire	medium	6.8	57	90	58
	high	3.4	38	109	55
Ireland	low	17.7	155	23	43
	medium	35.5	295	57	31
	high	17.8	185	97	34
Italy	low	19.2	395	-14	11
	medium	38.3	863	37	29
	high	19.2	627	160	96
Lombardia	low	.	.	.	.
	medium	3.9	54	81	45
	high	1.9	67	214	115
Luxembourg	low	.	.	.	.
	medium	0.2	19	118	58
	high	.	.	.	.
Netherlands	low	.	.	.	.
	medium	2.4	27	411	128
	high a) b)	1.6	15	1,828	1,002
Portugal	low	10.9	106	-14	-8
	medium	20.6	173	22	16
	high	10.5	85	126	88
United Kingdom	low	11.0	290	9	3
	medium	22.0	419	68	19
	high	10.9	287	113	34
England West	low	1.8	35	51	10
	medium	3.6	53	83	20
	high	1.7	37	122	32
EUR 12	low	125.7	1,848	4	15
	medium	251.3	3,576	66	32
	high a)	125.7	1,973	254	167

a) Note: See table 3.5; b) Highest 33% of the farms, medium as described in table heading.
Notes and source: See table 4.1.

4.6 Granivore farms

Net nitrogen surplus exceeds 250 kg/ha at around 75% of granivore farms in the European Union (figure 4.5). It even exceeds 1,000 kg/ha on around half of all granivore farms across EUR 12. The small size of utilized agricultural area on such farms of course is an important phenomenon in this respect. This farming type includes a considerable share of farms with an area arable crops and grass of less than 1 ha. Net nitrogen surplus is therefore also depicted at farm level in this section.

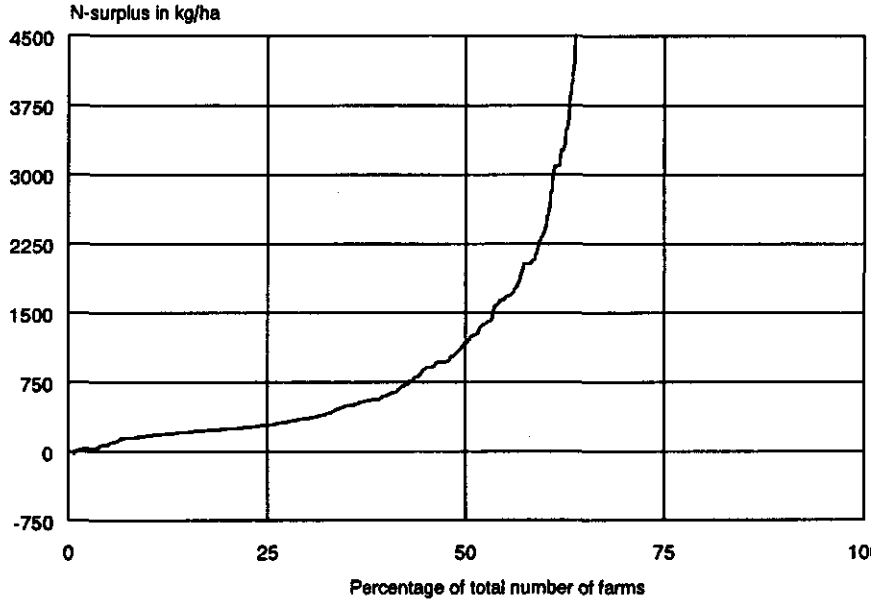

Figure 4.5 *Net nitrogen surplus of granivore farms across the European Union in 1990/91 (farms ranked by net nitrogen surplus). (Source: FADN-CCE-DG VIIA-3; adaptation LEI-DLO)*

Total net nitrogen surplus at farm level in EUR 12 differs largely among groups of farms with small and those with high surplus levels. It is in the range between around 2,300 kg (Italy, category 'low') and almost 13,000 kg (Denmark, category 'high'). Farm structure and livestock density differ largely among granivore farms in the EU. Net nitrogen surplus at farm level of the group of farms with highest surplus exceeds 10,000 kg in Belgium, Denmark, France and the Netherlands (table 4.5).

Net nitrogen surplus at farm level (instead of per ha) in category 'high' exceeds that of category 'low' in all countries, with the exception of Portugal and the United Kingdom. Surplus of nitrogen per farm in the United Kingdom at category 'low' (11,300 kg) is almost double the surplus at group

'high' (6,030 kg). Area arable crops and grass of all farms in group 'high' is zero in Belgium, Spain (including Aragon and Cataluna), Portugal and the United Kingdom. The area of fodder maize is assumed to be 0.001 ha in such cases.

Table 4.5 Distribution of average surplus of N and P_2O_5 on the 33% of farms with lowest N-surplus (low) and the 33% of farms with highest N-surplus (high) and the category in between (medium) on granivore farms

Country/region	Category	Number of farms represented (x 1,000)	Number of farms in sample	Net nitrogen surplus kg N per		Phosphate surplus kg P_2O_5 per	
				ha	farm	ha	farm
Belgium	low	1.2	53	555	6,311	407	4,635
	medium a)	1.2	48	2,094	5,985	1,804	5,156
	high a)	1.2	40	∞	10,374	∞	9,751
Denmark	low	1.6	55	171	5,494	52	1,676
	medium	1.6	68	241	7,771	88	2,835
	high a)	1.5	81	418	12,678	189	5,722
Germany	low	1.5	16	172	2,402	74	1,034
	medium	.	.	.	.	.	.
	high	.	.	.	.	.	.
Spain	low a)	5.4	59	172	2,426	173	2,445
	medium a)	5.3	66	5,848	6,799	6,842	7,953
	high a)	5.3	72	∞	6,551	∞	7,257
Aragon and	low a)	2.3	29	175	2,408	187	2,579
Cataluna	medium a)	2.2	34	3,082	4,667	3,453	5,230
	high a)	2.3	21	∞	8,814	∞	9,831
France	low	2.9	64	202	6,032	197	5,875
	medium	3.0	57	360	8,136	361	8,144
	high a)	2.9	57	1,273	12,299	1,402	13,548
Bretagne	low	1.7	37	206	6,370	203	6,278
	medium	1.7	39	335	8,054	335	8,061
	high a)	1.7	39	1,002	11,688	1,092	12,734
Italy	low	1.6	17	271	2,258	306	2,555
	medium	.	.	.	.	.	.
	high	.	.	.	.	.	.
Netherlands	low	3.2	51	831	7,402	522	4,647
	medium a)	3.3	66	3,144	9,933	2,480	7,836
	high a)	3.2	61	∞	11,639	∞	10,052
Portugal	low a)	1.1	24	187	2,966	205	3,244
	medium a)	1.0	21	4,579	2,399	5,002	2,621
	high a)	1.1	22	∞	2,331	∞	2,643
United Kingdom	low	1.4	32	405	11,312	281	7,838
	medium a)	1.5	29	2,824	11,636	2,376	9,792
	high a)	1.4	18	∞	6,030	∞	5,180
EUR 12	low	20.2	431	221	5,185	150	3,526
	medium a)	20.5	378	1,095	8,560	1,007	7,873
	high a)	20.0	352	∞	7,995	∞	8,090

a) Note: See table 3.5.
Notes and source: See table 4.1.

4.7 Mixed farms

Net nitrogen surplus on 75% of the mixed farms in EUR 12 is below 125 kg/ha and it increases rapidly within the group of mixed farms with highest surplus (figure 4.6). It was already mentioned before that this farming type includes a wide variety of crop and livestock combinations. Net nitrogen surplus within this group of farms is highest at farms with mixed livestock (e.g. mixed livestock, mainly granivores) and lowest at farms with crops and livestock combined.

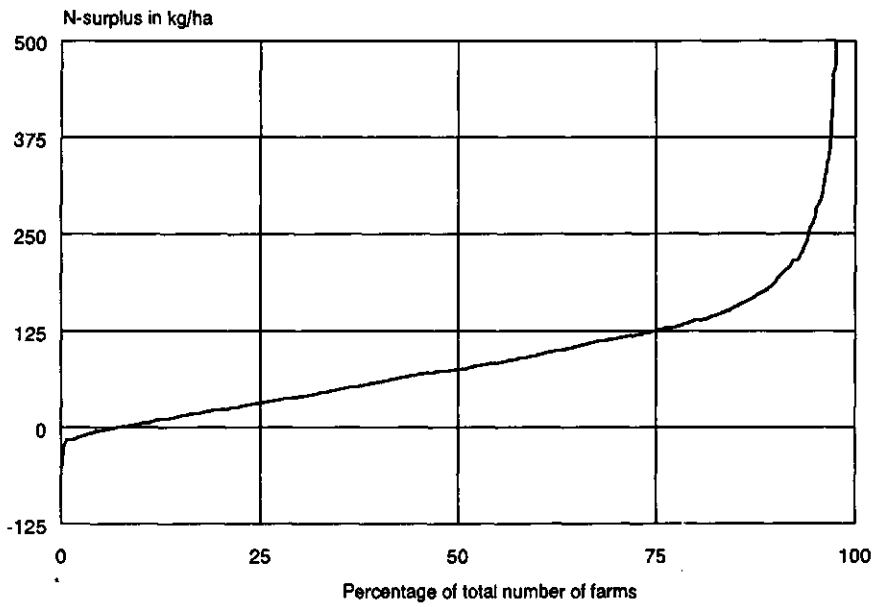

Figure 4.6 *Net nitrogen surplus of mixed farms across the European Union in 1990/91 (farms ranked by net nitrogen surplus). (Source: FADN-CCE-DG VIIA-3; adaptation LEI-DLO)*

Nitrogen surplus differs largely among groups of mixed farms. It differs in EUR 12 between 7 (group 'low') and 196 kg/ha (group 'high'). This is due to the combinations of crop and/or livestock production. Net nitrogen surplus of category 'low' is smallest in Spain, Italy and Portugal; it is highest in the Netherlands (almost 300 kg/ha). Net nitrogen surplus of category 'high' exceeds 300 kg/ha in Belgium, Spain and the Netherlands (table 4.6). It is highest in the region of Aragon and Cataluna (1,660 kg/ha), to be followed by the Netherlands (1,060 kg/ha).

Table 4.6 Distribution of average surplus of N and P_2O_5 on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on mixed farms

Country/region	Category	Number of farms represented (x 1,000)	Number of farms in sample	Net nitrogen surplus kg N/ha	Phosphate surplus kg P_2O_5/ha
Belgium	low	3.6	89	115	99
	medium	7.1	175	167	91
	high	3.6	123	397	228
Denmark	low	5.2	121	96	14
	medium	10.5	303	129	23
	high	5.2	168	209	51
Germany	low	30.4	435	95	42
	medium	60.9	905	126	48
	high	30.5	481	189	64
Nordrhein-Westfalen	low	5.6	60	116	45
	medium	11.2	156	160	52
	high	5.6	85	222	77
Greece	low	9.4	214	34	27
	medium	18.9	223	82	57
	high a)	9.4	155	239	223
Spain	low	19.9	140	9	23
	medium	41.5	197	60	48
	high a)	18.1	51	459	439
Aragon and Cataluna	low	3.4	18	9	29
	medium	6.8	41	50	50
	high a)	3.5	27	1,660	1,766
France	low	23.9	323	41	32
	medium	47.7	640	78	46
	high	23.8	319	154	156
Bretagne	low	3.2	31	112	200
	medium	6.5	76	143	207
	high	3.2	46	223	196
Ireland	low	1.6	15	39	58
	medium	3.2	40	57	58
	high	1.6	35	100	62
Italy	low	34.5	520	-5	10
	medium	69.0	1,470	30	26
	high	34.5	918	103	76
Lombardia	low	1.6	29	42	54
	medium	3.8	90	82	68
	high	1.8	38	176	136
Luxembourg	low b)	0.2	15	95	59
	medium	0.2	28	115	57
	high	.	.	.	.
Netherlands	low	2.1	20	292	140
	medium	4.1	48	444	179
	high	2.1	20	1,064	674
Portugal	low a)	36.5	120	-7	-2
	medium	72.5	208	21	16
	high a)	35.3	101	200	181
United Kingdom	low	3.8	70	48	11
	medium	7.7	215	73	15
	high	3.8	109	143	53
EUR 12	low	170.5	1,781	7	15
	medium	341.1	4,812	79	42
	high a)	170.5	2,428	196	103

a) Note: See table 3.5; b) Lowest 33%, medium as described in table heading.
Notes and source: See table 4.1.

4.8 Concluding remarks

1. Net nitrogen surplus of cereal farms shows a rather homogeneous pattern across Member States compared to the other farming types considered. National averages are well below 100 kg/ha, and their standard deviations are relatively small (table 4.7). They also are below 100 kg N/ha for all groups of farms considered with the exception of the group of 25% of cereal farms with smallest surplus (category 'high') in Germany (115 kg/ha) and France (126 kg/ha). Nitrogen surpluses are lowest in Italy and Portugal.
   Net nitrogen surplus of cereal farms in Spain, Italy and Portugal is below the average pattern in EUR 12; it is above the average pattern of EUR 12 in Denmark, Germany and France. The distribution of net nitrogen surplus among farms in Greece, Ireland and the United Kingdom is around the average in EUR 12.
2. Net nitrogen surplus of general cropping farms is highest in the Netherlands. Net nitrogen surplus of the group of farms with smallest surplus (category 'low') in this country is higher than that of categories 'high' in the other countries.
   Net nitrogen surplus of general cropping farms in Belgium, Denmark, Germany, France and the Netherlands is also above the average pattern of general cropping farms in EUR 12. It is below the average pattern in Spain, Italy and Portugal.
3. Mineral surpluses of dairy farms show a rather diverse pattern across Member States. Net nitrogen surpluses in Belgium, Denmark and the Netherlands are above the average pattern of dairy farms in EUR 12, and their standard deviation is far below the average of all dairy farms in EUR 12. Nitrogen surpluses are relatively low in Ireland, Italy and Portugal. They are around the average pattern of EUR 12 in Germany, Spain, France, Luxembourg and the United Kingdom.
   Nitrogen surplus in category 'high' exceeds 200 kg/ha in Belgium, Denmark, Spain, Lombardia and the Netherlands; net nitrogen surplus in category 'low' is below 50 kg/ha in Spain, France, Ireland, Italy and Portugal.
   The standard deviation of net nitrogen surplus of dairy farms in EUR 12 is relatively high because the area of arable crops and grass is below 1 ha on a considerable number of dairy farms (at least 5%) in Spain and Portugal.
4. The distribution of net nitrogen surplus at around 75% of the drystock farms in EUR 12 is about equivalent to that of dairy farms. Net nitrogen surplus of the remaining group of drystock farms exceeds that of dairy farms. Net nitrogen surplus of about 10% of the drystock farms in EUR 12 exceeds 500 kg/ha
   Net nitrogen surplus in Belgium, Greece, Spain and the Netherlands is above the average pattern in EUR 12, and below that pattern in France, Ireland, Italy and Portugal. It is around the average pattern in Germany, Luxembourg and the United Kingdom.

Table 4.7 Net nitrogen surplus (kg N/ha) and standard deviation (between brackets) by farming type in 1990/91

Country/region	Cereal		General cropping		Dairy		Drystock		Granivore		Mixed	
Belgium	.	(.)	103	(22)	162	(42)	178	(1,195)	1,591	(a)	184	(121)
Denmark	68	(12)	83	(19)	165	(47)	.	(.)	273	(1,494)	139	(50)
Germany	96	(17)	115	(20)	129	(25)	126	(31)	224	(46)	132	(38)
Niedersachsen	.	(.)	118	(16)	.	(.)	.	(.)	.	(.)	.	(.)
Nordrhein-Westfalen	.	(.)	.	(.)	140	(30)	.	(.)	.	(.)	163	(41)
Greece	27	(22)	30	(40)	161	(616)	308	(9,261)	6,282	(a)	78	(1,191)
St.Ellas N.Egae.												
Kriti	.	(.)	.	(.)	.	(.)	400	(a)	.	(.)	.	(.)
Spain	6	(5)	9	(15)	76	(1,086)	43	(7,592)	1,024	(a)	36	(5,703)
Galicia	.	(.)	.	(.)	.	(.)	60	(115)	.	(.)	.	(.)
Aragon and Catal.	.	(.)	.	(.)	.	(.)	.	(.)	1,035	(a)	87	(a)
France	79	(32)	74	(29)	76	(35)	47	(278)	427	(a)	82	(48)
North.cer. area	.	(.)	76	(16)	.	(.)	.	(.)	.	(.)	.	(.)
Pays de la Loire	.	(.)	.	(.)	.	(.)	91	(14)	621	(a)	.	(.)
Bretagne	.	(.)	.	(.)	124	(11)	.	(.)	392	(a)	151	(47)
Ireland	51	(11)	50	(15)	79	(36)	52	(30)	.	(.)	69	(45)
Italy	4	(24)	1	(26)	72	(151)	25	(69)	1,239	(2,181)	30	(468)
Lombardia	56	(18)	48	(24)	122	(84)	110	(79)	.	(.)	97	(77)
Luxembourg	.	(.)	.	(.)	123	(19)	121	(22)	.	(.)	117	(31)
Netherlands	.	(.)	333	(66)	337	(78)	455	(1,890)	2,335	(a)	488	(305)
Portugal	0	(8)	4	(31)	40	(598)	3	(42)	470	(a)	14	(410)
United Kingdom	55	(12)	68	(17)	108	(38)	35	(41)	909	(a)	79	(42)
England East	.	(.)	71	(15)	.	(.)	.	(.)	1,107	(a)	.	(.)
England West	.	(.)	.	(.)	114	(42)	77	(30)	.	(.)	.	(.)
EUR 12	32	(37)	57	(64)	114	(214)	48	(2,533)	688	(a)	85	(1,934)

(a) Standard deviation exceeds 10,000 kg N/ha and is therefore not presented.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

5. Net nitrogen surplus per farm at granivore farms is above the average pattern of EUR 12 in Belgium, Denmark, France and the Netherlands on average, it exceeds 10,000 kg per farm in these countries. It is below the average pattern in Germany, Spain, Italy and Portugal. Farm structure and livestock density differ largely among granivore farms in the EU.
6. Net nitrogen surpluses of mixed farms are relatively high compared to the average pattern in EUR 12 in Belgium, Denmark, Greece, Spain and the Netherlands. It is relatively low in Italy and Portugal; and around the average pattern of EUR 12 in Germany, France, Ireland, Luxembourg and the United Kingdom.

5. MINERAL SURPLUS AND STRUCTURE OF GENERAL CROPPING FARMS

5.1 Introduction

The distribution among farms of net nitrogen surplus was presented by farming type in the previous chapter. Some characteristics of farm structure will be examined of groups of farms with relatively small and those with relatively high surpluses. This is aimed at providing basic elements of farm structure which are critical to the assessment of mineral surpluses. General cropping farms have been selected because of the wide variation among farms in net nitrogen surplus. The distribution of net nitrogen surplus among general cropping farms in EUR 12 is in the range between -15 kg/ha (category 'low') and 98 kg/ha (category 'high').

Some characteristics of farm structure and farm output are presented for regions with a relatively high level of net nitrogen surplus. Farm structure (cropping plan, livestock composition and animal density) and farm output of categories 'low' and 'high' are compared. The regions selected for this investigation are Belgium, Denmark, Niedersachsen (Germany), the Northern cereal area (France), Lombardia (Italy), the Netherlands and England East (United Kingdom). Figures are presented of the share in total net nitrogen surplus of a group of holdings with ascending order of net nitrogen surplus per ha. The share in total output from crops and livestock is also provided. Such figures provide information on the share in total surplus and in total output of a group of holdings with low surpluses compared to the group of holdings with high surpluses.

5.2 Belgium

Net nitrogen surplus at category 'high' is some 50 kg above that of category 'low' which is due to the relatively high production of animal manure at category 'high' (table 5.1). The purchase of fertilizers and manure shows no large variation, and is assessed to be 160 kg N/ha (category 'high') and 169 kg N/ha (category 'low'). Costs of purchased fertilizers per ha do not differ either among the categories distinguished. The density of livestock population increases with increasing net nitrogen surplus. Net nitrogen surplus is lowest at the group of farms with a low density of livestock population and a high share of cereals in the cropping plan.

Farm net value added per ha arable crops and permanent grass at category 'low' (1,162 ECU) is below that of category 'high' (1,347 ECU). The

share of livestock in total output per ha is 4% (category 'low'), 26% (category 'medium') and 45% (category 'high') 1).

Half of the general cropping farms in Belgium also have a share of almost 50% in total net nitrogen surplus of this farming type. The distribution among farms of total output from crops and livestock is rather similar to that of net nitrogen surplus. The area arable crops and permanent grass of the group of farms with lowest net nitrogen surplus is above that of the average of all farms. The share in total net nitrogen surplus of 25% of total area of arable crops and permanent grass with lowest surplus is about 20% (figure 5.1).

Table 5.1 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on general cropping farms in Belgium in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	165	46	71	48
Number of farms represented	8,035	2,047	3,970	2,018
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	163	169	162	160
Manure production (kg N/ha)	55	7	51	117
Net nitrogen surplus (kg N/ha)	103	82	100	130
Phosphate surplus (kg P_2O_5/ha)	113	117	113	107
Farm structure				
Area arable crops and permanent grass (ha)	36.4	38.8	35.7	35.4
of which cereals (%)	49	54	49	42
of which oil seeds (%)	2	2	2	2
of which sugar beet (%)	23	23	23	21
Economic size (ESU)	47.9	50.2	43.8	53.8
Economic size per ha a) (ESU)	1.3	1.3	1.2	1.5
Livestock density (LU/ha a))	0.7	0.1	0.6	1.6
Farm input				
Purchased fertilizers per ha a) (ECU)	168	165	167	171
Farm output				
Crop output per ha a) (ECU)	1,767	2,025	1,621	1,769
Livestock output per ha a) (ECU)	661	77	578	1,475
Farm net value added per ha a) (ECU)	1,153	1,162	1,050	1,347

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaption LEI-DLO.

1) These farms are nevertheless classified as general cropping farms because the standard gross margin (sgm) used for typology not necessarily reflects the high output due to high (pig) prices in the actual year 1990.

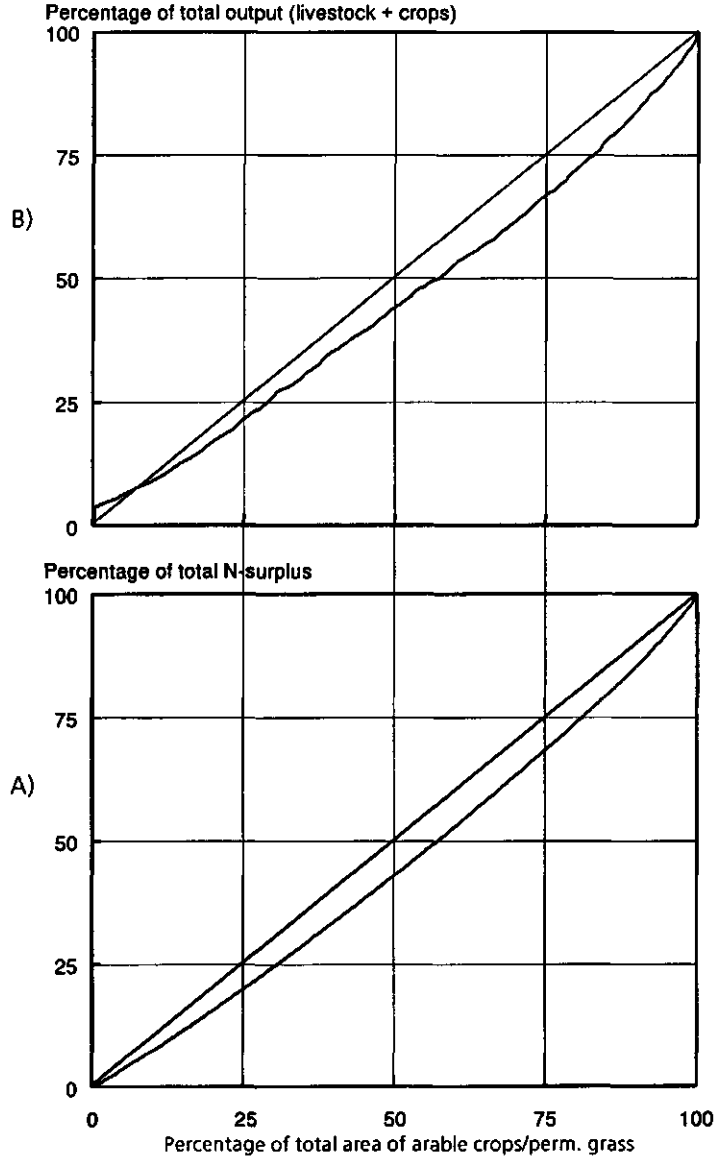

Figure 5.1 Share of total nitrogen surplus (part A) and share of total output (crops and livestock) (part B) by group of holdings, with ascending order of net nitrogen surplus per ha for general cropping farms in Belgium in 1990/91

5.3 Denmark

Net nitrogen surpluses of the three groups of general cropping farms in Denmark are below that of Belgium. This is primarily due to the lower production levels of animal manure (table 5.2). The production of animal manure at category 'high' (70 kg N/ha) exceeds that of category 'low' (5 kg N/ha). The share of cereals in the total cropping plan is high at all categories considered, and the share of oil seeds in the cropping plan increases with increasing net nitrogen surplus.

The output from crops and livestock is below that of general cropping farms in Belgium. The output from livestock as well as farm net value added per ha at category 'high' is above that of category 'low'.

Table 5.2 Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on general cropping farms in Denmark in 1990/91

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	523	123	264	136
Number of farms represented	24,620	6,156	12,312	6,152
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	160	137	169	164
Manure production (kg N/ha)	25	5	16	70
Net nitrogen surplus (kg N/ha)	83	64	80	108
Phosphate surplus (kg P_2O_5/ha)	4	1	3	11
Farm structure				
Area arable crops and permanent grass (ha)	37.4	35.0	40.8	33.1
of which cereals (%)	58	59	58	57
of which oil seeds (%)	14	7	14	21
of which sugar beet (%)	5	2	6	5
Economic size (ESU)	29.4	25.9	31.2	29.3
Economic size per ha a) (ESU)	0.8	0.7	0.8	0.9
Livestock density (LU/ha a))	0.4	0.1	0.3	1.1
Farm input				
Purchased fertilizers per ha a) (ECU)	125	133	122	126
Farm output				
Crop output per ha a) (ECU)	1,145	1,110	1,177	1,103
Livestock output per ha a) (ECU)	294	106	171	797
Farm net value added per ha a) (ECU)	481	388	495	542

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

The share in total net nitrogen surplus of a group of holdings with ascending order of net nitrogen surplus per holding shows a similar pattern in the total output of that group of holdings. Net nitrogen surplus increases

with increasing output from crops and livestock per ha. The group of farms with the smallest surplus has a less than proportional share in the total area of arable crops and permanent grass.

5.4 Germany

Net nitrogen surplus at general cropping farms in Niedersachsen exceeds that of general cropping farms in Belgium and Denmark. It ranges between 98 kg/ha (category 'low') and 137 kg/ha (category 'high'). The purchase of fertilizers and manure at category 'high' is assessed to be almost 80 kg above that of category 'low' (table 5.3). Also, the purchase of fertilizers and manure is substantially above the production of manure.

Table 5.3 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on general cropping farms in Niedersachsen in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	280	66	142	72
Number of farms represented	13,004	3,242	6,522	3,240
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	178	126	186	203
Manure production (kg N/ha)	25	22	19	42
Net nitrogen surplus (kg N/ha)	118	98	118	137
Phosphate surplus (kg P_2O_5/ha)	65	47	70	72
Farm structure				
Area arable crops and permanent grass (ha)	50.2	42.4	53.3	51.5
of which cereals (%)	55	53	55	56
of which oil seeds (%)	6	6	4	11
of which sugar beet (%)	18	10	21	17
Economic size (ESU)	42.0	31.4	45.3	45.8
Economic size per ha a) (ESU)	0.8	0.7	0.9	0.9
Livestock density (LU/ha a))	0.5	0.4	0.3	1.0
Farm input				
Purchased fertilizers per ha a) (ECU)	124	108	132	121
Farm output				
Crop output per ha a) (ECU)	1,339	919	1,445	1,467
Livestock output per ha a) (ECU)	425	304	304	776
Farm net value added per ha a) (ECU)	651	376	694	787

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

The share of cereals in the cropping plan is around 55% of the area of arable crops and permanent grass for all categories distinguished. The share

of oil seeds and sugar beet in the total area of category 'high' exceeds that of category 'low'. Livestock density at category 'high' (1 LU/ha) exceeds that of category 'low' (0.4 LU/ha). The output per ha from livestock and farm net value added per ha at category 'high' are more than double that of category 'low'. Total output per ha at category 'high' is almost double that of category 'low'.

The area of arable crops and permanent grass at category 'low' is below that of the other categories distinguished. The group of holdings in category 'low' also has a less than proportional share in the total area of arable crops and permanent grass than the group of holdings in category 'high'.

5.5 France

Net nitrogen surplus at general cropping farms in the Northern cereal area of France ranges between 52 and 94 kg/ha. This is mainly due to the

Table 5.4 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on general cropping farms in Northern cereal area of France in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	689	146	361	182
Number of farms represented	38,300	9,578	19,146	9,577
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	165	135	158	190
Manure production (kg N/ha)	13	9	15	11
Net nitrogen surplus (kg N/ha)	76	52	73	94
Phosphate surplus (kg P_2O_5/ha)	38	29	35	48
Farm structure				
Area arable crops and permanent grass (ha)	74.7	50.5	76.5	95.2
of which cereals (%)	54	54	54	55
of which oil seeds (%)	12	6	11	18
of which sugar beet (%)	8	12	9	6
Economic size (ESU)	59.4	43.4	59.7	74.5
Economic size per ha a) (ESU)	0.8	0.9	0.8	0.8
Livestock density (LU/ha a))	0.2	0.1	0.2	0.2
Farm input				
Purchased fertilizers per ha a) (ECU)	156	158	153	160
Farm output				
Crop output per ha a) (ECU)	1,362	1,767	1,232	1,356
Livestock output per ha a) (ECU)	138	79	160	134
Farm net value added per ha a) (ECU)	538	741	463	551

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

distribution among farms of the purchase of fertilizers and manure (table 5.4). The production of animal manure is around 10 kg N/ha. The area of arable crops and permanent grass at category 'high' (95 ha) is considerably above that of category 'low' (51 ha), and cereals cover about 55% of the cropping plan on all categories distinguished. The share of oil seeds in the cropping plan increases with increasing net nitrogen surplus.

Total output per ha from crops and livestock at category 'low' (1,846 ECU/ha) is above that of category 'high' (1,490 ECU/ha). Farm net value added per ha at category 'low' also exceeds that of category 'high'.

Farms with smallest net nitrogen surpluses have a relatively high share in total output from crops and livestock, compared to that of farms with high surplus levels (figure 5.2).

5.6 Italy

The net nitrogen surplus of general cropping farms in Italy is relatively low. Net nitrogen surpluses are negative or zero at categories 'low' and 'medium' (section 4.3). Mineral surplus is highest in Lombardia, and this region was selected for further investigation.

Net nitrogen surplus of general cropping farms in Lombardia is below that of the other regions considered in this chapter. It ranges between 22 and 74 kg/ha. The distribution among farms is mainly due to differences in the purchase of fertilizers and manure, which ranges between 106 (category 'low') and 172 kg/ha (category 'high') (table 5.5).

The shares of cereals and oil seeds in the total area of arable crops and permanent grass at category 'high' (64% and 23%) are above that of category 'low' (22% and 3%). Farm net value added per ha is relatively large (1,200 ECU/ha) at categories 'medium' and 'high' compared to that of category 'low' (660 ECU/ha).

Farms with low net nitrogen surpluses have a small share in total net nitrogen surplus of this farming type (figure 5.3). This is due to a combination of the small area of arable crops and permanent grass of these farms as well as the small surplus level.

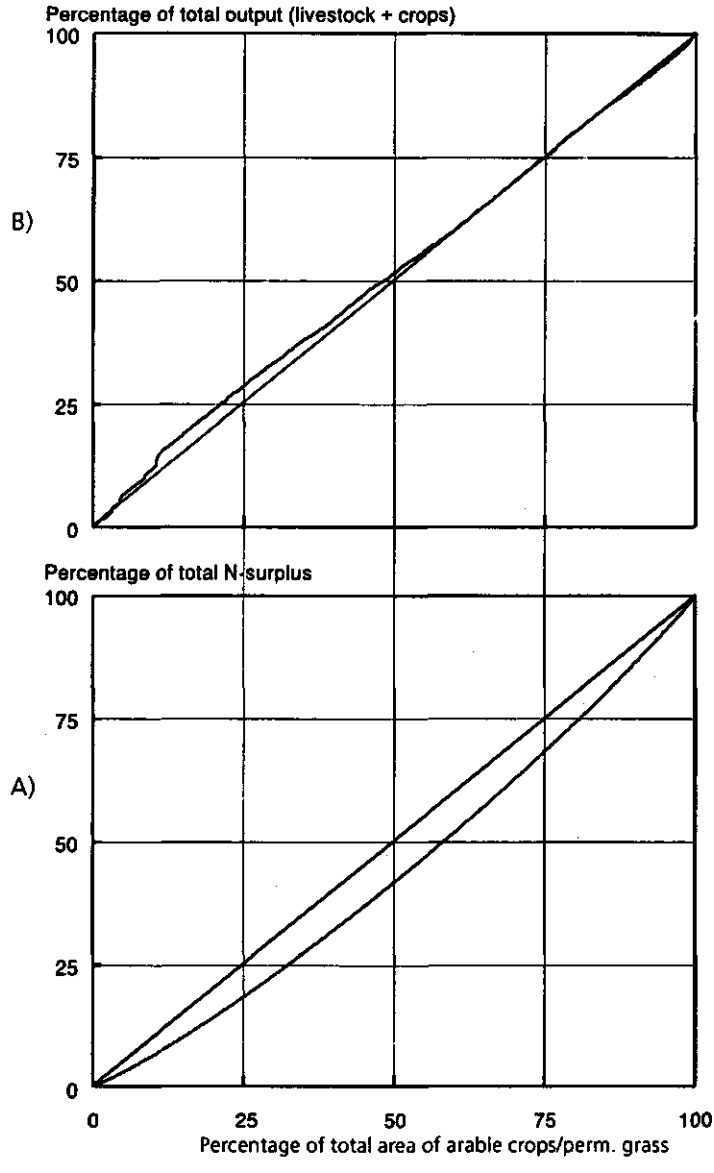

Figure 5.2 *Share of total nitrogen surplus (part A) and share of total output (crops and livestock) (part B) by group of holdings, with ascending order of net nitrogen surplus per ha for general cropping farms in Northern cereal area of France in 1990/91*

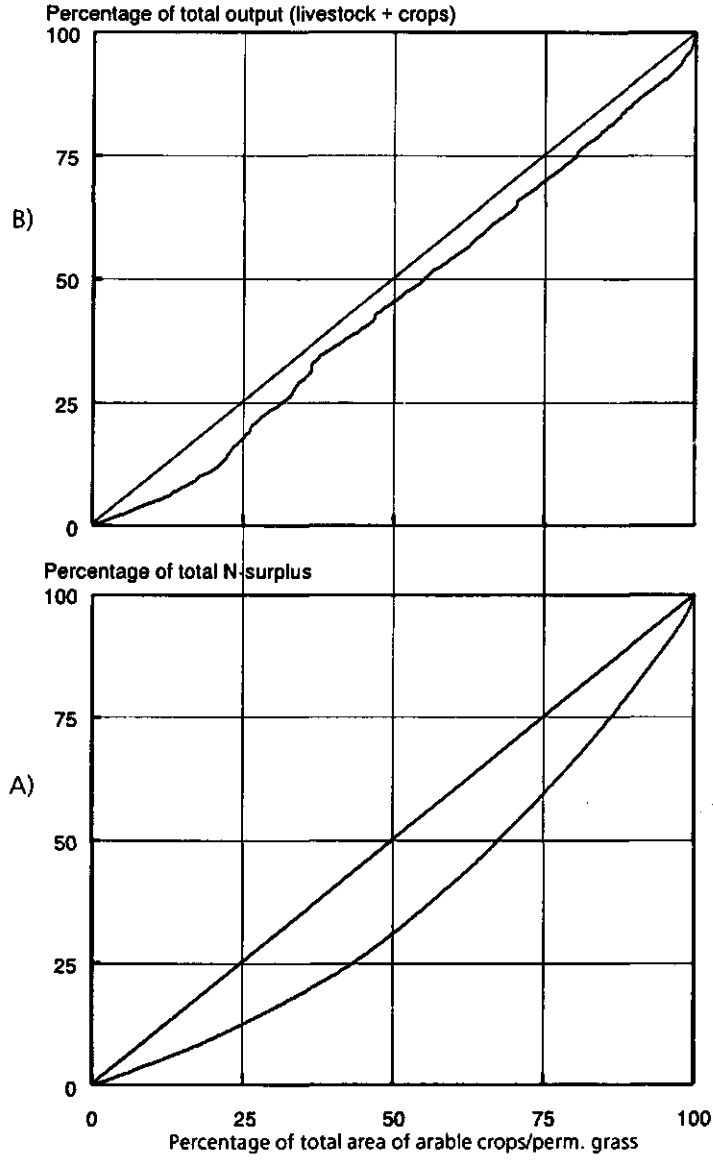

Figure 5.3 *Share of total nitrogen surplus (part A) and share of total output (crops and livestock) (part B) by group of holdings, with ascending order of net nitrogen surplus per ha for general cropping farms in Lombardia in 1990/91*

Table 5.5 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on general cropping farms in Lombardia in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	239	33	136	70
Number of farms represented	18,533	4,606	9,127	4,801
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	140	106	129	172
Manure production (kg N/ha)	11	-	4	25
Net nitrogen surplus (kg N/ha)	48	22	39	74
Phosphate surplus (kg P_2O_5/ha)	114	67	110	141
Farm structure				
Area arable crops and permanent grass (ha)	15.0	9.7	15.3	19.5
of which cereals (%)	46	22	42	64
of which oil seeds (%)	15	3	13	23
of which sugar beet (%)	9	1	15	4
Economic size (ESU)	20.9	7.1	22.6	31.0
Economic size per ha a) (ESU)	1.4	0.7	1.5	1.6
Livestock density (LU/ha a))	0.2	0.0	0.1	0.6
Farm input				
Purchased fertilizers per ha a) (ECU)	174	101	191	183
Farm output				
Crop output per ha a) (ECU)	2,316	1,361	2,567	2,397
Livestock output per ha a) (ECU)	244	-	100	576
Farm net value added per ha a) (ECU)	1,129	661	1,207	1,234

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

5.7 Netherlands

Net nitrogen surplus at general cropping farms in the Netherlands is assessed to range between 256 kg/ha (category 'low') and 424 kg/ha (category 'high'). The production of animal manure is low on this farming type, and the wide distribution of net nitrogen surpluses among the groups of farms is mainly due to the variation in purchase of fertilizers and manure (table 5.6).

The area of arable crops and permanent grass at category 'low' is above that of category 'high'. The share of cereals in the area of arable crops and permanent grass is highest in category 'low' (44%); the share of root crops (e.g. sugar beet and potatoes) in the total area is highest in category 'high'.

Farm net value added per ha is relatively high across the categories identified; it is highest (1,524 ECU/ha) at category 'medium'. The output per ha from crops and livestock rises with increasing net nitrogen surpluses.

Farms with low net nitrogen surpluses have a more than proportional share in the total area of arable crops and permanent grass. Total output per ha from crops and livestock increases proportional to the increasing level of net nitrogen surplus.

Table 5.6 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on general cropping farms in the Netherlands in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	334	83	166	85
Number of farms represented	14,038	3,489	6,993	3,557
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	430	366	433	502
Manure production (kg N/ha)	11	12	11	10
Net nitrogen surplus (kg N/ha)	333	256	335	424
Phosphate surplus (kg P_2O_5/ha)	216	215	216	217
Farm structure				
Area arable crops and permanent grass (ha)	39.1	42.7	40.1	33.4
of which cereals (%)	29	44	28	10
of which oil seeds (%)	1	2	1	-
of which sugar beet (%)	20	17	20	23
Economic size (ESU)	65.0	65.8	65.5	63.1
Economic size per ha a) (ESU)	1.7	1.5	1.6	1.9
Livestock density (LU/ha a))	0.1	0.1	0.1	0.1
Farm input				
Purchased fertilizers per ha a) (ECU)	157	150	160	160
Farm output				
Crop output per ha a) (ECU)	3,035	2,649	3,143	3,263
Livestock output per ha a) (ECU)	75	45	78	104
Farm net value added per ha a) (ECU)	1,420	1,244	1,524	1,395

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

5.8 United Kingdom

Net nitrogen surplus at general cropping farms in the United Kingdom ranges between 48 (category 'low') and 86 kg/ha (category 'high') (see also section 4.3). The distribution in England East is only slightly above that of general cropping farms in the United Kingdom.

The distribution of net nitrogen surplus among general cropping farms in England East is due to the variation in production of manure at such farms, as well as in purchase of fertilizers and manure (table 5.7). The amount of manure produced ranges between 16 and 50 kg N/ha; purchase of fertilizers and manure is in the range between 119 (category 'low') and

159 kg N/ha (category 'high'). The area of arable crops and permanent grass at category 'low' (119 ha) is substantially below that of category 'high' (208 ha). The output per ha of crops and livestock at category 'high' is more than double that of category 'low'.

The group of farms with small net nitrogen surplus have a less than proportional share in total net nitrogen surplus, as well as in the area arable crops and permanent grass, and in total output from crops and livestock.

Table 5.7 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on general cropping farms in England East in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	281	51	157	73
Number of farms represented	10,920	2,747	5,458	2,715
Mineral balance				
Purchase of fertilizer and manure(kg N/ha)	150	119	154	159
Manure production (kg N/ha)	24	16	13	50
Net nitrogen surplus (kg N/ha)	71	55	68	87
Phosphate surplus (kg P_2O_5/ha)	5	3	3	11
Farm structure				
Area arable crops and permanent grass (ha)	176.2	119.2	189.2	207.8
of which cereals (%)	56	54	58	52
of which oil seeds (%)	8	4	8	10
of which sugar beet (%)	9	7	10	8
Economic size (ESU)	187.4	91.9	193.4	271.8
Economic size per ha a) (ESU)	1.1	.8	1.0	1.3
Livestock density (LU/ha a))	0.4	0.2	0.2	0.9
Farm input				
Purchased fertilizers per ha a) (ECU)	113	94	111	127
Farm output				
Crop output per ha a) (ECU)	1,309	859	1,353	1,491
Livestock output per ha a) (ECU)	285	133	126	666
Farm net value added per ha a) (ECU)	645	359	603	886

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

5.9 Concluding remarks

1. Total output per ha from crops and livestock at category 'high' exceeds that of category 'low' for all regions investigated of general cropping farms, except in the Northern cereal area of France. The share of root crops (e.g. sugar beet) in total area arable crops and permanent grass in the Northern cereal area is highest in category 'low'. Output per ha of such root crops exceeds that of cereals.

Correlation between net nitrogen surplus and crop output per ha is positive in Lombardia and England East (table 5.8).

2. Output per ha from livestock at category 'high' exceeds that of category 'low' in all regions investigated. Livestock output per hectare increases with net nitrogen surplus in all regions, although the relationship is weak in Northern cereal area of France and the Netherlands. The share of livestock output in total output is highest (45%) in Belgium (category 'high').
3. Net nitrogen surpluses are highest at farms with a high supply of animal manure and a high share of oil seeds in total area of arable crops and permanent grass. Maximum rates considered to substitute between organic manure and fertilizers are important in this respect. The share of organic manure in total nitrogen requirements to grow oil seeds is up to 20%.
   Correlation between the assessed purchase of fertilizers and manure (kg N/ha) and the costs of purchased fertilizers (ECU) only is positive in Niedersachsen, Lombardia and England East (table 5.8). General cropping farms also apply animal manure from other farms which might explain negative correlation coefficients in Belgium and the Netherlands. The maximum rate of organic manure in total nitrogen requirements to grow potatoes and sugar beet in the Netherlands may be up to 50-60%.

Table 5.8 Correlation coefficients between general variables and net nitrogen surplus on general cropping farms

	Belgium	Denmark	Niedersachsen	Northern cereal area	Lombardia	Netherlands	England East
Net nitrogen surplus (kg N/ha)							
Purchased feedingstuffs per ha a) (ECU)	0.81	0.61	0.47	0.27	0.47	0.12	0.55
Purchased fertilizers per ha a) (ECU)	-0.15	-0.07	0.04	-0.09	0.34	-0.29	0.08
Area arable crops and permanent grass (ha)	-0.08	-0.03	0.14	0.29	0.19	-0.05	0.04
of which cereals (%)	-0.16	-0.10	0.07	0.05	0.62	-0.55	-0.00
of which oil seeds (%)	-0.01	0.43	0.27	0.40	0.29	-0.18	0.18
of which sugar beet (%)	0.05	0.02	0.22	-0.18	-0.08	0.32	-0.08
Crop output per ha a) (ECU)	-0.17	-0.07	-0.14	-0.22	0.24	-0.31	0.15
Farm net value added per ha a) (ECU)	-0.17	-0.07	-0.11	-0.19	0.22	-0.30	0.17
Phosphate surplus (kg P_2O_5/ha)	0.17	0.64	0.52	0.65	0.71	0.27	0.77
Nitrogen input, purchase of fertilizer and manure (kg N/ha)							
Purchased fertilizers per ha a) (ECU)	-0.40	-0.16	0.09	-0.16	0.42	-0.40	0.32

a) Area arable crops and permanent grass.

Costs of purchased fertilizers at category 'high' differs by less than 10% from that of category 'low' in Belgium, Denmark, Niedersachsen, Northern cereal area and the Netherlands.

4. Correlation between net nitrogen surplus and the share of sugar beet in total area of arable crops and permanent grass is highest in Niedersachsen and the Netherlands. The share of sugar beet in the total cropping plan of category 'high' there exceeds that of category 'low'.

6. MINERAL SURPLUS AND STRUCTURE OF DAIRY FARMS

6.1 Introduction

Some characteristics of farm structure for dairy farms are described in this chapter. A distinction is made between farms with a low net nitrogen surplus and those with a high surplus. This farming type was selected because of its large distribution of net nitrogen surplus across farms, its rather homogeneous nature of production with emphasis on milk production, and because it is a very important farming type in terms of production.

Regions selected are Belgium, Denmark, Nordrhein-Westfalen (Germany), Bretagne (France), Lombardia (Italy), the Netherlands and England West (United Kingdom). The FADN sample in the regions selected represents at least some 10,000 farms. Dairy farming is important in the regions identified. Also, regions selected are the ones with a large variation in net nitrogen surplus among farms (Lombardia) as well as regions with a rather homogeneous distribution of net nitrogen surpluses among farms (e.g. Bretagne).

6.2 Belgium

Net nitrogen surplus for the 25% of farms with highest surplus is about double of the 25% of farms with lowest surplus (table 6.1). The production of animal manure, as well as the density of livestock population at category 'high' also is double that of category 'low'.

Net nitrogen surplus increases with increasing shares of pigs and poultry in total livestock population. The share of pigs and poultry in total livestock population among the categories considered ranges between 1% (group 'low') and 15% (group 'high'). The costs of purchased feedingstuffs per ha at group 'high' is more than fourfold that of group 'low'.

The output from livestock as well as farm net value added per ha at group 'high' is more than double that of the group 'low'. Milk production per ha of forage crops also increases with increasing intensity of farming practice, and is in the range between 4,600 kg/ha (group 'low') and 9,800 kg/ha (group 'high').

The group of farms with lowest net nitrogen surpluses have a less than proportional share in total net nitrogen surplus as well as in output from milk production per ha forage crops (figure 6.1). Their share in total area of arable crops and permanent grass is more than proportional. This is because the area of holdings in category 'low' on average is 32 hectares which is above the area of the other categories considered.

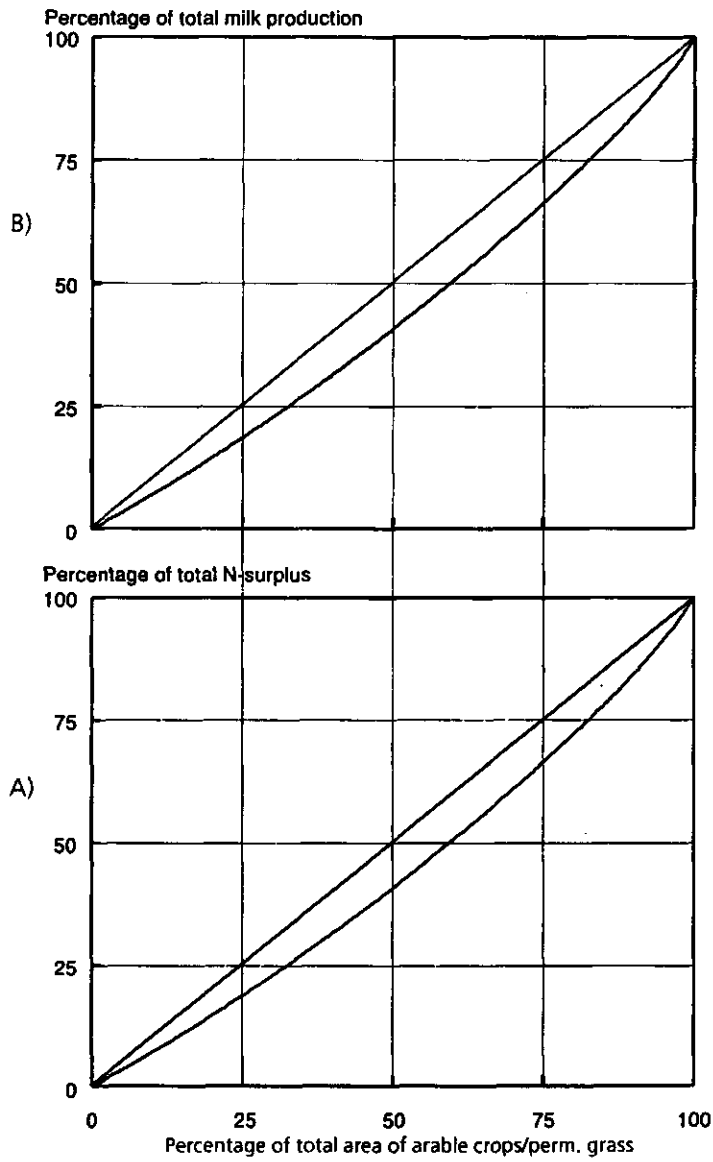

Figure 6.1 *Share of total nitrogen surplus (part A) and share of total milk production (part B) by group of holdings, with ascending order of net nitrogen surplus per ha on dairy farms in Belgium in 1990/91*

Table 6.1 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on dairy farms in Belgium in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	191	38	98	55
Number of farms represented	13,437	3,344	6,756	3,337
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	175	182	174	171
Manure production (kg N/ha)	197	135	192	290
Net nitrogen surplus (kg N/ha)	162	122	158	225
Phosphate surplus (kg P_2O_5/ha)	87	94	86	81
Farm structure				
Area arable crops and permanent grass (ha)	29	32	29	24
of which grass (including rough grazing) (%)	71	77	70	65
of which other forage crops (%)	22	15	22	31
Economic size (ESU)	32.2	26.0	32.1	38.5
Economic size per ha a) (ESU)	1.1	0.8	1.1	1.6
Livestock density (LU/ha a))	2.2	1.5	2.1	3.4
of which pigs and poultry (%)	6	1	2	15
of which grazing livestock (%)	94	99	98	85
Density of grazing livestock per ha forage crops (LU/ha)	2.2	1.6	2.2	3.0
Farm input				
Purchased feedingstuffs per ha a) (ECU)	484	228	415	996
Farm output				
Milk production per ha forage crops (kg)	6,950	4,607	6,985	9,843
Livestock output per ha a) (ECU)	2,597	1,644	2,556	3,971
Farm net value added per ha a) (ECU)	1,310	875	1,323	1,860

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

6.3 Denmark

Milk production per ha forage crops at dairy farms in Denmark is some 40% higher than in Belgium, but net nitrogen surplus at dairy farms does not differ among both countries (table 6.2). The average net nitrogen surplus of dairy farms in Denmark is 165 kg N/ha, which is similar to that of Belgium. Net nitrogen surplus at group 'high' in Denmark is some 10% above that of Belgium.

Livestock density at category 'high' in Denmark (3 LU/ha) is more than double that of category 'low' (1.3 LU/ha). The output of livestock per ha in Denmark is only slightly higher than in Belgium, and farm net value added per ha is below that of Belgium. The share of pigs and poultry in total livestock population is rather low in Denmark (up to 4%) and does not show major variation across the groups of farms considered.

The area of arable crops and permanent grass at category 'high' is only 23 ha, compared to an average of all dairy farms in Denmark of 36 hectares. The group of farms with small net nitrogen surpluses therefore has a more than proportional share in total area of arable crops and permanent grass. The shares in total net nitrogen surplus and total milk production of this group of farms is less than proportional.

Table 6.2 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on dairy farms in Denmark in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	430	92	235	103
Number of farms represented	15,270	3,784	7,642	3,844
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	159	155	160	166
Manure production (kg N/ha)	201	137	198	317
Net nitrogen surplus (kg N/ha)	165	123	163	245
Phosphate surplus (kg P_2O_5/ha)	26	16	25	44
Farm structure				
Area arable crops and permanent grass (ha)	36	40	40	23
of which grass (including rough grazing) (%)	14	16	15	11
of which other forage crops (%)	48	42	47	60
Economic size (ESU)	44.9	38.1	49.5	42.5
Economic size per ha a) (ESU)	1.3	0.9	1.2	1.8
Livestock density (LU/ha a))	1.9	1.3	1.9	3.0
of which pigs and poultry (%)	4	2	4	4
of which grazing livestock (%)	96	98	96	96
Density of grazing livestock per ha forage crops (LU/ha)	2.9	2.2	2.9	4.0
Farm input				
Purchased feedingstuffs per ha a) (ECU)	672	387	660	1200
Farm output				
Milk production per ha forage crops (kg)	10,130	7,737	10,217	13,189
Livestock output per ha a) (ECU)	2,748	1,870	2,764	4,187
Farm net value added per ha a) (ECU)	1,085	776	1,114	1,514

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

6.4 Germany

Net nitrogen surpluses of dairy farms in Nordrhein-Westfalen (table 6.3) are only slightly smaller than surpluses of dairy farms in Belgium. The production of animal manure as well as the purchase of fertilizers and animal manure in Nordrhein-Westfalen are substantially below that of dairy

farms in Belgium. Net nitrogen surpluses in Nordrhein-Westfalen are only slightly below that of Belgium because the uptake of nitrogen in Belgium is high compared to that of Nordrhein-Westfalen. Purchased feedingstuffs per ha in this region increases with increasing intensity of production, but these costs remain below that of Belgium and Denmark.

Table 6.3 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on dairy farms in Nordrhein-Westfalen in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	160	24	82	54
Number of farms represented	11,942	2,980	5,983	2,978
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	130	126	131	132
Manure production (kg N/ha)	131	89	123	191
Net nitrogen surplus (kg N/ha)	140	111	134	183
Phosphate surplus (kg P_2O_5/ha)	45	42	44	49
Farm structure				
Area arable crops and permanent grass (ha)	32	29	34	30
of which grass (including rough grazing) (%)	74	81	78	57
of which other forage crops (%)	10	3	7	26
Economic size (ESU)	30.3	19.9	30.1	41.2
Economic size per ha a) (ESU)	1.0	0.7	0.9	1.4
Livestock density (LU/ha a))	1.6	1.1	1.5	2.4
of which pigs and poultry (%)	3	2	3	5
of which grazing livestock (%)	97	98	97	95
Density of grazing livestock per ha forage crops (LU/ha)	1.8	1.3	1.7	2.7
Farm input				
Purchased feedingstuffs per ha a) (ECU)	324	165	285	567
Farm output				
Milk production per ha forage crops (kg)	5,877	4,007	5,444	8,722
Livestock output per ha a) (ECU)	2,126	1,416	2,007	3,091
Farm net value added per ha a) (ECU)	955	636	938	1,306

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

The share of pigs and poultry in total livestock population in Nordrhein-Westfalen is relatively small. It is 5% in category 'high' compared to an average of 3% across all dairy farms in this region.

The area of arable crops and permanent grass increases proportionally among farms, but milk production per ha of forage crops increases more than proportionally with increasing net nitrogen surplus.

6.5 France

The distribution among farms of net nitrogen surplus in Bretagne shows a limited variation. Net nitrogen surplus of category 'high' is only 22% above that of category 'low'. The production of animal manure ranges among these categories between 86 (category 'low') and 139 kg N/ha (category 'high'). Milk production between these groups is in the range between 5,200 and 7,600 kg per ha (table 6.4). Milk production per ha of forage crops in Bretagne therefore also shows a limited variation among the groups of farms considered, compared to that in other countries and regions. Farm net value added per ha is relatively small in Bretagne, compared to the other regions investigated. Milk production per ha of forage crops and livestock output per ha in Bretagne are relatively small as well, and around the levels of Nordrhein-Westfalen. The area of arable crops and permanent grass increases proportionally with increasing net nitrogen surplus (figure 6.2). Milk production per hectare of forage crops increases more than proportionally with increasing net nitrogen surplus. This trend is similar to that in Nordrhein-Westfalen, although differences among farms in Bretagne are less than among the ones in Nordrhein-Westfalen.

Table 6.4 Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on dairy farms in Bretagne in 1990/91

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	248	54	131	63
Number of farms represented	30,706	7,691	15,305	7,710
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	125	126	124	124
Manure production (kg N/ha)	115	86	118	139
Net nitrogen surplus (kg N/ha)	124	112	124	137
Phosphate surplus (kg P_2O_5/ha)	210	232	203	199
Farm structure				
Area arable crops and permanent grass (ha)	30	32	29	29
of which grass (including rough grazing) (%)	9	11	10	5
of which other forage crops (%)	75	69	76	78
Economic size (ESU)	23.6	20.6	23.2	27.2
Economic size per ha a) (ESU)	0.8	0.6	0.8	0.9
Livestock density (LU/ha a))	1.4	1.0	1.4	1.7
of which pigs and poultry (%)	3	0	2	8
of which grazing livestock (%)	97	100	98	92
Density of grazing livestock per ha forage crops (LU/ha)	1.6	1.3	1.6	1.9
Farm input				
Purchased feedingstuffs per ha a) (ECU)	310	176	314	445
Farm output				
Milk production per ha forage crops (kg)	6,398	5,272	6,387	7,590
Livestock output per ha a) (ECU)	2,010	1,481	2,076	2,450
Farm net value added per ha a) (ECU)	695	516	713	854

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

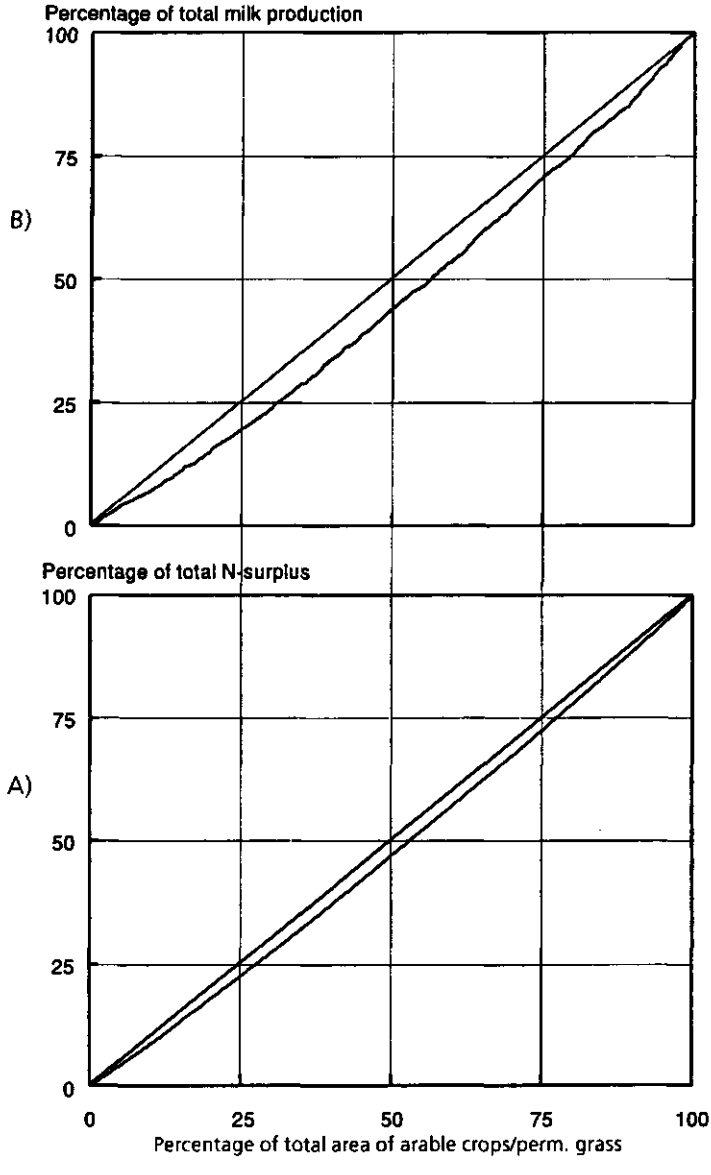

Figure 6.2 *Share of total nitrogen surplus (part A) and share of total milk production (part B) by group of holdings, with ascending order of net nitrogen surplus per ha on dairy farms in Bretagne in 1990/91*

6.6 Italy

Farm structure and farm output do differ largely among the group of farms with highest and the group with lowest net nitrogen surplus (table 6.5). Differences among these groups in Lombardia are larger than in the other regions considered. The production of manure at category 'high' (434 kg N/ha) is more than tenfold that of category 'low' and double that of category 'medium'. Land utilized to grow arable crops and permanent grass is relatively small in Lombardia (around 20 ha) compared to the other regions considered. The group of dairy farms with lowest nitrogen surplus is rather extensive, with livestock density of 0.4 LU/ha arable crops and permanent grass. Milk production per ha is also very small. Contrary to this, animal density at the group of farms with highest net nitrogen surplus is 5.3 LU/ha ara-

Table 6.5 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on dairy farms in Lombardia in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	390	15	217	158
Number of farms represented	14,633	3,825	7,142	3,667
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	62	69	63	49
Manure production (kg N/ha)	204	31	218	434
Net nitrogen surplus (kg N/ha)	122	44	120	247
Phosphate surplus (kg P_2O_5/ha)	73	44	65	137
Farm structure				
Area arable crops and permanent grass (ha)	20	24	19	16
of which grass (including rough grazing) (%)	45	93	27	14
of which other forage crops (%)	42	5	54	73
Economic size (ESU)	32.0	6.0	34.4	54.4
Economic size per ha a) (ESU)	1.6	0.3	1.8	3.3
Livestock density (LU/ha a))	2.5	0.4	2.6	5.3
of which pigs and poultry (%)	1	-	0	2
of which grazing livestock (%)	99	100	100	98
Density of grazing livestock per ha forage crops (LU/ha)	2.8	0.4	3.2	6.0
Farm input				
Purchased feedingstuffs per ha a) (ECU)	1,356	136	1,236	3,479
Farm output				
Milk production per ha forage crops (kg)	10,605	986	12,084	24,046
Livestock output per ha a) (ECU)	4,826	701	5,012	10,678
Farm net value added per ha a) (ECU)	2,558	408	2,813	5,252

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

ble crops and permanent grass. Milk production per ha is also very high (24,000 kg/ha forage crops). Farm net value added achieved by these farms is very high (5,300 ECU/ha). The costs of purchased feedingstuffs per ha also are very high at category 'high'.

The group of dairy farms in Lombardia with a small net nitrogen surplus has a less than proportional share in total net nitrogen surplus and an even smaller share in regional milk production (figure 6.3). These farms however have a high share in total area of arable crops and permanent grass; the area of dairy farms in category 'low' is higher than at the other categories distinguished.

Only 25% of total net nitrogen surplus and less than 20% of milk production is produced on about half of the total area of arable crops and permanent grass of holdings with smallest net nitrogen surpluses. Approximately half of total net nitrogen surplus in Lombardia is assessed on farms with highest surpluses, which cover 25% of total area of arable crops and permanent grass.

6.7 Netherlands

Net nitrogen surpluses among the groups of farms considered are in the range between 280 and 460 kg/ha (table 6.6). Manure production ranges among both groups of farms between 278 kg N/ha (category 'low') and 582 kg N/ha (category 'high'). Land utilized to grow arable crops and forage crops at the group of farms with a high nitrogen surplus is rather small (22 ha) compared to the other groups considered. Milk production per ha at the group of farms with a high nitrogen surplus is very high (14.8 tonnes per ha forage crops). About 37% of total livestock population at the group of farms with a high surplus is pigs and poultry. It is only 2% at the group of farms with lowest nitrogen surplus.

The share of farms in total net nitrogen surplus as well as in total milk production increases proportionally with increasing net nitrogen surplus. Farms with low net nitrogen surplus represent a more than proportional share in total area of arable crops and permanent grass at farms.

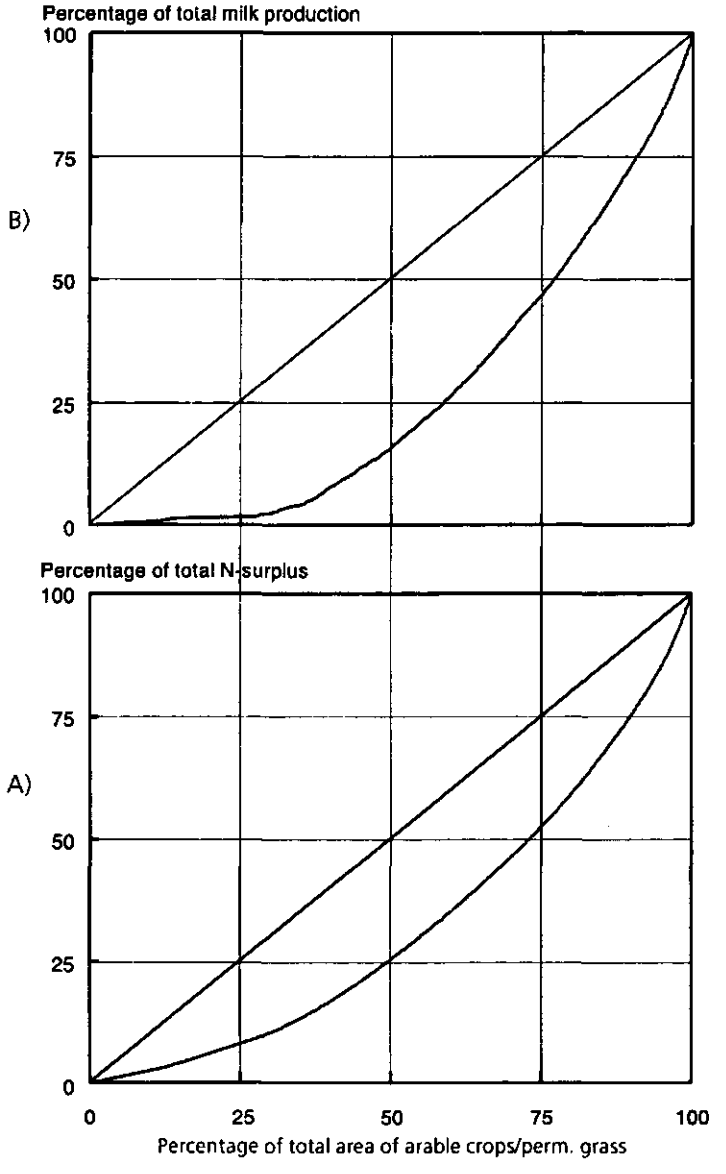

Figure 6.3 *Share of total nitrogen surplus (part A) and share of total milk production (part B) by group of holdings, with ascending order of net nitrogen surplus per ha on dairy farms in Lombardia in 1990/91*

Table 6.6 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on dairy farms in the Netherlands in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	487	112	248	127
Number of farms represented	37,894	9,467	18,931	9,496
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	221	243	217	201
Manure production (kg N/ha)	383	278	365	582
Net nitrogen surplus (kg N/ha)	337	286	319	461
Phosphate surplus (kg P_2O_5/ha)	113	122	99	139
Farm structure				
Area arable crops and permanent grass (ha)	29	31	31	22
of which grass (including rough grazing) (%)	86	86	89	77
of which other forage crops (%)	13	13	10	23
Economic size (ESU)	55.2	45.3	57.8	59.9
Economic size per ha a) (ESU)	1.9	1.5	1.9	2.7
Livestock density (LU/ha a))	3.1	2.1	2.8	5.5
of which pigs and poultry (%)	16	2	6	37
of which grazing livestock (%)	84	98	93	63
Density of grazing livestock per ha forage crops (LU/ha)	2.7	2.1	2.7	3.5
Farm input				
Purchased feedingstuffs per ha a) (ECU)	1,008	466	800	2,359
Farm output				
Milk production per ha forage crops (kg)	11,539	8,880	11,704	14,834
Livestock output per ha a) (ECU)	4,566	3,221	4,297	7,230
Farm net value added per ha a) (ECU)	1,897	1,464	1,864	2,605

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

6.8 United Kingdom

Net nitrogen surpluses increase at dairy farms with increasing output from livestock production (table 6.7). The size of farms with a high net nitrogen surplus is relatively small compared to the other farms considered. Total land coverage to grow arable crops and forage crops at the group of farms with highest surpluses is only 44 ha, compared to an average of dairy farms of 61 hectares.

The share of farms in total net nitrogen surplus as well as in total milk production increases proportionally with increasing net nitrogen surplus. The figures are rather similar to the ones for dairy farms in the Netherlands. Farms with a low net nitrogen surplus represent a more than proportional share of farms in total area of arable crops and permanent grass.

Table 6.7 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on dairy farms in England West in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	171	37	89	45
2Number of farms represented	11,120	2,764	5,549	2,807
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	85	85	86	85
Manure production (kg N/ha)	156	105	156	238
Net nitrogen surplus (kg N/ha)	114	79	114	170
Phosphate surplus (kg P_2O_5/ha)	32	18	29	60
Farm structure				
Area arable crops and permanent grass (ha)	61	72	64	44
of which grass (including rough grazing) (%)	60	65	58	55
of which other forage crops (%)	31	25	32	41
Economic size (ESU)	60.2	51.1	64.0	61.8
Economic size per ha a) (ESU)	1.0	0.7	1.0	1.4
Livestock density (LU/ha a))	1.9	1.3	1.9	2.9
of which pigs and poultry (%)	2	0	0	7
of which grazing livestock (%)	98	100	100	93
Density of grazing livestock per ha forage crops (LU/ha)	2.0	1.4	2.1	2.8
Farm input				
Purchased feedingstuffs per ha a) (ECU)	500	293	495	848
Farm output				
Milk production per ha forage crops (kg)	7,395	4,806	7,667	10,577
Livestock output per ha a) (ECU)	2,159	1,380	2,195	3,314
Farm net value added per ha a) (ECU)	848	530	875	1,284

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

6.9 Concluding remarks

1. Farm structure characteristics, such as density of livestock population, area arable crops and permanent grass, and share of pigs and poultry in livestock population as well as the output realized from farming practice do differ largely across the regions considered. Net nitrogen surplus is correlated positively in all regions with the costs of purchased feedingstuffs per ha (table 6.8). Correlation of net nitrogen surplus with milk production per ha of forage crops also is positive in all regions investigated.
2. Costs of purchased feedingstuffs show a positive correlation with net nitrogen surplus of dairy farms in the regions considered. This is explained by the fact that the need for feeding stuffs rises with increas-

ing intensity of production. The share of pigs and poultry in total livestock population is also highest at category 'high' in the regions investigated. In category 'high' this share is 15% in Belgium and 37% in the Netherlands 1).

3. Correlation coefficients between net nitrogen surplus and phosphate surplus are strongly positive in all regions distinguished, except in Belgium and in Bretagne (table 6.8). These differences are due to cropping pattern and livestock composition.

Table 6.8 Correlation coefficients between general variables and net nitrogen surplus on dairy farms

	Belg-ium	Den-mark	Nord-rhein-West-falen	Bret-agne	Lom-bardia	Nether-lands	Eng-land West
Net nitrogen surplus (kg N/ha)							
Purchased feedingstuffs per ha a) (ECU)	0.70	0.82	0.79	0.60	0.92	0.92	0.67
Purchased fertilizers per ha a) (ECU)	0.30	0.07	0.43	0.22	0.41	0.03	0.36
Area arable crops and permanent grass (ha)	-0.23	-0.31	-0.04	-0.04	-0.04	-0.31	-0.22
of which grass (including rough grazing) (%)	-0.14	-0.18	-0.52	-0.14	-0.45	-0.22	-0.14
of which field crops (%)	-0.18	-0.25	0.06	-0.09	0.09	-0.09	-0.16
of which other forage crops (%)	0.27	0.35	0.72	0.17	0.49	0.26	0.20
Milk production per ha forage crops (kg)	0.70	0.59	0.73	0.39	0.79	0.58	0.64
Farm net value added per ha a) (ECU)	0.63	0.55	0.56	0.31	0.83	0.57	0.67
Phosphate surplus (kg P_2O_5/ha)	0.06	0.97	0.67	-0.17	0.93	0.70	0.95
Nitrogen input, purchase of fertilizer and manure (kg N/ha)							
Purchased fertilizers per ha a) (ECU)	-0.42	0.13	-0.11	-0.09	-0.22	-0.18	0.20

a) Area arable crops and permanent grass.

4. Correlation coefficients are examined between the costs of purchased fertilizers per ha (from the FADN data base) and the input of nitrogen by purchase of fertilizers and manure. They are negative in most of the regions investigated, except in Denmark and England West (table 6.8). This is due to the starting points of the assessments to quantify surplu-

1) These farms are nevertheless classified as dairy farms because the standard gross margin (sgm) used for typology not necessarily reflects the high output due to high (pig) prices in the actual year 1990.

ses. The input of minerals at dairy farms does not reflect the intensity of production at farm level because regional averages have been used on yields of grass and other forage crops. The input of minerals at farm level therefore depends on regional averages of yields of forage crops and normative figures on the minerals required to achieve such yields. Contrary to this, the costs of fertilizers in the FADN are based on farming practice.

7. MINERAL SURPLUS AND STRUCTURE OF GRANIVORE FARMS

7.1 Introduction

The distribution of net nitrogen surplus among granivore farms in EUR 12 ranges between 221 (category 'low') and 31,000 kg/ha (category 'high') (section 4.6). The interpretation of figures per ha are difficult at this farming type because of the farms with small areas of arable crops and permanent grass. The area of arable crops and grass is less than 1 ha on at least five percent of the number of granivore farms represented by FADN in Belgium, Denmark, Spain, France, the Netherlands, Portugal and the United Kingdom.

The regions selected for the investigation of farm structure characteristics at granivore farms are Belgium, Denmark, Bretagne (France), Aragon and Cataluna (Spain) and the Netherlands.

Farm structure characteristics, input and output characteristics are not presented on a per hectare basis in case they exceed 10,000 units per hectare. They are depicted as ∞ in such cases.

7.2 Belgium

Net nitrogen surplus per farm ranges between 5,900 kg N (category 'low') and 12,100 kg N (category 'high') (table 7.1). The area of arable crops and permanent grass is 0.0 ha at category 'high', and 12 ha at category 'low'. Total livestock population at category 'high' (334 LU) is about double that of category 'low'. The share of poultry in total livestock population is very large at category 'high' (66%). It is only 1% at category 'medium'.

Net nitrogen surplus and farm output from crops and livestock increases proportionally for about half of the farms with smallest net nitrogen surplus. This group of farms includes about all of arable land and permanent grass of granivore farms in Belgium. Net nitrogen surplus and total output from crops and livestock increase less than proportionally for another 25% of the granivore farms in Belgium. More than half of net nitrogen surplus of granivore farms in Belgium is observed on 75% of total area of arable crops and permanent grass (figure 7.1).

Table 7.1 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on granivore farms in Belgium in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	141	39	71	31
Number of farms represented	3,571	886	1,791	894
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	142	139	149	20
Manure production (kg N/ha)	2,211	627	2,490	∞
Net nitrogen surplus (kg N/ha)	1,591	484	1,784	∞
Net nitrogen surplus per farm (kg N)	7,552	5,915	6,096	12,087
Phosphate surplus (kg P_2O_5/ha)	1,372	347	1,517	∞
Farm structure				
Area arable crops and permanent grass (ha)	4.7	12.2	3.4	0.0
of which cereals (%)	41	44	37	-
of which other forage crops (%)	15	14	18	100
Economic size (ESU)	41.5	42.5	41.2	41.0
Economic size per ha a) (ESU)	8.7	3.5	12.1	∞
Livestock population (LU)	222.3	169.4	192.7	334.0
of which pigs (%)	73	95	97	34
of which poultry (%)	25	-	1	66
Livestock density (LU/ha a))	46.8	13.9	56.4	∞
Farm input				
Purchased feedingstuffs (ECU)	119,214	74,614	91,533	218,808
Purchased feedingstuffs per ha a) (ECU)	∞	6,105	∞	∞
Farm output				
Crop output (ECU)	3,511	9,454	2,321	5
Crop output per ha a) (ECU)	740	774	679	5,280
Livestock output (ECU)	201,093	146,776	170,486	316,170
Livestock output per ha a) (ECU)	∞	∞	∞	∞
Farm net value added (ECU)	58,545	51,811	55,553	71,205
Farm net value added per ha a) (ECU)	∞	4,239	∞	∞

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

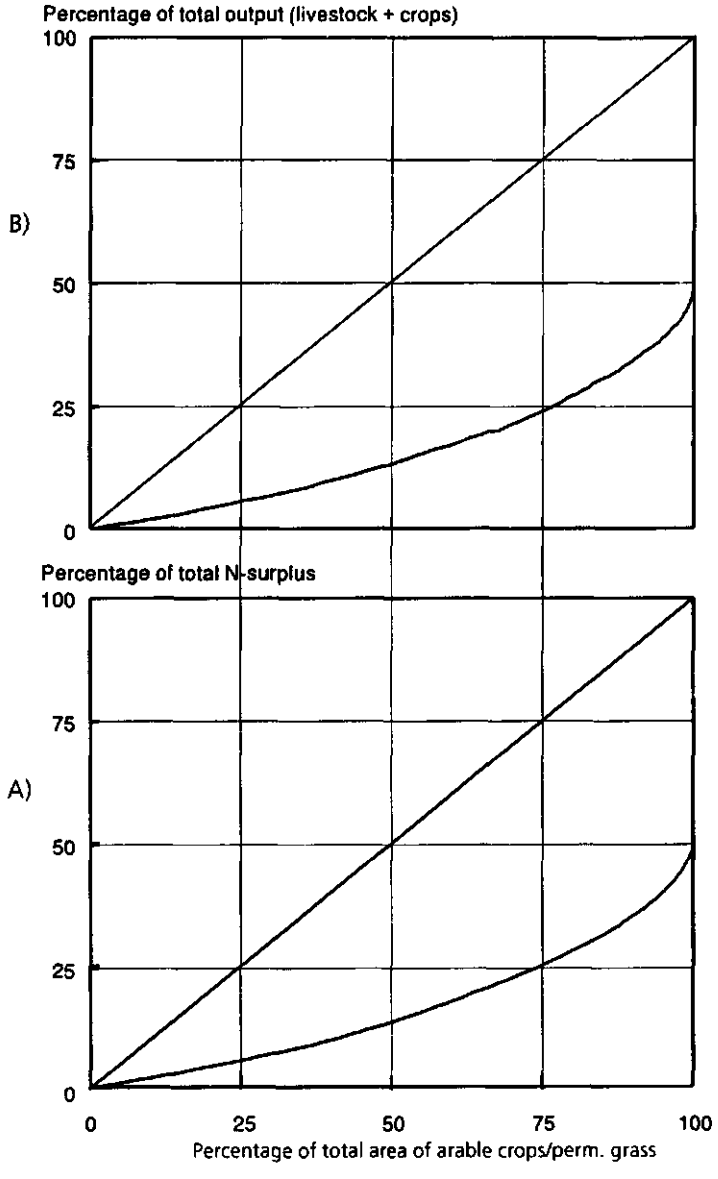

Figure 7.1 Share of total nitrogen surplus (part A) and share of total output (livestock and crops) (part B) by group of holdings, with ascending order of net nitrogen surplus per ha on granivore farms in Belgium in 1990/91

7.3 Denmark

The distribution of net nitrogen surplus at granivore farms in Denmark shows a rather similar pattern to that of granivore farms in Belgium, if reproduced at farm level. Net nitrogen surplus of these farms is well below that of Belgium if represented in kg per ha, which is due to the relatively large area of arable crops and permanent grass in Denmark (table 7.2).

Cereals cover at least 70% of the total area of arable crops and permanent grass for all categories distinguished. Farm net value added ranges between 46,000 ECU (category 'low') and 73,100 ECU (category 'high').

Net nitrogen surplus as well as total output from crops and livestock increase less than proportionally across farms with low net nitrogen surpluses (figure 7.2).

Table 7.2 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on granivore farms in Denmark in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	204	41	103	60
Number of farms represented	4,670	1,160	2,343	1,167
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	135	131	134	145
Manure production (kg N/ha)	330	170	291	637
Net nitrogen surplus (kg N/ha)	273	162	246	487
Net nitrogen surplus per farm (kg N)	8,636	5,309	8,406	12,404
Phosphate surplus (kg P_2O_5/ha)	108	47	90	234
Farm structure				
Area arable crops and permanent grass (ha)	31.6	32.7	34.1	25.5
of which cereals (%)	72	74	73	70
of which other forage crops (%)	3	1	2	6
Economic size (ESU)	83.9	63.8	84.7	102.2
Economic size per ha a) (ESU)	2.7	1.9	2.5	4.0
Livestock population (LU)	205.8	107.4	197.0	321.1
of which pigs (%)	97	100	99	94
of which poultry (%)	2	0	0	5
Livestock density (LU/ha a))	6.5	3.3	5.8	12.6
Farm input				
Purchased feedingstuffs (ECU)	83,286	44,222	79,968	128,773
Purchased feedingstuffs per ha a) (ECU)	2,636	1,351	2,345	5,059
Farm output				
Crop output (ECU)	30,736	29,960	33,319	26,318
Crop output per ha a) (ECU)	973	916	977	1,034
Livestock output (ECU)	179,947	121,454	173,817	250,388
Livestock output per ha a) (ECU)	5,695	3,711	5,097	9,837
Farm net value added (ECU)	59,710	45,988	59,855	73,057
Farm net value added per ha a) (ECU)	1,890	1,405	1,755	2,870

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

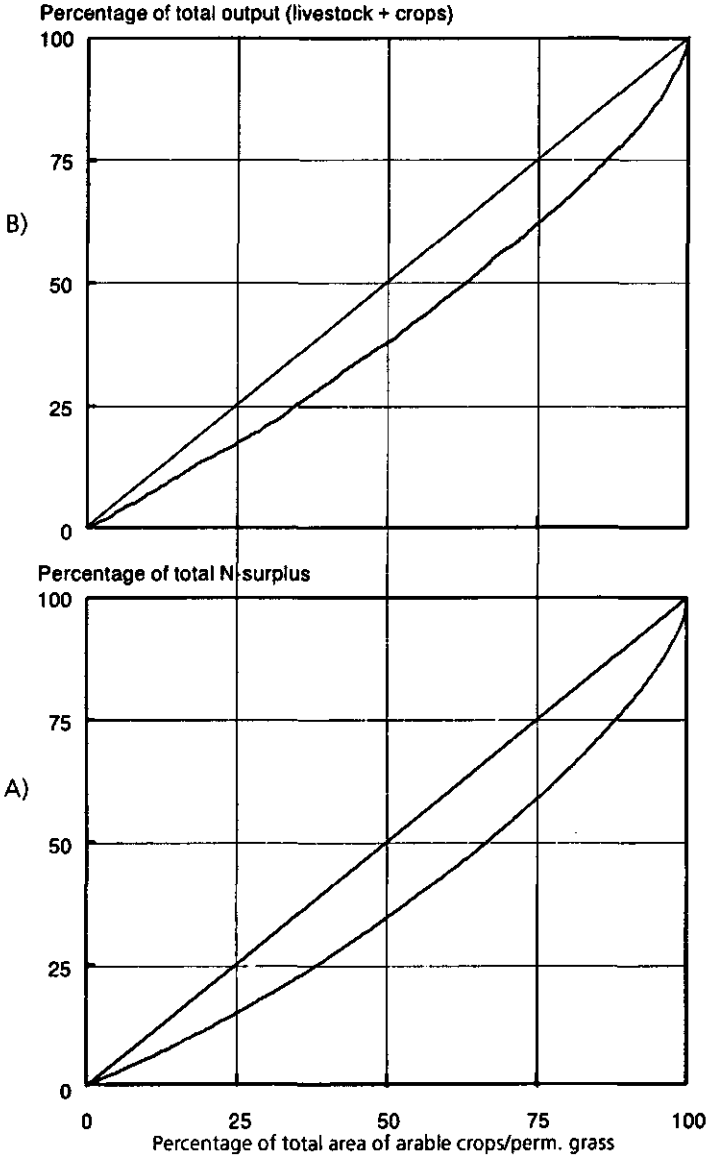

Figure 7.2 *Share of total nitrogen surplus (part A) and share of total output (livestock and crops) (part B) by group of holdings, with ascending order of net nitrogen surplus per ha on granivore farms in Denmark in 1990/91*

7.4 France

Net nitrogen surplus per farm at granivore farms in Bretagne shows a similar pattern to that of granivore farms in Denmark. It ranges between 190 kg/ha (category 'low') and 1,270 kg/ha (category 'high'). The area of arable crops and permanent grass at category 'high' is relatively small (10 ha) compared to that of category 'low' (29 ha) (table 7.3). The share of cereals in total cropping plan is around 60% for all categories distinguished. The share of poultry in total livestock population ranges between 7% (category 'low') and 39% (category 'high').

Table 7.3 Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on granivore farms in Bretagne in 1990/91

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	115	27	58	30
Number of farms represented	5,185	1,278	2,591	1,315
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	111	91	119	122
Manure production (kg N/ha)	512	233	420	1,758
Net nitrogen surplus (kg N/ha)	392	192	329	1,269
Net nitrogen surplus per farm (kg N)	8,698	5,525	8,265	12,636
Phosphate surplus (kg P_2O_5/ha)	406	182	336	1,386
Farm structure				
Area arable crops and permanent grass (ha)	22.2	28.8	25.2	10.0
of which cereals (%)	60	60	61	56
of which other forage crops (%)	21	23	20	20
Economic size (ESU)	64.4	48.2	65.0	79.1
Economic size per ha a) (ESU)	2.9	1.7	2.6	7.9
Livestock population (LU)	247.4	142.7	235.6	372.3
of which pigs (%)	76	90	84	60
of which poultry (%)	22	7	12	39
Livestock density (LU/ha a))	11.1	5.0	9.4	37.4
Farm input				
Purchased feedingstuffs (ECU)	115,696	68,532	115,653	161,620
Purchased feedingstuffs per ha a) (ECU)	5,212	2,379	4,598	∞
Farm output				
Crop output (ECU)	16,885	18,962	20,252	8,234
Crop output per ha a) (ECU)	761	658	805	827
Livestock output (ECU)	211,709	134,919	211,490	286,771
Livestock output per ha a) (ECU)	9,537	4,683	8,409	∞
Farm net value added (ECU)	55,657	34,191	54,649	78,505
Farm net value added per ha a) (ECU)	2,507	1,187	2,173	7,885

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

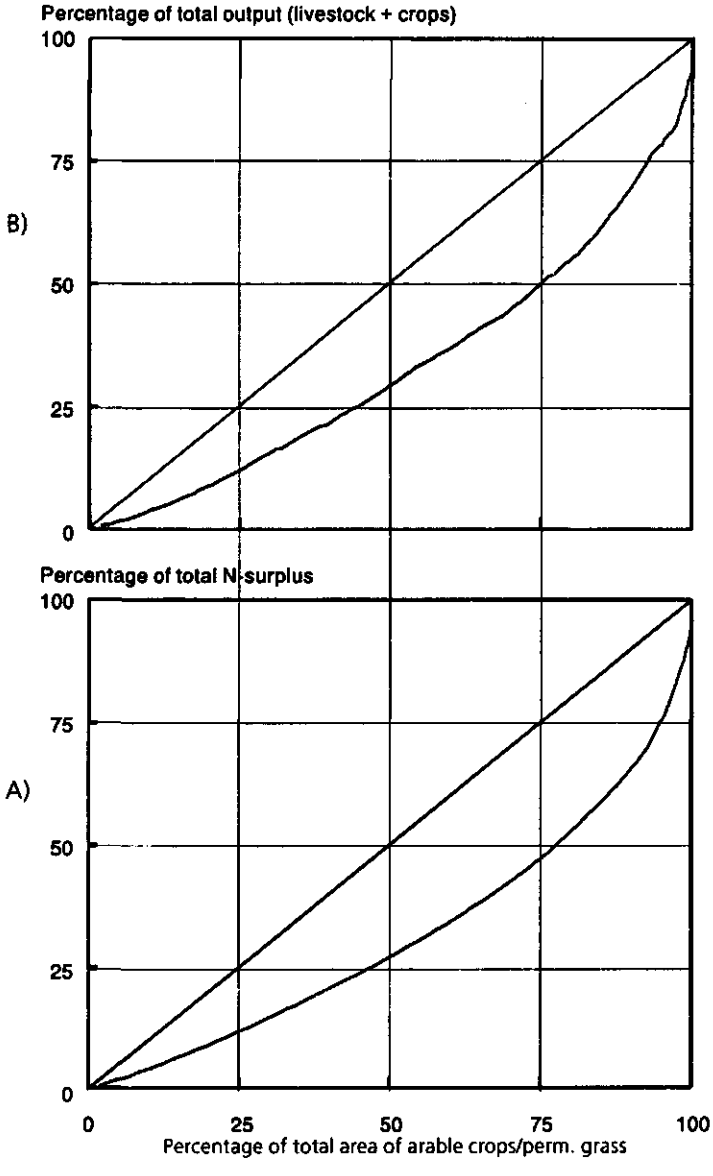

Figure 7.3 Share of total nitrogen surplus (part A) and share of total output (livestock and crops) (part B) by group of holdings, with ascending order of net nitrogen surplus per ha on granivore farms in Bretagne in 1990/91

Farm net value added at category 'high' (78,500 ECU) is more than double that of category 'low' and also exceeds that of the other regions selected in this chapter.

The share in total net nitrogen surplus and in total output from livestock and crops is less than proportional at the group of farms with low levels of net nitrogen surplus. About half of net nitrogen surplus at granivore farms in Bretagne is on about 75% of total area of arable crops and permanent grass (figure 7.3).

7.5 Spain

Net nitrogen surplus per farm in the region of Aragon and Cataluna ranges between 1,770 kg (category 'low') and 10,600 kg (category 'high'). In this region total net nitrogen surplus per farm on category 'low' is far below

Table 7.4 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on granivore farms in Aragon and Cataluna in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	84	22	49	13
Number of farms represented	6,902	1,717	3,522	1,663
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	40	44	25	4
Manure production (kg N/ha)	1,526	203	2,905	∞
Net nitrogen surplus (kg N/ha)	1,035	111	1,991	∞
Net nitrogen surplus per farm (kg N)	5,312	1,774	4,529	10,619
Phosphate surplus (kg P_2O_5/ha)	1,149	118	2,224	∞
Farm structure				
Area arable crops and permanent grass (ha)	5.1	16.0	2.3	0.0
of which cereals (%)	50	50	51	-
of which other forage crops (%)	46	47	41	100
Economic size (ESU)	26.1	22.1	20.1	43.0
Economic size per ha a) (ESU)	5.1	1.4	8.8	∞
Livestock population (LU)	142.4	68.6	121.3	263.4
of which pigs (%)	77	100	73	75
of which poultry (%)	23	-	26	25
Livestock density (LU/ha a))	27.8	4.3	53.3	∞
Farm input				
Purchased feedingstuffs (ECU)	74,459	42,314	61,755	134,538
Purchased feedingstuffs per ha a) (ECU)	∞	2,651	∞	∞
Farm output				
Crop output (ECU)	5,950	11,533	2,477	7,541
Crop output per ha a) (ECU)	1,160	723	1,089	∞
Livestock output (ECU)	109,987	72,212	87,962	195,609
Livestock output per ha a) (ECU)	∞	4,524	∞	∞
Farm net value added (ECU)	23,734	26,930	13,265	42,600
Farm net value added per ha a) (ECU)	4,625	1,687	5,831	∞

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

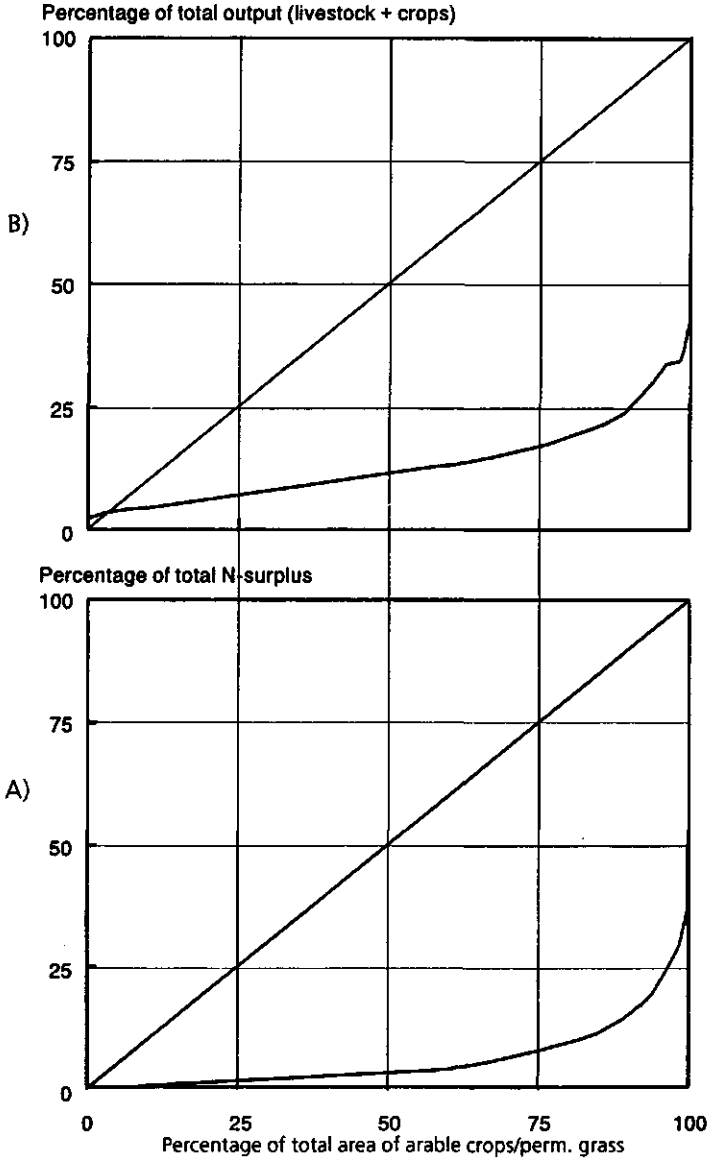

Figure 7.4 *Share of total nitrogen surplus (part A) and share of total output (livestock and crops) (part B) by group of holdings, with ascending order of net nitrogen surplus per ha on granivore farms in Aragon and Cataluna in 1990/91*

that of the other regions selected. Density of livestock population on this group (4.3 LU/ha arable crops and permanent grass) and total livestock population per farm are below that of the other regions investigated.

The area of arable crops and permanent grass is zero at category 'high'. It is 16 ha in category 'low', mainly for cereals (50%) and 'other' forage crops (47%). The share of poultry in total livestock population at categories 'medium' and 'high' is 25%.

The group of farms with lowest net nitrogen surpluses have a more than proportional share in the area of arable crops and permanent grass. This group has a less than proportional share in total output from crops and livestock. Aboput 10% of total net nitrogen surplus at granivore farms in that region is on about 75% of total area of arable crops and permanent grass (figure 7.4). All area of arable crops and permanent grass is on 50% of the farms with lowest net nitrogen surpluses. The group of 25% of the granivore farms in Aragon and Cataluna with highest net nitrogen surpluses represents half of net nitrogen surplus and around 40% of total output from crops and livestock.

7.6 Netherlands

Net nitrogen surplus per farm of granivore farms in the Netherlands does not vary largely across the groups of farms distinguished, compared to the variation observed in previous sections. Net nitrogen surplus per farm is largest in category 'high' (10,700 kg) and smallest in category 'low' (7,500 kg) (table 7.5).

The area of arable crops and permanent grass is 10 ha in category 'low' and only 0.1 ha in category 'high'. The share of poultry ranges between 1% (category 'low') and 48% (category 'high').

The share in total net nitrogen surplus and in total output from crops and livestock increases about proportionally with increasing net nitrogen surpluses. About 75% of total net nitrogen surplus is on approximately 2% of total area of arable crops and permanent grass (figure 7.5). The group of 25% of the granivore farms in the Netherlands with smallest net nitrogen surplus represents around 60% of the area of arable crops and permanent grass. All area of arable crops and permanent grass represented by this farming type is on 75% of the farms.

Table 7.5 *Farm structure and farm output characteristics by average N-surplus on the 25% of farms with lowest N-surplus (low) and the 25% of farms with highest N-surplus (high) and the category in between (medium) on granivore farms in the Netherlands in 1990/91*

	All categories	Category of N-surplus		
		low	medium	high
Number of farms in sample	178	40	92	46
Number of farms represented	9,745	2,432	4,898	2,415
Mineral balance				
Purchase of fertilizer and manure (kg N/ha)	196	202	186	196
Manure production (kg N/ha)	3,223	943	4,460	∞
Net nitrogen surplus (kg N/ha)	2,335	747	3,188	∞
Net nitrogen surplus per farm (kg N)	9,659	7,538	10,187	10,723
Phosphate surplus (kg P_2O_5/ha)	1,816	451	2,553	∞
Farm structure				
Area arable crops and permanent grass (ha)	4.1	10.1	3.2	0.1
of which cereals (%)	9	13	3	-
of which other forage crops (%)	40	36	47	10
Economic size (ESU)	59.0	57.4	59.8	59.2
Economic size per ha a) (ESU)	14.3	5.7	18.7	1,076.8
Livestock population (LU)	265.7	166.6	284.8	326.7
of which pigs (%)	63	94	60	52
of which poultry (%)	36	1	39	48
Livestock density (LU/ha a))	64.2	16.5	89.1	5,941.4
Farm input				
Purchased feedingstuffs (ECU)	130,327	85,263	139,034	158,042
Purchased feedingstuffs per ha a) (ECU)	∞	8,455	∞	∞
Farm output				
Crop output (ECU)	4,966	11,285	4,106	348
Crop output per ha a) (ECU)	1,201	1,119	1,285	6,326
Livestock output (ECU)	228,182	163,701	243,603	261,830
Livestock output per ha a) (ECU)	∞	∞	∞	∞
Farm net value added (ECU)	57,420	45,752	62,615	58,632
Farm net value added per ha a) (ECU)	∞	4,537	∞	∞

a) Area arable crops and permanent grass.
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

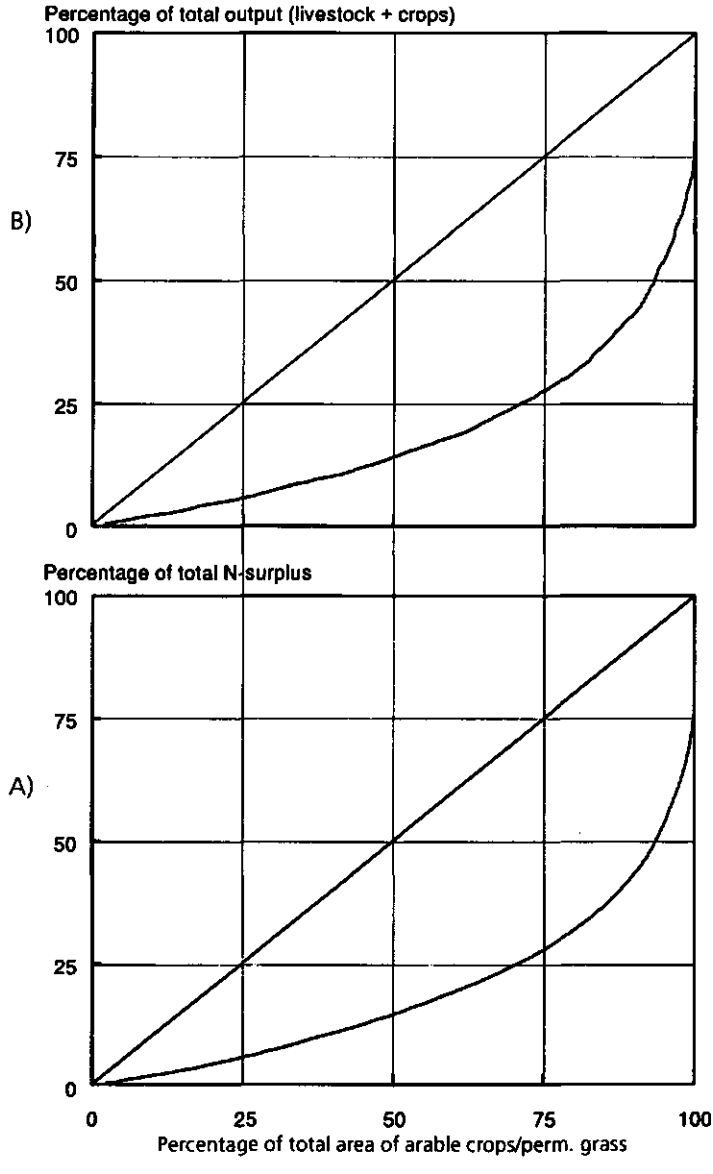

Figure 7.5 *Share of total nitrogen surplus (part A) and share of total output (livestock and crops) (part B) by group of holdings, with ascending order of net nitrogen surplus per ha on granivore farms in the Netherlands in 1990/91*

7.7 Concluding remarks

1. The group of granivore farms with highest net nitrogen surpluses has a more than proportional share in total net nitrogen surplus and in total output from crops and livestock, except for the Netherlands. Even half of total net nitrogen surplus of granivore farms in the region of Aragon and Cataluna originates from 25% of the number of farms. This group of farms in Aragon and Cataluna produces around 40% of total output from crops and livestock.
   Net nitrogen surplus per farm is also correlated strongly with livestock population and therefore also with livestock output (table 7.6).
2. About half of the granivore farms in Belgium and in the region of Aragon and Cataluna represents all area of arable crops and permanent grass. The same holds for 75% of the granivore farms in the Netherlands. The area of arable crops and permanent grass at granivore farms in Denmark increases proportionally with rising net nitrogen surplus. Correlation between net nitrogen surplus per farm and the area of arable crops and permanent grass is strongest in Denmark.
3. The share of poultry in total livestock population exceeds 20% in categories 'high' in Belgium (66%), Bretagne (39%), Aragon and Cataluna (25%) and the Netherlands (48%). It is also high at category 'medium' in the region of Aragon and Cataluna (26%) and the Netherlands (39%).

Table 7.6 Correlation coefficients between general variables and net nitrogen surplus on granivore farms

	Belgium	Denmark	Aragon and Cataluna	Bretagne	Netherlands
Net nitrogen surplus per farm (kg N)					
Purchased feedingstuffs (ECU)	0.95	0.96	0.76	0.69	0.81
Area arable crops and permanent grass (ha)	0.15	0.82	0.01	0.35	0.17
Livestock population (LU)	0.93	0.99	0.91	0.92	0.97
Livestock output (ECU)	0.95	0.96	0.81	0.77	0.82
Farm net value added (ECU)	0.69	0.87	0.63	0.74	0.75
Net phosphate surplus per farm (kg P_2O_5)	0.98	0.95	1.00	0.96	0.98
Manure production per farm (kg N)					
Purchased feedingstuffs (ECU)	0.96	0.96	0.78	0.69	0.81

8. THE NITRATE DIRECTIVE

8.1 Introduction

A directive concerning the protection of waters against pollution caused by nitrates from agricultural sources was announced to the Member States in December 1991 (Council Directive 91/676/EEC). The main objective of this Directive is to prevent or reduce the pollution of waters by nitrate from agricultural sources. It includes regulations on how to handle manure and fertilizers in zones which are identified to be vulnerable to the leaching of nitrate. Five Member States (Denmark, Germany, Luxembourg, the Netherlands and the United Kingdom) so far identified such zones. These countries, with the exception of the United Kingdom, consider that the whole territory needs to meet the requirements of the Directive. Approximately 650,000 ha are identified to be vulnerable to nitrate leaching in 72 zones of England and Wales. One of the main elements of the Directive is that the application of animal manure in vulnerable zones should not exceed 170 kg of nitrogen per ha. This standard should be met at farm level by the year 1999 at the latest unless the goals formulated in the Directive could be achieved through other instruments.

A list of actions for a reduction of nitrates in water is also included in the Fifth Environmental Action Programme, which comprises a strict application of the Nitrate Directive. Major adjustments are required in farming practice in the European Union to meet the Directive. This holds especially in regions with a high concentration of livestock production like Belgium, Denmark, Nordrhein-Westfalen (Germany), Bretagne (France), Lombardia (Italy) and the Netherlands.

The main objective of this chapter of the report is to examine relationships among farming practice in the EU and the Nitrate Directive. First an assessment is made of how many farmers might be affected in the EU by a standard of 170 kg of nitrogen from animal manure as formulated under the Directive. The number of holdings producing more than 170 kg of nitrogen per ha from animal manure is given by Member State. Such a figure indicates the number of farms that might be affected by the Directive given that their Member States do not have standards on the treatment of animal manure.

8.2 Production of animal manure

According to the EC Nitrate Directive the application of animal manure should not exceed 170 kg/ha (including manure from grazing livestock). This

is allowed to be 210 kg/ha during the transition period. The average production of nitrogen per farm from animal manure exceeds 170 kg N/ha for dairy farms (Belgium, Denmark, Greece and the Netherlands), drystock farms (Belgium, Greece and the Netherlands, granivore farms in all Member States, and mixed farms (Belgium and the Netherlands) (see also chapter 3 of the report).

Supply of animal manure in EUR 12 exceeds 170 kg N per ha on approximately 13% of the number of holdings represented by the FADN (table 8.1). This is the equivalent of almost 600,000 holdings.

Table 8.1 *Number of farms represented by FADN and farms with production levels of animal manure exceeding 170 kg of nitrogen per ha, by Member State in 1990/91*

Country	Number of farms represented (x 1,000)	Average production of animal manure (kg N/ha)	Farms with nitrogen from manure > 170 kg/ha	
			share of total number of farms (%)	average production (kg N/ha)
Belgium	51.9	196	47	327
Denmark	81.0	109	26	258
Germany	373.9	98	12	207
Greece	498.3	64	15	557
Spain	690.6	40	19	723
France	556.7	62	6	309
Ireland	140.2	93	8	225
Italy	1,369.8	55	6	361
Luxembourg	2.3	128	11	197
Netherlands	94.0	343	63	501
Portugal	448.5	40	18	357
United Kingdom	141.6	68	17	258
EUR 12	4,448.9	73	13	352

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

The production of animal manure in EUR 12 at the group of holdings with an excess of nitrogen from animal manure on average amounts to 350 kg per ha. This is about fivefold of the average of all farms across EUR 12.

Differences among Member States are large on the number of farms that produce more than 170 kg N/ha. The share of the number of farms with excess of nitrogen from animal manure in total number of farms is lowest in France, Ireland and Italy (less than 10 percent) and highest in Belgium (47%) and the Netherlands (63%) (see also figure 8.1). Important phenomena in this respect are differences in animal density and the large share of livestock production in total agricultural output. The production of manure on the group of farms which produce more than 170 kg/ha, on average is more than double their national averages in all Member States except Belgium,

Luxembourg and the Netherlands. The production of nitrogen from animal manure at Member State level exceeds 170 kg/ha in Belgium and the Netherlands. This means that these countries are not able to meet the Directive according to present farming practice (e.g. inputs used, cropping plan and livestock population) (Brouwer and Hellegers, 1995).

The production of animal manure exceeds 170 kg/ha at more than 25% of the farms in Belgium, Denmark, northwest coast of Spain (e.g. Galicia and Asturias) and the Netherlands (table 8.2). It is in the range between 15 and 25% in large areas of Germany (Nordrhein-Westfalen and Niedersachsen), France (Bretagne), Greece (e.g. Ipiros Pelop. N. Ioniou), Spain (e.g. Castilla-Leon), Italy (Lombardia), Portugal (Norte-Centro) and the United Kingdom (Wales, England North, England West).

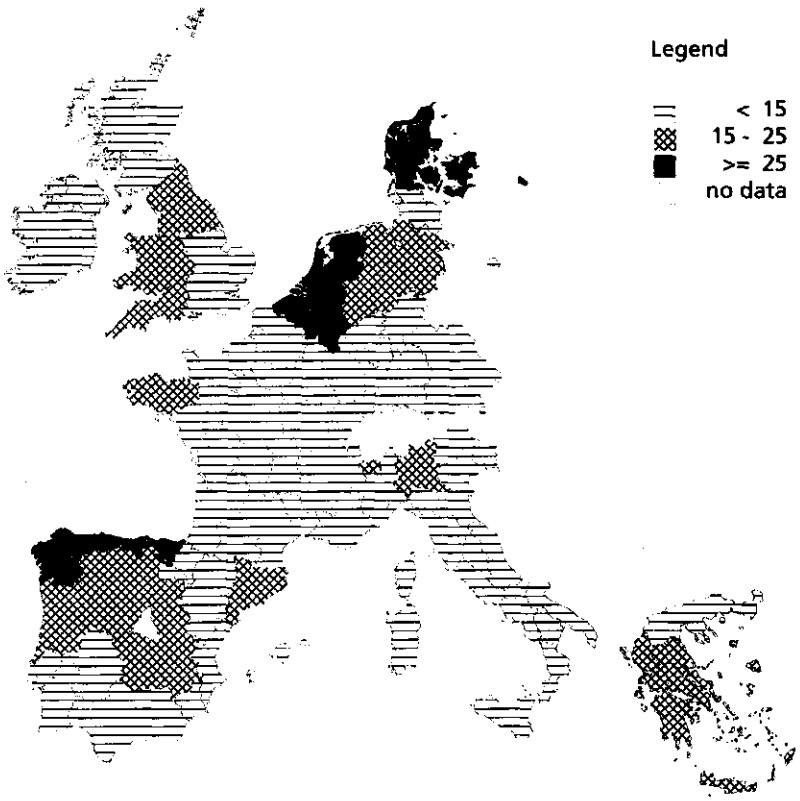

Figure 8.1 Farms producing more than 170 kg N from manure per ha (in % of total number of farms)
Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO

The group of farms in EUR 12 which produce more than 170 kg of nitrogen from manure per ha include 8% of utilized agricultural area and

produces 40% of nitrogen from manure. More than half of nitrogen from manure is produced at such farms in Belgium (71%), Denmark (59%), Greece (68%), Spain (64%) and the Netherlands (99%). It is also very high in Lombardia (81%). This implies that almost all manure produced in the Netherlands originates from farms with a supply of animal manure above 170 kg N/ha. Livestock production in Germany, Ireland and Luxembourg at the farms represented by FADN, is more extensive than elsewhere in the European Union. In Germany for example, about 12% of the farms produce more than 170 kg N/ha from animal manure, which is around the average of the EU. Their share in total manure production is only 21% which is less than the average of the EU (40%).

Table 8.2 Characteristics of holdings with manure production exceeding 170 kg of nitrogen per ha by Member State in 1990/91

Country/region	Share of total (in %)			Livestock density (LU/ha UAA)	Share pigs and poultry in livestock population (%)	Utilized agricultural area (UAA) (ha)		
	number of farms represented	utilized agricultural area (UAA)	manure production			total	of which (in %)	
							cereals	forage crops
Belgium	47	42	71	4.8	54	22.6	12	81
Denmark	26	25	59	3.5	61	33.0	46	42
Germany	12	10	21	3.5	55	24.0	31	64
Greece	15	9	68	4.5	7	3.8	44	49
Spain	19	3	64	9.4	54	4.1	26	68
Galicia	46	30	60	4.3	27	3.2	14	77
France	6	4	18	5.9	77	27.4	27	66
Bretagne	22	19	44	6.8	84	24.9	35	57
Ireland	8	7	17	3.1	26	31.5	2	98
Italy	6	7	49	5.9	50	10.3	27	70
Lombardia	23	26	81	7.7	57	18.8	30	66
Luxembourg	11	10	15	2.3	23	46.6	13	85
Netherlands	63	66	99	5.5	52	23.0	1	96
Portugal	18	5	35	3.7	46	3.1	24	65
United Kingdom	17	7	27	4.0	45	46.5	11	88
England West	22	13	32	3.7	39	47.3	11	88
EUR 12	13	8	40	5.0	53	13.5	20	75

Source: FADN-CCE-DG VI/A-3; adaptation LEI-DLO.

9. CONCLUDING REMARKS

9.1 Introduction

Some of the major findings on the assessment of mineral balances at farm level in the European Union are summarized in this chapter. A distinction is made between the methodology used (section 9.2) and the relationship between mineral surplus and farming practice (section 9.3). Finally some recommendations are provided (section 9.4).

9.2 Methodology used

Hypothesis of mineral surplus at farm level

1. An assessment of mineral flows at farm level in the European Union, including input and output flows, is aimed at investigating the distribution of surpluses among farms. This is based on the hypothesis that nitrogen surplus increases with the intensity of agricultural production. Mineral surpluses vary largely across groups of farms in the European Union because of the differences in farm structure and input use. Stocking density of livestock population and the intensity of crop production are crucial elements to be considered. Structural characteristics of farms with high surpluses are compared with the ones with low surpluses. This provides the basic elements of farm characteristics which are critical to the identification of mineral surpluses.

Data available across the European Union

2. The Farm Accountancy Data Network (FADN) is used, since that is the only source of information for all Member States which links the structure of individual farms with total output, intermediate consumption and a profit and loss account. Farm specific data on the yields of crops are also provided by that data source. This kind of information needs to be combined with information about mineral requirements of crops, the uptake of minerals by crops, as well as the production of animal manure from livestock. Manure production estimates are derived from coefficients on the excretion of minerals from livestock. These coefficients are obtained from experts in various Member States (Schleef and Kleinhanss, 1994).
3. The variation between farms in yields of crops is only used to a limited extent. Information on the yields of arable crops is available at farm level. Such differences across farms are also reflected in different mineral requirements to grow crops. Contrary to this, regional averages

have been used on the yields of forage crops. The total amount of fertilizers required to grow these crops therefore shows minor variation across farms within a region. The amount of fertilizers used per hectare in reality shows a large variation across farms in a region. The application of fertilizers of specialized dairy farms in the Netherlands in 1989 on average is around 330 kg N/ha of grassland (Brouwer, 1994). The use of fertilizers between groups of farms with lowest surpluses and the ones with highest surpluses ranges between around 200 kg N/ha and 400 kg N/ha. The variation in use of inputs in reality will therefore likely show larger variations than reflected in this report. The variation between farms in using inputs arises because of differences across farms in yield of forage crops, and because of farm management aspects to treat and apply minerals. Such factors are not taken into account.

4. The assessments available in the European Union of mineral surplus at farm level are rather limited so far. A consistent comparison of results with balances from other sources is difficult. A limited set of results is available for Belgium, Germany, Bretagne (France) and the Netherlands. Differences will be briefly commented upon for Belgium and Bretagne in the following paragraphs.

   Recent estimates of farm gate balances in Belgium for example, indicate much higher values than presented in this report. Gross nitrogen surplus of dairy farms in the present report for example is assessed to be around 190 kg N/ha. More recent estimates however indicate surpluses which are around 300 kg N/ha. Differences in mineral surplus are mainly due to the nitrogen content of animal manure, which is likely to be some 50% higher than considered in the present report. The excretion of dairy cows is assessed to be 88 kg N/year, which is substantially below more recent estimates of about 130 kg N/year (Lauwers, personal communication, 1994).

   Net nitrogen surplus at granivore farms in Bretagne is assessed to be around 8,700 kg N/farm. Mineral balances in that region are also available from other sources. Bonnieux et al. (1994) provides estimates of nitrogen surplus at pig farms. The average nitrogen surplus of pig farms is assessed to be around 8,200 kg N/farm, which is below estimates of granivore farms from the report. Differences between both sources are likely to result from the farming types included in the assessments. The estimate from Bonnieux et al. (1994) is based on all farms with pigs. Estimates in the present report include the average of granivore farms. This also includes poultry farms. These factors explain why estimates in the present report are above estimates provided in Bonnieux et al. (1994).

Methods available

5. Mineral balances in the report are based on the so-called surface balance approach. It reflects the application and treatment of minerals on the field. Another approach would have been the farm gate balance

approach. This approach reflects the amount of minerals which enter or leave the farm.

Both methods should provide the same results if measured at a regional level. Differences mainly arise in case transport of animal manure is considered. This happens to be the case primarily in granivore farms. The surface balance approach was chosen because no detailed information is available at farm level on the treatment of animal manure in the European Union, nor that of the amount of minerals in feed concentrate.

6. The two approaches to assess mineral balances may provide different results, if identified at farm level. There are several elements which contribute to that difference.

An important aspect to be considered is the way how animal manure is treated. Transport of animal manure is part of the output component in the framework of the farm gate balance approach. A large share of animal manure produced at granivore farms is to be applied elsewhere in most Member States of the European Union.

Differences among the two approaches may also arise because of the normative nature of figures used. An estimation of the mineral content of feed concentrate or of animal manure is partly based on normative estimations. This of course also affects the assessment of the mineral surplus.

Differences might also arise because figures are provided on a per hectare basis. Surpluses may reach extremely high values in case the area of arable crops and permanent grass is very small on a large share of the number of farms represented in the sample.

7. A distinction is made in the report between so-called gross nitrogen surpluses and net nitrogen surpluses. Gross nitrogen surplus equals the total input of nitrogen available for crop growth from fertilizers and manure, minus the uptake by crops. The input component is limited to minerals from agricultural sources. Losses of minerals by the emissions of ammonia are not taken into account. The calculation of net nitrogen surpluses includes all nitrogen available and also assumes that part of animal manure is emitted to the air by emissions of ammonia. It is identified as the total input of nitrogen by deposition from the atmosphere, by fertilizers, organic manure excluding emissions of ammonia, minus the uptake by crops. It is assumed that 30% of nitrogen from manure is lost to ammonia during storage and spreading.

Surplus of nitrogen may be stored in soils and therefore be a potential source of leaching. In case surpluses are lost by denitrification, they may become available for crop growth and leaching at a later stage.

It is recommended to assess net nitrogen surpluses because they are more appropriate towards the identification of the potential of leaching to soils than gross nitrogen surpluses do.

Treatment of minerals

8. Farm management aspects, including the way to treat and apply animal manure, cannot be investigated with the approach used. An examination of farm management aspects may be considered in an assessment of mineral surplus according to the farm gate approach, because all inflow and outflow components are taken into account. Any differences at farm level in the treatment and application of animal manure for example may affect inflow and/or outflow figures.
   Farm management may largely affect mineral surplus. Milk production per hectare at dairy farms as well as farm output may show less variation as nitrogen surplus does. This is because part of the inputs used can be attributed to as over-use. Farm management therefore is important to the understanding of factors which explain mineral surplus.
   Structural characteristics are important to link with the surface balance approach. Characteristics such as milk production per hectare, are critical to the identification of factors determining mineral surplus at dairy farms.
9. Substitution rates between mineral fertilizers and organic manure are important towards the identification of nitrogen surpluses. In the Netherlands for example, fertilizers cannot be replaced by organic manure to grow cereal crops. All animal manure produced at such farms therefore accounts for surpluses unless it could be applied on other field crops at these farms. Coefficients used in the report were obtained from experts, and are considered to reflect farmers' behaviour on the treatment of animal manure around the year 1990.
   Replacement rates are based on actual farmers' behaviour which is subject to change over time. The use of organic manure at arable farms in the Netherlands presently shows an increasing trend at the expense of inorganic fertilizers. The application of organic manure at arable farms presently exceeds the application of inorganic fertilizers by some 30 percent, if measured in phosphate. The use of animal manure at arable farms increased largely in a period of less than five years (Poppe et al., 1994). Changes also take place in the way animal manure is applied. In several Member States animal manure presently is injected immediately or worked under the ground soon after application. This implies that the emissions are reduced compared to application practice in the past.

Improvements proposed

10. Excretion levels of livestock population were obtained from national experts. The supply of nitrogen from organic manure per animal is highest in the Netherlands. Coefficients used for dairy cows are relatively high in Denmark (126 kg N/year) and the Netherlands (144 kg N/year). They are between 80 and 90 kg N/year for the remaining countries. Differences may arise across countries due to different feeding or housing systems, or due to differences in productivity (e.g. milk production per cow) and production systems (e.g. the period of fatten-

ing of pigs). Differences however may also arise due to different methods to measure the mineral content of animal manure. The nitrogen content of animal manure could be measured at various stages, such as ex stable or ex storage. Estimates used in this report aim to reflect excretion levels from livestock.

Data on the excretion levels by animal type have recently been harmonized in the Netherlands. Various research and monitoring groups with expertise in this field contributed to a Working Group on the Harmonization of Manure and Mineral Coefficients from Livestock. These efforts presently allow for harmonized coefficients in the Netherlands. Updates are provided on an annual basis because of changes in the way to apply animal manure (E.G. emission-reduced application) and of changes in feeding systems.

The provision of harmonized data on the excretion from livestock across Member States will provide the basic elements required to the monitoring of environmental targets in the European Union. It is recommended in this respect to monitor manure production levels and their mineral content according to harmonized procedures and accounting rules. This will allow for improvements in the calculation of mineral surpluses and subsequent losses to the environment.

11. Major difficulties remain to assess mineral balances according to the farm gate balance approach. They primarily relate to the minerals in feed concentrate and to the treatment of animal manure at farm level. The data bases available for EUR 12 presently do not provide information on these matters. A normative figure however might be used on the amount of minerals in feed. This kind of information is to result from national statistics. This could be input to the costs of feed concentrates from FADN. Also, a farm gate balance approach could be identified including or excluding the treatment of animal manure. The treatment of animal manure could be based on national policy with standards on the treatment and application of animal manure at farm level.

9.3 Relationship between mineral surplus and farming practice

Nitrogen surplus and farm structure

1. Net nitrogen surplus in the EU varies largely across regions, between farming types within the regions considered and across groups of farms within a farming type in a region. Structural characteristics of farming practice like stocking density of livestock population and intensity of crop production determine the distribution of nitrogen surplus among farms.

   Net nitrogen surplus in EUR 12 on average is lowest (below 100 kg/ha) at cereal farms, general cropping farms, drystock farms and mixed farms. On average it is slightly above 100 kg/ha at dairy farms. It is almost 700 kg/ha at granivore farms. Differences across regions are large.

The standard deviation of net nitrogen surplus across farms in EUR 12 exceeds 1,000 kg N/ha at drystock farms, granivore farms and mixed farms. Net nitrogen surplus therefore differs largely within groups of farms considered, either within regions and/or across regions in EUR 12. The assessments presented in this report show that nitrogen surpluses may reach very high figures in case the area arable crops and permanent grass is less than 1 ha on more than 5 percent of the farms with highest surpluses.

2. Net nitrogen surplus in the European Union exceeds 100 kg N/ha in Belgium, Denmark, Germany, Bretagne (France), Luxembourg and the Netherlands. Purchases of fertilizers also are above 100 kg N/ha in these regions. The production of animal manure is larger than 100 kg N/ha with the exception of Germany (98 kg N/ha). It is highest in the Netherlands (340 kg N/ha), to be followed by Belgium (around 200 kg N/ha).
   Surpluses are highest in regions with high stocking density of livestock population. The density of livestock population exceeds 2 LU/ha UAA in Belgium, Galicia (Spain), Bretagne (France), Lombardia (Italy) and the Netherlands. The share of pigs and poultry in total livestock population is relatively high (i.e. more than 40%) in these regions, except for Galicia where grazing livestock includes 80% of total livestock population. This share is highest in Denmark (60%), with an average in EUR 12 of only 30%.

Variation in nitrogen surplus across farms

3. It was concluded before that net nitrogen surplus differs largely across farms in the EU. Nitrogen from animal manure is one of the input components that contributes to a surplus. This element requires special attention under the Nitrate Directive. The Directive states that the application of animal manure should not exceed 170 kg N/ha in regions identified by Member States to be vulnerable for leaching of nitrate. A variety of responses are to be expected by farmers:
   - farming practice needs to be adjusted at farms with a production of animal manure which exceeds 170 kg N/ha. Such farms have to treat animal manure in a more efficient way. The application of animal manure at other farms will most likely gain importance. Costs of transport of animal manure will become increasingly important as a production factor;
   - arable farms may play an important role under this Directive through the substitution of inorganic fertilizers by organic manure. Substitution rates used are considered to reflect actual farmers' behaviour. They may increase by allowing for higher application levels of animal manure at the expense of mineral fertilizers. The treatment of animal manure could be improved by application during the period of crop growth.

4. Farms with a high nitrogen surplus are characterized by a high output of crops and livestock per hectare, as well as a high Farm Net Value Added per hectare and a large economic size per hectare.
   There are significant differences in the cropping plan and livestock composition among groups of farms with high and low surpluses. Farms with high surpluses are characterized by a higher input of purchased fertilizers and of purchased feeding concentrates per ha. Net nitrogen surplus increases with rising economic size per ha.
5. Net nitrogen surplus in EUR 12 on average is lowest at cereal farms (32 kg N/ha), which is primarily due to small levels of manure production (6 kg N/ha). Surplus at general cropping farms exceeds that of cereal farms in all Member States except in France. This is due to the production of animal manure at general cropping farms, which is higher than at cereal farms. Less than half the utilized agricultural area of general cropping farms in EUR 12 is used to grow cereals. This share is 75% at cereal farms.
   Manure production at dairy farms exceeds the input of mineral fertilizers, with the exception of Bretagne.
   Net nitrogen surpluses in EUR 12 are highest at granivore farms. Countries with highest surpluses at granivore farms (over 1,000 kg N/ha) in descending order are Greece, the Netherlands, Belgium and Italy. Density of livestock population in these countries exceeds 45 LU/ha UAA.
6. Total output per ha from crops and livestock at farms with high surpluses exceeds that of farms with low surpluses for all regions investigated of general cropping farms, except in the Northern cereal region of France.
   The output per hectare of livestock increases at general cropping farms with net nitrogen surplus although the relationship is rather weak in Northern cereal area of France, as well as in the Netherlands.
7. Net nitrogen surpluses of dairy farms show a positive correlation with costs of purchased feedingstuffs and to a lesser extent also of purchased fertilizers. The need for feedingstuffs rises with increasing intensity of production. Net nitrogen surplus shows a rather homogeneous distribution across dairy farms in the regions considered, except for Lombardia. Only 25% of net nitrogen surplus in that region originates from about half of the dairy farms with smallest surpluses.
8. The group of granivore farms with highest surpluses have a more than proportional share in total surplus and in total output, except for the Netherlands. About half of total surplus in the region of Aragon and Cataluna originates from 25% of the granivore farm. This group of farms produces around 40% of total output from crops and livestock.

The Nitrate Directive and the treatment of organic manure

9. The Nitrate Directive is aimed at reducing nitrate levels such that standards accepted by the World Health Organisation are met. Nitrate levels in water used for drinking water purposes should not exceed 50

mg per liter. Actual leaching levels of nitrogen depend on a variety of conditions including soil conditions and climatic variation.
The application of animal manure should not exceed 170 kg N/ha in regions which are identified to be vulnerable to the leaching of nitrate. Usage levels of inorganic fertilizers, as well as local conditions of soils (e.g. levels of denitrification) and climate (e.g. rainfall) are important. Codes of Good Agricultural Practice are part of the Nitrate Directive and should also contribute towards the achievement of objectives.
A limit on the application of animal manure could only be interpreted as an approximation to the leaching of nitrates to water. A proper monitoring system on the progress achieved by the agricultural sector towards objectives of the Nitrate Directive requires harmonisation of methods to assess excretion levels by livestock.

10. The supply of animal manure exceeds the limits of the Nitrate Directive (a maximum of 170 kg of N per hectare) on approximately 13% of the number of farms in EUR 12. This is equivalent to almost 600,000 farms. Manure production at the group of holdings that exceed the Directive is about fivefold that of the average of all farms across EUR 12 (71 kg N/ha).

9.4 Recommendations

Nitrate levels in groundwater need to be reduced in the European Union, and a strict application of the Nitrate Directive (Council Directive 676/91) is one of the actions to achieve that. A major target up to the year 2000 formulated in the Fifth Environmental Action Programme 'Towards Sustainability' is to achieve a standstill or reduction of nitrate levels in groundwater. Some recommendations are formulated in the following to contribute to the objectives of the Nitrate Directive. Several of them focus on keeping records of critical indicators in the framework of existing databases.

Recommendation 1

Knowledge on the amount of minerals in animal manure is not sufficient for an assessment of leaching losses to the environment. Mineral balances are more appropriate in that respect, including both inflow and outflow elements. It is recommended to assess net nitrogen surplus at farm level because this indicator is more appropriate towards the identification of the potential of leaching to soils than gross nitrogen surplus is.

Recommendation 2

The Nitrate Directive states that the application of animal manure in zones vulnerable to leaching should not exceed 170 kg of nitrogen per ha. It is recommended in this respect to register production and treatment of animal manure in the Farm Accountancy Data Network (FADN) of the European Commission. This will provide information on the way how animal manure is

being treated at farm level. Such a registration would be required in zones vulnerable to leaching of nitrates to monitor progress achieved by the agricultural sector in meeting the objectives of the Nitrate Directive.

Recommendation 3

Similar to the previous recommendation, it is recommended to register usage of mineral fertilizers at crop level. This work may build upon the experience from the Farm Accountancy Data Network in the Netherlands and their expertise to keep records of inflow and outflow components of mineral balances at farm level. Mineral balances at farm level could contribute largely towards monitoring of progress achieved in agri-environmental policy.

Recommendation 4

Differences across Member States are large regarding the mineral content of animal manure. It is recommended to harmonize these coefficients to allow for assessments of manure production levels and their mineral content, according to harmonized procedures and accounting rules. This is required to support monitoring of progress by the agricultural sector in meeting requirements of the Nitrate Directive.

Recommendation 5

Regional averages of yields of forage crops have been used to assess mineral balances at farm level. Also the uptake of minerals by crops is based on national equations. Farm management aspects regarding the treatment of minerals from organic sources therefore are not included in the assessment.

It is recommended to improve the understanding of farm gate balances. This approach would allow for the inclusion of farm management aspects, since it is based on the amount of minerals which enter or leave the farm.

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LIST OF SYMBOLS AND ABBREVIATIONS

-	Nil
0	Data less than half the unit used
.	No data available or sample less than 15 farms
∞	Infinite
CAP	Common Agricultural Policy
CEC	Commission of the European Communities
DG-XII	Directorate General for Science, Research and Development of the CEC
EC	European Communities
ECU	European Currency Unit
EEC	European Economic Community
ESU	European Size Unit
EU	European Union
FADN	Farm Accountancy Data Network
FAL	Bundesforschungsanstalt für Landwirtschaft (Federal Agricultural Research Centre), Institut für Betriebswirtschaft (Institute of Farm Economics), Braunschweig, Germany
FNVA	Farm Net Value Added
FSS	Farm Structure Survey of Eurostat
INRA	Institut National de la Recherche Agronomique, Rennes, France
LEI-DLO	Landbouw-Economisch Instituut (Agricultural Economics Research Institute), The Hague, the Netherlands
LEI-IEA	Landbouw-Economisch Instituut, Brussels, Belgium
LU	Livestock Unit
N	Nitrogen
NUTS	Nomenclature of Territorial Units for Statistics
P_2O_5	Phosphate
REGIO	Regional Data Bank of Eurostat
RIVM	Rijksinstituut voor Volksgezondheid en Milieuhygiëne (National Institute of Public Health and Environmental Protection), Bilthoven, the Netherlands
RIZA	Rijksinstituut voor Integraal Zoetwaterbeheer en Afvalwaterbehandeling (Institute for Inland Water Management and Waste Water Treatment), Lelystad, the Netherlands
SJI	Statens Jordbrugsøkonomiske Institut (Institute of Agricultural Economics), Copenhagen, Denmark
STI	Economics Department of the University of Stirling, Stirling (Scotland), United Kingdom
UAA	Utilized Agricultural Area

APPENDICES

Appendix 1 Regional division of the EU in this study

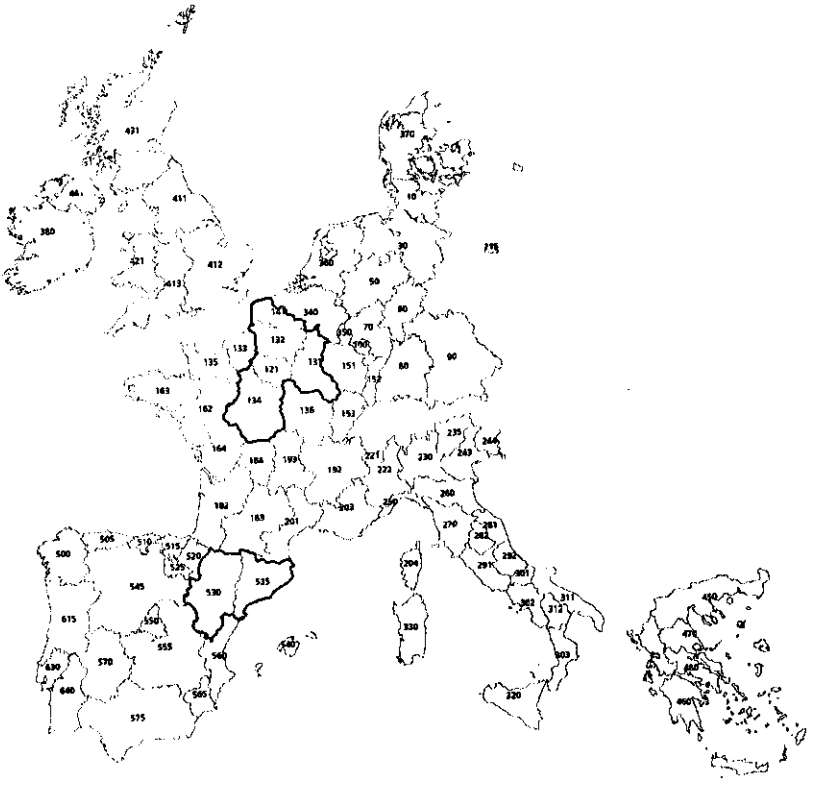


Figure A1.1 Regional division of the EU in this study

The codes in the map refer to the following EU regions:

GERMANY
010 Schleswig-Holstein
030 Niedersachsen
050 Nordrhein-Westfalen
060 Hessen
070 Rheinland-Pfalz
080 Baden-Wuerttemberg
090 Bayern
100 Saarland
115 Hamburg, Bremen, Berlin

FRANCE
121 Île de France
131 Champagne-Ardenne
132 Picardie
133 Haute-Normandie
134 Centre (F)
135 Basse-Normandie
136 Bourgogne
141 Nord-Pas-de-Calais
151 Lorraine
152 Alsace
153 Franche-Comté
162 Pays de la Loire
163 Bretagne
164 Poitou-Charentes
182 Aquitaine
183 Midi-Pyrénées
184 Limousin
192 Rhône-Alpes
193 Auvergne
201 Languedoc-Roussillon
203 Prov.-Alpes-C.d'Azur
204 Corse

ITALY
221 Valle d'Aosta
222 Piemonte
230 Lombardia
235 Trentino-Alto Adige
243 Veneto
244 Friuli-Venezia Giulia
250 Liguria
260 Emilia-Romagna
270 Toscana
281 Marche
282 Umbria
291 Lazio
292 Abruzzi
301 Molise
302 Campania
303 Calabria
311 Puglia
312 Basilicata
320 Sicilia
330 Sardegna

BELGIUM
340 Belgique-België

LUXEMBOURG
350 Luxembourg

NETHERLANDS
360 Nederland

DENMARK
370 Danmark

IRELAND
380 Ireland

UNITED KINGDOM
411 England North
412 England East
413 England West
421 Wales
431 Scotland
441 Northern Ireland

GREECE
450 Makedonia Thraki
460 Ipiros Pelop. N.Ioniou
470 Thessalia
480 St.Ellas N.Egae. Kriti

SPAIN
500 Galicia
505 Asturias
510 Cantabria
515 Pais Vasco
520 Navarra
525 Rioja
530 Aragon
535 Cataluna
540 Baleares
545 Castilla-Leon
550 Madrid
555 Castilla-La Mancha
560 Comunidad Valenciana
565 Murcia
570 Extremadura
575 Andalucia
580 Canarias (not illustrated)

PORTUGAL
615 Norte-Centro
630 Lisboa-Vale do Tejo
640 Alentejo-Algarve
650 Acores-Madeira (not illustrated)

SPECIAL GROUPINGS USED IN THIS STUDY
Northern cereal area (regions 121, 131, 132, 134, 141)
Aragon and Cataluna (regions 530, 535)

Appendix 2 FADN farming types

9 farming types		17 principal farming types	
1	Cereal farms	Type 11	specialist cereal
2	General cropping farms	Type 12	general field cropping
		Type 60	mixed cropping
3	Horticultural holdings	Type 20	specialist horticulture
4	Vineyards	Type 31	specialist vineyards
5	Permanent crop holdings	Type 32	specialist fruit and citrus fruit
		Type 33	specialist olives
		Type 34	various permanent crops combined
6	Dairy farms	Type 41	specialist dairying
7	Drystock farms	Type 42	specialist cattle-rearing and fattening
		Type 43	cattle-dairying, rearing and fattening combined
		Type 44	sheep, goats and other grazing livestock
8	Granivore farms	Type 50	specialist granivores
9	Mixed farms	Type 71	mixed livestock, mainly grazing livestock
		Type 72	mixed livestock, mainly granivores
		Type 81	field crops-grazing livestock, combined
		Type 82	various crops and livestock, combined

Source: CEC, 1989:14.

Appendix 3 Coefficients used to convert species and classes of livestock to Livestock Units (LU)

Class or species	Number of livestock units per animal
Cattle	
calves for fattening	0.4
other cattle < 1 year	0.4
male cattle 1 - <2 years	0.6
female cattle 1 - <2 years	0.6
male cattle >= 2 years	1.0
breeding heifers	0.5
heifers for fattening	0.5
dairy cows	1.0
cull dairy cows	1.0
other cows	0.8
Pigs	
piglets	0.027
breeding sows	0.5
pigs for fattening	0.3
other pigs	0.3
Poultry	
table chickens	0.007
laying hens	0.014
other poultry	0.03
Sheep	
ewes	0.1
other sheep	0.1
Goats	
goats, breeding females	0.1
other goats	0.1
Other animals	
equines	0.6

Source: CEC, 1989:70; *personal additional information* CEC.

Appendix 4 Definitions of variables used in the model

Crop areas	
Variable in this study	Variable in FADN
Utilized agricultural area (UAA)	UAA in owner occupation Rented UAA UAA in share cropping
Arable crops and permanent grass	
- Field crops	
Cereals	
Wheat	Common wheat Durum wheat
Barley	Barley
Grain maize	Grain maize
Other cereals	Rye (incl. meslin) Oats Summer cereal mixes Rice Other cereals
- Other field crops	
Potatoes	Potatoes
Sugar beet	Sugar beet
Oil seeds	Oil seeds
Rape seed	Rape
Sunflower	Sunflower
Other oil seeds	Other oil seeds
Dry pulses	Dry pulses
Hops	Hops
Tobacco	Tobacco
Other industrial crops	Other industrial crops
Fresh vegetables - open field	Fresh vegetables - open field
Market gardening and flowers	Fresh vegetables - market garden Fresh vegetables - under glass Flowers - open air Flowers - protected
Forage crops	
Grass (including rough grazing)	
Grass (excluding rough grazing)	Meadows + permanent pastures
Rough grazing	Rough grazing
Other forage crops	
Fodder	
- crops (fodder roots and brassicas + temporary grass)	Fodder roots + brassicas Temporary grass
- maize (fodder maize and other fodder plants)	Other forage plants
Fallow land	Fallow land

Crop areas	
Variable in this study	Variable in FADN
Other arable crops	*Grass seed* Other seeds Other arable crops
Permanent crops	
- Fruit and citrus fruit (orcharding)	Fruit + berry orchards Citrus orchards
- Vineyards	Vines
- Olive groves	Olive groves
- Other permanent crops	Permanent crops under protection Nurseries (incl. vines) Other permanent crops

In the model used for this study many variables are related to areas. If there is no area at all, or no area of the groups used in this model, technical problems arise with the software used (division by zero is not allowed and data then are transformed to missing values).

To avoid this problem, the denominator in the divisions is replaced by a low dummy value (0.001 ha).

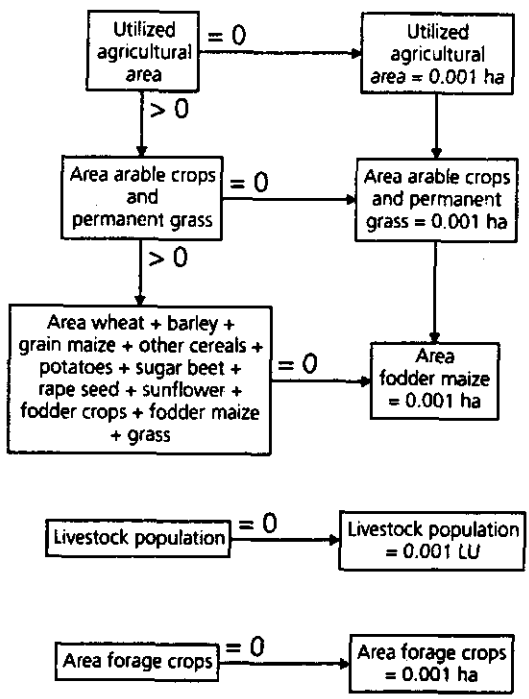
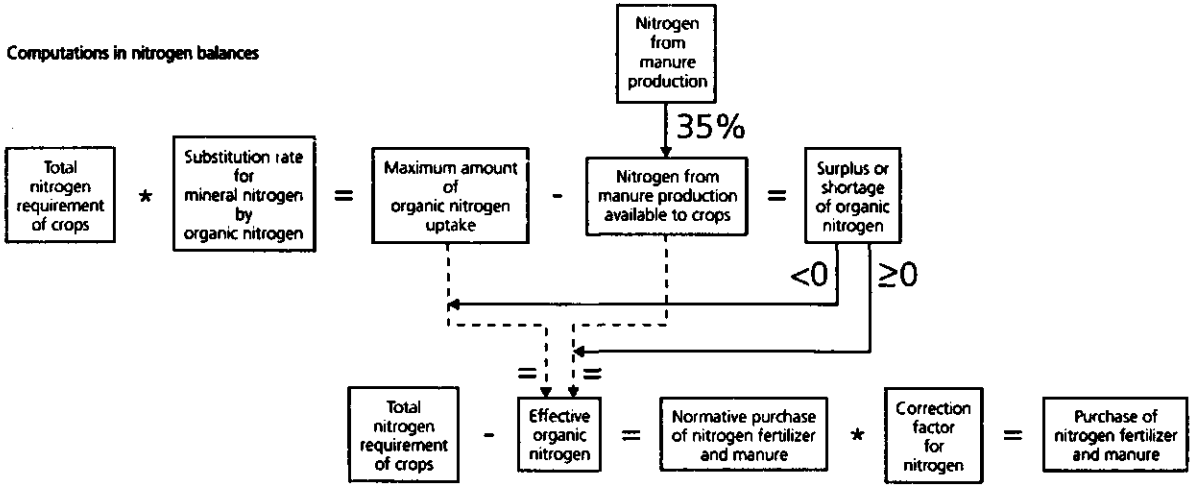


Figure A4.1 Use of variables in this study

Livestock population	
Variable in this study	Variable in FADN
Grazing livestock	
Cattle: Dairy cows	Dairy cows
Other cattle: Calves	Calves for fattening
	Other cattle < 1 year
Male cattle 1 - <2 years	Male cattle 1-<2 years
Female cattle 1 - <2 years	Female cattle 1-<2 years
Male cattle >= 2 years	Male cattle >=2 years
Breeding heifers	Breeding heifers
Heifers for fattening	Heifers for fattening
Other cows	Cull dairy cows
	Other cows
Sheep	Ewes
	Other sheep
Goats	Goats, breeding females
	Other goats
Pigs and poultry	
Pigs: Breeding sows	Breeding sows
Pigs for fattening	Pigs for fattening
Other pigs	Other pigs
Poultry	Table chickens
	Laying hens
	Other poultry
Other animals: Equines	Equines

Other variables used	
Variable in this study	Variable in FADN
Economic size	
(in European Size Units (ESU)	Economic size of farm in ecu, "default" SGMs
Purchased fertilizers (ECU)	Crop costs fertilizers
Purchased feedingstuffs (ECU)	Concentrated feedingstuffs for grazing livestock
	Coarse fodder for grazing livestock
	Pigfeed
	Feedingstuffs for poultry and small animals
Milk production (kg)	Cows' milk production
	Cows' milk products production
Livestock output (ECU)	Output: livestock
	Output: livestock products
	Output: livestock appreciation
Crop output (ECU)	Output: crops + crop products
Farm net value added (FNVA) (ECU)	Farm Net Value Added (FNVA)



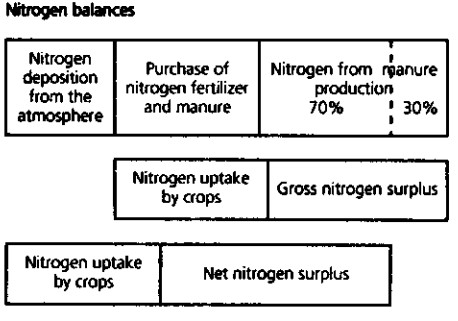
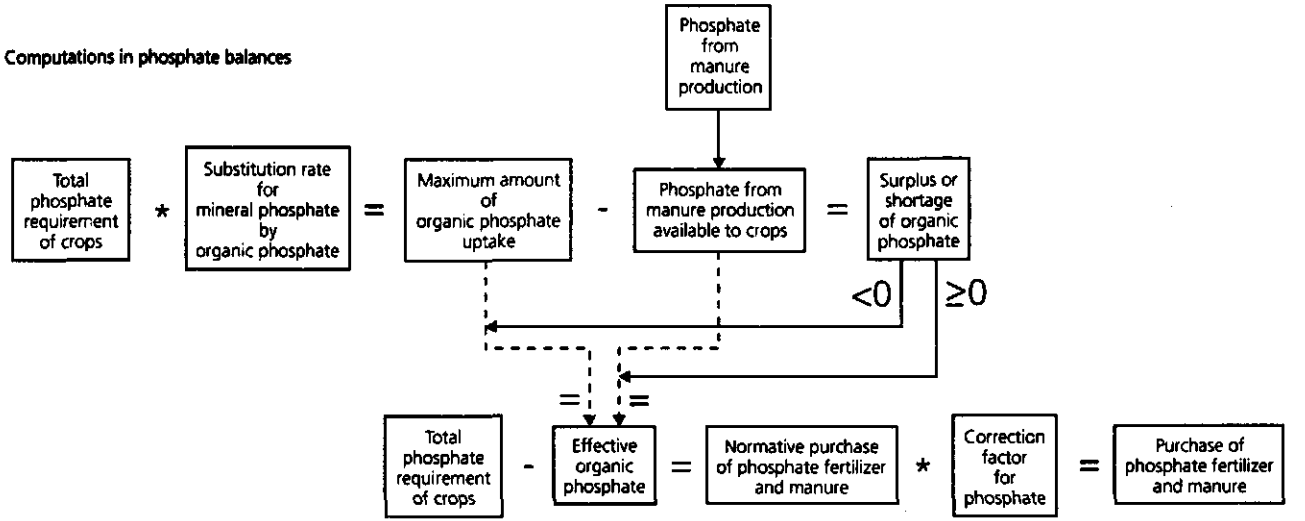


Figure A4.2 Computations in nitrogen balances

Computations in phosphate balances



Phoshate balance

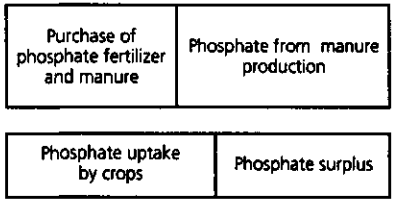


Figure A4.3 Computations in phosphate balances

Appendix 5 Coefficients used in the calculation of the nitrogen and phosphate balances

Table A5.1 Nitrogen supply from organic manure in kg N/animal/year by species and country

Animal	Country				
	Germany United Kingdom Ireland	France Italy Greece Spain Portugal	Denmark	Belgium Luxembourg	Netherlands
Dairy cows	85	84	126.3	88	144
Calves	15	17.3	38.3	26.4	25.4
Male cattle 1-<2 yr.	50	50.4	43.8	61.6	78
Female cattle 1-<2 yr.	50	50.4	38.3	61.6	78
Male cattle >=2 yr.	85	59.1	43.8	88	100
Breeding heifers	85	67.2	38.3	88	100
Heifers for fattening	85	59.1	38.3	88	100
Other cows	85	58.7	73.3	88	120
Sheep	7	8.1	15	7.5	21.8
Goats	7	8.1	15	7.5	15
Breeding sows	29	39.7	30.9	27.5	35
Pigs for fattening	11	10.1	14.5	11.8	13.9
Other pigs	18.3	20.1	22.9	17.2	17.2
Poultry	0.5	0.6	0.66	0.6	0.58
Equines	68.6	67.2	50	88	45

Table A5.2 Nitrogen requirement of crops in kg N/ha

Crop	Country		
	Germany United Kingdom Ireland Belgium Luxembourg Denmark	France Italy Portugal Spain Greece	Netherlands
Wheat	10 + 25 * yld	24 * yld	167
Barley	20 + 20 * yld	19 * yld	108
Grain maize	40 + 20 * yld	40 + 20 * yld	40 + 20 * yld
Other cereals	20 + 20 * yld	20 * yld	108
Potatoes	40 + 4 * yld	4.4 * yld	333
Sugar beet	80 + 2 * yld	2.3 * yld	268
Rape seed	60 + 50 * yld	60 + 50 * yld	125
Sunflower	5 + 40 * yld	5 + 40 * yld	-
Grass a)	-30 + 24 * yld	-30 + 24 * yld	-30 + 24 * yld
Fodder - crops b)	-30 + 24 * yld	-30 + 24 * yld	-30 + 24 * yld
- maize c)	30 + 3.2 * yld	30 + 3.2 * yld	30 + 3.2 * yld

a) Excl. rough grazing; b) Temporary grass and fodder roots and brassicas; c) Fodder maize and other forage plants; yld = yield of the crop in ton per ha.

Table A5.3 Maximum kg N from organic manure per kg total N requirement of crops

Crop	Country		
	Germany United Kingdom Ireland Belgium Luxembourg Denmark	France Italy Portugal Spain Greece	Netherlands
Wheat	0.15	0.15	0.00
Barley	0.15	0.15	0.00
Grain maize	0.20	0.80	0.00
Other cereals	0.15	0.15	0.00
Potatoes	0.20	0.20	0.50
Sugar beet	0.20	0.20	0.60
Rape seed	0.20	0.20	0.00
Sunflower	0.00	0.00	-
Grass a)	0.20	0.50	0.50
Fodder - crops b)	0.20	0.50	0.50
- maize c)	0.30	0.80	0.50

a) Excl. rough grazing; b) Temporary grass and fodder roots and brassicas; c) Fodder maize and other forage plants.

Table A5.4 Nitrogen uptake of crops in kg N/ha

Crop	Country		
	Germany United Kingdom Ireland Belgium Luxembourg Denmark	France Italy Portugal Spain Greece	Netherlands
Wheat	20 * yld	19 * yld	22.2 * yld
Barley	17 * yld	15 * yld	18.5 * yld
Grain maize	14 * yld	15 * yld	15 * yld
Other cereals	16 * yld	16 * yld	16.3 * yld
Potatoes	3.2 * yld	3.5 * yld	3.6 * yld
Sugar beet	1.8 * yld	1.8 * yld	1.5 * yld
Rape seed	33 * yld	35 * yld	33.3 * yld
Sunflower	30 * yld	19 * yld	-
Grass a)	17 * yld	17 * yld	17 * yld
Fodder - crops b)	17 * yld	17 * yld	17 * yld
- maize c)	3 * yld	3.1 * yld	3.1 * yld

a) Excl. rough grazing; b) Temporary grass and fodder roots and brassicas; c) Fodder maize and other forage plants; yld = yield of the crop in ton per ha.

Table A5.5 Phosphate supply from organic manure in kg P_2O_5/animal/year by species and country

Animal	Country			
	Germany United Kingdom Ireland	France Italy Greece Spain Portugal	Denmark	Belgium Luxembourg Netherlands
Dairy cows	35	36	40	37
Calves	5	3	9.8	11.1
Male cattle 1-<2 yr.	20	21.6	11	25.9
Female cattle 1-<2 yr.	20	21.6	9.8	25.9
Male cattle >=2 yr.	35	25.2	11	37
Breeding heifers	35	28.8	9.8	37
Heifers for fattening	35	25.2	9.8	37
Other cows	35	25.2	16.9	37
Sheep	2.8	6	7	3.5
Goats	2.8	6	7	3.5
Breeding sows	18	29.7	19.7	17
Pigs for fattening	6.5	7.5	5.7	7.7
Other pigs	12	15	13.1	17
Poultry	0.3	0.5	0.34	0.4
Equines	25	28.8	18.3	33

Table A5.6 Phosphate requirement of crops in kg P_2O_5/ha

Wheat	10 + 15 * yld
Barley	10 + 15 * yld
Grain maize	80 + 10 * yld
Other cereals	10 + 15 * yld
Potatoes	80 + 1 * yld
Sugar beet	20 + 2.5 * yld
Rape seed	40 + 20 * yld
Sunflower	25 * yld
Grass a)	12 * yld
Fodder - crops b)	12 * yld
- maize c)	10 + 3 * yld

a) Excl. rough grazing; b) Temporary grass and fodder roots and brassicas; c) Fodder maize and other forage plants; yld = yield of the crop in ton per ha.

Table A5.7 Maximum kg P_2O_5 from organic manure per kg total P_2O_5 requirement of crops

Crop	Country	
	Netherlands	Other countries
Wheat	0	1
Barley	0	1
Grain maize	0	0.75
Other cereals	0	1
Potatoes	0.8	1
Sugar beet	1	1
Rape seed	0	1
Sunflower	0	1
Grass a)	1	1
Fodder - crops b)	1	1
- maize c)	0.75	0.75

a) Excl. rough grazing; b) Temporary grass and fodder roots and brassicas; c) Fodder maize and other forage plants.

Table A5.8 Phosphate uptake of crops in kg P_2O_5/ha

Wheat	8.5 * yld
Barley	8.5 * yld
Grain maize	8.5 * yld
Other cereals	8.5 * yld
Potatoes	1.4 * yld
Sugar beet	1.0 * yld
Rape seed	18.0 * yld
Sunflower	18.0 * yld
Grass a)	6.5 * yld
Fodder - crops b)	6.5 * yld
- maize c)	2.0 * yld

a) Excl. rough grazing; b) Temporary grass and fodder roots and brassicas; c) Fodder maize and other forage plants; yld = yield of the crop in ton per ha.

Appendix 6 Nitrogen deposition from the atmosphere and sales of fertilizers per ha in 1990

Country/region	Nitrogen deposition kg N	Fertilizer sales	
		kg N	kg P_2O_5
Belgium	33.1	163.0	57.8
Denmark	18.1	142.1	34.0
Germany			
Schleswig-Holstein	26.2	127.6	52.8
Niedersachsen	34.6	127.6	52.8
Nordrhein-Westfalen	38.1	127.6	52.8
Hessen	30.2	127.6	52.8
Rheinland-Pfalz	26.4	127.6	52.8
Baden-Wuerttemberg	25.3	127.6	52.8
Bayern	28.5	127.6	52.8
Saarland	28.5	127.6	52.8
Hamburg, Bremen, Berlin	32.3	127.6	52.8
Greece			
Makedonia Thraki	8.3	46.4	20.4
Ipiros Pelop. N.Ioniou	5.4	46.4	20.4
Thessalia	8.3	46.4	20.4
St.Ellas N.Egae. Kriti	4.0	46.4	20.4
Spain a)			
Galicia	7.2	37.5	30.5
Asturias	7.2	37.5	30.5
Cantabria	7.2	37.5	30.5
Pais Vasco	6.8	37.5	30.5
Navarra	6.8	37.5	30.5
Rioja	6.8	37.5	30.5
Aragon	6.8	37.5	30.5
Cataluna	5.2	37.5	30.5
Baleares	3.1	37.5	30.5
Castilla-Leon	6.6	37.5	30.5
Madrid	7.2	37.5	30.5
Castilla-La Mancha	6.6	37.5	30.5
Comunidad Valenciana	5.2	37.5	30.5
Murcia	3.8	37.5	30.5
Extremadura	6.6	37.5	30.5
Andalucia	3.8	37.5	30.5
Canarias	3.8	37.5	30.5

Country/region	Nitrogen deposition kg N	Fertilizer sales	
		kg N	kg P_2O_5
France			
Île de France	18.9	153.0	89.0
Champagne-Ardenne	18.9	145.0	84.0
Picardie	18.9	160.0	72.0
Haute-Normandie	18.9	125.0	64.0
Centre (F)	18.9	126.0	65.0
Basse-Normandie	18.9	71.0	39.0
Bourgogne	18.9	65.0	39.0
Nord-Pas-de-Calais	25.5	126.0	55.0
Lorraine	20.1	101.0	46.0
Alsace	20.1	103.0	76.0
Franche-Comte	20.1	46.0	45.0
Pays de la Loire	17.2	84.0	39.0
Bretagne	17.2	108.0	49.0
Poitou-Charentes	17.2	112.0	67.0
Aquitaine	11.4	115.0	78.0
Midi-Pyrenees	11.4	70.0	51.0
Limousin	11.4	19.0	24.0
Rhone-Alpes	15.4	52.0	36.0
Auvergne	15.4	29.0	25.0
Languedoc-Roussillon	10.4	62.0	49.0
Prov.-Alpes-C.d Azur	10.4	67.0	60.0
Corse	10.4	17.0	12.0
Ireland b)	10.4	59.7	24.9
Italy			
Valle d Aosta	15.3	2.4	3.0
Piemonte	15.3	53.8	32.5
Lombardia	23.1	87.2	58.5
Trentino-Alto Adige	20.2	12.3	6.1
Veneto	20.2	72.8	62.8
Friuli-Venezia Giulia	20.2	64.7	54.2
Liguria	15.3	11.8	8.9
Emilia-Romagna	18.3	72.7	63.2
Toscana	10.5	46.6	30.3
Marche	10.5	53.9	53.6
Umbria	10.5	49.8	38.8
Lazio	8.8	43.0	32.7
Abruzzi	10.3	40.3	42.6
Molise	10.3	26.7	29.8
Campania	8.1	46.5	23.5
Calabria	6.7	21.4	15.2
Puglia	6.7	37.9	32.7
Basilicata	6.7	16.1	16.0
Sicilia	3.6	24.8	23.5
Sardegna	3.6	11.5	14.1
Luxembourg a)	26.9	128.4	58.3
Netherlands	35.7	218.2	35.9

Country/region	Nitrogen deposition kg N	Fertilizer sales	
		kg N	kg P_2O_5
Portugal b)			
Norte-Centro	3.9	31.5	17.3
Lisboa-Vale do Tejo	3.9	31.5	17.3
Alentejo-Algarve	3.9	31.5	17.3
Acores-Madeira	3.9	31.5	17.3
United Kingdom			
England North	22.8	92.2	24.9
England East	22.4	92.2	24.9
England West	19.5	92.2	24.9
Wales	17.4	92.2	24.9
Scotland	6.9	92.2	24.9
Northern Ireland	9.5	92.2	24.9

a) Sales of fertilizers per ha for the year 1989; b) Sales of fertilizers per ha for the year 1988.
Sources: Own calculations based on FAL, FAO and Eurostat.

Appendix 7 Yields of arable crops and grass in ton/ha in 1990

	Wheat	Barley	Grain maize	Other cereals	Potatoes	Sugar beet	Rape seed	Sun-flower	Fodder maize a)	Grass and other forage crops b,c)
Belgium	6.27	5.54	7.74	4.33	34.39	59.49	3.02	.	41.89	12.13
Denmark	7.42	5.54	.	5.03	37.46	53.43	2.94	.	46.66	11.67
Germany										
Schleswig-Holstein	7.81	6.82	6.71	5.14	32.44	49.97	3.36	.	35.03	8.01
Niedersachsen	7.04	5.25	6.07	4.42	36.48	52.21	3.15	2.10	40.89	6.69
Nordrhein-Westfalen	6.25	5.16	6.94	4.50	39.46	56.47	2.79	2.10	41.57	7.60
Hessen	6.52	5.81	7.06	4.50	32.25	51.95	3.09	2.10	50.52	6.22
Rheinland-Pfalz	5.52	4.95	5.61	4.23	31.57	51.90	2.34	2.10	44.90	6.77
Baden-Wuerttemberg	6.10	5.49	7.04	4.72	29.01	51.95	2.80	2.10	44.80	6.22
Bayern	6.62	5.48	7.44	5.14	30.95	59.33	3.00	2.10	46.61	7.12
Saarland	5.50	4.68	5.69	4.25	32.95	.	2.36	2.10	44.89	5.61
Hamburg, Bremen, Berlin	7.22	5.20	6.07	4.28	30.06	51.23	3.43	.	37.34	5.35
Greece										
Makedonia Thraki	1.91	2.02	9.89	2.64	21.61	57.53	.	1.47	10.50	3.25
Ipiros Pelop. N.Ioniou	2.10	1.81	8.02	8.33	21.93	.	.	1.47	10.50	0.68
Thessalia	2.19	1.73	10.86	2.01	14.82	57.68	.	1.85	12.42	3.40
St.Ellas N.Egae. Kriti	2.00	1.46	6.16	1.75	14.79	53.32	.	1.47	10.50	1.19
Spain d)										
Galicia	1.83	1.69	2.78	1.48	16.13	.	.	.	33.25	7.77
Asturias	1.62	.	2.76	1.54	24.20	.	.	.	55.00	5.39
Cantabria	2.73	2.50	2.73	1.34	15.44	.	.	.	40.00	8.28
Pais Vasco	4.06	3.69	2.87	3.45	23.21	44.34	1.18	1.53	40.39	6.40
Navarra	3.18	2.24	6.43	1.70	18.08	39.10	1.62	1.89	31.75	1.75

	Wheat	Barley	Grain maize	Other cereals	Potatoes	Sugar beet	Rape seed	Sun-flower	Fodder maize a)	Grass and other forage crops b,c)
Spain d)										
Rioja	3.16	2.60	8.26	2.61	37.32	42.73	1.50	2.01	48.57	1.72
Aragon	3.01	2.33	7.06	2.11	19.82	31.46	1.43	1.87	43.51	1.43
Cataluna	3.83	2.86	4.65	2.61	17.03	.	1.45	1.81	43.05	2.77
Baleares	1.05	0.92	5.82	0.67	15.53	.	.	.	30.60	3.56
Castilla-Leon	2.15	1.96	7.83	1.62	24.05	45.80	1.05	0.91	53.46	3.68
Madrid	2.47	2.49	8.01	1.27	22.17	42.00	.	0.81	55.00	3.34
Castilla-La Mancha	1.83	2.44	8.99	1.22	19.14	39.71	1.10	0.69	38.82	2.60
Comunidad Valenciana	3.68	2.45	6.63	2.11	19.54	.	.	0.85	26.69	6.67
Murcia	1.98	1.66	7.49	1.55	20.56	30.00	.	0.46	40.00	3.90
Extremadura	1.42	1.42	7.93	1.23	19.26	39.24	0.90	0.61	29.22	3.09
Andalucia	2.75	1.78	8.23	2.23	21.52	37.18	1.28	1.10	33.92	3.90
Canarias	1.06	1.25	2.74	0.64	10.70	.	.	.	10.88	2.72
France										
Île de France	7.90	6.80	4.90	7.10	26.50	55.90	3.00	2.20	35.77	5.25
Champagne-Ardenne	8.20	7.12	6.20	5.55	35.60	72.90	3.30	2.70	34.12	3.09
Picardie	8.10	7.40	4.70	7.45	30.90	66.30	3.30	2.70	30.96	7.32
Haute-Normandie	7.80	7.20	4.90	7.60	28.60	70.40	3.30	1.80	30.77	6.21
Centre (F)	6.20	5.70	5.50	3.19	28.40	68.20	2.60	2.00	19.47	3.00
Basse-Normandie	7.20	5.30	4.40	5.06	24.80	57.30	2.50	2.10	32.48	4.70
Bourgogne	6.20	5.30	5.40	3.49	28.20	67.10	2.80	2.30	26.89	4.16
Nord-Pas-de-Calais	8.70	7.50	5.40	6.93	31.40	65.90	3.70	.	31.91	7.98
Lorraine	6.60	6.00	5.00	3.77	27.00	50.20	3.30	2.70	30.37	4.24
Alsace	6.40	5.60	8.30	5.88	32.10	65.20	2.90	3.30	54.00	3.74
Franche-Comte	6.40	5.30	6.00	4.44	21.30	68.80	2.80	2.90	47.79	3.20
Pays de la Loire	5.30	4.40	4.40	4.53	24.30	45.90	2.10	2.00	18.36	4.59
Bretagne	5.80	4.70	5.50	3.84	25.30	.	2.50	2.10	30.94	6.10

	Wheat	Barley	Grain maize	Other cereals	Potatoes	Sugar beet	Rape seed	Sun-flower	Fodder maize a)	Grass and other forage crops b,c)
France										
Poitou-Charentes	5.60	5.00	6.90	4.29	20.90	.	2.20	2.10	25.96	3.18
Aquitaine	5.00	4.40	6.20	5.06	28.70	.	2.10	2.00	22.12	4.46
Midi-Pyrenees	4.30	4.10	5.50	3.70	25.40	.	2.10	1.80	28.22	3.19
Limousin	4.40	3.40	3.10	3.49	26.10	.	2.10	1.60	18.52	4.63
Rhone-Alpes	4.50	4.40	6.40	3.73	22.10	61.60	2.50	2.40	34.70	2.75
Auvergne	5.40	4.40	6.70	3.64	18.50	74.80	2.30	2.90	28.47	4.09
Languedoc-Roussillon	3.50	3.60	5.20	2.92	18.60	.	1.90	2.00	27.13	0.99
Prov.-Alpes-C.d Azur	3.40	3.60	7.50	3.35	23.30	.	2.50	2.80	34.98	0.57
Corse	3.90	2.80	8.40	2.14	15.80	.	2.50	2.50	55.56	1.03
Ireland e)	7.86	6.03	.	5.85	24.71	40.06	3.24	.	30.06	3.99
Italy										
Valle d Aosta	2.40	2.00	4.00	1.97	15.67	55.90	.	.	48.57	2.29
Piemonte	4.63	4.79	6.08	3.12	22.94	51.88	2.33	1.72	37.93	3.88
Lombardia	5.65	5.47	9.13	3.49	31.29	52.16	.	3.50	53.32	6.37
Trentino-Alto Adige	2.33	1.45	3.72	1.51	18.64	55.90	.	.	41.09	2.32
Veneto	5.91	5.67	9.35	3.98	32.56	55.68	2.50	3.37	48.45	8.40
Friuli-Venezia Giulia	5.26	4.63	8.20	3.45	32.81	62.51	3.17	3.37	42.77	2.91
Liguria	2.40	2.56	4.92	1.88	16.04	55.90	.	.	47.45	1.52
Emilia-Romagna	5.44	5.07	8.38	6.44	29.02	41.64	.	2.99	46.31	7.44
Toscana	3.73	3.54	6.09	2.93	18.52	46.66	1.87	2.11	39.00	1.94
Marche	4.17	4.28	7.42	4.98	12.90	35.97	1.78	2.34	36.75	2.55
Umbria	4.01	3.69	7.29	3.63	18.55	40.84	2.37	1.93	29.71	2.66
Lazio	3.22	3.41	6.83	2.72	18.92	46.38	3.03	1.89	42.09	2.09
Abruzzi	2.73	2.79	4.06	2.39	20.41	29.23	2.58	1.72	39.92	1.13
Molise	2.87	2.90	4.75	2.47	9.01	43.01	1.94	2.00	28.73	0.45
Campania	2.72	2.64	6.51	2.23	22.10	46.16	.	1.97	43.75	5.85

	Wheat	Barley	Grain maize	Other cereals	Potatoes	Sugar beet	Rape seed	Sun-flower	Fodder maize a)	Grass and other forage crops b,c)
Italy										
Calabria	1.03	0.99	3.36	1.10	18.10	31.50	.	3.00	39.83	3.69
Puglia	1.84	1.50	5.09	1.38	14.82	36.50	2.04	1.70	40.00	3.68
Basilicata	1.24	1.28	1.38	1.29	3.58	38.54	2.00	0.84	43.10	1.96
Sicilia	1.26	1.14	4.35	1.23	17.39	55.90	.	1.03	40.70	5.46
Sardegna	1.02	1.57	6.58	1.62	15.41	40.34	.	.	49.34	1.75
Luxembourg d)	3.92	3.58	.	3.24	29.96	26.43	2.90	.	50.00	8.25
Netherlands	7.65	5.42	5.00	6.10	40.14	69.01	3.03	.	45.92	11.48
Portugal f)										
Norte-Centro	1.25	0.66	2.55	0.91	9.05	32.67	.	0.80	38.13	3.56
Lisboa-Vale do Tejo	1.75	0.99	3.15	3.27	9.37	32.67	.	1.18	38.13	4.28
Alentejo-Algarve	1.72	0.97	1.23	2.06	8.79	32.67	.	0.64	38.13	3.24
Acores-Madeira	1.29	2.02	3.03	7.06	14.60	32.67	.	0.80	38.13	3.31
United Kingdom										
England North	7.49	5.59	.	4.63	35.90	41.82	3.10	.	33.73	5.12
England East	6.92	5.15	.	5.12	35.90	41.82	3.10	.	29.06	4.85
England West	6.24	4.71	.	4.21	35.90	41.82	3.10	.	29.95	5.89
Wales	5.79	4.38	.	3.68	32.68	41.82	3.10	.	34.90	5.00
Scotland	8.32	5.58	.	5.18	43.18	41.82	3.10	.	30.06	2.02
Northern Ireland	6.82	4.54	.	4.29	31.75	41.82	3.10	.	30.06	5.21

a) Measured in green matter; b) Excluding rough grazing; c) Measured in hay, 85% dry matter; d) Yields in 1989; e) Yields in 1988; f) Yields in 1987.

Sources: Own calculations based on FAL and Eurostat.