Appendix

Table1 Studies used in this meta-analysis, a Y (yes) indicate if methane (CH_4) or nitrous oxide (N_2O) emission/uptake were reported in the study.

Experiment site	N application rate kg N ha^{-1}	Cropping system	Climate zone	Application times	CH_4 uptake	CH_4 emission	N_2O emission	Reference
Nanjing, Jiangsu	100, 180	Wheat-rice	Subtropics	3			Y	Chen et al. 2008
	200, 300	Wheat-rice	Subtropics	3			Y	
	200	Wheat-maize	Subtropics	3			Y	
Hangzhou, Zhengjiang	150, 300	Wheat-rice	Subtropics				Y	Chen et al. 2011
Wuxue, Hubei	210	Rice-rice	Subtropics	4		Y	Y	Dai et al. 2009
Fengqiu, Henan	150, 250	Wheat-maize	Warm temperate	1, 3			Y	Ding et al. 2007
Qizhou, Shanxi	217, 300	Wheat-maize	Warm temperate	2	Y		Y	Guo et al. 2012
Quzhou, Hebei	180, 200	Wheat-maize	Warm temperate	2	Y		Y	Hu et al. 2013
Nanjingmoling, Jiangsu	180, 200	Rice-rice	Subtropics	3			Y	Huang et al. 2011
	250	Wheat-rice	Subtropics	3			Y	
Qiyang, Hunan	90, 209	Wheat-maize	Subtropics	1			Y	Huang et al. 2010
Jurong, Jiangsu	240	Wheat-rice	Subtropics	3			Y	Ji et al. 2011
Jurong, Jiangsu	100, 200, 270	Wheat-rice	Subtropics	2			Y	Ji et al. 2012
Wangcheng, Hunan	150, 180	Rice-rice	Subtropics	2		Y		Ji et al. 2011
Lishui, Jiangsu	76.4, 158, 230	Wheat-rice	Subtropics	3		Y	Y	Jiao et al. 2005; Jiao et al. 2008
Lianshui, Jiangsu	76.4, 158, 230	Wheat-rice	Subtropics	3		Y	Y	
Jiangsu Academy of Agricultural Sciences	76.4, 158, 230	Wheat-rice	Subtropics	3		Y	Y	
South China University of Agriculture	180	Rice-rice	Subtropics	3		Y	Y	Li et al.2005
Xiangyin, Hunan	127.5, 150	Rice-rice	Subtropics	3		Y	Y	Li et al. 2013

Experiment site	N application rate kg N ha^{-1}	Cropping system	Climate zone	Application times	CH_4 uptake	CH_4 emission	N_2O emission	Reference
Haidian, Beijing	255, 260	Wheat-maize	Warm temperate	2	Y		Y	Li 2014
Hubei Academy of Agricultural Sciences	157.5, 225	Wheat-rice	Subtropics	2, 3			Y	Liang et al. 2010
	147, 210	Wheat-rice	Subtropics	2, 3			Y	
Yangling, Shanxi	180	Single maize	Warm temperate	1			Y	Liang et al. 2007
Fuzhou, Fujian	103.5	Rice-rice	Warm temperate	2		Y		Lin et al. 2014
Yongji, Shanxi	62, 124, 198, 299	Wheat-maize	Warm temperate	3	Y		Y	Liu et al. 2012
Taoyuan, Hunan	81, 102	Rice-rice	Subtropics	2, 3		Y	Y	Liu et al. 2008
Suzhou, Jiangsu	256	Rice-rice	Subtropics	2		Y	Y	Liu et al. 2011
Guanghan, Sichuan	240	Wheat-rice	Subtropics			Y	Y	Liu 2013
Jinxian, Jiangxi	180	Rice-rice	Subtropics			Y	Y	
Wuwei, Gansu	250, 300	Single maize	Temperate	2			Y	Lv 2011
Zhejiang Academy of Agricultural Sciences	145	Wheat-rice	Subtropics	3		Y		Lv et al. 2004
Agricultural university of Hebei	75, 150, 225, 300	Wheat-maize	Warm temperate	2			Y	Ma et al., 2012
	60, 120, 180, 240	Wheat-maize	Warm temperate	2			Y	
Yixing, Jiangsu	200, 270	Wheat-rice	Subtropics	3		Y	Y	Ma et al. 2011
Fengqiu, Henan	150	Wheat-maize	Warm temperate	1, 2			Y	Meng et al. 2008
Haerbin, Heilongjiang	225, 225	Single maize	Temperate	2	Y		Y	Ni et al. 2012
Wangdu, Hebei	165, 176	Wheat-maize	Warm temperate	2	Y		Y	Pei et al. 2012
Yucheng, Shandong	240, 293	Wheat-maize	Warm temperate	2	Y			Qi et al. 2002

Experiment site	N application rate kg N ha^{-1}	Cropping system	Climate zone	Application times	CH_4 uptake	CH_4 emission	N_2O emission	Reference
Hailun, Heilongjiang	112.5	Single maize	Temperate	2			Y	Qiao et al. 2000
Wangcheng, Hunan	150, 180	Rice-rice	Subtropics	2		Y	Y	Qin et al. 2006
Changwu, Shanxi	120	Single wheat	Warm temperate	1			Y	Shi 2011
Changsha, Hunan	52.5, 105, 150, 180	Rice-rice	Subtropics	2		Y	Y	Shi et al. 2011a
	67.5, 135, 165, 210	Rice-rice	Subtropics	2		Y	Y	
Changsha, Hunan	165, 180	Rice-rice	Subtropics	2			Y	Shi et al. 2012b
Huantai, Shandong	118, 300	Wheat-maize	Warm temperate	2	Y		Y	Shi et al. 2013
	100, 300	Wheat-maize	Warm temperate	2	Y		Y	
Liuyang, Hunan	120, 150, 180	Rice-rice	Subtropics	2, 3, 4		Y	Y	Shi 2012
	135, 165, 195	Rice-rice	Subtropics	2, 3,4		Y	Y	
Sipingzhuang, Hebei	180, 300	Wheat-maize	Warm temperate	2	Y		Y	Shi et al. 2012
Sanjiang, Heilongjiang	150, 250	Single maize	Temperate	2	Y		Y	Song et al. 2009
Luancheng, Heibei	100, 200, 300	Wheat-maize	Warm temperate	1	Y		Y	Wang et al. 2011
Hengshui, Hebei	168, 210, 300	Wheat-maize	Warm temperate	1, 2			Y	Wang 2009
Changshu, Jiangsu	100, 150, 200, 250, 300	Wheat-rice	Subtropics	3			Y	Wang et al. 2009
Changshu, Jiangsu	180	Wheat-rice	Subtropics	1		Y	Y	Wang et al. 2013
Sanjing plain, Heilongjiang	150, 250	Single rice	Temperate	2		Y	Y	Wang et al. 2008
Shenyang, Liaoning	150	Single rice	Temperate	3		Y	Y	Wang et al. 2006
Wuxi, Jiangsu	150, 250	Wheat-rice	Subtropics	2, 3		Y	Y	Xie et al.2010
Yanting, Sichuan	150, 250	Rice-rice	Subtropics	2, 3		Y		Xie et al.2010

Experiment site	N application rate kg N ha^{-1}	Cropping system	Climate zone	Application times	CH_4 uptake	CH_4 emission	N_2O emission	Reference
	150, 250	Wheat-rice	Subtropics	2, 3		Y		
Shenyang, Liaoning	150, 250	Single rice	Temperate	2, 3		Y		Xie et al. 2010
Chengduwenjiang, Sichuan	150	Wheat-rice	Subtropics	2			Y	Xing et al. 2007
Yangling, Shanxi	187.5	Single wheat	Warm temperate	3			Y	Xu et al. 2009
Xishuangbanna, Yunnan	150, 300	Single rice	Subtropics	3		Y	Y	Yang et al. 2008
Jinzhou, Liaoning	210, 265	Maize	Temperate	2			Y	Yang et al., 2014
Jiangdu, Jiangsu	150, 250	Wheat-rice	Subtropics	2, 3		Y	Y	Yao et al. 2012
Yanting, Sichuan	150	Wheat-maize	Subtropics	1			Y	Zeng et al. 2011
Yucheng, Shandong	100, 200, 300	Wheat-maize	Warm temperate	3	Y			Zhang et al. 2006
Yinchuan, Ningxia	240, 300	Single rice	Warm temperate	3			Y	Zhang et al. 2011
Yanting, Sichuan	90, 226	Wheat-rice	Subtropics	2		Y		Zhang et al.2005
Zhangqiu, Shandong	121, 158, 220	Wheat-maize	Warm temperate	2	Y		Y	Zhang 2012
Shanghai	180	Wheat-rice	Subtropics	3		Y	Y	Zhao et al. 2014
Nanning, Guangxi	225	Rice-rice	Subtropics	3		Y		Zheng et al. 2012
Wuxi, Jiangsu	150, 250	Wheat-rice	Subtropics	2, 3			Y	Zheng et al. 2004
Jinzhong, Shanxi	180	Wheat-maize	Warm temperate	2			Y	Zhou et al. 2011
Jiangsu Academy of Agricultural Sciences	75, 150, 300	Wheat-rice	Subtropics	2			Y	Zou et al., 2005
	100, 200, 300	Wheat-rice	Subtropics	2			Y	

Reference

Chen S, Huang Y, Zou J (2008) Relationship between nitrous oxide emission and winter wheat production. Biol Fertil Soils 44:985-989

Chen Y, Tang X, Yang S et al. (2011) The N_2O emission from rice fields under rice-barley rotation system. Chine J Soil Sci 42(2) 342-350 (in Chinese with English abstract)

Dai G, Li C, Cao C et al. (2009) Effect of no-tillage and fertilization on paddy soil CH_4 and N_2O emissions and their greenhouse effect in central China. Chin J Appl Ecol 20:2166-2172 (in Chinese with English abstract)

Ding W, Cai Y, Cai Z et al. (2007) Nitrous oxide emissions from an intensively cultivated maize–wheat rotation soil in the North China Plain. Sci Total Environ 373: 501-511

Guo Y, Wu G, Wu X et al. (2012) Influence of different fertilization modes to corn production and greenhouse gas emissions. J Shanxi Agric Sci 40:1067-1070 (in Chinese with English abstract)

Hu X, Su F, Ju X et al. (2013) Greenhouse gas emissions from a wheatemaize double cropping system with different nitrogen fertilization regimes. Environ Poll 176 :198-207

Huang J, Zhang Y, Liu H et al. (2011) CO_2 and N_2O emissions from red soil during wheat and corn growing under different patterns of long-term fertilization. J Ecology Rural Environ 27: 7-13 (in Chinese with English abstract)

Huang T (2011) Greenhouse gases emissions from different rotation systems in paddy fields. Nanjing Agricultural University (in Chinese with English abstract)

Ji X, Wu J, Peng H et al. (2012) The effect of rice straw incorporation into paddy soil on carbon sequestration and emissions in the double cropping rice system. J Sci Food Agric 92:

1038-1045

Ji Y, Liu G, Ma J et al (2012) Effect of controlled-release fertilizer on nitrous oxide emission during the wheat growing period. Acta Pedologica Sinica 49:526-534 (in Chinese with English abstract)

Ji Y, Zhang X, Ma J et al. (2011) Effects of applying controlled-release fertilizer and its combination with urea on nitrous oxide emission during rice growth period. Chin J Appl Ecology 22:2031-2037 (in Chinese with English abstract)

Jiao Y, Huang Y, Zong L et al. (2005) Impact of different levels of nitrogen fertilizer on CH4 emission from different paddy soils. Environ Sci 26: 21-24 (in Chinese with English abstract)

Jiao Y, Huang Y, Zong L et al. (2008) Impact of different levels of nitrogen fertilizer on CH4 emission from different paddy soils. Environ Sci 29: 2094-2098 (in Chinese with English abstract)

Li B, Rong X, Xie G et al. (2013) Effect of combined application with organic and inorganic fertilizers on N_2O emission in double-cropping paddy fields. Ecology Environ Sci 22:276-282 (in Chinese with English abstract)

Li F, Fan X, Liu F et al. (2004) Effects of controlled release fertilizers on N2O emission from paddy field. Chin J Appl Ecology 15:2170-2174 (in Chinese with English abstract)

Li XM (2014) Study on greenhouse gas emissions and its influencing factors from the maize-wheat rotation field. Beijing Forestry University (in Chinese with English abstract)

Liang D, Li S, Wu Q et al. (2007) The production and emission of N_2O and influential factors in the corn growing season of loess soil. J Northwest A&F Univer 35:131-137 (in Chinese with English abstract)

Liang G, Zhou W, Xia W et al. (2010) Effect of optimized nitrogen application on N_2O emission from paddy field under wheat-rice rotation system. Plant Nutrition Fertilizer Sci 16(2): 304-311 (in Chinese with English abstract)

Lin C, Wang F, He CM et al. (2014) CH_4 emission characteristics of yellow-mud field under long-term fertilization in southern China and its greenhouse effect. Hunan AgricSci 35-37 (in Chinese with English abstract)

Liu C, Wang K, Zheng X (2012) Responses of N_2O and CH_4 fluxes to fertilizer nitrogen addition rates in an irrigated wheat-maize cropping system in northern China. Biogeosci 9: 839-850

Liu J (2008) Study on methane emission from the double-cropping rice in Hunan red soil under different long-term fertilizing systems. Nanjing Agricultural University (in Chinese with English abstract)

Liu X (2013) Effects of soil organic amendment on productivity and greenhouse gas mitigation of croplands: Field studies and synthetic analysis. Nanjing Agricultural University (in Chinese with English abstract)

Liu X, Li Z, Pan G et al. (2011) Greenhouse gas emission and C intensity for a long-term fertilization rice paddy in tai lake region, China. J Agro-Environ Sci 30: 1783-1790 (in Chinese with English abstract)

Lv P (2011) The effects of nitrogen application on CO_2 and N_2O emission flux in the growing season of the maize field. Gansu Agric University (in Chinese with English abstract)

Ma J, Li XL, Xu H et al. (2007) Effects of nitrogen fertiliser and wheat straw application on CH_4 and N_2O emissions from a paddy rice field. Aust J Soil Res 45: 359-367

Ma Y, Ji Y, Li X et al. (2012) Effects of N fertilization rates on the NH_3 volatilization and N_2O

emissions from the wheat-maize rotation system in North China Plain. Ecology Environ Sci 2:225-230 (in Chinese with English abstract)

Meng L, Cai Z, Ding W (2008) Effects of long-term fertilization on N distribution and N2O emission in fluvoaquci soil in North China. Acta Ecologica Sinica 28: 6197-6203 (in Chinese with English abstract)

Ni K, Ding W, Zaman M et al. (2012) Nitrous oxide emissions from a rainfed-cultivated black soil in Northeast China: effect of fertilization and maize crop. Biol Fertil Soils DOI 10.1007/s00374-012-0709-y

Pei S, Zhang Y, Liu J et al. (2012) Greenhouse gas emission under the treatments of fertilization and wheat straw returning during the maize growing seasons. Environ Chem 31: 407-414 (in Chinese with English abstract)

Qi Y, Dong Y, Zhang S (2002) Methane fluxes of typical agricultural soil in the North China plain. Rural Eco-Environ 18:56-58, 60 (in Chinese with English abstract)

Qiao Y (2012) The carbon and nitrogen conversion process affected by fertflization is Chinese Mollisols. Jilin Agricultural University (in Chinese with English abstract)

Qin X, Li Y, Liu K et al. (2006) Methane and nitrous oxide emission from paddy field under different fertilization treatments. Transactions of the CSAE 22:143-148 (in Chinese with English abstract)

Shi P (2011) Effects of long-term application of fertilizer on wheat yield and emission of the CO_2 and N_2O from soil in loess plateau. Northwest A&F University (in Chinese with English abstract)

Shi S (2012) Typical farmland N2O and CH4 net exchange characteristics of different nitrogen

management. Hebei Agricultural University (in Chinese with English abstract)

Shi S, Li Y, Li M et al. (2011a) Annual CH_4 and N_2O emissions from double rice cropping systems under various fertilizer regimes in Hunan Province, China. Chin J Atmosph Sci 35:707-720 (in Chinese with English abstract)

Shi S, Li Y, Wan Y et al. (2011b) Observation for CH_4 and N_2O emissions under different rates of nitrogen and phosphate fertilization in double rice fields. Environ Sci 32: 1899-1907 (in Chinese with English abstract)

Shi Y (2012) Studies on Ammonia volatilization and greenhouse gas emissions in different cultivation modes under double-harvest rice system. Hunan Agricultural University (in Chinese with English abstract)

Song C, Zhang J (2009) Effects of soil moisture, temperature, and nitrogen fertilization on soil respiration and nitrous oxide emission during maize growth period in northeast China. Acta Agriculturae Scandinavica, Section B - Soil Plant Science 59: 97-106

Wang C, Zheng J, Gu J et al. (2006) Emission and affecting factors of major greenhouse gases form single-season paddy field in the lower reaches of Liaole plain. J Agro-Environ Sci 25: 237-242 (in Chinese with English abstract)

Wang H, Xing G (2009) Effect of nitrogen fertilizer rates on nitrous oxide emission from paddy field under rice-wheat rotation. J Agro-Environ Sci 28:2631-2636 (in Chinese with English abstract)

Wang J, Chen Z, Ma Y et al. (2013) Methane and nitrous oxide emissions as affected by organic–inorganic mixed fertilizer from a rice paddy in southeast China. J Soils Sediments 13:1408-1417

Wang X (2009) Nitrogen cycling and balancein winter wheat-summer corn rotation system under optimized nitrogen management. Chinese Academy of Agricultural Sciences (in Chinese with English abstract)

Wang Y, Chen W, Zhao Z et al. (2008) Characteristics and estimation of CH_4, N_2O emission from cold paddy field in the Sanjiang Plain. Transactions of the CSAE 24: 170-176 (in Chinese with English abstract)

Wang Y, Hu C (2011) Soil greenhouse gas emission in winter wheat/summer maize rotation ecosystem as affected by nitrogen fertilization in the Piedmont Plain of Mount Taihang, China. Chin J Eco-Agric 19: 1122-1128 (in Chinese with English abstract)

Xie B, Zheng X, Zhou Z et al. (2010) Effects of nitrogen fertilizer on CH4emission from rice fields: multi-site field observations. Plant Soil 326: 393-401

Xing G (2007) Study on the greenhouse-gas emission and characteristies of soil microbe on dry land agro-ecology system in Chengdu Plain. Sichuan Agric University (in Chinese with English abstract)

Xu J (2008) A study of fertilization and nitrous oxide losses on loess soil. Northwest A&F University

Yang L, Wang L, Li H, Qiu J, Liu H (2014) Impacts of fertilization alternatives and crop straw incorporation on N_2O emissions from a spring maize field in northeastern China. Journal of Integrative Agriculture 13(4): 881-892 April 2014

Yang G, Wu W, Sha L (2007) CH_4 emission from paddy fields in Xishuangbanna SW China. J Mount Sci 45: 461-468 (in Chinese with English abstract)

Yao Z, Zheng X, Dong H et al. (2012) A 3-year record of N_2O and CH_4 emissions from a sandy

loam paddy during rice seasons as affected by different nitrogen application rates. Agric Ecosyst Environ 152:1-9

Zeng Z (2011) The effeet of fertilization on soil mcrobial activity and N_2O emissions of purple soil in hilly of the Central Sichuan. Sichuan Agric University (in Chinese with English abstract)

Zhang H (2011) Gaseous loss and balance of nitrogen from paddy field in irrigation area of the upper yellow river. Chinses Academy of Agricultural Sci Ph. D Dissertation (in Chinese with English abstract)

Zhang J (2012) The exchanges of greenhouse gases and effect factors in winter wheat/green onion interplanting system. Chinses Academy of Agricultural Sci Ph. D Dissertation (in Chinese with English abstract)

Zhang X, Shen S, Li J et al. (2006) Soil CH_4 uptake in winter wheat field in the north China plain. J Nanjing Institu Meteo 29:181-187

Zhang Z (2004) Research on emission fluxes of greenhouse gas in dry land ecosystem of central Sichuan hilly area. Southwest Agric University (in Chinese with English abstract)

Zhao Z, Yue YB, Zhang Y et al. (2014) Impact of different fertilization practices on greenhouse gas emission from paddy field. J Agro-Environ Sci 33 (11): 2273-2278 (in Chinese with English abstract)

Zheng T, Yang C, Xu S et al. (2012) Dynamic changes of CH_4 emission from rice fields under different tillage patterns and nitrogen application levels. J South Agric 43: 1509-1513 (in Chinese with English abstract)

Zheng X, Han S, Huang Y et al. (2004) Re-quantifying the emission factors based on field

measurements and estimating the direct N_2O emission from Chinese croplands. Global Biogeochem Cycles 18 GB201810.1029/2003GB002167

Zhou P, Li Y, Liu L et al. (2011) Effects of fertilizatio and environment factors on N_2O emission in spring corn field in North China plain. Chin J Agromete 32:179-184 (in Chinese with English abstract)

Zou J, Huang Y, Lu Y et al. (2005) Direct emission factor for N_2O from rice–winter wheat rotation systems in southeast China. Atmospheric Environment 39:4755-4765