

A8.4 Worksheets for the agriculture sector

Animal numbers in New Zealand Revised 2004

Agricultural sector calculations: emissions from domestic livestock and agricultural soils

	Dairy	Dairy	Non-dairy	Non-dairy	Sheep	Sheep	Goat	Goat	Deer	Deer	Swine	Swine
	cattle ¹	cattle	cattle ¹	cattle	numbers ¹	numbers	numbers ¹	numbers	numbers ²	numbers	numbers ¹	numbers
	(jun yr)	(3 yr av)	(jun yr)	(3 yr av)	(jun yr)	(3 yr av)	(jun yr)	(3 yr av)	(jun yr)	(3 yr av)	(jun yr)	(3 yr av)
							(1000s)	(1000s)			(1000s)	(1000s)
1989	3,302,377		4,526,056		60,568,653		1,222		834,972		411	
1990	3,440,815	3,390,873	4,593,160	4,596,595	57,852,192	57,860,829	1,063	1,026	1,042,986	1,035,915	395	404
1991	3,429,427	3,446,022	4,670,569	4,646,742	55,161,643	55,194,076	793	796	1,229,788	1,204,193	407	404
1992	3,467,824	3,482,464	4,676,497	4,701,676	52,568,393	52,676,132	533	559	1,339,804	1,269,824	411	405
1993	3,550,140	3,619,049	4,757,962	4,827,436	50,298,361	50,777,603	353	390	1,239,880	1,286,611	395	410
1994	3,839,184	3,826,380	5,047,848	4,996,106	49,466,054	49,526,895	284	324	1,280,148	1,246,352	423	416
1995	4,089,817	4,031,366	5,182,508	5,027,512	48,816,271	48,558,744	337	283	1,219,029	1,243,856	431	426
1996	4,165,098	4,170,305	4,852,179	4,946,896	47,393,907	47,681,393	228	264	1,232,391	1,264,401	424	424
1997	4,256,000	4,255,033	4,806,000	4,696,726	46,834,000	46,727,969	228	228	1,341,784	1,324,601	417	418
1998	4,344,000	4,305,470	4,432,000	4,627,235	45,956,000	46,156,630	228	214	1,399,629	1,388,297	412	399
1999	4,316,409	4,419,515	4,643,705	4,556,578	45,679,891	45,093,255	186	197	1,423,478	1,439,739	369	383
2000	4,598,136	4,598,136	4,594,029	4,594,029	43,643,873	43,643,873	175	175	1,496,110	1,490,786	369	364
2001	4,879,862	4,879,862	4,544,354	4,543,221	41,607,855	41,607,855	164	164	1,552,770	1,565,593	354	355
2002	5,161,589	5,047,684	4,491,281	4,554,078	39,571,837	40,243,931	153	153	1,647,900	1,630,023	342	358
2003	5,101,600	5,139,096	4,626,600	4,521,994	39,552,100	39,459,512	142	142	1,689,400	1,698,800	377	369
2004	5,154,100	5,118,800	4,448,100	4,527,667	39,254,600	39,572,433	131	137	1,759,100	1,720,000	389	385
2005	5,100,700		4,508,300		39,910,600				1,711,500		389	

1. 1994, 1995, 1996, 1999 and 2002 data from Statistics New Zealand. Other estimates provided by MAF based on a combination of official livestock survey data, information from the Meat and Wool Board Economic Service, and CES Forecast estimates.

Animal numbers in New Zealand (thousands) Revised 2004
Agricultural sector calculations: emissions from domestic livestock and agricultural soils

	Poultry	Poultry	Poultry	Poultry	Horse	Horse
	numbers	others and	numbers	numbers	numbers ³	numbers
	layers ¹⁴	broilers ²⁴	total	(3 yr av)	(jun yr)	(3 yr av)
	(June yr)	(June yr)	(June yr)			
1989	3,324	4,925	8,249		98.0	
1990	2,996	6,089	9,085	8,670	94.0	94.0
1991	2,908	5,770	8,677	8,677	90.0	90.6
1992	2,819	5,450	8,270	8,988	87.9	88.4
1993	2,862	7,154	10,016	10,016	87.2	81.0
1994	2,905	8,858	11,762	11,762	67.8	74.5
1995	2,947	10,561	13,509	12,914	68.6	68.0
1996	3,210	10,262	13,472	13,953	67.7	68.5
1997	3,211	11,667	14,878	14,878	69.1	69.1
1998	3,212	13,072	16,284	16,284	70.4	70.4
1999	3,213	14,476	17,690	17,690	71.8	71.8
2000	3,215	15,881	19,096	19,096	73.1	73.1
2001	3,216	17,286	20,502	20,502	74.5	74.5
2002	3,217	18,691	21,908	21,499	75.9	76.9
2003	3,218	18,868	22,086	22,389	80.4	77.7
2004	3,219	19,954	23,173	23,183	76.9	78.1
2005	3,220	21,069	24,289		76.9	

1. 1995, 1996 and 2002 (provisional) data from Statistics New Zealand. 1989, 1990 and 1992 from M Other estimates provided by MAF February 2003.
2. 2002 data from Statistics New Zealand. 1989, 1990, 1992, 1995 and 1996 from MAF survey data. 2003-2005 data not available from Statistics New Zealand and are extrapolated.
3. 1994, 1995, 1996 and 2002 data from Statistics New Zealand. 1990, 1992 and 1993 from MAF sur 2003-2005 data not available from Statistics New Zealand and are extrapolated.
4. Poultry numbers for 2005 extrapolated

Livestock productivity data for New Zealand 2004

Agricultural sector calculations: CH₄ emissions from domestic livestock

Table 1: Average weights, average annual milk yields and average milk composition of dairy cattle in New Zealand 1990-2004. All data are three year averages.

	Dairy cow weights (kg)	Milk yields (litres/year)	Milk fat (percent)	Milk protein (percent)
1990	447	2801	4.85	3.58
1991	449	2858	4.88	3.61
1992	450	3011	4.90	3.63
1993	451	3029	4.90	3.62
1994	452	3076	4.89	3.61
1995	451	3121	4.88	3.61
1996	452	3227	4.85	3.59
1997	449	3247	4.82	3.58
1998	451	3303	4.80	3.58
1999	453	3430	4.81	3.61
2000	456	3625	4.83	3.63
2001	458	3670	4.84	3.66
2002	457	3680	4.85	3.67
2003	457	3628	4.88	3.70
2004	456	3660	4.91	3.69

Livestock productivity data for New Zealand 2004

Agricultural sector calculations: CH₄ emissions from domestic livestock

Table 2: Average weights of beef cattle in New Zealand 1990-2004. All data are three year averages

	Beef cow weights (kg)	Heifer weights at slaughter (kg)	Bull weights at slaughter (kg)	Steer weights at slaughter (kg)
1990	379	413	553	568
1991	381	417	562	577
1992	389	422	566	584
1993	403	427	574	593
1994	406	432	581	598
1995	412	436	585	601
1996	418	438	593	601
1997	430	438	600	601
1998	426	438	603	599
1999	423	437	599	602
2000	423	437	599	607
2001	432	441	603	614
2002	433	446	605	615
2003	430	453	608	617
2004	433	457	615	620

Livestock productivity data for New Zealand 2004

Agricultural sector calculations: CH₄ emissions from domestic livestock

Table 3: Weights of ewes and lambs in New Zealand 1990-2004. All data are three year averages

	Ewe weights (kg)	Lamb weights at slaughter (kg)
1990	48.4	31.2
1991	49.0	32.1
1992	49.1	33.0
1993	49.6	33.6
1994	49.4	33.5
1995	49.7	33.4
1996	50.0	33.7
1997	51.1	34.4
1998	52.0	34.7
1999	53.0	35.4
2000	54.1	36.2
2001	54.7	37.0
2002	54.8	37.1
2003	55.1	37.6
2004	56.2	38.1

Livestock productivity data for New Zealand 2004

Agricultural sector calculations: CH₄ emissions from domestic livestock

Table 4: Weights of deer in New Zealand 1990-2004. All data are three year averages

	Breeding hind live weight (kg)	Breeding stag live weight (kg)	Growing stag live weight at slaughter (kg)	Growing hind live weight at slaughter (kg)
1990	112.5	153.2	95.6	79.0
1991	115.1	157.4	98.3	80.8
1992	114.7	162.1	101.2	80.5
1993	115.4	165.7	103.4	81.0
1994	114.5	166.0	103.6	80.4
1995	116.8	166.3	103.8	82.0
1996	117.8	170.0	106.1	82.7
1997	121.8	176.6	110.3	85.5
1998	124.3	181.0	113.0	87.2
1999	127.6	175.9	109.8	89.6
2000	128.8	170.6	106.5	90.4
2001	129.9	168.1	104.9	91.2
2002	130.2	167.5	104.6	91.4
2003	130.1	165.6	103.4	91.3
2004	130.8	162.0	101.1	91.8

Livestock productivity data for New Zealand 2004

Agricultural sector calculations: CH₄ emissions from domestic livestock

Table 5: Assumed monthly energy concentrations of the diets consumed by beef cattle, sheep, dairy cattle and deer for all years 1990-2004

	Dairy cattle and deer MJ ME/kg dry matter	Beef cattle and sheep MJ ME/kg dry matter
July	12.6	10.8
August	11.5	10.8
September	11.7	11.4
October	12.0	11.4
November	11.6	11.4
December	10.8	9.9
January	11.1	9.9
February	10.6	9.9
March	10.7	9.6
April	11.3	9.6
May	12.0	9.6
June	11.7	10.8

Livestock productivity data for New Zealand 2004

Agriculture sector calculations: emissions from domestic livestock and soils

Table 6: Nitrogen excretion (Nex) for grazing animals

	Sheep (kg/head/yr)	Non-dairy cattle (kg/head/yr)	Dairy cattle (kg/head/yr)	Deer (kg/head/yr)
1990	12.16	65.89	106.24	20.96
1991	12.35	66.73	107.14	20.71
1992	12.47	68.09	109.56	20.57
1993	12.67	70.07	110.21	20.47
1994	12.73	69.37	110.33	20.58
1995	12.87	69.09	109.82	20.91
1996	13.10	68.15	110.65	21.31
1997	13.50	70.71	110.30	21.88
1998	13.61	70.62	111.51	22.18
1999	13.77	71.62	113.33	22.32
2000	14.01	71.30	116.31	22.37
2001	14.34	72.87	116.38	22.34
2002	14.34	72.44	116.50	22.36
2003	14.60	72.60	116.13	22.10
2004	14.83	72.55	117.00	22.03

Module 2004 Agriculture (New Zealand)
Submodule Domestic livestock emissions from enteric fermentation and manure management
Worksheet 4.1 (1 of 2)
Sheet Methane emissions

Livestock type	Number of animals (3 yr av) (1000s)	Emission factor for enteric fermentation ¹ (kg CH ₄ /head/yr)	Emissions from enteric fermentation (Gg)	Emission factor for manure management ² (kg CH ₄ /head/yr)	Emissions from manure management (Gg)	Total CH ₄ emissions from dom livestock (Gg)
Dairy cattle	5,119	79.4	406.31	0.889	4.551	410.87
Non-dairy cattle	4,528	56.2	254.49	0.909	4.116	258.60
Sheep	39,572	10.8	427.38	0.178	7.044	434.42
Goats	137	9.0	1.23	0.180	0.025	1.25
Deer	1,720	22.0	37.90	0.369	0.635	38.53
Horses	78	18.0	1.41	2.080	0.162	1.57
Swine	385	1.5	0.58	20.000	7.697	8.27
Poultry	23,183	NE	NE	0.117	2.712	2.71
Total			1,129.28		26.941	1,156.23

1. Horses, goats and swine use IPCC default emission factors for enteric fermentation.

1. Enteric emission factors for dairy, non-dairy, sheep and deer are implied emission factors

2. Manure management: Horses, goats, swine and poultry use IPCC default emission factors from IPCC Reference Manual B-7 & B-6

2. Manure management: Dairy, non-dairy cattle, sheep and deer from Joblin and Waghorn (1994)

Module 2004 Agriculture (New Zealand)
Submodule Domestic livestock emissions from enteric fermentation and manure management
Worksheet 4.1 (2 of 2)
Sheet Nitrous oxide emissions from manure management

Animal waste management system (AWMS)	N excretion for each AWMS (N _{ex(AWMS)}) (kg N)	Emission factor for each AWMS (EF ₃) (kg N ₂ O-N/kg N)	Emissions from domestic livestock (Gg N ₂ O)
Anaerobic lagoons	33,331,062	0.001	0.052
Liquid Systems			NO
Daily spread			IE
Solid storage and drylot	1,046,773	0.02	0.033
Pasture range and paddock			IE
Other	15,216,318	0.005	0.120
Total			0.205

N₂O emissions from daily spread and pasture range and paddock are reported under agricultural soils.

2004 Agriculture (New Zealand)

Table 4.17 (IPCC Workbook, adapted)

Parameter values for agricultural emissions of nitrous oxide

Parameter	Value	Fraction of ...	Additional sources
Frac _{BURN}	0.5	... crop residue burned in fields	Ministry of Agriculture and Forestry (expert opinion)
Frac _{BURNL}	0	... Legume crop residue burned in fields	Ministry of Agriculture and Forestry (expert opinion)
Frac _{FUEL}	0	... livestock nitrogen excretion in excrements burned for fuel	Practice does not occur in New Zealand
Frac _{GASF}	0.1	... total synthetic fertiliser emitted as NO _x or NH ₃	IPCC Reference manual Table 4.19
Frac _{GASM}	0.2	... total nitrogen excretion emitted as NO _x or NH ₃	IPCC Reference manual Table 4.19
Frac _{GRAZ}		... livestock nitrogen excreted and deposited onto soil during grazing	Refer worksheet 4.1 Supplemental
Frac _{LEACH}	0.07	... nitrogen input to soils that is lost through leaching and run-off	Thomas et al (2002)
Frac _{NCRBF}	0.03	... nitrogen in N-fixing crops	IPCC Reference manual Table 4.19
Frac _{NCR0}	0.015	... nitrogen in non-N-fixing crops	IPCC Reference manual Table 4.19
Frac _R	0.45	... crop residue removed from the field as crop	IPCC Reference manual Table 4.19

2004 Agriculture (New Zealand)

Table 4.18 (IPCC Workbook, adapted)

Emission factors for agricultural emissions of nitrous oxide

Emission factor	Value	Emission factor for ...	Additional sources
EF ₁	0.01	... direct emissions from N input to soil	IPCC GPG Table 4.17
EF ₂	8	... direct emissions from organic soil mineralisation due to cultivation	IPCC GPG Table 4.17
EF ₃ (AL)	0.001	... direct emissions from waste in the <i>anaerobic lagoons</i> AWMS	IPCC GPG Table 4.12
EF ₃ (SS&D)	0.02	... direct emissions from waste in the <i>solid waste and drylot</i> AWMS	IPCC GPG Table 4.12
EF ₃ (PR&P)	0.01	... direct emissions from waste in the <i>pasture range and paddock</i> AWMS	Carran et al (1995), Sherlock et al (1995), Kelliher et al.(2003)
EF ₃ (OTHER)	0.005	... direct emissions from waste in other AWMSs	IPCC GPG Table 4.13 (poultry manure without bedding and swine deep litter < 1 month)
EF ₄	0.01	... indirect emissions from volatilising nitrogen	IPCC GPG Table 4.18
EF ₅	0.025	... indirect emissions from leaching nitrogen	IPCC GPG Table 4.18



Module 2004 Agriculture (New Zealand)
Submodule Domestic livestock emissions
Worksheet 4.1 (supplemental) for worksheet 4.1 (2 of 2)
Sheet Nitrogen excretion from anaerobic lagoons (AWMS=AL)

Livestock type	Number of animals (3 yr av) (1000s)	Nitrogen excretion ¹ (Nex) (kg/head/yr)	Percentage of nitrogen excretion in AWMS=AL ²	Nitrogen excretion from AL (kg N)
Non-dairy cattle	4,528			no
Dairy cattle	5,119	117.0	5%	29,944,444
Poultry	23,183			no
Sheep	39,572			no
Swine	385	16.0	55%	3,386,618
Goats	137			no
Deer	1,720			no
Horses	78			no
Total (Nex_{AL})				33,331,062

1 Nex value for dairy cattle based on Ledgard, AgResearch (2003)
 2 Value for dairy cattle from Ledgard and Brier (2004).

Module 2004 Agriculture (New Zealand)
Submodule Agricultural soils
Worksheet 4.1 (supplemental) for worksheet 4.5 (3 of 5)
Sheet Nitrogen excretion from pasture range and paddock (AWMS=PR&P)

Livestock type	Number of animals (3 yr av) (1000s)	Nitrogen excretion ¹ (Nex) (kg/head/yr)	Percentage of nitrogen excretion in AWMS=PR&P ^{2,3}	Nitrogen excretion from PR&P (kg N)
Non-dairy cattle	4,528	72.5	100%	328,464,729
Dairy cattle	5,119	117.0	95%	568,944,432
Poultry	23,183	0.6	3%	417,285
Sheep	39,572	14.8	100%	586,942,285
Swine	385			no
Goats	137	9.5	100%	1,296,750
Deer	1,720	22.0	100%	37,895,664
Horses	78	25.0	100%	1,951,792
Total (Nex_{PR&P})				1,525,912,937

1 Values for sheep, non-dairy and dairy cattle, and deer from Ledgard, AgResearch (2003)
 Values from goats from Ulyatt (pers comm).
 2 Value for dairy cattle from Ledgard and Brier (2004).
 3 Values for goats and deer from the Ministry of Agriculture and Forestry.

Module 2004 Agriculture (New Zealand)
Submodule Domestic livestock emissions
Worksheet 4.1 (supplemental) for worksheet 4.1 (2 of 2)
Sheet Nitrogen excretion from solid storage and drylot (AWMS=SS&D)

Livestock type	Number of animals (3 yr av) (1000s)	Nitrogen excretion (Nex) (kg/head/yr)	Percentage of nitrogen excretion in AWMS=SS&D	Nitrogen excretion from SS&D (kg N)
Non-dairy cattle	4,528			no
Dairy cattle	5,119			no
Poultry	23,183			no
Sheep	39,572			no
Swine	385	16.0	17%	1,046,773
Goats	137			no
Deer	1,720			no
Horses	78			no
Total (Nex _{SS&D})				1,046,773

Module 2004 Agriculture (New Zealand)
Submodule Domestic livestock emissions
Worksheet 4.1 (supplemental) for worksheet 4.1 (2 of 2)
Sheet Nitrogen excretion from other management systems (AWMS=OTHER)

Livestock type	Number of animals (3 yr av) (1000s)	Nitrogen excretion (Nex) (kg/head/yr)	Percentage of nitrogen excretion in AWMS=OTHER	Nitrogen excretion from OTHER (kg N)
Non-dairy cattle	4,528			no
Dairy cattle	5,119			no
Poultry	23,183	0.6	97%	13,492,221
Sheep	39,572			no
Swine	385	16.0	28%	1,724,097
Goats	137			no
Deer	1,720			no
Horses	0			no
Total (Nex _{OTHER})				15,216,318

2004 Agriculture (New Zealand)**F_{AW} calculation for worksheet 4.5 (1 of 5)****Nitrogen input to agricultural soils from animal waste (supplemental worksheet 4.5A)**

N excretion spread from all AWMSs (kg N) ¹	Fraction of N excretion burned for fuel	Fraction of N excretion deposited onto soil during grazing	Fraction of N excretion emitted as NO _x or NH ₃	Nitrogen input from animal waste (kg N)
N_{spread}	$\times (1 - \text{Frac}_{\text{FUEL}})$	$+ \text{Frac}_{\text{GRAZ}}$	$+ \text{Frac}_{\text{GASM}}$	$= F_{\text{AW}}$
49,594,153	0		0.2	39,675,323

1 Animal waste in all AWMS except *pasture range and paddock*.

2 FracGRAZ is not required as waste from grazing livestock is already excluded.

2004 Agriculture (New Zealand)**F_{BN} calculation for worksheet 4.5 (1 of 5)****Nitrogen input to agricultural soils from N-fixing crops**

Production of pulses and soyabeans (kg dry biomass)	Fraction of nitrogen in N-fixing crops	Nitrogen input from N-fixing crops (kg N)
Crop_{BF}	$\times \text{Frac}_{\text{NCRBF}}$	$\times 2 = F_{\text{BN}}$
61,800,000	0.03	3,708,000

2004 Agriculture (New Zealand)**F_{SN} calculation for worksheet 4.5 (1 of 5)****Nitrogen input to agricultural soils from synthetic fertiliser use**

Synthetic fertiliser use (kg N)	One minus the fraction of syn. fertiliser emitted as NO _x or NH ₃	Nitrogen input from synthetic fertiliser use (kg N)
N_{FERT}	$\times (1 - \text{Frac}_{\text{GASF}})$	$= F_{\text{SN}}$
345,240,000	0.9	310,716,000

2004 Agriculture (New Zealand)**F_{CR} calculation for worksheet 4.5 (1 of 5)****Nitrogen input to agricultural soils from crop residues (supplemental worksheet 4.5B)**

Production of non-N-fixing crops (kg dry biomass)	Fraction of nitrogen in non-N-fixing crops	Production of pulses and soyabeans (kg dry biomass)	Fraction of nitrogen in N-fixing crops	One minus the fraction of crop residue removed from field as crop	One minus the fraction of crop residue burned in the field	Nitrogen input from crop residues (F _{CR}) (kg N)
(Crop_0)	$\times \text{Frac}_{\text{NCR0}}$	$+ \text{Crop}_{\text{BF}}$	$\times \text{Frac}_{\text{NCRBF}}$	$\times (1 - \text{Frac}_{\text{CR}})$	$\times (1 - \text{Frac}_{\text{BURN}})$	$\times 2 = F_{\text{CR}}$
796,073,478	0.015	61,800,000	0.03	0.55	1	2,039,400
				0.55	0.50	6,567,606
						8,607,006

Module 2004 Agriculture (New Zealand)
Submodule Agricultural soils
Worksheet 4.5 (1 of 5)
Sheet Direct nitrous oxide emissions from agricultural soils (excluding histosols)

Type of N input to soil	Amount of N input to soil (kg N)	Emission factor for direct emissions (EF ₁) (kg N ₂ O-N/kg N)	Direct soil emissions (excl. histosols) (Gg N ₂ O-N)	Direct soil emissions (excl. histosols) (Gg N ₂ O)
Synthetic fertiliser (F _{SN})	310,716,000	0.01	3.107	4.883
Animal Waste (F _{AW}) ¹	39,675,323	0.01	0.397	0.623
N-Fixing crops (F _{BN})	3,708,000	0.01	0.037	0.058
Crop residue (F _{CR})	8,607,006	0.01	0.086	0.135
Total			3.627	5.700

¹ Based on animal waste in all AWMS except *pasture range and paddock*.

Module 2004 Agriculture (New Zealand)
Submodule Agricultural soils
Worksheet 4.5 (2 of 5)
Sheet Direct nitrous oxide emissions from agricultural soils (histosols)

Area of cultivated organic soils ¹ (ha) (F _{OS})	Emission factor for direct soil emissions (EF ₂) (kg N ₂ O-N/ha/yr)	Direct soil emissions from histosols (Gg N ₂ O-N)	Direct soil emissions from histosols (Gg N ₂ O)
345,240,000	8	2,761.920	4,340.160

¹ MAF estimate

Module 2004 Agriculture (New Zealand)
Submodule Agricultural soils
Worksheet 4.5 (3 of 5)
Sheet Direct nitrous oxide emissions from animal production (grazing animals)

Pasture, range and paddock AWMS	N excretion for AWMS PRP (kg N)	Emission factor for AWMS (EF _{3 PRP}) ¹ (kg N ₂ O-N/kg N)	Total direct animal prodn. emissions of N ₂ O-N (Gg)	Total direct animal prodn. emissions of N ₂ O (Gg)
PRP	1,525,912,937	0.01	15.259	23.979

¹ Value based on Carran et al (1995) and Sherlock et al (1995).

Module 2004 Agriculture (New Zealand)
Submodule Agricultural soils
Worksheet 4.5 (4 of 5)
Sheet Indirect nitrous oxide emissions from nitrogen used in agriculture (atmospheric deposition of NH₃ and NO_x)

Synthetic fertiliser applied to soil (N _{FERT}) (kg N)	Fraction of syn. fertiliser N that volatilises (Frac _{GASF})	Amount of syn. N applied to soil that volatilises (kg N)	Total nitrogen excreted by livestock (kg N)	Fraction of N excretion that volatilises (Frac _{GASL})	Amount of N excretion that volatilises (kg N)	Emission factor (EF ₄) (kg N ₂ O-N/kg volatilised N)	Indirect N ₂ O emissions from atmos. deposition (Gg N ₂ O-N)	Indirect N ₂ O emissions from atmos. deposition (Gg N ₂ O)
345,240,000	0.1	34,524,000	1,575,507,090	0.2	315,101,418	0.01	3.496	5.494

Module 2004 Agriculture (New Zealand)
Submodule Agricultural soils
Worksheet 4.5 (5 of 5)
Sheet Indirect nitrous oxide emissions from nitrogen used in agriculture (leaching) and total nitrous oxide emissions from agricultural soils

Synthetic fertiliser applied to soil (N _{FERT}) (kg N)	Total nitrogen excreted by livestock (kg N)	Fraction of nitrogen that leaches (Frac _{LEACH})	Emission factor (EF ₅) (kg N ₂ O-N/kg leached N)	Indirect N ₂ O emissions from leaching (Gg N ₂ O-N)	Indirect N ₂ O emissions from leaching (Gg N ₂ O)
345,240,000	1,575,507,090	0.07	0.025	3.361	5.282

Module 2004 Agriculture (New Zealand)
Submodule Agricultural soils
Worksheet 4.5 (4 of 5)
Sheet Total nitrous oxide emissions agricultural soils

Total indirect N ₂ O emissions from N used in agric. (Gg N ₂ O)	Total direct N ₂ O emissions (Gg N ₂ O)	Total nitrous oxide emissions from agricultural soils (Gg N ₂ O)
10.776	4,369.838	4,380.614

Module 2004 Agriculture (New Zealand)
Submodule Prescribed burning of savanna

Year	Otago consented area (ha)	Canterbury consented area (ha)	Southland consented ³ area (ha)	Total consented area (ha)	3 yr ave consented area (ha)	assume 20% consented area (ha)	above ground bio-burned mass density	biomass burnt (t)
1989	11310.0	15425.7	5445.0	32180.7				
1990	14332.0	15425.7	5634.0	35391.7	36471.2	7294.2	0.0	0.32
1991	22020.0	15241.2	4580.0	41841.2	36108.1	7221.6	0.0	0.32
1992	10740.0	15531.5	4820.0	31091.5	34571.7	6914.3	0.0	0.32
1993	15229.0	10953.5	4600.0	30782.5	27819.7	5563.9	0.0	0.32
1994	7875.0	9900.0	3810.0	21585.0	22006.2	4401.2	0.0	0.32
1995	7485.0	1626.0	4540.0	13651.0	17770.7	3554.1	0.0	0.32
1996	4790.0	9061.0	4225.0	18076.0	16109.0	3221.8	0.0	0.32
1997	5895.0	6955.0	3750.0	16600.0	14466.7	2893.3	0.0	0.32
1998	1810.0	5314.0	1600.0	8724.0	10919.3	2183.9	0.0	0.32
1999	1.0	4963.0	2470.0	7434.0	9921.3	1984.3	0.0	0.32
2000	2425.0	9491.0	1690.0	13606.0	10424.3	2084.9	0.0	0.32
2001	3770.0	4303.0	2160.0	10233.0	11943.7	2388.7	0.0	0.32
2002	350.0	8792.0	2850.0	11992.0	10972.0	2194.4	0.0	0.32
2003	4670.0	3721.0	2300.0	10691.0	10901.7	2180.3	0.0	0.32
2004	1125.0	2714.0	6183.0	10022.0	8986.0	1797.2	28.0	0.3
2005	0.0	200.0	6045.0	6245.0				

Notes

¹ from Ian J. Payton & Grant Pearce (2001) Does fire deplete the physical and biological resources of tall-tussock (Chionochloa) grasslands? The latest attempt at some answers . Pp. 243-249 in proceedings: Bushfire 2001. Australasian Bushfire Conference.

3-6 July 2001, Christchurch, New Zealand

² from Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual

Module 2004 Agriculture (New Zealand)
Submodule Prescribed burning of savanna
Worksheet 4.3 (3 of 3)

Sheet Non-CO2 released from savanna burning

Year	CH4 emission ratio2	CO emission ratio2	N2O emission ratio2	NOx emission ratio2	N/C ratio2	CH4 emissions (Gg)	CO emissions (Gg)	N2O emissions (Gg)	NOx emissions (Gg)	Total CH4 and N2O in CO2 equivalent (Gg)
2004	0.00	0.06	0.01	0.12	0.01	0.033	0.869	0.000	0.015	0.822

¹ from Ian J. Payton & Grant Pearce (2001) Does fire deplete the physical and biological resources of tall-tussock (Chionochloa) grasslands? The latest attempt at some answers . Pp. 243-249 in proceedings: Bushfire 2001. Australasian Bushfire Conference.

3-6 July 2001, Christchurch, New Zealand

² from Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual

Module 2004 Agriculture (New Zealand)
Submodule Prescribed burning of savanna
Worksheet 4.3 (2 of 3)

Sheet Total carbon released from burning

Year	biomass burned (t)	fraction of live material1	fraction of dead material1	fraction live material oxidised2	fraction dead material oxidised2	C content of live biomass (living)2	C content of dead biomass2	carbon released from live biomass (t)	carbon released from dead biomass (t)	total carbon released (t)
2004	16103	0.36	0.64	0.8	1	0.45	0.4	2090	4119	6209

Non-N-fixing crop yields in New Zealand Revised 2004

Agricultural sector calculations: emissions from field burning and agricultural soils

	Barley prodn (jun yr) (tonnes)	Barley prodn (3 yr av) (Gg)	Wheat prodn (jun yr) (tonnes)	Wheat prodn (3 yr av) (Gg)	Maize prodn (jun yr) (tonnes)	Maize prodn (3 yr av) (Gg)	Oats prodn (jun yr) (tonnes)	Oats prodn (3 yr av) (Gg)	Non-N- fixing crops (3 yr av) (kg)
1989	326,850		134,994		138,694		65,892		
1990	434,856	381.2	188,042	167.9	161,651	161.2	78,877	67.3	
1991	382,043	378.6	180,690	186.6	183,388	169.6	57,187	64.6	
1992	318,787	363.5	191,039	197.0	163,842	160.1	57,625	57.2	
1993	389,523	367.9	219,414	217.5	133,069	146.6	56,793	57.4	
1994	395,500	362.6	241,900	235.5	142,768	145.5	57,718	51.1	
1995	302,800	355.2	245,200	254.7	160,797	171.1	38,735	45.9	
1996	367,200	360.3	277,000	279.9	209,710	188.1	41,217	43.0	
1997	411,000	372.7	317,379	298.8	193,806	193.2	49,065	44.2	
1998	340,000	351.7	302,100	313.2	176,148	189.0	42,223	44.3	
1999	304,000	315.3	320,000	316.0	197,000	184.7	41,702	39.8	
2000	302,000	300.7	326,000	336.7	181,000	185.0	35,398	33.2	
2001	296,000	346.3	364,000	330.5	177,000	168.9	22,400	30.9	
2002	440,883	371.7	301,498	328.5	148,847	174.3	34,987	29.1	
2003	378,340	348.4	319,977	292.4	197,182	180.7	29,934	30.9	
2004	226,082	290.1	255,860	289.6	196,000	187.1	27,845	29.3	
2005	266,000		293,000		168,000		30,000		

Source: Statistics New Zealand.

Estimates provided by MAF for 1998, 1999, 2000, 2001, 2004 and 2005

N-fixing crop yields in New Zealand Revised 2004

Agricultural sector calculations: emissions from field burning and agricultural soils

	Processed peas prodn** (jun yr) (tonnes dry weight)	Peas prodn** (jun yr) (tonnes)	Peas Processed* and Seed Peas (tonnes DW)	Peas prodn (3 yr av) (Gg)	Lentils prodn* (jun yr) (tonnes)	Lentils prodn (3 yr av) (Gg)	N-fixing crops (3 yr av) (kg)
1989	24,000	47,308	71,308		3,386		
1990	24,000	57,378	81,378	80.6	3,386	3.4	83,969,333
1991	24,000	65,064	89,064	89.9	3,386	4.0	93,902,667
1992	24,000	75,290	99,290	91.9	5,204	4.5	96,410,000
1993	24,000	63,268	87,268	90.2	5,018	4.3	94,463,333
1994	24,000	59,898	83,898	83.9	2,712	2.9	86,755,667
1995	24,000	56,448	80,448	79.6	923	1.5	81,080,333
1996	24,000	50,337	74,337	76.5	923	0.9	77,397,000
1997	24,300	50,337	74,637	82.1	923	0.9	83,053,333
1998	31,200	66,200	97,400	86.1	940	0.6	86,766,667
1999	34,200	52,200	86,400	94.6	0	0.3	94,913,333
2000	36,000	64,000	100,000	86.7	0	0.0	86,700,000
2001	36,000	37,700	73,700	79.7	0	1.1	80,819,667
2002	36,000	29,457	65,457	67.2	3,302	1.8	68,953,000
2003	31,200	31,200	62,400	61.6	2,000	2.4340	64,053,000
2004	28,500	28,500	57,000	59.8	2,000	2.0000	61,800,000
2005	28,500	31,500	60,000		2,000		

1 MAF estimate. Zero has been entered when production negligible.

2 Statistics New Zealand. 1998, 1999, 2000, 2001 estimates provided by MAF.

Production pea data for 2003 calculated from area in peas.

3 MAF estimates for 2004 and 2005

Miscellaneous agricultural data Revised 2004

Agricultural sector calculations: emissions from agricultural soils

	Cultivated organic soils (ha) ¹ (jun yr)	Cultivated organic soils (ha) (3 yr av)	Synthetic fertiliser use (kg N) ² (jun yr)	Synthetic fertiliser use (kg N) (3 yr av)
1989	10,109		51,663,000	
1990	10,109	10,109	59,265,000	57,540,667
1991	10,109	10,109	61,694,000	63,693,667
1992	10,109	10,109	70,122,000	78,637,000
1993	10,109	10,109	104,095,000	99,449,333
1994	10,109	10,109	124,131,000	126,496,333
1995	10,109	10,109	151,263,000	143,058,000
1996	10,109	10,109	153,780,000	149,446,000
1997	10,109	10,109	143,295,000	150,847,333
1998	10,109	10,109	155,467,000	155,193,667
1999	10,109	10,109	166,819,000	170,460,667
2000	10,109	10,109	189,096,000	201,305,000
2001	10,109	10,109	248,000,000	248,765,333
2002	10,109	10,109	309,200,000	298,200,000
2003	10,109	10,109	337,400,000	331,533,333
2004	10,109	10,109	348,000,000	345,240,000
2005	10,109		350,320,000	

1 MAF estimate 2003

2 Best estimate from MAF and sales records obtained by FertResearch

Module 2004 Agriculture (New Zealand)
Submodule Field burning of agricultural residues
Worksheet 4.4 (1 and 2 of 3)
Sheet Calculation of carbon and nitrogen releases

Crops	Production (3 yr av) (Gg crop)	Residue to crop ratio	Quantity of residue (Gg biomass)	Dry matter fraction	Quantity of dry residue (Gg dm)	Fraction burned in fields ¹	Fraction oxidised	Biomass burned (Gg dm)	Carbon fraction of residue	Carbon released (Gg C)	Nitrogen- carbon- ratio	Nitrogen released (Gg N)
Cereals	609.0		762.7		636.5			171.8		80.895		1.091
a Barley	290.1	1.2	348.2	0.83	289.0	0.3	0.9	78.0	0.4567	35.634	0.015	0.535
b Wheat	289.6	1.3	376.5	0.83	312.5	0.3	0.9	84.4	0.4853	40.946	0.012	0.491
c Oats	29.3	1.3	38.0	0.92	35.0	0.3	0.9	9.4	0.4567	4.315	0.015	0.065

¹ Ministry of Agriculture and Forestry.

Maize no longer included in calculation as no maize residue burning occurs - MAF 2003

Module 2004 Agriculture (New Zealand)
Submodule Field burning of agricultural residues
Worksheet 4.4 (3 of 3)
Sheet Total non-CO₂ trace gas emissions from cereals

	Emission ratio to C or N	Emissions (Gg C or N)	Conversion ratio	Emissions (Gg of gas)
CH ₄	0.005	0.404	1.333	0.539
CO	0.060	4.854	2.333	11.325
N ₂ O	0.007	0.008	1.571	0.012
NO _x	0.121	0.132	3.286	0.434

Module 2004 Agriculture (New Zealand)
Submodule Field burning of agricultural residues
Worksheet 4.4 (supplementary)
Sheet Calculation of carbon and nitrogen releases per crop type

Crops	Emissions of CH ₄ (Gg)	Emissions of CO (Gg)	Emissions of N ₂ O (Gg)	Emissions of NO _x (Gg)
Cereals				
a Barley	0.238	4.989	0.006	0.213
b Wheat	0.273	5.732	0.005	0.195
d Oats	0.029	0.604	0.001	0.026