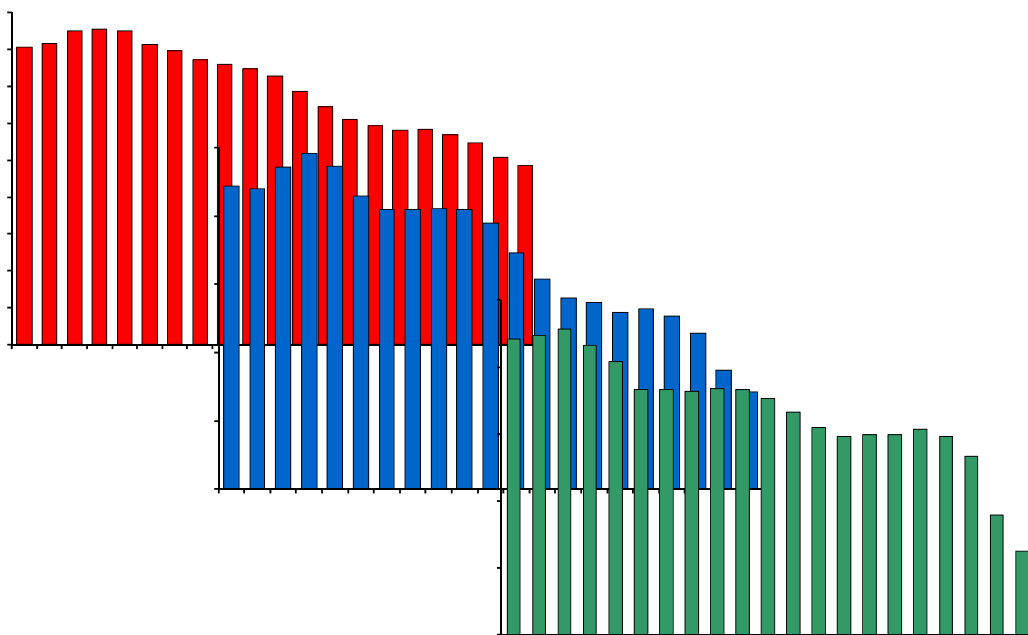




Nutrient balances and nutrient surpluses in Danish agriculture 1989-2009 (2010)

Nitrogen **Phosphorus** **Potassium**



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Introduction

Each year, the Faculty of Agricultural Sciences (DJF) at Aarhus University updates the national nutrient balances for the last 20 years for the use of nitrogen (N), phosphorus (P) and potassium (K) in agriculture, which includes calculations of surpluses and use efficiencies of the three nutrients. The balances are normally updated at the end of the year, when the previous year's results for harvest yield, feed consumption, etc., are available. This report furthermore contains preliminary calculations for the 2009/10 period, and for the entries where results were not available, figures from the previous 2008/09 reporting period have been used. Results for 2009/10 are therefore preliminary.

For nutrients, where a loss can have an adverse impact on the environment, the surplus is a good indicator of the development in the potential environmental impact of agriculture seen over a number of years. The nutrient surplus corresponds to the total quantity of excess nutrients on the farm when the import of feedstuffs and inorganic fertilizers have been deducted from the amount exported via sales of plant and animal products. The surplus thus consists of what can be lost via ammonia volatilisation from housing and stores or during field application, denitrification, leaching or surface runoff, or through changes in the soil pool of organic complexes.

It should be pointed out, that the balances calculated are national farm balances, which means that the surplus is the difference between input and output from the farm, and initiatives implemented in the field to reduce the discharge of nutrients such as the increased use of catch crops to reduce N leaching, injection of slurry to reduce ammonia volatilisation or the establishment of buffer zones to reduce the leaching of phosphorus do not affect the farm balance.

Method

The balances are based on statistical data, mainly the agricultural statistics collected by Statistics Denmark, but data from the Environment Agency, the National Environmental Research Institute and the Faculty of Agricultural Sciences at Aarhus University are also included in the calculations (Fig. 1).

The nutrient surplus is calculated as a national farm balance, where the difference between input and output amounts constitutes the surplus of a particular nutrient. In contrast to the field balance, the relatively uncertain internal flux between field and livestock buildings is not included in the calculation of the farm balance (Fig. 1). For further information on the calculation of balances, please consult Kyllingsbæk (2005)¹.

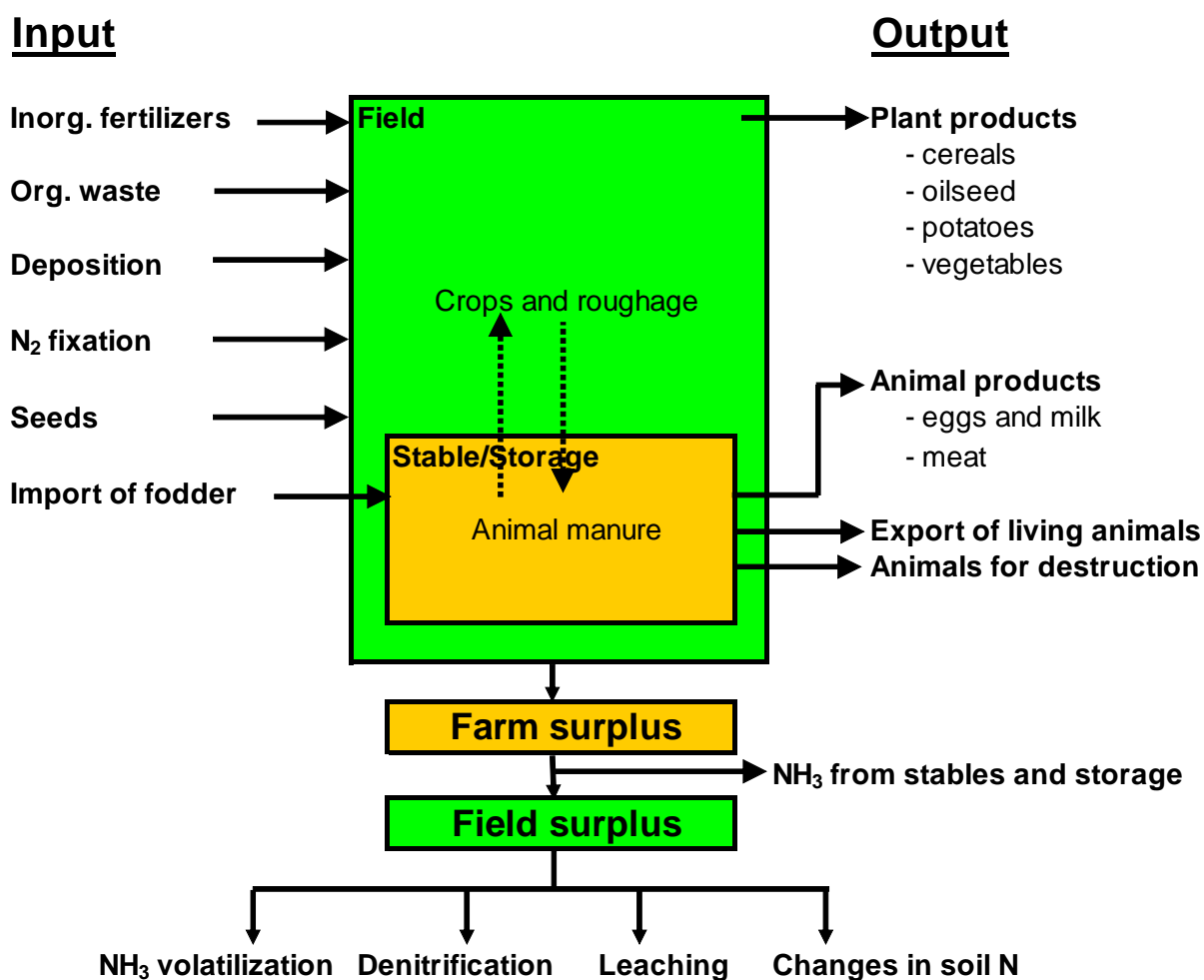


Figure 1. Schematic for calculation of the nutrient surplus in agriculture.

Results

Synopsis

The agricultural surplus (input minus output) of N, P and K has been considerably reduced over the last two decades.

The N surplus has been reduced from 487,000 t in 1986/87 to 293,000 t in 2005/06, corresponding to a 40% reduction. For the period 2005/06 and until the preliminary results for 2009/10, the N surplus has been further reduced (Table 1), so the total surplus for 2009/10 is 52% of what it was in 1986/87. As the consumption of inorganic fertiliser fell by 15,000 t in 2009/2010, it is realistic to expect a similar reduction in the N surplus in 2010/11.

For both P and K the surplus in 2009/10 was 25% of the surplus in 1986/87; in other words, the surplus of these two nutrients has been reduced by 75%. However, for P and K the consumption of P and K in inorganic fertiliser is expected to rise by respectively 4,000 and 15,000 t, so – all other things being equal – the surplus is expected to increase again in 2010/11.

Table 1. Development in nutrient surplus for Denmark (in tonnes) for the last five years.

	2005/06	2006/07	2007/08	2008/09	2009/10*
Nitrogen	293,000	288,000	279,000	262,000	254,000
Phosphorus	26,000	26,000	22,000	16,000	13,000
Potassium	77,000	75,000	68,000	46,000	33,000

* preliminary

Table 2 below shows the calculated surplus per hectare of cultivated area, and Table 3 gives the nutrient use efficiency for the last five years. The following pages list separately the results for input, output, surplus and use efficiencies for the three nutrients for the last 20 years with the data supporting the figures listed in tabular form at the end of the report.

Table 2. Development in nutrient surplus (kg/ha) over the last five years.

	2005/06	2006/07	2007/08	2008/09	2009/10*
Nitrogen	117	114	110	102	97
Phosphorus	11	10	9	6	5
Potassium	31	30	27	18	13

* preliminary

Table 3. Development in nutrient use efficiency (output as a percentage of input) over the last five years.

	2005/06	2006/07	2007/08	2008/09	2009/10*
Nitrogen	37	38	40	43	45
Phosphorus	57	58	63	71	76
Potassium	44	45	50	64	72

* preliminary

Nitrogen

Nitrogen input

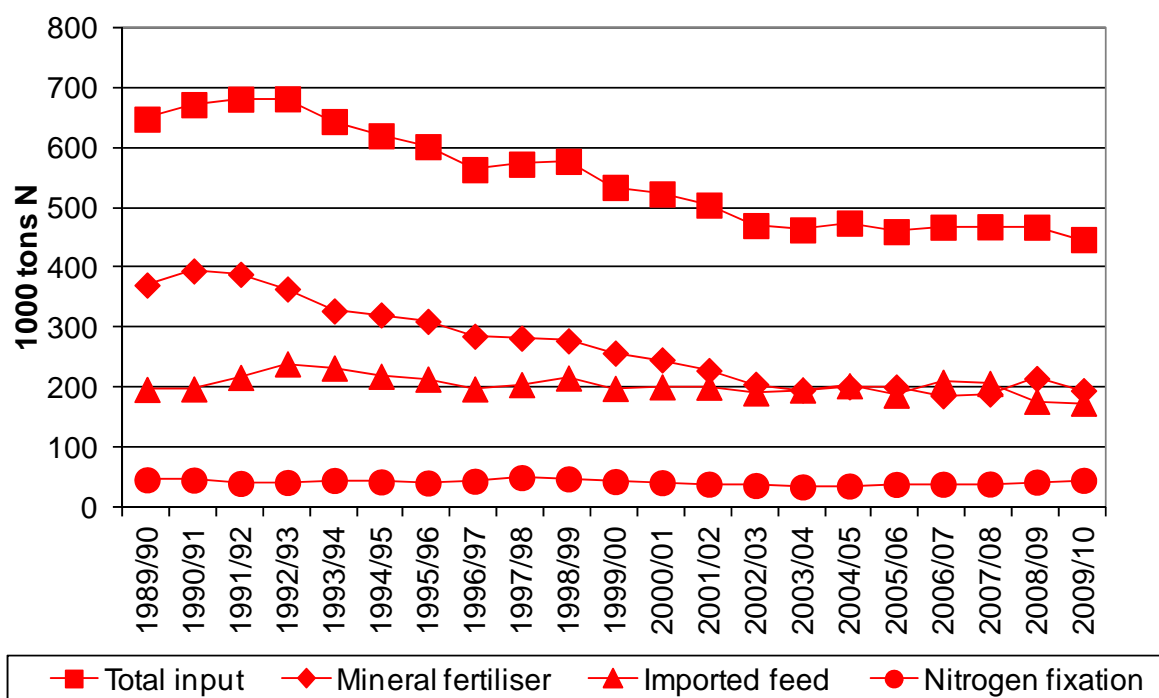


Figure 2. Total input of nitrogen and inputs from different sources¹.

- Total input of nitrogen has been falling from the early 1990s and until 2003/04 and remained relatively constant at around 465,000 t N until 2008/09, since when it has again fallen by approx. 20,000 t to 448,000 t N in 2009/10.
- The input of N in inorganic fertiliser has fallen from approx. 400,000 t N in 1989/90 to approx. 200,000 t N in 2001/02 and has subsequently varied between 190,000 and 200,000 t N. In 2009/10 the input was 195,000 t and in 2010/11 this will be further reduced to 185,000 t N.
- The input in, respectively, imported feedstuff and in nitrogen fixation has remained constant over the period at 200,000 and 45,000 t N.

¹ When summarising the nitrogen input from the different sources, the input in inorganic fertiliser has been rolled over to the following year, as fertiliser purchased in one accounting period is related to the harvest in the following accounting period. As an example, the sum of inputs for the accounting period 2009/10 uses the input figure for inorganic fertiliser purchased in the accounting period 2008/09.

Nitrogen output

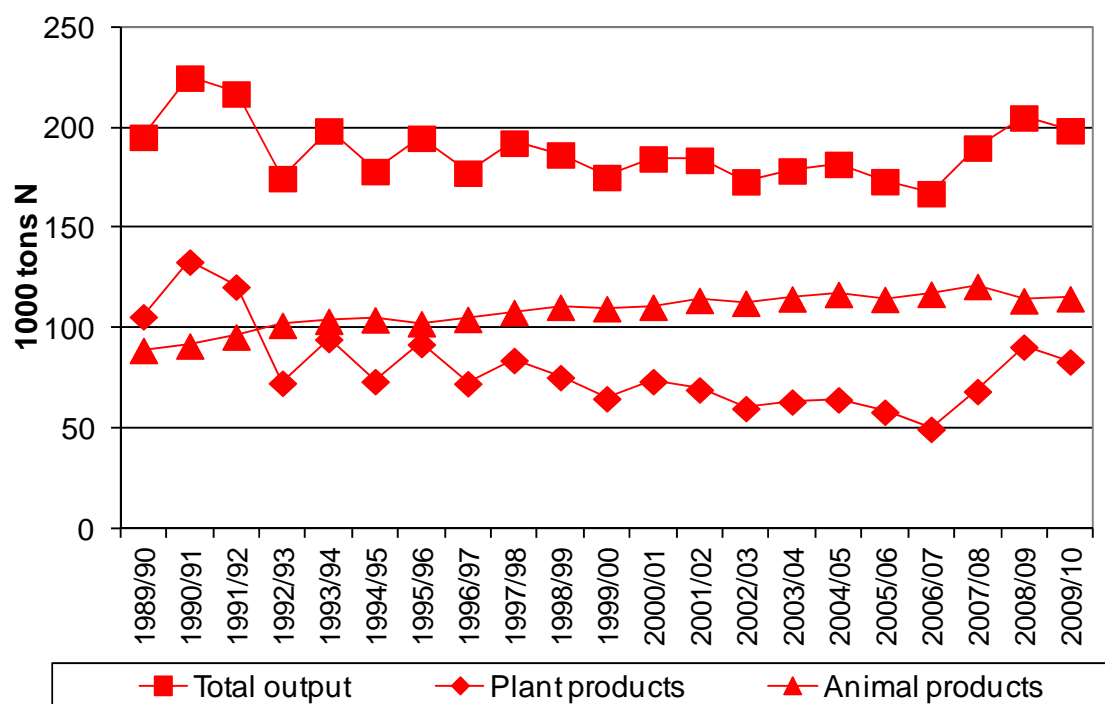


Figure 3. Total output of nitrogen and outputs in plant and animal products.

- Total output of nitrogen increased until the early 1990s, but has since fallen to the level of the late 1980s. Over the last three years, there has, however, been a significant rise in the output in plant products, and a slightly smaller fall in the output of animal products, so that the total output rose by approx. 30,000 t N.

Nitrogen surplus

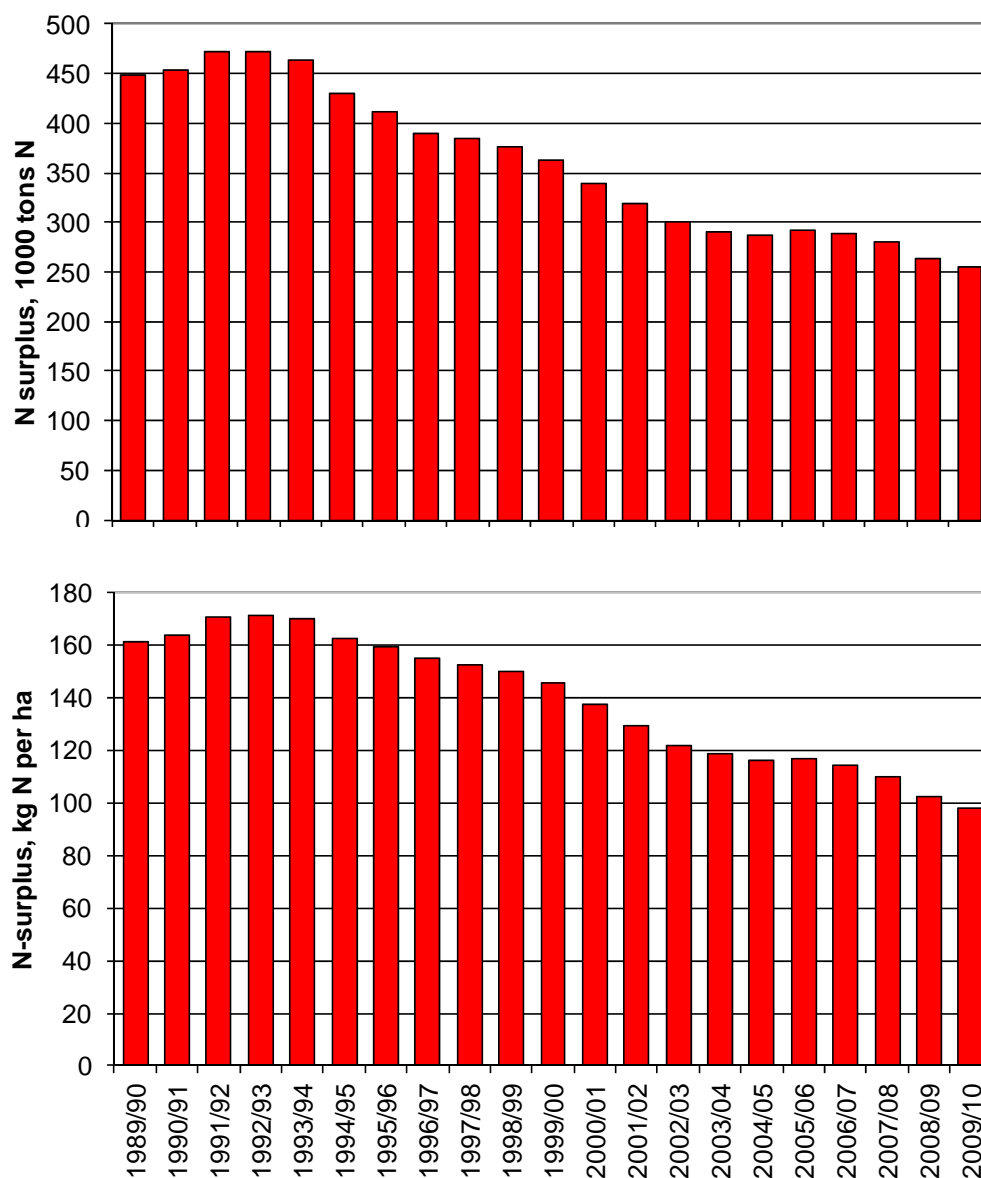


Figure 4. Nitrogen surplus, averages of three preceding years (only two preceding years in the last accounting period). Top figure in 1,000 tonnes N, bottom figure in kg N per ha.

- The nitrogen surplus fell steadily from the early 1990s until 2003/04, from when it remained constant until 2007/08 at around 290,000 t N. Over the last two years there has again been a reduction in the surplus by around 25,000 t N. This is partly due to the increase in the area under cereal and partly due to the relatively larger yields in cereal, which has resulted in a marked increase in the output of plant products (Fig. 3), but it is also due to a fall in the input of inorganic fertiliser (Fig. 2).
- The nitrogen surplus in kg N per ha (bottom figure) has fallen more strongly over the last two years than the total surplus given reported in 1,000 t N, which is due to some of the land previously used for setaside now being cultivated, giving an increase in the total area farmed from 2007/08 to 2009/10 of 110,000 ha.

Nitrogen use efficiency

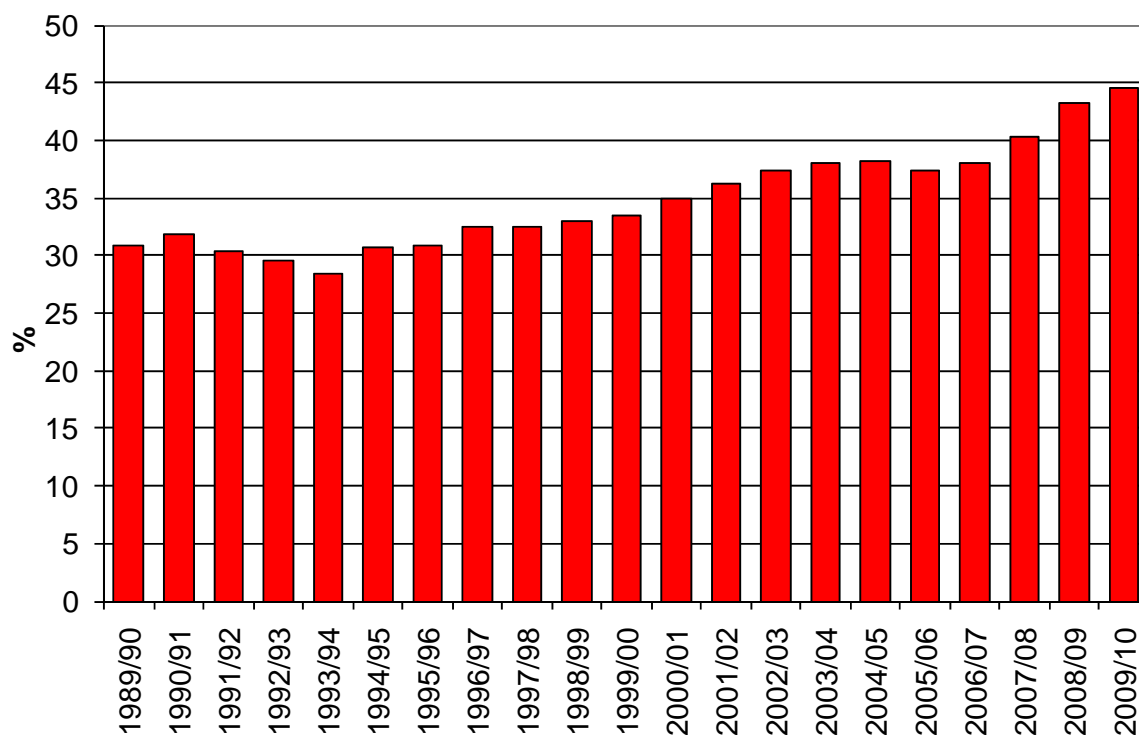


Figure 5. Nitrogen use efficiency (output as a percentage of input), as averages of three preceding years (only two preceding years in the last accounting period).

- Nitrogen use efficiency, i.e. the output as a percentage of input, has increased significantly throughout the period and was 45% in 2009/10. The slight drop in 2005/06 and 2006/07 is due to the relatively low cereal yields and thus lower outputs of plant products (Fig. 3).

Phosphorus

Phosphorus input

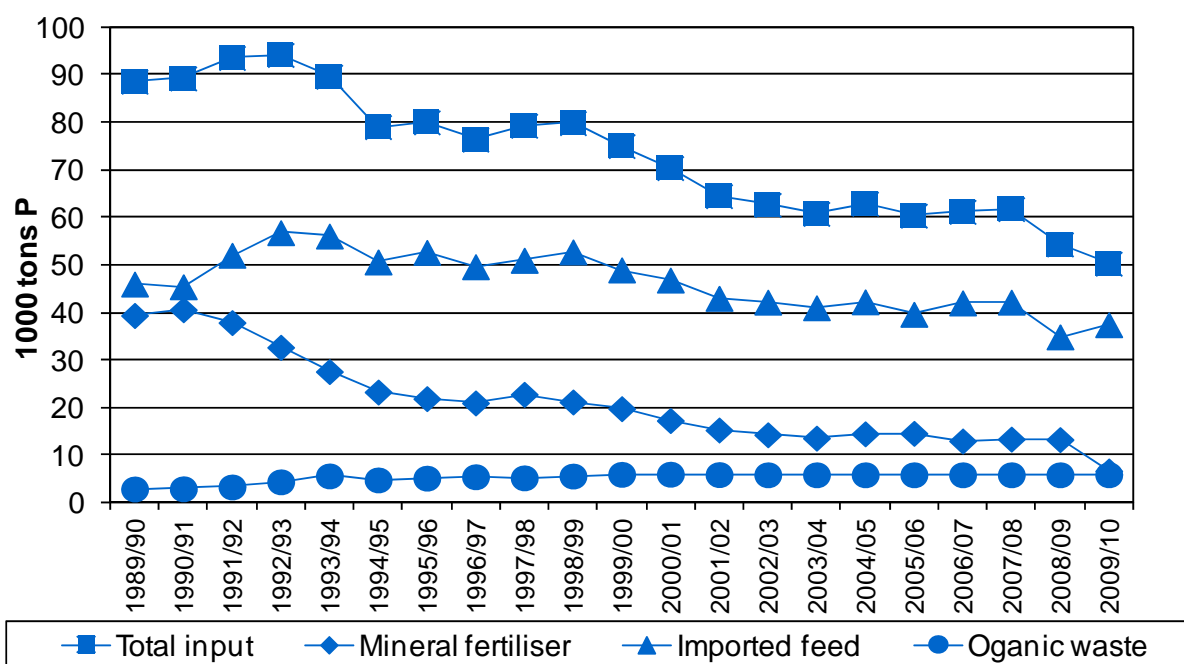


Figure 6. Total input of phosphorus and inputs from different sources².

- Total input of phosphorus fell from the early 1990s and to 2003/04 from approx. 90,000 t to 60,000 t, and remained then relatively constant until 2007/08 since when there has been a significant fall to approx. 50,000 t P in 2009/10.
- The input of P in inorganic fertiliser fell from approx. 40,000 t in 1989/90 to approx. 15,000 t in 2001/02, and remained at this level until 2008/09. In 2009/10 the input in inorganic fertiliser was halved to approx. 7,000 t P, but is expected to increase again in 2010/11 to approx. 11,000 t P.
- Since the 1990s the proportion of P sourced from imported feedstuff has been significantly larger than that from inorganic fertiliser and currently makes up 75% of the total input. The input in feedstuff fell in the period by 8,000–10,000 t P.

² Same as footnote 2.

Phosphorus output

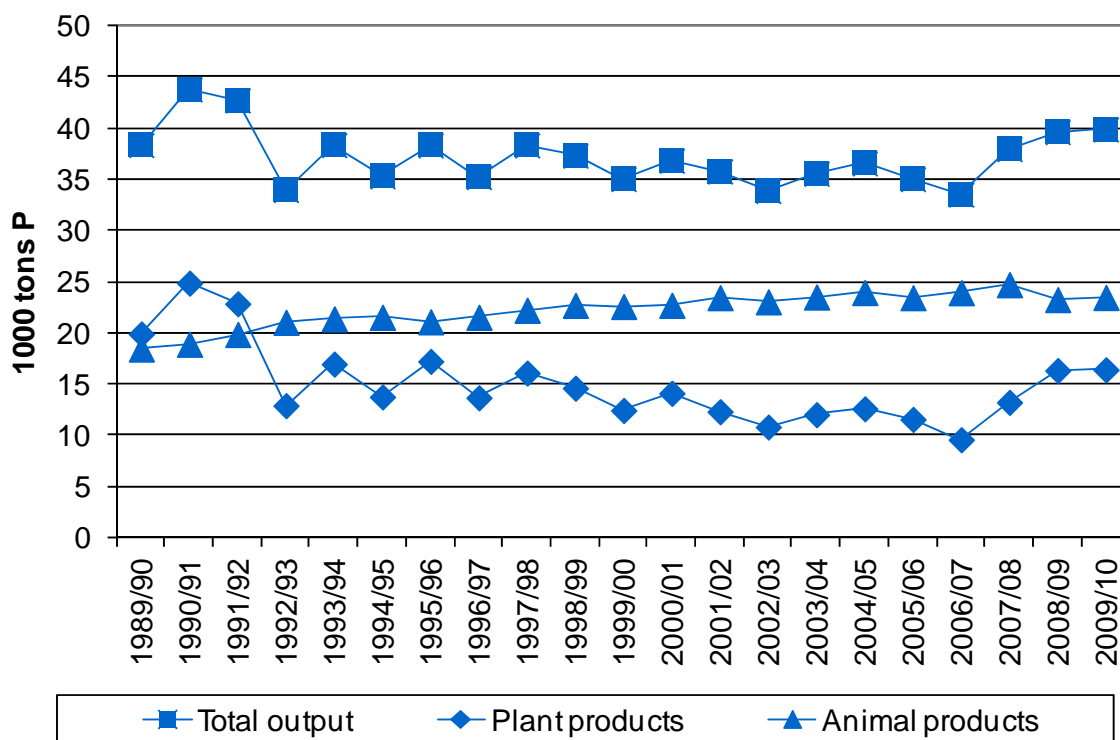


Figure 7. Total output of phosphorus and outputs in plant and animal products.

- As with nitrogen, there has been a significant rise in the output of phosphorus in plant products and a slight fall in animal products over the last three years, giving an increase in the total output by approx. 6,000 t compared to 2006/07.

Phosphorus surplus

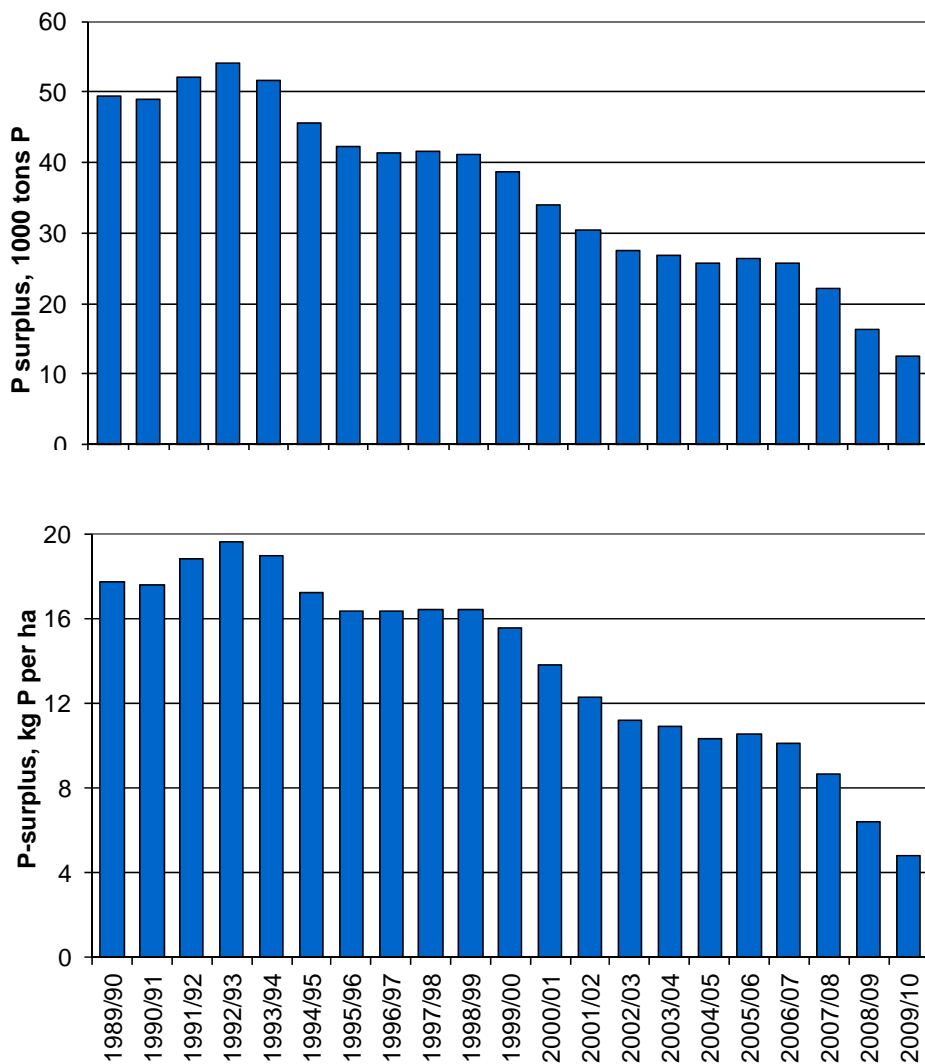


Figure 8. Phosphorus surplus, averages of three preceding years (only two preceding years in the last accounting period). Top figure in 1,000 t P and bottom figure in kg P per ha.

- Although there have been fluctuations along the way, the phosphorus surplus has fallen fairly steadily from 50-60,000 t P in the early 1990s to approx. 25,000 P in 2003/04, remaining at this level until 2006/07 since when it has nearly halved. It is, however, likely that the surplus will increase again in 2010/11 as the input of P in inorganic fertiliser has risen by approx. 4,000 t.
- The surplus per unit area (kg P/ha) has been reduced to between 25-33% of what it was in the early 1990s.

Phosphorus use efficiency

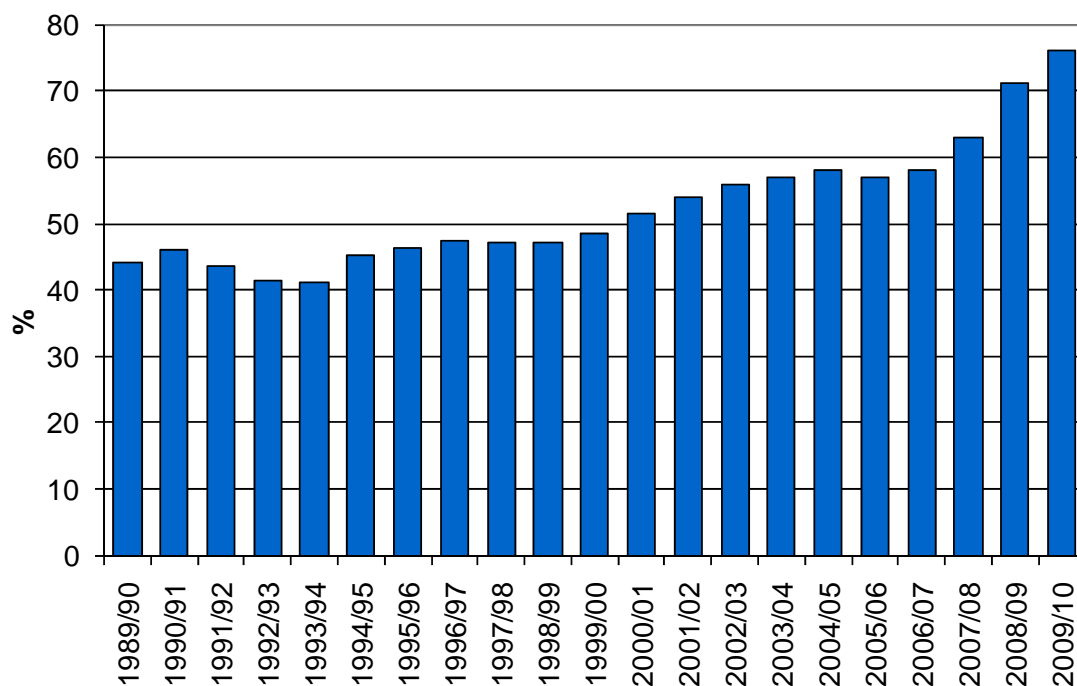


Figure 9. Phosphorus use efficiency (output as a percentage of input), as averages of three preceding years (only two preceding years in the last accounting period).

- The phosphorus use efficiency has risen markedly in the period until 2004/05, whereafter it remained relatively constant until 2007/08, since when it again rose strongly to approx. 75% in 2009/10. Here again the figure is likely to fall again in 2010/11, as the input of P in inorganic fertiliser has increased by approx. 4,000 t.

Potassium

Potassium input

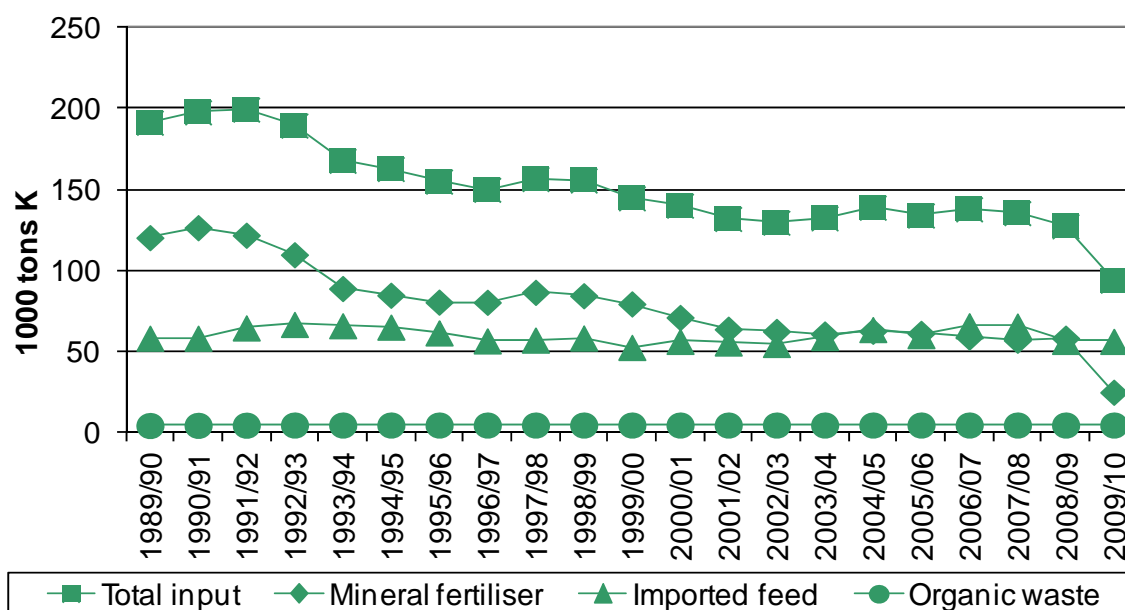


Figure 10. Total potassium input and inputs from different sources³.

Potassium output

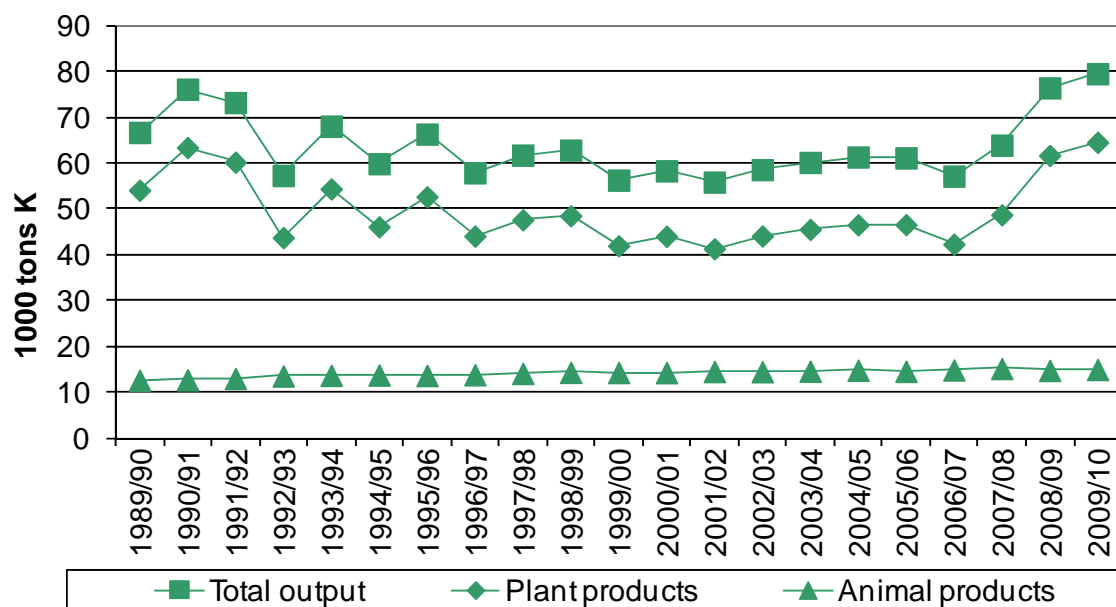


Figure 11. Total potassium outputs and outputs in plant and animal products.

³ Same as footnote 2.

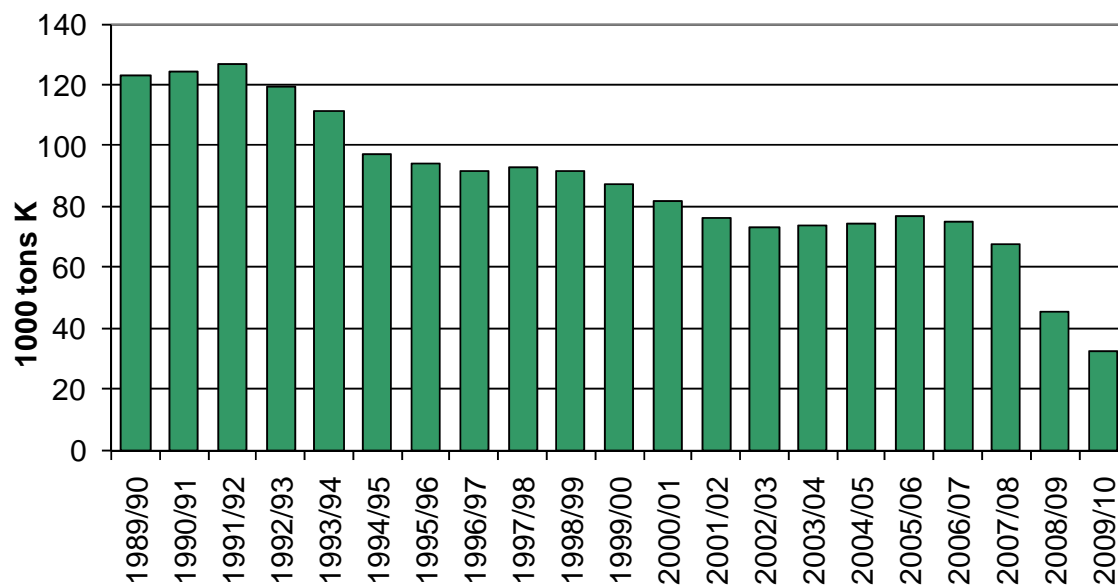
Potassium surplus

Figure 12. Potassium surplus, rolling average of the three preceding years (only two preceding years in the last accounting period).

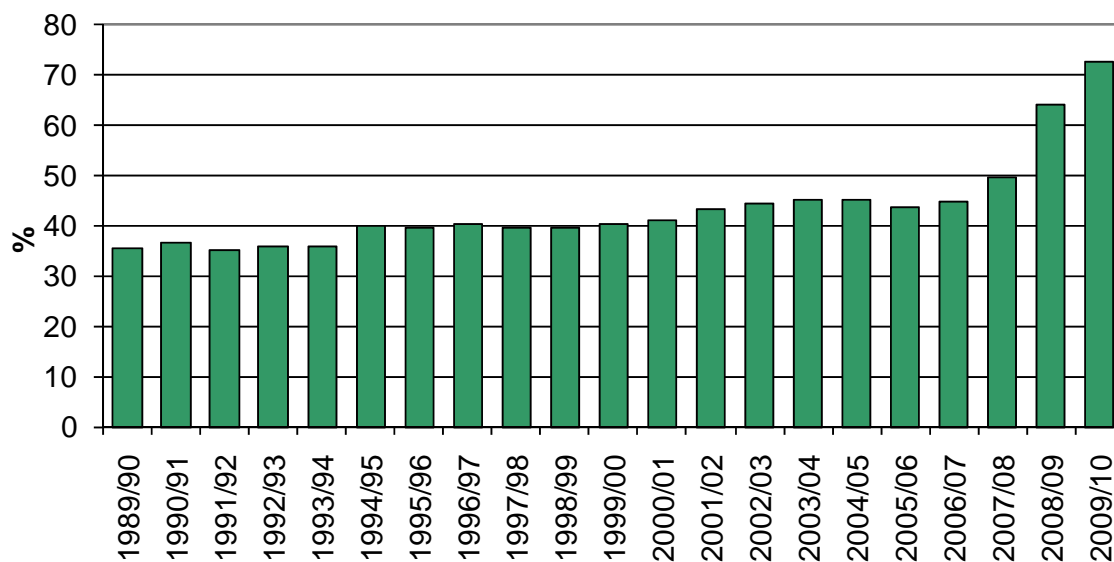
Potassium use efficiency

Figure 13. Potassium utilisation (output as a percentage of input), average of three preceding years (only two preceding years in the last accounting period).

Summary of results

Nitrogen

Table 4. Nitrogen input, output, surplus and use efficiency.

Production year	Input			Output			N surplus		Area minus set aside	N surplus pr. ha		Use efficiency	
	Fertiliser*, atmosphere & N fixation	Imported feed	Total	Plant products	Animal products	Total	Annual	Avg. 3 yr**		Annual	Avg. 3 yr**	Annual	Avg. 3 yr**
	----- tons N -----									ha	---- kg N ----		---- % ----
1989/90	449834	197288	647122	106126	89383	195509	451613	448869	2774128	163	161	30.2	30.8
1990/91	473305	197987	671292	133408	91612	225020	446272	453757	2788276	160	163	33.5	31.9
1991/92	463328	217174	680502	121003	96113	217117	463386	471914	2769657	167	170	31.9	30.4
1992/93	441316	239770	681086	73095	101905	175000	506086	471326	2756327	184	171	25.7	29.5
1993/94	410434	232826	643260	94859	103895	198754	444506	463874	2738559	162	170	30.9	28.5
1994/95	400358	219172	619530	73878	104623	178501	441029	430629	2691174	164	163	28.8	30.7
1995/96	386998	214418	601416	92376	102687	195064	406352	410954	2509555	162	159	32.4	30.9
1996/97	365239	197961	563200	72847	104874	177721	385479	390473	2525333	153	155	31.6	32.6
1997/98	367045	205175	572220	84375	108256	192631	379588	385104	2540614	149	152	33.7	32.5
1998/99	360786	216243	577029	75903	110881	186784	390246	375970	2530418	154	150	32.4	33.0
1999/00	334700	198926	533626	65379	110170	175549	358077	362062	2461143	145	146	32.9	33.5
2000/01	321126	201548	522674	73871	110938	184809	337865	338656	2455687	138	137	35.4	34.9
2001/02	303113	201018	504130	69769	114334	184103	320027	318186	2473749	129	129	36.5	36.3
2002/03	278594	191437	470031	60449	112917	173366	296665	300240	2460786	121	122	36.9	37.3
2003/04	266580	196231	462811	63720	115063	178782	284029	290917	2451122	116	119	38.6	38.0
2004/05	270843	203282	474124	64780	117288	182067	292057	287513	2448332	119	116	38.4	38.2
2005/06	272203	187729	459931	58679	114800	173479	286452	292776	2532036	113	117	37.7	37.3
2006/07	258078	209239	467317	50115	117383	167498	299818	288054	2543005	118	114	35.8	38.1
2007/08	260851	207217	468068	68946	121231	190177	277891	279958	2509191	111	110	40.6	40.1
2008/09	289869	177494	467363	91087	114110	205197	262166	262652	2597233	101	102	43.9	43.0
2009/10	272396	174301	446697	83665	115132	198798	247899	255033	2618276	95	98	44.5	44.2

* When summarising, the input of inorganic fertiliser is rolled over to the following year, as the purchase of fertiliser in one accounting period is related to the harvest in the following accounting period.

** For the last accounting period, this is a two-year average (two preceding years)

Phosphorus

Table 5. Phosphorus input, output, surplus and use efficiency.

Production year	Input			Output			P surplus		Area minus set aside	P surplus pr. ha		Use efficiency	
	Fertiliser*, atmosphere org. waste	Imported feed	Total	Plant products	Animal products	Total	Annual	Avg. 3 yr**		Annual	Avg. 3 yr**	Annual	Avg. 3 yr**
	----- tons P -----									ha	---- kg P ----		---- % ----
1989/90	42577	46000	88577	19911	18437	38348	50230	49413	2774128	18.1	17.8	43.3	44.2
1990/91	43819	45434	89253	24877	18909	43786	45467	48848	2788276	16.3	17.6	49.1	46.0
1991/92	41507	52060	93567	22861	19858	42719	50848	52183	2769657	18.4	18.8	45.7	43.6
1992/93	37386	56809	94194	12913	21048	33961	60234	54114	2756327	21.9	19.6	36.1	41.5
1993/94	33524	56091	89615	16971	21384	38354	51260	51737	2738559	18.7	18.9	42.8	41.2
1994/95	28379	50641	79020	13764	21540	35304	43716	45556	2691174	16.2	17.2	44.7	45.1
1995/96	27353	52663	80016	17234	21091	38325	41691	42193	2509555	16.6	16.4	47.9	46.2
1996/97	26742	49653	76395	13683	21539	35222	41173	41283	2525333	16.3	16.3	46.1	47.4
1997/98	28309	51001	79310	16096	22228	38324	40986	41561	2540614	16.1	16.4	48.3	47.1
1998/99	27087	52756	79843	14619	22701	37320	42523	41166	2530418	16.8	16.4	46.7	47.3
1999/00	26044	48981	75026	12444	22593	35037	39989	38697	2461143	16.2	15.6	46.7	48.6
2000/01	23575	46828	70402	14117	22708	36825	33577	34093	2455687	13.7	13.8	52.3	51.5
2001/02	21498	42991	64489	12324	23454	35778	28711	30357	2473749	11.6	12.3	55.5	53.9
2002/03	20457	42200	62656	10828	23047	33875	28782	27569	2460786	11.7	11.2	54.1	56.0
2003/04	19756	41013	60768	12033	23520	35553	25216	26782	2451122	10.3	10.9	58.5	56.9
2004/05	20655	42260	62914	12607	23957	36565	26350	25650	2448332	10.8	10.4	58.1	58.2
2005/06	20761	39643	60404	11569	23449	35019	25386	26469	2532036	10.0	10.6	58.0	57.0
2006/07	19156	42040	61196	9585	23941	33525	27671	25618	2543005	10.9	10.1	54.8	58.1
2007/08	19557	42201	61758	13235	24726	37961	23797	22065	2509191	9.5	8.7	61.5	63.0
2008/09	19457	34885	54342	16346	23267	39613	14729	16315	2597233	5.7	6.4	72.9	71.2
2009/10	12852	37450	50303	16412	23472	39884	10419	12574	2618276	4.0	4.8	79.3	76.1

* When summarising, the input of inorganic fertiliser is rolled over to the following year, as the purchase of fertiliser in one accounting period is related to the harvest in the following accounting period.

** For the last accounting period, this is a two-year average (two preceding years)

Potassium

Table 6. Potassium input, output, surplus and use efficiency.

Production year	Input			Output			P surplus		Area minus set aside	K surplus pr. ha		Use efficiency	
	Fertiliser*, atmosphere org. waste	Imported feed	Total	Plant products	Animal products	Total	Annual	Avg. 3 yr**		Annual	Avg. 3 yr**	Annual	Avg. 3 yr**
	----- tons K -----									ha	----- kg K -----	---- % ----	
1989/90	133022	58249	191271	54103	12623	66727	124545	122962	2774128	44.9	44.2	34.9	35.6
1990/91	139365	58304	197668	63428	12726	76154	121514	124051	2788276	43.6	44.7	38.5	36.7
1991/92	134709	64630	199339	60225	13020	73246	126093	126591	2769657	45.5	45.7	36.7	35.2
1992/93	122769	66738	189507	43772	13570	57342	132165	119300	2756327	47.9	43.3	30.3	35.9
1993/94	101816	65928	167744	54402	13701	68103	99641	111518	2738559	36.4	40.8	40.6	35.9
1994/95	97574	65080	162654	46126	13779	59905	102749	96984	2691174	38.2	36.6	36.8	40.1
1995/96	93378	61549	154927	52693	13671	66364	88563	94414	2509555	35.3	36.6	42.8	39.4
1996/97	93248	56609	149857	44102	13823	57925	91932	91734	2525333	36.4	36.3	38.7	40.3
1997/98	99364	57110	156474	47649	14117	61766	94708	93131	2540614	37.3	36.8	39.5	39.5
1998/99	97216	58409	155625	48529	14344	62874	92751	91921	2530418	36.7	36.6	40.4	39.6
1999/00	92032	52582	144614	41994	14316	56311	88303	87587	2461143	35.9	35.3	38.9	40.3
2000/01	83741	56317	140058	44053	14299	58352	81706	81995	2455687	33.3	33.3	41.7	41.0
2001/02	76527	55329	131856	41333	14549	55881	75974	76214	2473749	30.7	30.9	42.4	43.1
2002/03	75197	54371	129567	44117	14488	58605	70962	72997	2460786	28.8	29.6	45.2	44.4
2003/04	73573	58659	132232	45564	14615	60179	72053	73486	2451122	29.4	30.0	45.5	45.0
2004/05	75236	63578	138814	46565	14805	61370	77444	74101	2448332	31.6	29.9	44.2	45.1
2005/06	74122	59864	133986	46598	14580	61178	72808	76961	2532036	28.8	30.7	45.7	43.8
2006/07	71832	65996	137828	42334	14863	57197	80631	74982	2543005	31.7	29.7	41.5	44.8
2007/08	69688	65764	135452	48752	15194	63946	71506	67664	2509191	28.5	26.6	47.2	49.6
2008/09	71004	56312	127316	61697	14765	76462	50854	45535	2597233	19.6	17.8	60.1	64.0
2009/10	37472	56312	93784	64560	14980	79540	14244	32549	2618276	5.4	12.5	84.8	72.4

* When summarising, the input of inorganic fertiliser is rolled over to the following year, as the purchase of fertiliser in one accounting period is related to the harvest in the following accounting period.

** For the last accounting period, this is a two-year average (two preceding years)

