

Supplementary Information

An ammonia emissions inventory for agricultural source in Hefei, China

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Table S1. NH₃ emission source categories and activity data.

Category	Subcategory	Activity data description
Livestock waste management	Livestock	Animal population (yellow cattle, buffalo, beef cattle, dairy cows, reproductive sow, goat, sheep, hog)
	Poultry	Animal population (laying hen, laying duck, laying goose, broiler, meat duck, meat goose)
Farmland ecosystem	N fertilizer application	N fertilizer consumption (urea, ammonium bicarbonate, ammonium nitrate, ammonium sulfate, and others)
	Crop residues	Crop residues mass composted
	N-fixing crop	Cultivated areas of beans and peanut
Biomass burning	Cropland soil	Cultivated areas
	Open burning of waste straw	The mass of various crop residue

Table S2. Parameters for estimating the amount of TAN^a.

Livestock	Period (day)	Excreta (kg/day/head)		N content (%)		TAN (%)
		Urine	Feces	Urine	Feces	
Beef cattle<1 yr	365	5	7	0.90	0.38	60
Beef cattle>1 yr	365	10	20	0.90	0.38	60
Dairy cow<1 yr	365	5	7	0.90	0.38	60
Dairy cow>1 yr	365	19	40	0.90	0.38	60
Goat<1 yr	365	0.66	1.5	1.35	0.75	60
Goat>1 yr	365	0.75	2.6	1.35	0.75	50
Sheep<1 yr	365	0.66	1.5	1.35	0.75	60
Sheep>1 yr	365	0.75	2.6	1.35	0.75	50
Reproductive Sow	365	5.7	2.1	0.40	0.34	70
Hog>75 day	75	1.2	0.5	0.40	0.34	70
Hog<75 day	75	3.2	1.5	0.40	0.34	70
Laying hen	365	0	0.12	0	1.63	70
Laying duck	365	0	0.13	0	1.10	70
Laying goose	365	0	0.13	0	0.55	70
Broiler	50	0	0.09	0	1.63	70
Meat duck	55	0	0.10	0	1.10	70
Meat goose	70	0	0.10	0	0.55	70

^aFrom Ministry of Ecology and Environment of the People's Republic of China (2014a)

Table S3. NH₃ emission factors of livestock^a

Livestock	EF _{outside} (% of TAN)	EF _{house_liquid} (% of TAN)	EF _{house_solid} (% of TAN)	EF _{storage_liquid} (% of TAN)				EF _{storage_solid} (% of TAN)				EF _{spread_liquid} (% of TAN)	EF _{spread_solid} (% of TAN)
				NH ₃	N ₂ O	NO	N ₂	NH ₃	N ₂ O	NO	N ₂		
Free-range system													
Beef cattle<1 yr	53	7	7	20	1	0.01	0.3	27	8	1	30	55	79
Beef cattle>1 yr	53	14	14	20	1	0.01	0.3	27	8	1	30	55	79
Dairy cow<1 yr	53	7	7	20	1	0.01	0.3	27	8	1	30	55	79
Dairy cow>1 yr	30	14	14	20	1	0.01	0.3	27	8	1	30	55	79
Goat<1 yr	53	7	7	20	1	0.01	0.3	27	8	1	30	55	79
Goat>1 yr	75	14	14	28	7	0.01	0.3	28	7	1	30	90	81
Sheep<1 yr	53	7	7	20	1	0.01	0.3	27	8	1	30	55	79
Sheep>1 yr	75	14	14	28	7	0.01	0.3	28	7	1	30	90	81
Reproductive Sow	0	14.7	14.7	14	0	0.01	0.3	45	5	2	30	40	81
Hog>75 day	0	15.6	15.6	14	0	0.01	0.3	45	5	1	30	40	81
Hog<75 day	0	10.2	10.2	14	0	0.01	0.3	45	5	1	30	40	81
Laying hen	69	45.2	45.2	0	0	0	0	14	4	1	30	0	63
Laying duck	54	45.2	45.2	0	0	0	0	24	3	1	30	0	63
Laying goose	54	45.2	45.2	0	0	0	0	24	3	1	30	0	63
Broiler	66	40.3	40.3	0	0	0	0	17	3	1	30	0	63
Meat duck	54	40.3	40.3	0	0	0	0	24	3	1	30	0	63
Meat goose	54	40.3	40.3	0	0	0	0	24	3	1	30	0	63
Intensive system													
Beef cattle<1 yr	53	7	7	15.8	1	0.01	0.3	4.2	8	1	30	55	79
Beef cattle>1 yr	53	14	14	15.8	1	0.01	0.3	4.2	8	1	30	55	79
Dairy cow<1 yr	53	7	7	15.8	1	0.01	0.3	4.2	8	1	30	55	79
Dairy cow>1 yr	30	14	14	15.8	1	0.01	0.3	4.2	8	1	30	55	79
Goat<1 yr	53	7	7	15.8	1	0.01	0.3	4.2	8	1	30	55	79
Goat>1 yr	75	14	14	15.8	7	0.01	0.3	4.2	7	1	30	90	81
Sheep<1 yr	53	7	7	15.8	1	0.01	0.3	4.2	8	1	30	55	79
Sheep>1 yr	75	14	14	15.8	7	0.01	0.3	4.2	7	1	30	90	81
Reproductive Sow	0	14.3	14.7	3.8	0	0.01	0.3	4.2	5	2	30	40	81
Hog>75 day	0	15.6	15.6	3.8	0	0.01	0.3	4.2	5	1	30	40	81
Hog<75 day	0	18.5	18.5	3.8	0	0.01	0.3	4.2	5	1	30	40	81
Laying hen	69	0	35.9	0	0	0	0	3.7	4	1	30	0	63
Laying duck	54	0	35.9	0	0	0	0	3.7	3	1	30	0	63
Laying goose	54	0	35.9	0	0	0	0	3.7	3	1	30	0	63
Broiler	66	0	40.3	0	0	0	0	0.8	3	1	30	0	63
Meat duck	54	0	40.3	0	0	0	0	0.8	3	1	30	0	63
Meat goose	54	0	40.3	0	0	0	0	0.8	3	1	30	0	63

^aFrom Ministry of Ecology and Environment of the People's Republic of China (2014a)

Table S4. Ratios of different fertilizer applications^b

Fertilizer type	ABC	Urea	AN	AS	Others
Use rate (%)	24	64	4	4	4

^bFrom (Deng et al. 2006)

Table S5. Percentage of nitrogenous fertilizer applied each month^c.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fertilizer	1.04	7.5	10.15	15.06	11.01	5.92	12.76	6.79	3.7	21.64	2.38	2.06

^cFrom (Zhang et al. 2011)

Table S6. Benchmark ammonia emission factors of different nitrogen fertilizers (%)^a.

Soil type	Temperature	Urea	ABC	AN	AS	Others
Acid soil	<10°C	0.51	1.71	0.36	0.66	0.21
	10–20°C	2.51	2.61	0.40	0.82	0.23
	20–30°C	4.5	3.52	0.45	0.97	0.26
	>30°C	5.5	3.98	0.47	1.05	0.27
Alkaline soil	<10°C	12.66	6.02	0.36	1.25	0.21
	10–20°C	14.66	6.93	0.40	1.40	0.23
	20–30°C	16.66	7.84	0.45	1.56	0.26
	>30°C	17.66	2.09	0.47	1.43	0.27

^aFrom Ministry of Ecology and Environment of the People's Republic of China (2014a)

Table S7. Average monthly temperature in Hefei in 2017 (°C)^d.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average temperature	5.4	6.4	10.8	18.0	23.1	25.7	30.8	28.1	23.2	16.4	11.8	5.4

^dFrom NBSC (2018)

Table S8. Average grass-valley ratio of all crops^e.

Crop type	Rice	Wheat	Maize	Others
Grass-valley ratio	1.323	1.718	1.269	1.5

^eFrom Ministry of Ecology and Environment of the People's Republic of China (2014b)

Table S9. Some other NH₃ emission factors used in this study.

Source	Emissions factor		Units
Livestock waste ^f	Yellow cattle	15.44	kg head ⁻¹
	Buffalo	9.74	kg head ⁻¹
	Cropland soil	0.12	kg mu ⁻¹
Farmland ecosystem ^a	Nitrogen-fixing crops	0.07 (Soybean)	kg mu ⁻¹
		0.08 (Peanut)	kg mu ⁻¹
	Crop residues compost	0.32	kg t ⁻¹
Biomass burning ^a	Open burning of waste straw	0.37 (Wheat)	g NH ₃ kg ⁻¹
		0.68 (Corn)	g NH ₃ kg ⁻¹
		0.52 (Others)	g NH ₃ kg ⁻¹

^aFrom Ministry of Ecology and Environment of the People's Republic of China (2014a)^fFrom Shen (2014)

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