GENERAL FICHE

IMPROVED MANURE LAND APPLICATION TECHNIQUES

Data extracted in June 2021

Note to the reader: This *general fiche* summarises all the environmental and climate impacts of IMPROVED MANURE LAND APPLICATION TECHNIQUES found in a systematic review of 12 synthesis research papers [1]. These papers were selected, according to our inclusion criteria, from an initial number of 277 yielded by a systematic literature search strategy[2].

The general fiche provides the highest level of synthesis – symbolised by the top of the pyramid. As each synthesis research paper involves a number of individual papers ranging from 21 to 172, the assessment of impacts relies on a large number of results obtained mainly in field experiments (carried out in situations close to real farming environment), and sometimes in lab experiments or from model simulations. In addition to this general fiche, *single-impact fiches* provide a deeper insight in each individual impact of IMPROVED MANURE LAND APPLICATION TECHNIQUES (Ammonia emission, GHG emissions, Soil biological quality, Soil organic carbon, Soil nutrients, Crop yield), with more detailed information – medium part of the pyramid. Finally, *individual reports* provide fuller information about the results reported in each synthesis paper, in particular about the modulation of effects by factors related to soil, climate and management practices – base of the pyramid.

This general fiche on IMPROVED MANURE LAND APPLICATION TECHNIQUES is part of a set of similar fiches providing a comprehensive picture of the impacts of farming practices on climate and the environment.

1. DESCRIPTION OF THE FARMING PRACTICE

Description	• <u>Improved manure land application techniques</u> are used to limit nutrients losses and emissions release during land application of manure (either solid or liquid manure fractions)[2].
Key descriptors	Here, the main types of improved manure land application techniques considered are: • Liquid manure (shallow or deep) placement/injection or solid manure (e.g. poultry litter, cattle manure) immediate incorporation • Manure band application by trailing hoses or other equivalent systems • Land application with additives (including mainly nitrification inhibitors, lava meal, biochar, superphosphate, sawdust) • Land application of processed manure fractions (e.g. digestate, composted, solid fraction, liquid fraction, etc.) • Irrigation coupled to manure application • Avoid manure application to paddy rice fields.

[1] Synthesis research papers include either meta-analysis or systematic reviews with quantitative results.
[2] AMEC – Environment & infrastructure UK limited, in partnership with BIO intelligence service. Collection and analysis of data for the control of emissions from the spreading of manure - Final report 2014 for The European Commission. Available at https://ec.europa.eu/environment/air/pdf/Final%20Report.pdf
[2] For further details on the search strategy and inclusion criteria, see section 4 in single-impact fiches.

	This list is not exhaustive but covers the improved manure land application techniques found in the synthesis papers meeting the selection criteria of our review. Note that the overall impacts of manure processing techniques (e.g. anaerobic digestion, improved composting, solid-liquid separation, etc.) are not considered here but addressed in another group of fiches (Manure processing techniques).

2. DESCRIPTION OF THE IMPACTS OF THE FARMING PRACTICE ON CLIMATE AND THE ENVIRONMENT

We reviewed the impacts of improved manure land application techniques compared to conventional land application techniques (e.g. broadcasting/surface spreading of raw/unprocessed manure).

The table below shows the number of synthesis papers reporting positive, negative or no effect, based on the statistical comparison of the intervention and the control. In addition, we include the number of synthesis papers reporting relevant results, but without statistical test of the effects (uncertain). For each impact, the effect with the higher score is marked in bold and the cell coloured. The numbers between parentheses indicate the number of synthesis papers with a quality score of at least 50%. Details on quality criteria can be found in this document →.

Out of the 12 synthesis papers selected, 10 reported studies conducted in Europe and 11 have a quality score higher than 50%. Some synthesis papers reported more than one impact.

Impact	Metric	Intervention (technique)	Positive	Negative	No effect	Uncertain*
Decrease ammonia emission		Land application with deep placement or immediate incorporation	5 (5)	0	1 (1)	2 (1)
		Land application with banding	2 (2)	0	1 (1)	0
		Irrigation coupled to manure application	1 (1)	0	0	0
		Land application of composted/digested manure	0	0	3 (3)	0
		Land application of separated solid or liquid fractions	1 (1)	0	1 (1)	0
		Land application with additives	0	0	2 (2)	1 (1)
Decrease GHG emissions	CH_4**	Land application with deep placement or immediate incorporation	1 (1)	0	1 (1)	0
		Land application with banding	0	1 (1)	0	0
		No manure on paddy rice fields	1 (1)	0	0	0
	CO_2-biogenic**	Land application with deep placement or immediate incorporation	0	0	1 (1)	0
		Land application with banding	0	1 (1)	0	0
	N_2O**	Land application of composted/digested manure	2 (2)	0	1 (1)	0
		Land application with deep placement or incorporation	1 (1)	2 (2)	3 (3)	1 (0)
		Land application with banding	0	0	1 (1)	0
		Land application with additives	1 (1)	0	1 (1)	0
		No manure on paddy rice fields	1 (1)	0	0	0
		Land application of separated solid or liquid fractions	1 (1)	0	1 (1)	0
Increase soil biological quality		Land application of composted/digested manure	1 (1)	0	0	0
Increase soil organic carbon		Land application of composted/digested manure	0	0	1 (1)	0
Increase soil nutrients (soil total nitrogen)		Land application of composted/digested manure	0	0	1 (1)	0
Increase crop yield		Land application with banding	0	0	1 (1)	0

	Land application with deep placement or immediate incorporation	1 (1)	0	2 (2)	0

* Number of synthesis papers that report relevant results but without statistical test comparison of the intervention and the control.

** accounting for emissions on site, only.

DESCRIPTION OF THE KEY FACTORS INFLUENCING THE SIZE OF THE EFFECT

Only the factors explicitly studied in the reviewed synthesis papers with a significant effect are reported below. Details regarding the factors can be found in the *individual reports* following the hyperlinks (□ or refX).

Impact	**Factors**
Decrease ammonia emission	Livestock type (ref 10), Manure characteristics (ref 11)
Decrease GHG emissions	Climate (ref 3), Crop type (ref 3), Water filled pore space (ref 3), Duration of treatment (ref 3), Soil organic carbon (ref 3)

3. IMPLEMENTATION IN THE PERIOD 2014-2020

GAEC Cross compliance	
Greening	
Rural development measure – submeasure	

5. PICTURES

Pictures are not relevant in this case.

6. LINKS TO OTHER RELEVANT COMPLEMENTARY INFORMATION

We include in this section the links to other complementary sources of information (not peer-reviewed meta-analyses or systematic reviews), provided by DG AGRI or other stakeholders

7. LIST OF SYNTHESIS PAPERS INCLUDED IN THE REVIEW OF THE FARMING PRACTICE IMPACTS

Ref. Num	Authors	Year	Title	Reference	DOI
1	Xia, F; Mei, K; Xu, Y; Zhang, C; Dahlgren, RA; Zhang, MH	2020	Response of N_2O emission to manure application in field trials of agricultural soils across the globe	SCIENCE OF THE TOTAL ENVIRONMENT, 733, 139390.	10.1016/j.scitotenv.2020.139390
2	Liu, SB; Wang, JY; Pu, SY; Blagodatskaya, E; Kuzyakov, Y; Razavi, BS	2020	Impact of manure on soil biochemical properties: A global synthesis	SCIENCE OF THE TOTAL ENVIRONMENT, 745, 141003.	10.1016/j.scitotenv.2020.141003
3	Emmerling, C; Krein, A; Junk, J	2020	Meta-Analysis of Strategies to Reduce NH_3 Emissions from Slurries in European Agriculture and Consequences for Greenhouse Gas Emissions	Agronomy 10, 1633	10.3390/agronomy10111633
4	Ti, CP; Xia, LL; Chang, SX; Yan, XY	2019	Potential for mitigating global agricultural ammonia emission: A meta-analysis	Environ. Pollut. 245, 141–148	10.1016/j.envpol.2018.10.124
5	Wang, Y; Xue, W; Zhu, Z; Yang, J; Li, X; Tian, Z;Dong, H; Zou, G;	2019	Mitigating ammonia emissions from typical broiler and layer manure management - A system analysis	Waste Management	10.1016/j.wasman.2019.05.019
6	Lin, YR; Watts, DB; van Santen, E; Cao, GQ	2018	Influence of Poultry Litter on Crop Productivity under Different Field Conditions: A Meta-Analysis	Agron. J. 807–18	10.2134/agronj2017.09.0513
7	Sajeev, EPM; Winiwarter, W; Amon, B	2018	Greenhouse Gas and Ammonia Emissions from Different Stages of Liquid Manure Management Chains: Abatement Options and Emission Interactions	Journal of environmental quality	10.2134/jeq2017.05.0199
8	Wang, Y; Li, XR; Yang, JF; Tian, Z; Sun, QP; Xue, WT; Dong, HM	2018	Mitigating Greenhouse Gas and Ammonia Emissions from Beef Cattle Feedlot Production: A System Meta-Analysis	Environmental Science & Technology	10.1021/acs.est.8b02475
9	Han, Z; Walter, MT; Drinkwater, LE	2017	N_2O emissions from grain cropping systems: a meta-analysis of the impacts of fertilizer-based and ecologically-based nutrient management strategies	NUTRIENT CYCLING IN AGROECOSYSTEMS, 107, 335-355.	10.1007/s10705-017-9836-z
10	Wang, Y; Dong, HM; Zhu, ZP; Gerber, PJ; Xin, HW; Smith, P; Opio, C; Steinfeld, H; Chadwick, D	2017	Mitigating Greenhouse Gas and Ammonia Emissions from Swine Manure Management: A System Analysis	ENVIRONMENTAL SCIENCE & TECHNOLOGY	10.1021/acs.est.6b06430

Ref. Num	Authors	Year	Title	Reference	DOI
11	Nkebiwe, PM; Weinmann, M; Bar-Tal, A; Muller, T	2016	Fertilizer placement to improve crop nutrient acquisition and yield: A review and meta-analysis	Field Crops Research 196, 389-401	10.1016/j.fcr.2016.07.018
12	Hou, Y; Velthof, GL; Oenema, O	2015	Mitigation of ammonia, nitrous oxide and methane emissions from manure management chains: a meta-analysis and integrated assessment	Glob. Chang. Biol. 21, 1293–1312	10.1111/gcb.12767