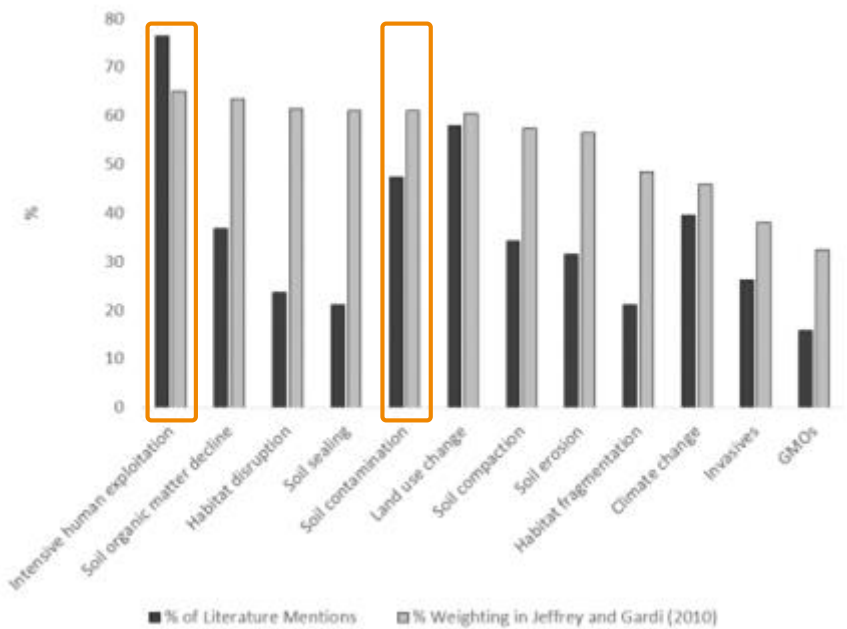
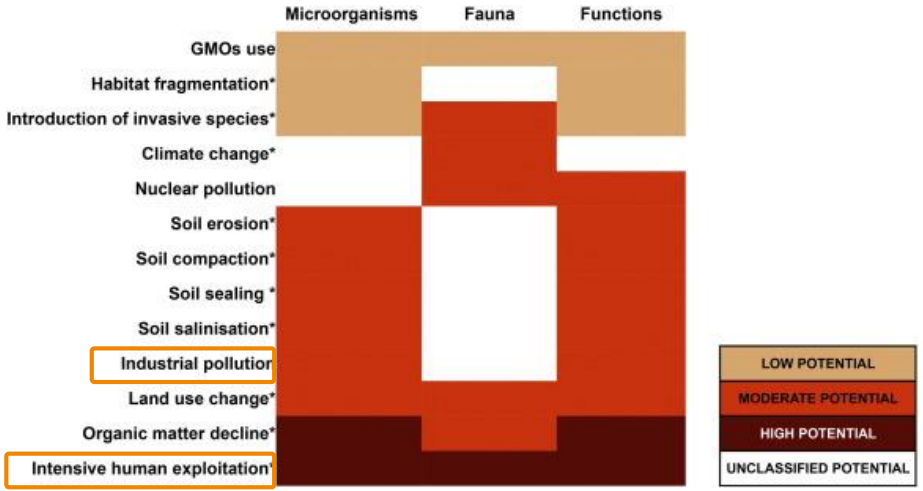
https://www.demeter-im-norden.de/bodenconnection#mesofauna

Soil biodiversity under threat

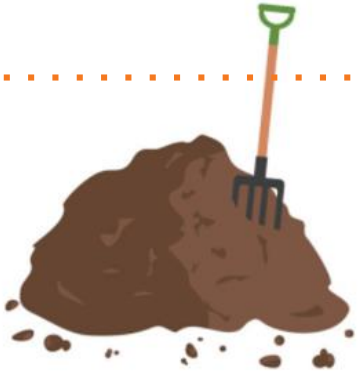


Tibbett et al. 2020



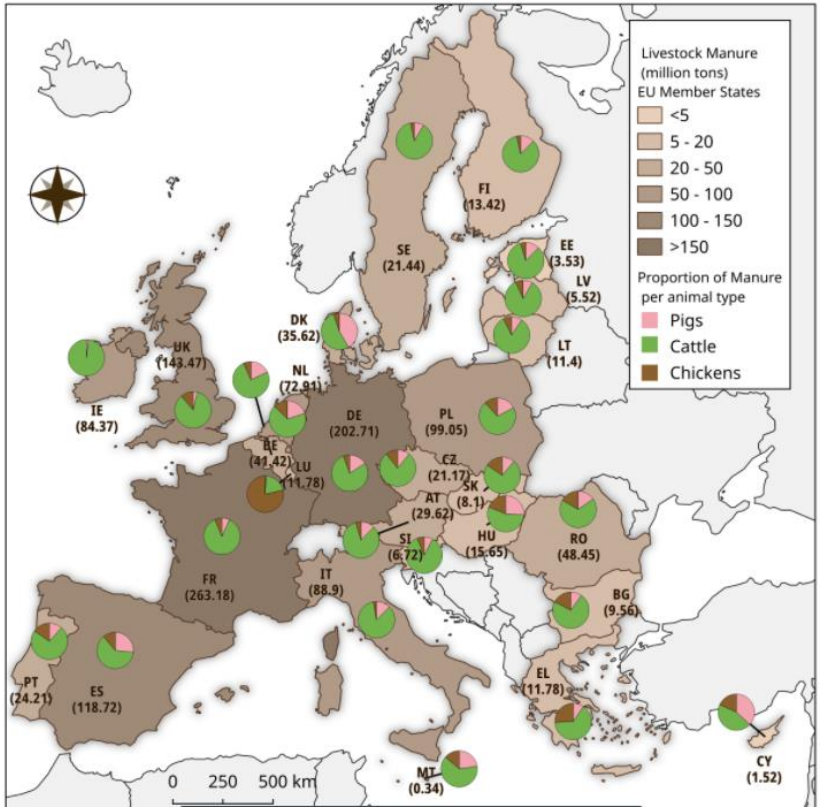
Orgiazzi et al. 2016

Manure in the EU



- > 1.4 billion t y^{-1} of manure are generated in the EU and UK
- Manure is increasingly generated in highly intensive farming systems (Bernal et al., 2015)

  → 4% of European farms produced 80% of the total amounts of manure in 2018 (Amann et al., 2018)



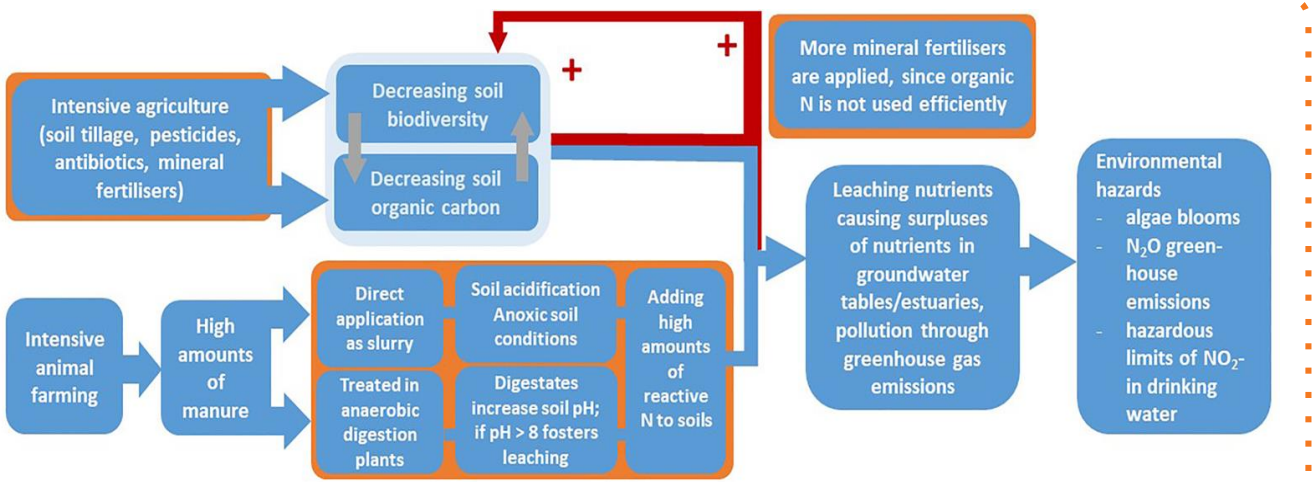
Soil Biodiversity and Manure Management

CONTAMINATION WITH
HEAVY METALS (Zn, Cu), ANTIBIOTICS, HORMONES, PATHOGENS

\-

\+

- **FODDER SOURCE**
- **GENETIC MATERIAL**
- **EVAPORATION PROTECTION**
- **EROSION PROTECTION**



The links between organic matter, nitrogen surpluses and soil biota - impact & consequences (simplification; dependent on various environmental char-acteristics such as soil properties, climate, type of organic fertiliser and land-use practices).

Research Protocol

Research Question (RQ)	Aim	Method	Keywords in the Search
RQ1: Which factors regulate the direct and indirect effects of farm manures on soil biodiversity and their implications on the fate of manure additions? (Section 3.1)	To identify the factors determining the impact of manure on soil biodiversity including benefits and threats to soil biodiversity as well as the effects of soil biodiversity on the fate of manure	To perform a systematic literature review on the effects of manure on soil biodiversity and vice versa	Manure management and/or animal faeces and/or animal dung and/or animal urine, benefit and/or harm, soil biodiversity
RQ2: Which practices help to achieve sustainable manure management in the EU? (Section 3.2)	Recommend best practices for integrating soil biodiversity in manure management to enhance benefits of manure for soil biodiversity	To examine sustainable farming practices for the role and integration of manure	Manure management, and/or sustainable agriculture, and European Union
RQ3: What role and importance, if any, is attributed to soil biodiversity in current European legislation on manure management? (Section 3.3)	To investigate the extent to which European policy instruments integrate soil biodiversity and manure management	To examine the integration of manure management and soil biodiversity in legal frameworks	Manure management, and/or soil biodiversity, and/or policy instruments, and/or European Union
RQ4: Which shortcomings in regulations and practices, if any, currently prevent sustainable manure management in the EU? (Section 3.4)	To determine knowledge gaps and limitations in current manure management practices and regulations to recommend sustainable manure management in the EU	To evaluate and combine/match the findings derived from the two previous methods	Manure management, shortcomings and/or limitations, and/or sustainable agriculture, and European Union

Effects of manure on soil biodiversity

Sustainable manure management practices

Soil biodiversity in EU legislation on manure management

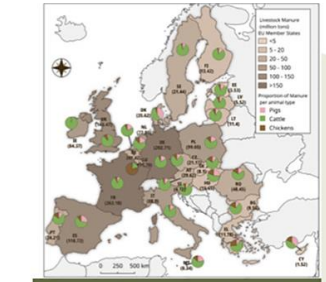
Shortcomings in current legislations

Agricultural Systems
Volume 194, December 2021, 103251

Review

Manure management and soil biodiversity: Towards more sustainable food systems in the EU

Julia Köninger [a, b], Emanuele Lugato [b], Panos Panagos [b], Mrinalini Kochupillai [c], Alberto Orgiazzi [b], Maria J.I. Briones [a]



EU and UK animal farming manure: 1.4 billion tonnes

- Effects on soil biodiversity are often not assessed
- The interaction between manure and soil biodiversity have not been reviewed

REVIEW OF 407 PAPERS & EUROPEAN LEGISLATION

- Relationship between manure and soil biodiversity
- Soil biodiversity in manure legislation
- Practices considering soil biodiversity in manure management

EFFECT OF MANURE ON SOIL BIODIVERSITY

Harm (−) / Benefits (+) depend on manure management:

Pre-spreading phase
- Manure type
- Storage
- Manure treatment

Spreading phase
- Application methods
- Quantity
- Environmental interactions

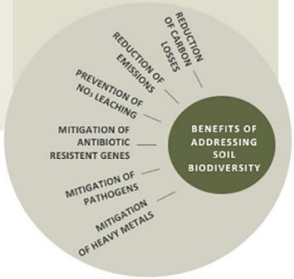


Table 2

The impact of manure treatment on the environment (with focus on soils) and biodiversity (for low to medium amounts of manure, not exceeding 25 t ha^{-1}): ++ large positive impact; + positive impact; − negative impact; −- large negative impact; 0 neutral (neither positive nor negative impact); + − No clear position in literature; NA refers to no available studies. Techniques separating manure into solid and liquid fraction allowing their separate management are not covered in the table since the impact on the environment and biodiversity depends on the fraction and the technique.

Impact / Manure Treatments	Environmental impacts with focus on soils (see supplementary text in Appendix A for more details)						Soil Biodiversity			
	NH_3 Loss	Heavy metal soil pollution	Salinisation	Antibiotics	Pathogens	Soil organic Carbon content	Microbial biomass	Genetic diversity	Soil fauna	Plant-parasitic nematodes
Raw application (from animals farmed in stables, excluding untreated manure by grazing animals)	−	−	−	−	−	+	+−	+−	−	+
Aerobic composting of the solid fractions (Aerobic microorganisms decompose organic matter, occurring naturally when manure is stored in heaps)	−	+	++	+	+	++	+	++	++	+−
Biostimulant Fermentation (Naturally-occurring acidification e.g., compost teas)	**NA**	−	+	+	++	++	++	++	++	++
Anaerobic digestion (Microbial degradation of organic matter to biogas, as methane and carbon dioxide)	−	−	++	−	−	+	**0**	+−	−	+
Additives and other pre/ treatments (e.g., acidification through the addition of chemical compounds such as sulfuric acid)	+	**NA**	**NA**	**NA**	−	**NA**	**NA**	**NA**	**0**	++

→ The higher the soil biodiversity, the better threats of manure contaminants can be prevented:

Table 3
The impact of soil biodiversity on the environmental threats caused by manure application: ++ large positive impact; + positive impact; − negative impact; −- large negative impact; 0 neutral (neither positive nor negative impact); + − No clear position in literature; NA refers to not available studies. Techniques separating manure into solid and liquid fraction allowing their separate management is not covered in the table since the impact on the environment and biodiversity depends on the fraction and the technique.

	Environmental Threats (relevant to soils)					
Impact of biodiversity	Emissions	NH_3 Leaching	Heavy Metal soil contamination	Pathogens (*Salmonella*)	Antibiotic resistance genes	Carbon losses
Microbial biomass	+−	++	++	++	++	+−
Genetic diversity	+	+	+	++	++	++
Soil fauna	+	+	+	++	++	++

BENEFICIAL MANURE PRACTICES

MANURE QUALITY	Limit/prevent food supplements such as hormones, antibiotics and heavy metals. Replace mineral zinc with organic zinc. No usage of manure as organic fertiliser when both copper and antibiotic oxytetracycline were fed simultaneously.
	Respect animal welfare (space, stress,…)
	When animals have been treated with antibiotics, hormones or heavy metals, adding organic matter (e.g. plant residues) reduces the toxic effect of manure
MANURE STORAGE	Combining storing and composting manure reduces antibiotics more efficiently
MANURE TREATMENT	Manure from ill animals containing pathogens require treatment (e.g. composting or anaerobic digestion)
	To prevent the leaching of N, high amounts of manure should be composted before application
	Fermenting manure enhances benefits to soil biota (compost-tea preparations)
MANURE QUANTITY	Application amount below 25t/ha -1. If manure contains toxic pollutants, the quantity should be reduced, see the threshold for heavy metals)

HARMFUL MANURE PRACTICES

MANURE QUALITY	Usage of antibiotics in animal farming
	When heavy metals are fed as additives in animal farming: thresholds should be considered for applying manure from animals that received heavy metal supplements: 4-5 mg/kg Cu and 10-50 mg/kg Zn depending on animal size
	Usage of hormones as additives in animal farming
MANURE STORAGE	Storing manure does not adequately reduce antibiotic resistance genes
MANURE TREATMENT	To prevent the leaching of N, the quantity of digestates applied to alkaline soils must be limited or coupled to further treatments (e.g. N recovery by separation)
MANURE QUANTITY	Manure quantity exceeding 25t/ha -1 (if manure contains toxic pollutants, the quantity should be reduced, see the threshold for heavy metals)
CLIMATIC/ EDAPHIC CONDITIONS	No application to frozen or waterlogged soils or soils with extreme pH values, no machine application after rain since earthworms are more likely being harmed

SUSTAINABLE MANURE MANAGEMENT

CHECKLIST: MANURE MANAGEMENT <> SOIL BIODIVERSITY

1. QUALITY CONTROL

INDICATORS

Pathogens	Storing/Composting/Anaerobic digestion	✓
Antibiotics	Treatment: Composting	✓
Hormones	Treatment: Composting	✓
Heavy metals	Treatment does not impact heavy metals; manure should not exceed thresholds between 4-5mg/kg Cu and 10-50 mg/kg Zn	X

2. MANURE TREATMENT

Manure free of eco-toxicological pollutants

3. QUANTITY OF MANURE

Tonne/ha -1 (<25t/ha -1)

4. CLIMATIC/ EDAPHIC CONDITIONS

Frozen or waterlogged soils	X
Soils with extreme pH values (Particularly when manure contains heavy metals)	X
No machine application after rain	X

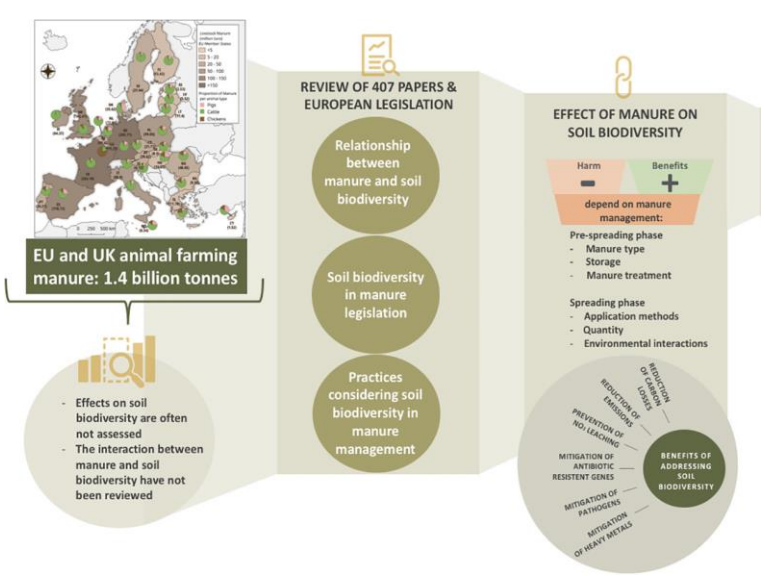
Soil Biodiversity in EU Manure Policies:

- Animal By-Products and Derived Products Regulation 1069/2009
- The Common Agricultural Policy (CAP) Regulation (EU) No 1306/2013
- Air Quality and National Emission Ceilings Directive 2016/ 2284
- EU Nitrates Directive 91/676/EEC
- Organic Production Schemes Council Regulation (EEC) No 2092/91
- Fertilising Products Regulation (EC) No 2003/2003 replaced by Regulation (EU) 2019/1009
- Veterinary Medicinal Directive 2001/82/EC replaced by Regulation EU/2019/6
- Industrial Emissions Directive (2010/75/EU)

Neglected:

- Quality of manure
- Coupeling with practices beneficial for soil biodiversity
- Raw manure

Conclusion



LEGISLATION ON MANURE MANAGEMENT

- Is scattered across different policy areas and legislations
- Ignores effects on soil biodiversity

CONCLUSION & RECOMMENDATIONS

- Manure quality is currently neglected though crucial for soil biodiversity
- Soil biodiversity plays a crucial role in reducing pollution risks
- Pollution risks could be reduced by protecting and enhancing soil biodiversity
- Radical changes in philosophies and practices of intensive animal farming needed to protect soil biota and to reduce environmental risks and costs

Thanks!

@Andy Murray

Nematode, South Devon

A *Platanurida* species of springtail

A *Temeritas* species of springtail

Dicyrtomina novazealandae