



Nitrogen balances in Agriculture

In 1997, 50% of the total supply of nitrogen was attributed to mineral fertilisers

Statistics
in focus

ENVIRONMENT AND
ENERGY

THEME 8 – 16/2000

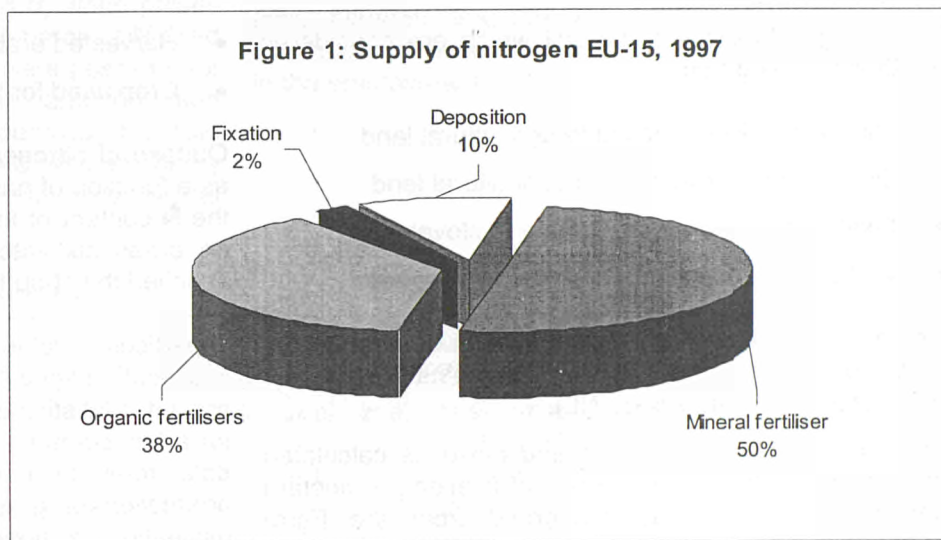
Contents

1. Introduction	1
2. Methodology and Data Sources	2
3. Comments on main results.....	4

Jakob Hansen

1. Introduction

The risk to the environment, and particularly to groundwater, due to leaching of minerals from soil is of major public concern. Agricultural activities are one of the major, but not the only, source of nitrogen pollution, and the quality of water is one of the most important environmental issues in areas with a high density of livestock per hectare. This can be due to either the high surplus of minerals from agriculture or to vulnerability of the soil to leaching, or a combination of these two phenomena. The relative distribution of the main nitrogen sources is shown below.



Harmonised statistical information, based on common standards and methods, on nitrogen surpluses in agriculture is nevertheless scarce. International organisations, such as OECD, have proposed the use of nitrogen balances as an indicator of the risk posed to the environment from excessive nitrogen.

However nitrogen balances on a national level do not provide useful information on the state of nitrogen surpluses, except perhaps in small homogenous countries. Regional balances provide a better picture for policy makers, enabling them to identify areas of high surplus and thus where surface and ground water may be at risk. Also, tracking the change in these surpluses over a number of years can be used to assess the effectiveness of policy measures. The use of the balance as an indicator of loss to water nevertheless requires careful interpretation. The balance between inputs and outputs for a system contains all potential losses, plus any change in the store of nitrogen, principally within the soil. The potential loss pathways for nitrogen are to air as ammonia by direct volatilisation; to air as nitrous oxide and nitrogen gas by denitrification; and to water by the leaching of nitrate.



Manuscript completed on: 2.10.2000
ISSN 1562-3106
Catalogue number: KS-NQ-00-016-EN-C
Price in Luxembourg per single copy
(excl. VAT): EUR 6

© European Communities, 2000

Moreover, the relationship between nitrogen balance and loss to water differs between agricultural systems, and it is affected by intensity of land use, farm management, soil type, and climate conditions.

This publication presents a first attempt to construct nitrogen balances at national level and to extend the balances to the regional level.

2. Methodology and Data Sources

There are various methods to calculate nitrogen balances. The nitrogen balance presented here is calculated on an annual basis, using the *soil surface* approach and is deliberately simplified. The approach based on the soil surface nitrogen balance seems best suited to the objective of identifying structural excesses. Furthermore it is at this level that the statistical data is most readily useable and complete, especially for the calculation of regional nitrogen balances, even if certain assumptions have been necessary to compensate for missing data.

The soil surface balance looks at the nitrogen inputs to and exports from the soil surface. Thus grass growth, which is recycled internally within a farm, must be explicitly accounted for as nitrogen removal by cutting or grazing of grass.

Input of nitrogen

The nitrogen fluxes into the soil which are considered are those coming from :

- Mineral fertilisers applied to agricultural land
- Organic manure applied to agricultural land
- Fixation by leguminous crops and clover
- Wet and dry deposition from the atmosphere.

Regional data on *wet and dry deposition of nitrogen* are received from the RIMV (Rijksinstituut voor Volksgezondheid en Milieu - NL).

Fixation by leguminous crops and clover is calculated using expert estimates of the rate of fixation per hectare and statistics on areas concerned from the Farm Structure Survey (FSS).

Data on consumption of mineral fertilisers at national level¹ is converted to regional data, based on the application rates for different crops², and regional data on area cultivated for these crops, taken from the FSS.

Nitrogen input due to *livestock manure* is calculated as a function of the number of animals present in the different regions at the time of the FSS, and expert estimates of the quantities of nitrogen which they eject, taking into account that around 15% of ammonia is volatilised during storage before spreading.

In practice most countries provide a set of coefficients for different livestock types based on measurements of nitrogen content. This set of coefficients is used for all regions of the country. Some countries were unable to supply coefficients, and in this case coefficients from France were applied (Greece, Italy, Portugal).

Outtake (removals) of nitrogen

Outtake is taken to mean the nitrogen content of those crop parts removed from the field, whether at harvest or by grazing. Removals subsequently used as straw for livestock, and removals in grass by grazing livestock or by cutting have been quantified, but crop residues, which are left in the field or immediately returned to the field, have been ignored.

The nitrogen fluxes out of the soil are defined as nitrogen in:

- Harvested arable crops
- Crop used for fodder.

Outtake of nitrogen from harvested crops is calculated as a function of national crop production, coefficients for the N-content of the harvested crops and regional data on areas cultivated. Experts in Member States have supplied the N-outtake coefficients.

A particular problem arises for areas under grass, as it is difficult to know the amount of grass harvested and/or grazed. Statistics on harvested grass are only available for a few countries, and it is not always clear if existing data refer to harvested production or to potential production of grass. To overcome this some further estimation is needed, based on calculations of the animals' theoretical fodder needs. The grass removed corresponds to the total amount of grass eaten by the animal, whether harvested or grazed. From the quantity of dry matter in the form of fodder needed for different categories of animals, the difference between these needs and the quantity supplied by fodder other than grass is calculated. To overcome a tendency to overestimate the removal via grass, feedstuffs bought from outside agriculture have been taken into account.

(1) as reported to FAO from Member States.

(2) supplied by the European Fertiliser Manufacturers Association (EFMA).

As no information on nitrogen content of bought feedstuffs is available, the calculations have been made in dry-matter equivalent, and the end product has been transformed into nitrogen, using standard coefficients.

Data quality and interpretation

A certain number of variables in the balance (on both the input and the outtake side) which can contribute to the change in stock have not been taken into account, either for lack of data or because they are considered negligible. The most important omitted variables are:

- *Volatilisation* of ammonia, following spreading of manure on the soil.
- *Sewage sludge* (no data are available at European level).
- *Denitrification* (which can be an important factor in wet-zones).
- *Nitrogen mineralised* (as a result of ploughing up of permanent grasslands).
- *Nitrogen contained in irrigation water*

Fixation by leguminous crops and clover is to an certain extent underestimated, as only fixation by dried pulses have been taken into account³. No estimates of N fixed by grasslands and other forage crops were possible, for lack of reliable information on the amounts and composition of these crops in most countries. It should also be noted that the figures presented here are partly based on experts' estimates of different biological relations, for the country as a whole.

However in reality, there may be large regional variations for some of these, and therefore the regional figures should be interpreted with care. Before comparing Member States, it should also be borne in mind that the calculations are based on a harmonised methodology, which may not in all cases reflect country-specific particularities. Moreover, the N-coefficients supplied by the Member States also differ remarkably between countries, to an extent, which is sometimes difficult to explain. (See for instance Table 1.)

As a general rule, the data on inputs are estimated to be more accurate and reliable than the data on outputs. Not only are the calculations on outputs mainly based on statistics at national level extrapolated to regional level, but also the lack of (reliable) data on harvested fodder and grass, mentioned above, also adds an element of uncertainty to the figures. As this uncertainty is carried through to the total N-balance, the same precautions should also be taken before drawing conclusions from the results of the total balance.

Although nitrogen surpluses can show areas where ground and surface waters may be at risk, they should not be interpreted as real losses to the environment. In order to assess the environmental impact of excess nitrogen, more information is needed on, among others, farm nitrogen management, soil type, and climate conditions, all of which play a role in the fate of nitrogen in the environment.

Table 1: Nitrogen - manure coefficient, 1997

(kg N/animal*year)

	B	DK	D	EL	E	F	IRL	I	L	NL	A	P	FIN	S	UK
Equidea	65.0	44.0	42.5	120.0	25.6	120.0	40.0	120.0	87.2	-	34.0	120.0	-	42.5	40.0
Bovines <1 year	28.0	38.8	26.4	21.9	21.9	21.9	24.0	21.9	33.5	27.6	23.1	21.9	25.0	23.0	17.3
Bovines <1 year,male	23.0	46.9	28.1	-	-	21.9	24.0	-	-	16.5	-	-	25.0	27.2	17.2
Bovines<1year,females	33.0	31.7	25.5	-	-	21.9	24.0	-	-	41.5	-	-	25.0	18.7	17.4
Bovines,>=1<2years,m.	61.0	57.7	38.3	43.8	43.8	43.8	57.0	43.8	55.8	59.2	40.5	43.8	40.0	49.3	40.2
Bovines,>=1<2 years,f.	56.0	41.5	42.5	43.8	43.8	43.8	57.0	43.8	55.8	88.7	40.5	43.8	37.0	40.0	43.4
Bovines, >=2 year,m.	77.0	52.9	42.5	51.1	51.1	51.1	68.0	51.1	79.7	72.3	57.8	51.1	40.0	49.3	62.0
Heifers,>= 2 years	77.0	51.4	42.5	58.4	58.4	58.4	63.0	58.4	79.7	88.6	57.8	58.4	40.0	40.0	54.5
Dairy cows >=2 years	97.0	121.6	80.3	73.0	60.2	73.0	85.0	73.0	87.2	123.7	80.8	73.0	100.0	99.5	103.5
Other cows >=2 years	10.5	18.2	11.1	10.0	10.2	10.0	15.0	10.0	10.5	23.5	18.7	10.0	17.0	10.2	8.8
Sheep,breeding female	4.4	8.3	-	4.5	2.9	4.5	4.0	4.5	4.4	-	-	4.5	-	-	4.5
Goats,breeding female	10.5	-	-	10.0	8.8	10.0	15.0	10.0	0.0	-	-	10.0	17.0	-	-
Piglets	2.5	0.4	-	4.6	1.2	2.9	10.0	4.6	3.2	-	-	4.6	3.2	2.0	4.4
Breeding sows	24.0	54.4	28.1	26.3	14.8	26.3	25.0	26.3	20.0	21.0	28.1	26.3	26.0	16.2	19.5
Other pigs	13.0	13.2	10.9	12.6	8.5	8.8	9.0	12.6	9.9	10.4	12.8	12.6	11.0	7.7	10.5

(3) More detailed data from Denmark suggests an underestimation of 10 kg N/ha.

3. Comments on main results

Mineral fertilisers are the major source of nitrogen in the EU

Within the EU, mineral (commercial) fertilisers are the largest source of nitrogen applied to agricultural soils, mainly as straight nitrogen fertilisers in the form of calcium ammonium nitrate and ammonium nitrate (table 2).

Nitrogen in commercial fertiliser is particularly soluble to facilitate uptake by crops, but this also makes it vulnerable to run-off after heavy rainfall, and to leaching to groundwater.

Table 2: Supply and use of nitrogen, 1997

(kg N/ha)

	B	DK	D	EL	E	F	IRL	I	L	NL	A	P	FIN	S	UK	EU-15
TOTAL INPUT	370	246	201	146	73	157	225	120	284	486	104	75	127	114	163	149
mineral fertiliser	114	106	104	88	41	89	91	62	142	184	33	31	81	66	77	75
Organic fertilisers	220	114	65	49	23	46	123	45	114	265	48	39	39	39	67	56
bovine	140	52	45	7	10	34	97	24	106	171	33	17	29	30	38	34
pigs	59	58	14	3	4	5	4	7	5	57	12	8	7	5	5	9
sheep and goats	1	1	1	33	8	3	19	7	0	9	0	8	1	1	17	7
poultry	18	3	3	3	1	3	2	5	0	28	2	3	2	2	7	4
Fixation	3	8	3	2	3	5	1	2	1	1	3	2	3	4	3	3
Deposition	33	18	29	7	6	16	10	12	27	36	20	3	5	5	15	15
TOTAL OUTTAKE	225	135	109	98	38	116	162	80	186	230	68	51	72	79	125	96
harvested	49	73	56	29	20	51	15	48	26	38	30	11	36	39	31	39
fodder ⁴	177	62	54	69	18	65	147	32	160	192	38	40	36	40	94	57
Surplus 1997	145	111	92	48	35	41	63	40	99	256	36	24	56	35	37	52
Agricultural area 1997 [1.000 ha] ⁵	1 383	2 689	17 169	3 486	25 625	28 303	4 342	14 773	127	2 011	3 407	3 796	2 172	3 109	16 169	128 559
total input 1995	370	248	199	146	68	152	219	121	284	517	103	77	128	110	165	147
total input 1993	372	263	192	155	68	147	217	122	282	517	:	78	:	:	163	148
total output 1995	235	130	104	97	31	112	152	78	185	243	72	51	67	73	123	93
total output 1993	232	128	100	96	34	110	152	72	181	245	:	49	:	:	121	93
surplus 1995	136	119	94	49	37	40	68	43	100	274	32	26	61	36	42	55
surplus 1993	140	135	92	59	34	38	64	50	100	271	:	29	:	:	41	55
Agricultural area 1995 [1.000 ha]	1 354	2 727	17 170	3 565	25 225	28 235	4 325	14 625	127	1 999	3 417	3 897	2 192	3 060	16 447	128 362
Agricultural area 1993 [1.000 ha]	1 344	2 739	17 029	3 525	24 707	28 070	4 278	14 670	127	2 015	:	3 919	:	:	16 383	118 806

Table 3: Total mineral fertilizer consumption distributed on crops, 1997

(%)

	B	DK	D	EL	E	F	IRL	I	L	NL	A	P	FIN	S	UK
Cereals	22	55	48	41	35	41	6	33	20	10	40	16	40	45	29
other arable	16	9	16	22	16	24	2	28	3	15	24	20	6	8	8
Fodder (including maize)	15	17	9	2	2	20	15	2	14	3	10	16	53	36	6
Fertilised grass land	46	19	27	0	22	13	77	6	62	72	25	21	1	11	57
Permanent crops (fruit, vineyard)	1	0	0	35	25	2	0	31	0	1	2	27	0	0	0
TOTAL N [1000 ton]	158	285	1 788	307	1 042	2 518	395	915	18	370	112	116	175	206	1 251

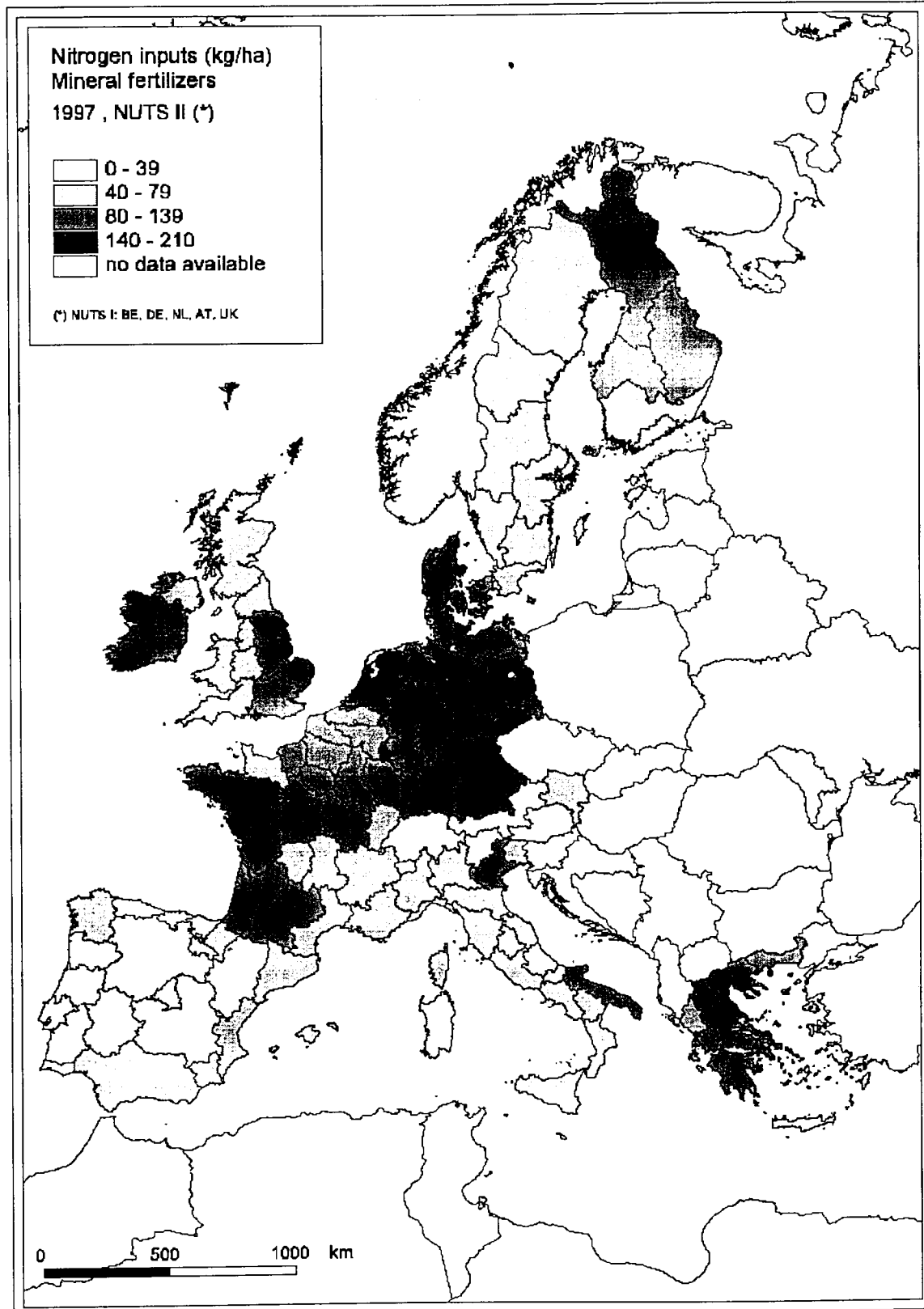
(4) Includes: fodder beets, other forage crops and pasture (grass)

(5) Includes: arable land, permanent crops and permanent meadows and pastures.

The regions with higher nitrogen fertiliser application rates are located in the Netherlands, Belgium, Germany and France (see map 1). In general, in Central and Western Europe, (with regional differences) an

important share of the total input is due to fertilised grassland. For example, as shown in table 3, fertilised grassland accounts for more than 50% of total input in Irl, NL, L and UK.

Map 1: Nitrogen Inputs (kg/ha) / Mineral fertiliser, 1997



Livestock manure: the second major source of nitrogen

As shown in table (2), in 1997 the Netherlands and Belgium both of which have a high livestock density had the largest input of nitrogen per ha of agricultural area from livestock manure followed by Ireland, Luxembourg and Denmark.

Within the larger countries there are also some regional "hot spots", areas of high nitrogen loading from manure, again because of high livestock densities. In particular North-west in England, Wales, Brittany and Lombardy. (See map 2).

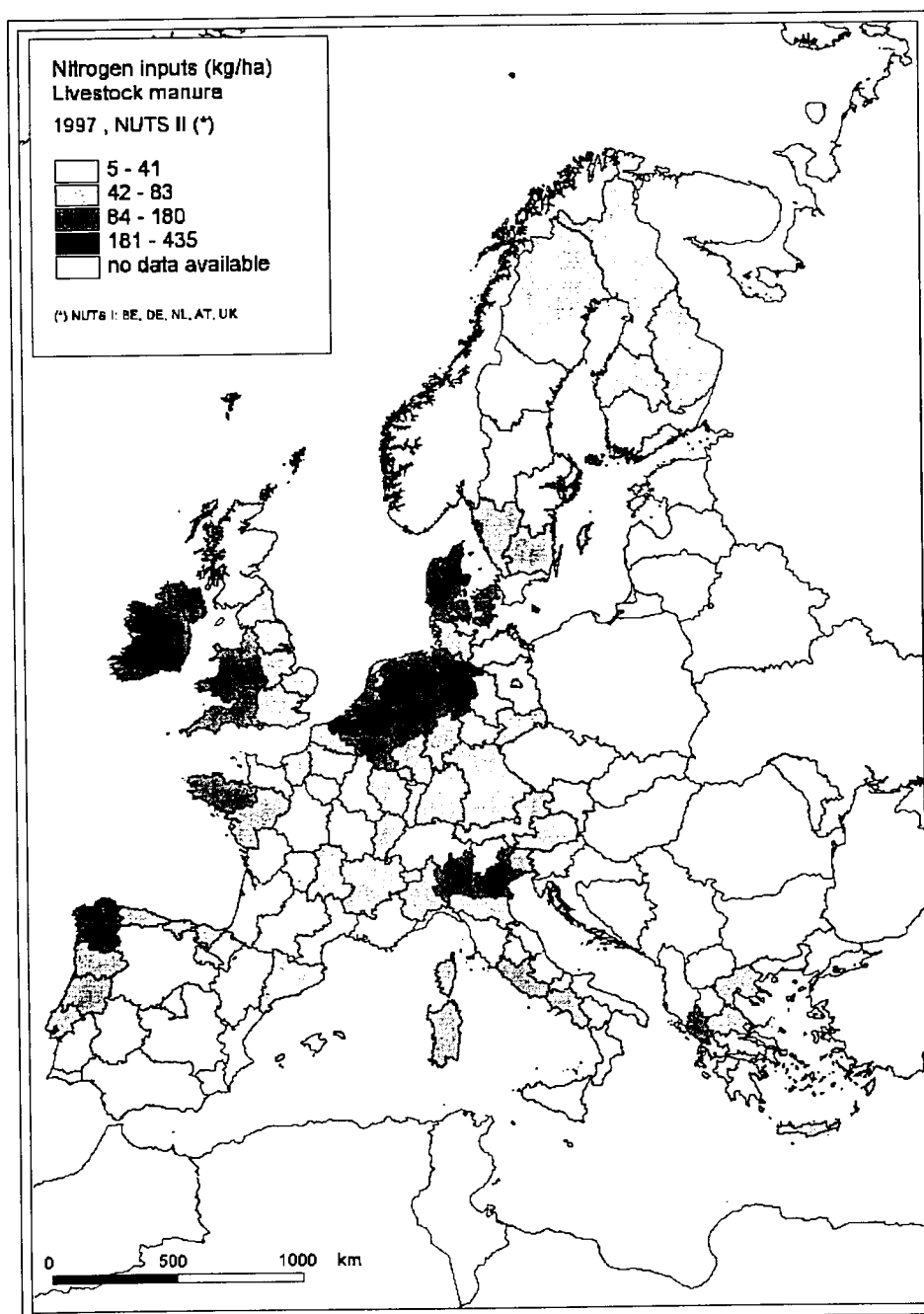
Removals of nitrogen from agricultural soils

As shown in table 2, fodder crops is the main crop responsible for removing nitrogen from soil in all EU countries. It accounts for more than 50% of the nitrogen removals in 12 of the 15 countries.

The Netherlands (190 kg N/ha) and Belgium (180 kg N/ha) had the largest outtake of nitrogen per ha of agricultural area by fodder crops, followed by Luxembourg and Ireland.

Within other arable crops, cereals dominate, with wheat the second most important crop in terms of nitrogen removals for most countries.

Map 2: Nitrogen Inputs / Livestock manure, 1997

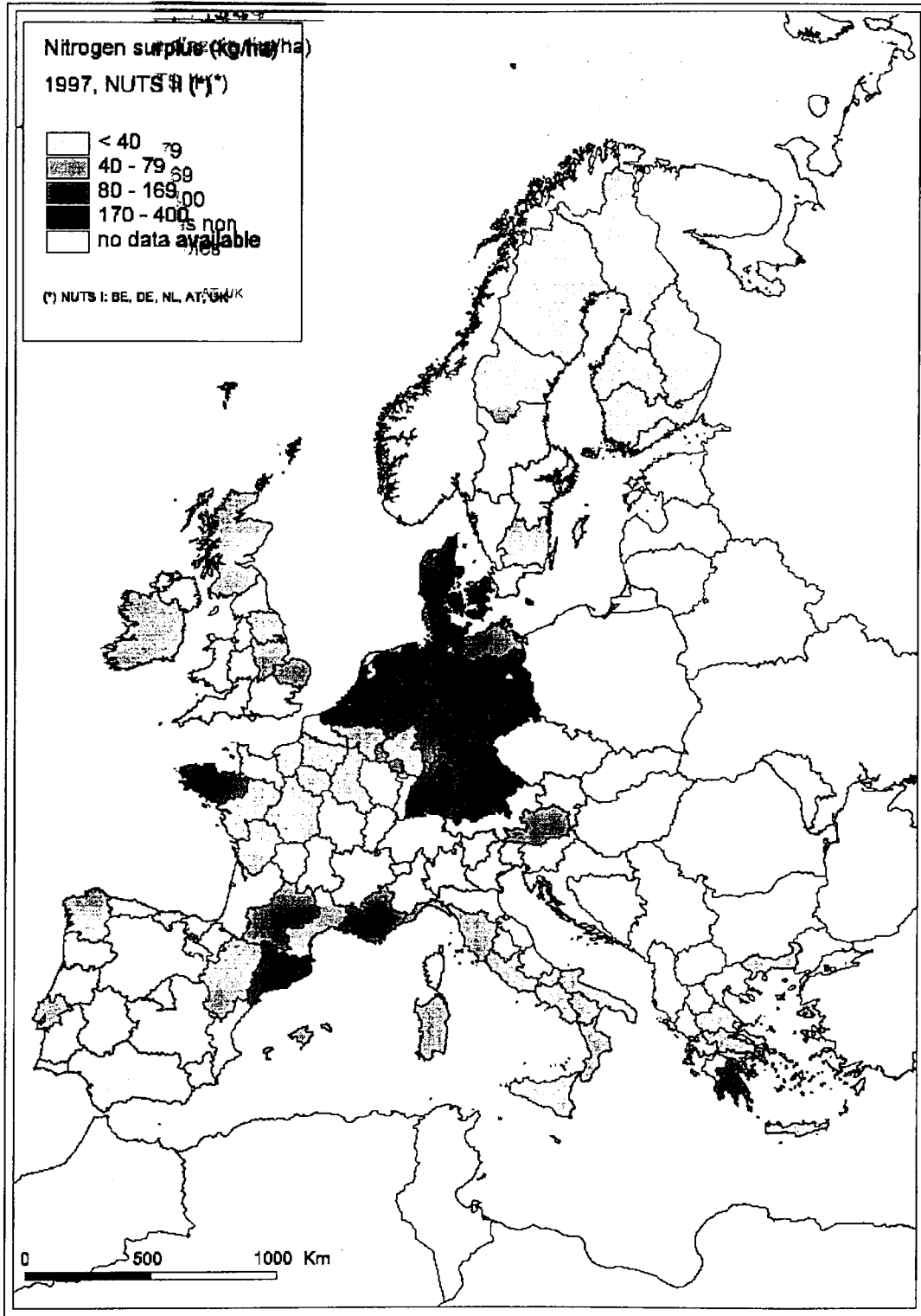


Surplus of nitrogen

Not surprisingly the Member States with high livestock densities are also the ones with high nitrogen surpluses. In the Netherlands the average indicative nitrogen surplus is 256 kg N/ha, followed by Belgium and Denmark with respectively 145 kg N/ha and 144 kg N/ha.

Within the larger countries, regions with relatively high indicative surpluses are Nordrhein-Westfalen, Niedersachsen, Brittany and Catalonia (See map 3).

Map 3: Nitrogen surplus (kg/ha), 1997



Further information:

➤ Databases

New Cronos Theme 8, Domain milieu/agri

To obtain information or to order publications, databases and special sets of data, please contact the **Data Shop** network:

BELGIQUE/BELGIË	DANMARK	DEUTSCHLAND	ESPAÑA	FRANCE	ITALIA – Roma
Eurostat Data Shop Bruxelles/Brussel Planistat Belgique 124 Rue du Commerce Handelsstraat 124 B-1000 BRUXELLES / BRUSSEL Tel. (32-2) 234 67 50 Fax (32-2) 234 67 51 E-Mail: datashop@planistat.be	DANMARKS STATISTIK Bibliotek og Information Eurostat Data Shop Sejrogade 11 DK-2100 KØBENHAVN Ø Tel. (45-39) 17 30 30 Fax (45-39) 17 30 03 E-Mail: bib@dst.dk	STATISTISCHES BUNDESAMT Eurostat Data Shop Berlin Otto-Braun-Straße 70-72 D-10178 BERLIN Tel. (49-30) 23 24 64 27/28 Fax (49-30) 23 24 64 30 E-Mail: datashop@statistik-bund.de	INE Eurostat Data Shop Paseo de la Castellana, 183 Oficina 009 Entrada por Estébanez Calderón E-28046 MADRID Tel. (34-91) 583 91 67 Fax (34-91) 579 71 20 E-Mail: datashop.eurostat@ine.es	INSEE Info Service Eurostat Data Shop 195, rue de Bercy Tour Gamma A F-75582 PARIS CEDEX 12 Tel. (33-1) 53 17 88 44 Fax (33-1) 53 17 88 22 E-Mail: datashop@insee.fr	ISTAT Centro di Informazione Statistica Sede di Roma, Eurostat Data Shop Via Cesare Balbo, 11a I-00184 ROMA Tel. (39-06) 46 73 31 02/06 Fax (39-06) 46 73 31 01/07 E-Mail: dipdiff@istat.it
ITALIA – Milano	LUXEMBOURG	NEDERLAND	NORGE	PORTUGAL	SCHWEIZ/SUISSE/SVIZZERA
ISTAT Ufficio Regionale per la Lombardia Eurostat Data Shop Via Fieno 3 I-20123 MILANO Tel. (39-02) 8061 32460 Fax (39-02) 8061 32304 E-mail: mileuro@tin.it	Eurostat Data Shop Luxembourg BP 453 L-2014 LUXEMBOURG 4, rue A. Weicker L-2721 LUXEMBOURG Tel. (352) 43 35 22 51 Fax (352) 43 35 22 221 E-Mail: dslux@eurostat.datashop.lu	STATISTICS NETHERLANDS Eurostat Data Shop-Voorburg po box 4000 2270 JM VOORBURG Nederland Tel. (31-70) 337 49 00 Fax (31-70) 337 59 84 E-Mail: datashop@cbs.nl	Statistics Norway Library and Information Centre Eurostat Data Shop Kongens gate 6 P. b. 8131, dep. N-0033 OSLO Tel. (47-22) 86 46 43 Fax (47-22) 86 45 04 E-Mail: datashop@ssb.no	Eurostat Data Shop Lisboa INE/Serviço de Difusão Av. António José de Almeida, 2 P-1000-043 LISBOA Tel. (351-21) 842 61 00 Fax (351-21) 842 63 64 E-Mail: data.shop@ine.pt	Statistisches Amt des Kantons Zürich, Eurostat Data Shop Bleicherweg 5 CH-8090 Zürich Tel. (41-1) 225 12 12 Fax (41-1) 225 12 99 E-Mail: datashop@zh.ch Internetadresse: http://www.zh.ch/statistik
SUOMI/FINLAND	SVERIGE	UNITED KINGDOM	UNITED KINGDOM	UNITED STATES OF AMERICA	
Eurostat Data Shop Helsinki Tilastokirjasto Postiosoite: PL 2B Käymösoite: Työpajakatu 13 B, 2 krs FIN-00022 Tilastokeskus Tel. (358-9) 17 34 22 21 Fax (358-9) 17 34 22 79 E-mail: datashop.tilastokeskus@tilastokeskus.fi Internetadresse: http://www.tilastokeskus.fi/tix/tilastokeskus.html	STATISTICS SWEDEN Information service Eurostat Data Shop Karlavägen 100 - Box 24 300 S-104 51 STOCKHOLM Tel. (46-8) 50 69 48 01 Fax (46-8) 50 69 48 99 E-Mail: info@scb.se URL: http://www.scb.se/info/datashop/ eudatashop.asp	Eurostat Data Shop Enquiries & advice and publications Office for National Statistics Customers & Electronic Services Unit 1 Drummond Gate - B1/05 UK-LONDON SW1V 2QQ Tel. (44-207) 533 56 76 Fax (44-1633) 812 762 E-Mail: eurostat.datashop@ons.gov.uk	Eurostat Data Shop Electronic Data Extractions, Enquiries & advice - R.CADE Unit 1L Mountjoy Research Centre University of Durham UK - DURHAM DH1 3SW Tel: (44-191) 374 7350 Fax: (44-191) 384 4971 E-Mail: r-CADE@dur.ac.uk URL: http://www.rcade.dur.ac.uk	HAVER ANALYTICS Eurostat Data Shop 60 East 42nd Street Suite 3310 USA-NEW YORK, NY 10165 Tel. (1-212) 986 93 00 Fax (1-212) 986 69 81 E-Mail: eurodata@haver.com	

Media Support Eurostat (for professional journalists only).
Bech Building Office A3/48 • L-2920 Luxembourg • Tel. (352) 4301 33408 • Fax (352) 4301 32649 • e-mail: eurostat-mediasupport@cec.eu.int

For information on methodology

Jakob Hansen, Eurostat/F3, L-2920 Luxembourg, Tel. (352) 4301 35271, Fax (352) 4301 37316,

E-mail: Jakob-Peter.HANSEN@cec.eu.int

ORIGINAL: English

Please visit our web site at www.europa.eu.int/comm/eurostat/ for further information!

A list of worldwide sales outlets is available at the **Office for Official Publications of the European Communities**.

2 rue Mercier - L-2985 Luxembourg
Tel. (352) 2929 42118 Fax (352) 2929 42709
Internet Address <http://eur-op.eu.int/fr/general/s-ad.htm>
e-mail: info.info@cec.eu.int

BELGIQUE/BELGIË - DANMARK - DEUTSCHLAND - GRECE/ELLADA - ESPAÑA - FRANCE - IRELAND - ITALIA - LUXEMBOURG - NEDERLAND - ÖSTERREICH
PORTUGAL - SUOMI/FINLAND - SVERIGE - UNITED KINGDOM - ISLAND - NORGE - SCHWEIZ/SUISSE/SVIZZERA - BALGARIE - CESHÁ REPUBLIKA - CYPRUS
EESTI - HRVATSKA - MAGYARORSZÁG - MALTA - POLSKA - ROMÂNIA - RUSSIA - SLOVAKIA - SLOVENIA - TÜRKIYE - AUSTRALIA - CANADA - EGYPT - INDIA
ISRAËL - JAPAN - MALAYSIA - PHILIPPINES - SOUTH KOREA - THAILAND - UNITED STATES OF AMERICA

Order form

I would like to subscribe to Statistics in focus (from 1.1.2000 to 31.12.2000):
(for the Data Shop and sales office addresses see above)

Formula 1: All 9 themes (approximately 140 issues)

Paper: EUR 360

PDF: EUR 264

Paper + PDF: EUR 432

Language required: DE EN FR

Formula 2: One or more of the following seven themes:

Theme 1 'General statistics'

Paper: EUR 42 PDF: EUR 30 Combined: EUR 54

Theme 2 'Economy and finance'

Theme 3 'Population and social conditions'

Theme 4 'Industry, trade and services'

Theme 5 'Agriculture and fisheries'

Theme 6 'External trade'

Theme 8 'Environment and energy'

Paper: EUR 84 PDF: EUR 60 Combined: EUR 114

Language required: DE EN FR

Please send me a free copy of 'Eurostat Mini-Guide' (catalogue
containing a selection of Eurostat products and services)
Language required: DE EN FR

I would like a free subscription to 'Statistical References', the information
letter on Eurostat products and services
Language required: DE EN FR

Mr Mrs Ms

(Please use block capitals)

Surname: _____ Forename: _____

Company: _____ Department: _____

Function: _____

Address: _____

Post code: _____ Town: _____

Country: _____

Tel.: _____ Fax: _____

E-mail: _____

Payment on receipt of invoice, preferably by:

Bank transfer

Visa Eurocard

Card No: _____ Expires on: ____/____/____

Please confirm your intra-Community VAT number:

If no number is entered, VAT will be automatically applied. Subsequent
reimbursement will not be possible.