SINGLE-IMPACT FICHE
MANURE PROCESSING TECHNIQUES

IMPACT: NUTRIENTS RECOVERY

Data extracted in July 2021
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Note to the reader: This fiche summarises the effects of Manure processing techniques on NUTRIENTS RECOVERY. It is based on 3 synthesis papers[1], including from 28 to 114 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

The effects of manure processing techniques on nutrients recovery and conservation are reported in **Table 1**.

The table below shows the number of synthesis papers with statistical tests reporting i) a significant difference between the Intervention and the Comparator, that is to say, a significant statistical effect, which can be positive or negative; or ii) a non-statistically significant difference between the Intervention and the Comparator. In addition, we include, if any, the number of synthesis papers reporting relevant results but without statistical test of the effects. Details on the quality assessment of the synthesis papers can be found in the methodology section of this WIKI.

- Manure management including struvite precipitation (compared to the absence of the treatment) was found to have positive effect (according to 1 synthesis paper) on phosphorous recovery.
- For manure management including ammonia stripping evidence was not sufficient (non-statistically tested results in 1 synthesis paper).
- Solid manure composting (including periodical turning, forced aeration, use of bulking agents) resulted in either negative or non-significant effects on total-nitrogen recovery. In particular, composting with forced aeration was found to significantly increase total nitrogen losses, as compared to untreated manure.
- Composting piles with optimized aeration rates and carbon/nitrogen regulation, as compared to untreated manure piles resulted in significantly higher total nitrogen conservation, according to 1 synthesis paper.

All selected synthesis papers included studies conducted in Europe (see **Table 2**).

Table 1: Summary of effects. Number of synthesis papers reporting positive, negative or non-statistically significant effects on environmental and climate impacts. The number of synthesis papers reporting relevant results but without statistical test of the effects are also provided. When not all the synthesis papers reporting an effect are of high quality, the number of synthesis papers with a quality score of at least 50% is indicated in parentheses. The reference numbers of the synthesis papers reporting each of the effects are provided in **Table 3**. Some synthesis papers may report effects for more than one impact or more than one effect for the same impact.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Increase nutrients recovery	P recovery	Treatment with struvite precipitation	Conventional management	1	0	0	1
Increase nutrients recovery	Total nitrogen loss	Composting	Conventional management	1	1	1	0

QUALITY OF THE SYNTHESIS PAPERS

The quality of each synthesis paper was assessed based on 16 criteria regarding three main aspects: 1) the literature search strategy and primary studies selection; 2) the statistical analysis conducted; and 3) the evaluation of potential bias. We assessed whether authors addressed and reported these criteria. Then, a quality score was calculated as the percentage of these 16 criteria properly addressed and reported in each synthesis paper. Details on quality criteria can be found in the methodology section of this WIKI.

2. IMPACTS

The main characteristics and results of the 3 synthesis papers are reported in **Table 2** with the terminology used in those papers, while **Table 3** shows the reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**. Comprehensive 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, are provided in the **summaries of the synthesis papers** available in this WIKI.

Table 2: Main characteristics of the synthesis papers reporting effects on nutrients recovery. The references are ordered chronologically with the most recent publication date first.

[1] Synthesis research papers include either meta-analysis or systematic reviews with quantitative results. Details can be found in the methodology section of the WIKI.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref7	Digestate liquid fraction	Global	28	Struvite precipitation	No treatment	Nitrogen and Phosphorous removal from liquid phase	When performed under the right conditions (i.e. pH around 9.5 and Mg:PO_4 ratio of at least 1:1), struvite precipitation is an effective technology for the recovery of nutrients from the liquid phase of anaerobic digestate. The evidence base was limited for ammonia stripping.	75%
Ref9	Soild manure and organic waste	Global	114	Mitigation strategies in solid manure composting, i.e. C/N ratio regulation (C/N RR), optimized aeration rate or turning frequency (OAT).	No mitigation technique	Total nitrogen loss	The reduction of total nitrogen losses across all technologies for composting optimization was statistically significant, and averaged C/N regulation 27.9%, optimized aeration 26.9%.	69%
Ref17	Solid manure (dairy cows, swine, poultry, green waste)	Global	76	Solid manure Solid manure improved composting techniques (turning, forced aeration, compaction, covering, bulking agents, additives)	Solid manure conventional storage (heaps)	Total-N losses	The incorporation of a bulking agent do not increase substantially N losses. Forced aeration showed significant losses in total nitrogen, while no significant effect was associated with turning.	69%

Table 3: Reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Increase nutrients recovery	P recovery	Treatment with struvite precipitation	Conventional management	Ref7			Ref7
Increase nutrients recovery	Total nitrogen loss	Composting	Conventional management	Ref9	Ref17	Ref17	

3. FACTORS INFLUENCING THE EFFECTS ON NUTRIENTS RECOVERY

Table 4: List of factors reported to significantly affect the size and/or direction of the effects on nutrients recovery, according to the synthesis papers reviewed.

Factor	Reference number
Mg:PO_4 ratio	Ref7
NA	Ref9, Ref9, Ref9, Ref9, Ref9, Ref9, Ref9, Ref9, Ref7, Ref7, Ref7, Ref7, Ref7, Ref7, Ref17, Ref17, Ref17, Ref17, Ref17, Ref17, Ref17 and Ref17
pH	Ref7

4. KNOWLEDGE GAPS

Table 5: Knowledge gap(s) reported by the authors of the synthesis papers included in this review.

Ref Num	Gap
Ref7	The limitations of the review process may originate from: (1) the search strategy; and (2) bias in the pool of studies found.

5. SYNTHESIS PAPERS INCLUDED IN THE REVIEW

Table 6: List of synthesis papers included in this review. More details can be found in the summaries of the meta-analyses.

Ref Num	Author(s)	Year	Title	Journal	DOI
Ref7	Lorick, D; Macura, B; Ahlstrom, M; Grimvall, A; Harder, R	2020	Effectiveness of struvite precipitation and ammonia stripping for recovery of phosphorus and nitrogen from anaerobic digestate: a systematic review	Environmental Evidence 9, 1–20	10.1186/s13750-020-00211-x
Ref9	Zhao, SX; Schmidt, S; Qin, W; Li, J; Li, GX; Zhang, WF	2020	Towards the circular nitrogen economy - A global meta-analysis of composting technologies reveals much potential for mitigating nitrogen losses	Sci. Total Environ. 704, 135401	10.1016/j.scitotenv.2019.135401
Ref17	Pardo, G; Moral, R; Aguilera, E; del Prado, A	2015	Gaseous emissions from management of solid waste: a systematic review	Glob. Chang. Biol. 21, 1313–1327	10.1111/gcb.12806

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