



STEP 9 TOTAL N₂O EMISSIONS FROM AGRICULTURAL SOILS

Total Nitrous Oxide Emissions from agricultural soils can be calculated as the sum of direct emissions (Worksheet 4-5, sheet 2, step 4), emissions from animal waste (Worksheet 4-5, sheet 3, step 5) and indirect emissions (Worksheets 4-5, sheet 5, step 8). Thus

Total N₂O–N emissions from a country (kg N₂O–N/yr) are:

EQUATION 10

$$N_2O = N_2O_{\text{DIRECT}} + N_2O_{\text{ANIMALS}} + N_2O_{\text{INDIRECT}}$$

- 1 Sum the totals in column G (Worksheet 4-5, sheet 2, step 4), column C (Worksheet 4-5, sheet 3, step 5) and column N (Worksheet 4-5, sheet 5, step 8) to give the Total Nitrous Oxide Emissions from agricultural soils. Enter the result in column O.

TABLE 4-19 DEFAULT VALUES OF PARAMETERS FOR INDIRECT EMISSIONS	
Fra _C _{NPR}	0.16 kg N/kg of protein
Fra _C _{LEACH}	0.3 (0.1-0.8) kg N/kg of fertiliser or manure N



Appendix A

Data Underlying Nitrous Oxide Emissions from Agricultural Soils

This appendix presents the data used to calculate the manure-N excretion and N₂O emission factors in Table A-1.



TABLE A-1
CALCULATION OF MANURE-N EXCRETION AND N₂O EMISSION FACTORS FOR DIFFERENT ANIMAL WASTE MANAGEMENT SYSTEMS IN DIFFERENT WORLD REGIONS. THESE ARE TO BE REPORTED UNDER MANURE MANAGEMENT, EXCEPT FOR DAILY SPREAD AND PASTURE RANGE OF PADDOCK (EMISSIONS FROM AGRICULTURAL SOILS) AND EMISSIONS AFTER USE AS A FUEL (ENERGY)

Region	Type of Animal	Number of Animals (x10 ⁶)	Nitrogen Excretion kg N/animal/yr	Emission Factor for AWMs EF ₃ (% of Manure N Excreted that is lost as N ₂ O)							Total N Excreted (Tg N)
				Anaerobic Lagoon (EF ₃)	Liquid Systems (EF ₃)	Daily Spread (EF ₃)	Solid Storage & Drylot (EF ₃)	Pasture Range Paddock (EF ₃)	Used Fuel (EF ₃)	Other System (EF ₃)	
North America	Non-dairy Cattle	99.199	70	0.1	0.1	0.0	2.0	2.0	0.0	0.5	6.9
	Dairy Cattle	16.521	100	0.1	0.1	0.0	2.0	2.0	0.0	0.5	1.7
	Poultry (E)	1486.266	0.6	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.9
	Sheep	11.336	16	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.2
	Swine	66.146	20	0.1	0.1	0.0	2.0	2.0	0.0	0.5	1.3
Western Europe	Other animals (F)	6.067	25	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.2
	Non-dairy Cattle	56.618	70	0.1	0.1	0.0	2.0	2.0	0.0	0.5	4.0
	Dairy Cattle	31.099	100	0.1	0.1	0.0	2.0	2.0	0.0	0.5	3.1
	Poultry (E)	880.000	0.6	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.5
	Sheep	93.856	20	0.1	0.1	0.0	2.0	2.0	0.0	0.5	1.9
Eastern Europe	Swine	114.959	20	0.1	0.1	0.0	2.0	2.0	0.0	0.5	2.3
	Other animals (F)	31.578	25	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.8
	Non-dairy Cattle	101.447	50	0.1	0.1	0.0	2.0	2.0	0.0	0.5	5.1
	Dairy Cattle	56.800	70	0.1	0.1	0.0	2.0	2.0	0.0	0.5	4.0
	Poultry (E)	1667.000	0.6	0.1	0.1	0.0	2.0	2.0	0.0	0.5	1.0
	Sheep	188.159	16	0.1	0.1	0.0	2.0	2.0	0.0	0.5	3.0
	Swine	152.757	20	0.1	0.1	0.0	2.0	2.0	0.0	0.5	3.1
	Other animals (F)	21.558	25	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.5

TABLE A-1 (CONTINUED)

CALCULATION OF MANURE-N EXCRETION AND N₂O EMISSION FACTORS FOR DIFFERENT ANIMAL WASTE MANAGEMENT SYSTEMS IN DIFFERENT WORLD REGIONS. THESE ARE TO BE REPORTED UNDER MANURE MANAGEMENT, EXCEPT FOR DAILY SPREAD AND PASTURE RANGE OF PADDOCK (EMISSIONS FROM AGRICULTURAL SOILS) AND EMISSIONS AFTER USE AS A FUEL (ENERGY)

Region	Type of Animal	Number of Animals (x 10 ⁶)	Nitrogen Excretion kg N/animal/yr	Emission Factor for AWMs EF ₃ (% of Manure N Excreted that is lost as N ₂ O)							Total N Excreted. (Tg N)
				Anaerobic Lagoon (EF ₃)	Liquid Systems (EF ₃)	Daily Spread (EF ₃)	Solid Storage & Drylot (EF ₃)	Pasture Range Paddock (EF ₃)	Used Fuel (EF ₃)	Other System (EF ₃)	
Oceania	Non-dairy Cattle	27.610	60	0.1	0.1	0.0	2.0	2.0	0.0	0.5	1.7
	Dairy Cattle	4.441	80	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.4
	Poultry (E)	71.000	0.6	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.0
	Sheep	228.982	20	0.1	0.1	0.0	2.0	2.0	0.0	0.5	4.6
	Swine	5.003	16	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.1
Latin America	Other animals (F)	2.579	25	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.1
	Non-dairy Cattle	272.871	40	0.1	0.1	0.0	2.0	2.0	0.0	0.5	10.9
	Dairy Cattle	37.560	70	0.1	0.1	0.0	2.0	2.0	0.0	0.5	2.6
	Poultry (E)	1259.000	0.6	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.8
	Sheep	117.312	12	0.1	0.1	0.0	2.0	2.0	0.0	0.5	1.4
Africa	Swine	78.150	16	0.1	0.1	0.0	2.0	2.0	0.0	0.5	1.3
	Other animals (F)	71.699	40	0.1	0.1	0.0	2.0	2.0	0.0	0.5	2.9
	Non-dairy Cattle	133.198	40	0.1	0.1	0.0	2.0	2.0	0.0	0.5	5.3
	Dairy Cattle	18.734	60	0.1	0.1	0.0	2.0	2.0	0.0	0.5	1.1
	Poultry (E)	646.000	0.6	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.4
	Sheep	179.171	12	0.1	0.1	0.0	2.0	2.0	0.0	0.5	2.2
	Swine	12.445	16	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.2
	Other animals (F)	162.194	40	0.1	0.1	0.0	2.0	2.0	0.0	0.5	6.5



TABLE A-1 (CONTINUED)

CALCULATION OF MANURE-N EXCRETION AND N₂O EMISSION FACTORS FOR DIFFERENT ANIMAL WASTE MANAGEMENT SYSTEMS IN DIFFERENT WORLD REGIONS. THESE ARE TO BE REPORTED UNDER MANURE MANAGEMENT, EXCEPT FOR DAILY SPREAD AND PASTURE RANGE OF PADDOCK (EMISSIONS FROM AGRICULTURAL SOILS) AND EMISSIONS AFTER USE AS A FUEL (ENERGY)

Region	Type of Animal	Number of Animals (x 10 ⁶)	Nitrogen Excretion (kg N/animal/yr)	Emission Factor for AWMs EF ₃ (% of Manure N Excreted that is lost as N ₂ O)							Total N Excreted (Tg N)
				Anaerobic Lagoon (EF ₃)	Liquid Systems (EF ₃)	Daily Spread (EF ₃)	Solid Storage & Drylot (EF ₃)	Pasture range Paddock (EF ₃)	Used Fuel (EF ₃)	Other System (EF ₃)	
Near East and Mediterranean	Non-dairy Cattle	44.562	50	0.1	0.1	0.0	2.0	2.0	0.0	0.5	2.2
	Dairy Cattle	17.174	70	0.1	0.1	0.0	2.0	2.0	0.0	0.5	1.2
	Poultry (E)	656.000	0.6	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.4
	Sheep	187.502	12	0.1	0.1	0.0	2.0	2.0	0.0	0.5	2.3
	Swine	0.174	16	0.1	0.1	0.0	2.0	2.0	0.0	0.5	0.0
Asia and Far East	Other animals (F)	81.962	40	0.1	0.1	0.0	2.0	2.0	0.0	0.5	3.3
	Non-dairy Cattle	440.398	40	0.1	0.1	0.0	2.0	2.0	0.0	0.5	17.6
	Dairy Cattle	45.240	60	0.1	0.1	0.0	2.0	2.0	0.0	0.5	2.7
	Poultry (E)	3949.000	0.6	0.1	0.1	0.0	2.0	2.0	0.0	0.5	2.4
	Sheep	202.442	12	0.1	0.1	0.0	2.0	2.0	0.0	0.5	2.4
World Total	Swine	403.231	16	0.1	0.1	0.0	2.0	2.0	0.0	0.5	6.5
	Other animals (F)	293.700	40	0.1	0.1	0.0	2.0	2.0	0.0	0.5	11.7
											135.3

(D) Includes buffalo

(E) Includes chickens, turkeys and ducks

(F) Includes goats, horses, mules, donkeys and camels



MODULE		AGRICULTURE					
SUBMODULE		METHANE AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT					
WORKSHEET		4-1					
SHEET		1 OF 2 METHANE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT					
		STEP 1			STEP 2		STEP 3
Livestock Type	A Number of Animals (1000s)	B Emissions Factor for Enteric Fermentatio n (kg/head/yr)	C Emissions from Enteric Fermentation (t/yr)	D Emissions Factor for Manure Management (kg/head/yr)	E Emissions from Manure Management (t/yr)	F Total Annual Emissions from Domestic Livestock (Gg)	
			$C = (A \times B)$		$E = (A \times D)$	$F = (C + E)/1000$	
Dairy Cattle							
Non-dairy Cattle							
Buffalo							
Sheep							
Goats							
Camels							
Horses							
Mules & Asses							
Swine							
Poultry							
Totals							

AGRICULTURE

MODULE	AGRICULTURE			
SUBMODULE	METHANE AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT			
WORKSHEET	4-1 (SUPPLEMENTAL)			
SPECIFY AWMS				
SHEET	NITROGEN EXCRETION FOR ANIMAL WASTE MANAGEMENT SYSTEM			
Livestock Type	A Number of Animals (1000s)	B Nitrogen Excretion Nex (kg//head/(yr))	C Fraction of Manure Nitrogen per AWMS (%/100) (fraction)	D Nitrogen Excretion per AWMS, Nex (kg/N/yr) D = (A x B x C)
Non-dairy Cattle				
Dairy Cattle				
Poultry				
Sheep				
Swine				
Others				
TOTAL				



MODULE	AGRICULTURE		
SUBMODULE	METHANE AND NITROUS OXIDE EMISSIONS FROM DOMESTIC LIVESTOCK ENTERIC FERMENTATION AND MANURE MANAGEMENT		
WORKSHEET	4-1		
SHEET	2 OF 2 NITROUS OXIDE EMISSIONS FROM ANIMAL PRODUCTION EMISSIONS FROM ANIMAL WASTE MANAGEMENT SYSTEMS (AWMS)		
STEP 4			
Animal Waste Management System (AWMS)	A Nitrogen Excretion $N_{ex(AWMS)}$ (kg N/yr)	B Emission Factor For AWMS EF_3 (kg N_2O-N /kg N)	C Total Annual Emissions of N_2O (Gg)
			$C = (A \times B)[44/28] \times 10^{-6}$
Anaerobic lagoons			
Liquid systems			
Daily spread			
Solid storage & drylot			
Pasture range and paddock			
Other			
Totals			

AGRICULTURE

MODULE		AGRICULTURE				
SUBMODULE		METHANE EMISSIONS FROM FLOODED RICE FIELDS				
WORKSHEET		4-2				
SHEET		1 OF 1				
Water Management Regime		A Harvested Area (m ² x 10 ⁻⁹)	B Scaling Factor for Methane Emissions	C Correction Factor for Organic Amendment	D Seasonally Integrated Emission Factor for Continuously Flooded Rice without Organic Amendment (g/m ²)	E CH ₄ Emissions (Gg)
						E = (A x B x C x D)
Irrigated	Continuously Flooded					
	Intermittently Flooded	Single Aeration				
		Multiple Aeration				
Rainfed	Flood Prone					
	Drought Prone					
Deep Water	Water Depth 50-100 cm					
	Water Depth > 100 cm					
Totals						

MODULE	AGRICULTURE		
SUBMODULE	PRESCRIBED BURNING OF SAVANNAS		
WORKSHEET	4-3		
SHEET	2 OF 3		
STEP 3			
I Fraction Oxidised of living and dead biomass	J Total Biomass Oxidised (Gg dm)	K Carbon Fraction of Living & Dead Biomass	L Total Carbon Released (Gg C)
	<i>Living: J = (G x I)</i> <i>Dead: J = (H x I)</i>		$L = (J \times K)$
Living			
Dead			
Living			
Dead			
Living			
Dead			
Living			
Dead			
Living			
Dead			
Living			
Dead			
Living			
Dead			
Total			



MODULE				AGRICULTURE		
SUBMODULE				PRESCRIBED BURNING OF SAVANNAS		
WORKSHEET				4-3		
SHEET				3 OF 3		
STEP 4				STEP 5		
L Total Carbon Released (Gg C)	M Nitrogen- Carbon Ratio	N Total Nitrogen Content (Gg N)	O Emissions Ratio	P Emissions (Gg C or Gg N)	Q Conversion Ratio	R Emissions from Savanna Burning (Gg)
		$N = (L \times M)$		$P = (L \times O)$		$R = (P \times Q)$
					16/12	CH_4
					28/12	CO
				$P = (N \times O)$		$R = (P \times Q)$
					44/28	N_2O
					46/14	NO_x

MODULE		AGRICULTURE		
SUBMODULE		FIELD BURNING OF AGRICULTURAL RESIDUES		
WORKSHEET		4-4		
SHEET		3 OF 3		
STEP 6				
	M Emission Ratio	N Emissions (Gg C or Gg N)	O Conversion Ratio	P Emissions from Field Burning of Agricultural Residues (Gg)
		$N = (J \times M)$		$P = (N \times O)$
CH ₄			16/12	
CO			28/12	
		$N = (L \times M)$		$P = (N \times O)$
N ₂ O			44/28	
NO _x			46/14	



MODULE	AGRICULTURE		
SUBMODULE	AGRICULTURAL SOILS		
WORKSHEET	4-5		
SHEET	1 OF 5 DIRECT NITROUS OXIDE EMISSIONS FROM AGRICULTURAL FIELDS, EXCLUDING CULTIVATION OF HISTOSOLS		
	STEP 1		STEP 2
Type of N input to soil	A Amount of N Input (kg N/yr)	B Emission Factor for Direct Emissions EF ₁ (kg N ₂ O-N/kg N)	C Direct Soil Emissions (Gg N ₂ O-N/yr)
			C = (A x B)x10 ⁻⁶
Synthetic fertiliser (F _{SN})			
Animal waste (F _{AW})			
N-fixing crops (F _{BN})			
Crop residue (F _{CR})			
	Total		

AGRICULTURE

MODULE		AGRICULTURE			
SUBMODULE		AGRICULTURAL SOILS			
WORKSHEET		4-5A (SUPPLEMENTAL)			
SHEET		1 OF 1 MANURE NITROGEN USED			
A	B	C	D	E	F
Total Nitrogen Excretion	Fraction of Nitrogen Burned for Fuel	Fraction of Nitrogen Excreted During Grazing	Fraction of Nitrogen Excreted Emitted as NO _x and NH ₃	Sum	Manure Nitrogen Used (corrected for NO _x and NH ₃ emissions), F _{AW}
(kg N/yr)	(fraction)	(fraction)	(fraction)	(fraction)	(kg N/yr)
				$F = 1 - (B + C + D)$	$F = (A \times E)$

MODULE		AGRICULTURE				
SUBMODULE		AGRICULTURAL SOILS				
WORKSHEET		4-5B (SUPPLEMENTAL)				
SHEET		1 OF 1 NITROGEN INPUT FROM CROP RESIDUES				
A	B	C	D	E	F	G
Production of non - N - Fixing Crops	Fraction of Nitrogen of non - N - Fixing Crops,	Production of Pulses and Soybeans	Fraction of Nitrogen in N-Fixing Crops,	One minus the Fraction of Crop Residue Removed From Field,	One minus the Fraction of Crop Residue Burned	Nitrogen Input from Crop Residues
(kg dry biomass/yr)	(kg N/kg dry biomass)	(kg dry biomass/yr)	(kg N/kg dry biomass)	(fraction)	(fraction)	(kg N/yr)
						$G = 2 \times (A \times B + C \times D) \times E \times F$



MODULE	AGRICULTURE			
SUBMODULE	AGRICULTURAL SOILS			
WORKSHEET	4-5			
SHEET	2 OF 5 DIRECT NITROUS OXIDE EMISSIONS FROM CULTIVATION OF HISTOSOLS			
	STEP 3			STEP 4
	D Area of Cultivated Organic Soils F_{OS} (ha)	E Emission Factor for Direct Soil Emissions EF_2 (kg N ₂ O–N/ha/yr)	F Direct Emissions from Histosols (Gg N ₂ O–N/yr)	G Total Direct Emissions of N ₂ O (Gg)
			$F=(D \times E) \times 10^{-6}$	$G = (C+F)[44/28]$
Subtotal				

MODULE	AGRICULTURE		
SUBMODULE	AGRICULTURAL SOILS		
WORKSHEET	4-5		
SHEET	3 OF 5 NITROUS OXIDE SOIL EMISSIONS FROM GRAZING ANIMALS - PASTURE RANGE AND PADDOCK		
	STEP 5		
Animal Waste Management System (AWMS)	A Nitrogen Excretion $N_{EX(AWMS)}$ (kg N/yr)	B Emission Factor for AWMS EF_3 (kg N ₂ O–N/kg N)	C Emissions Of N ₂ O from Grazing Animals (Gg)
			$C = (A \times B)[44/28] \times 10^{-6}$
Pasture range & paddock			

AGRICULTURE

MODULE	AGRICULTURE							
SUBMODULE	AGRICULTURAL SOILS							
WORKSHEET	4-5							
SHEET	4 OF 5 INDIRECT NITROUS OXIDE EMISSIONS FROM ATMOSPHERIC DEPOSITION OF NH ₃ AND NO _x							
STEP 6								
Type of Deposition	A Synthetic Fertiliser N Applied to Soil, N _{FERT} (kg N/yr)	B Fraction of Synthetic Fertiliser N Applied that Volatilizes Frac _{GASFS} (kg N/kg N)	C Amount of Synthetic N Applied to Soil that Volatilizes (kg N/kg N) C = (A x B)	D Total N Excretion by Livestock N _{EX} (kg N/yr)	E Fraction of Total Manure N Excreted that Volatilizes Frac _{GASM} (kg N/kg N)	F Total N Excretion by Livestock that Volatilizes (kg N/kg N) F = (D x E)	G Emission Factor EF ₄ (kg N ₂ O-N/kg N)	H Nitrous Oxide Emissions (Gg N ₂ O-N/yr) H = (C + F) x G x 10 ⁻⁶
Total								



MODULE	AGRICULTURE					
SUBMODULE	AGRICULTURAL SOILS					
WORKSHEET	4-5					
SHEET	5 OF 5 INDIRECT NITROUS OXIDE EMISSIONS FROM LEACHING					
STEP 7						
I Synthetic Fertiliser Use N _{FERT} (kg N/yr)	J Livestock N Excretion NEX (kg N/yr)	K Fraction of N That Leaches Frac _{LEACH} (kg N/kg N)	L Emission Factor EF ₅	M Nitrous Oxide Emissions From Leaching (Gg N ₂ O–N/yr)	N Total Indirect Nitrous Oxide Emissions (Gg N ₂ O/yr)	O Total Nitrous Oxide Emissions (Gg)
				$M = (I + J) \times K \times L \times 10^{-6}$	$N = (H + M) [44/28]$	$O = (G + C + N)$ (G from Worksheet 4 -5, sheet 2, Step 4; C from Worksheet 4-5, sheet 3, Step 5; N from Worksheet 4-5, sheet 5, Step 8).
Total						