

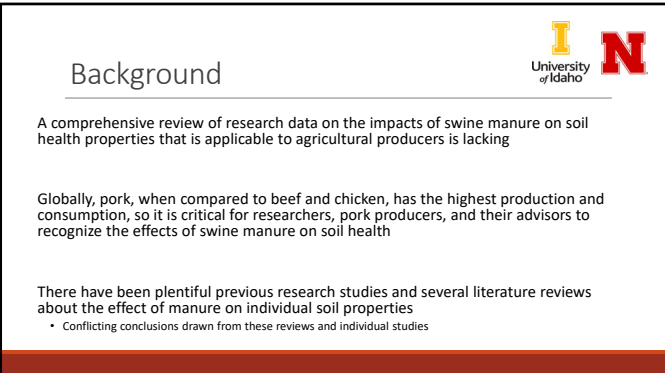


Impact of Swine Manure on Soil Health Properties: A Systematic Review

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Background

A comprehensive review of research data on the impacts of swine manure on soil health properties that is applicable to agricultural producers is lacking

Globally, pork, when compared to beef and chicken, has the highest production and consumption, so it is critical for researchers, pork producers, and their advisors to recognize the effects of swine manure on soil health

There have been plentiful previous research studies and several literature reviews about the effect of manure on individual soil properties

- Conflicting conclusions drawn from these reviews and individual studies

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Objectives

To synthesize literature describing impacts of swine manure on soil properties that affect "soil health"

To identify knowledge gaps and research needs to further our understanding of this topic

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Data Collection

Data Source


- Google Scholar
- Web of Science

Data Collected

- Soil property data
 - Chemical
 - Physical
 - Biological
- Swine manure data

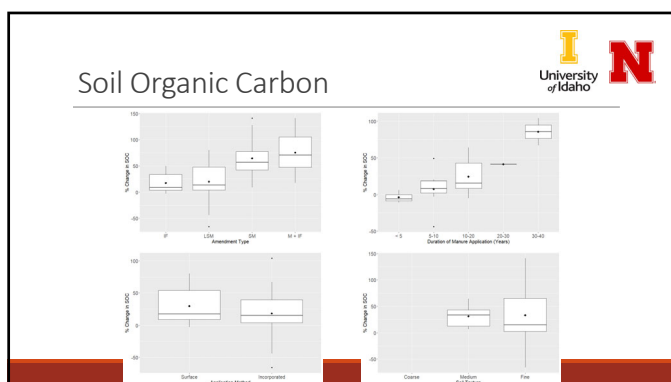
Criterion

- Replicated field experiments
- Manure was the only differing factor between or among studies
- Data means of swine manure amended treatments and controls were included

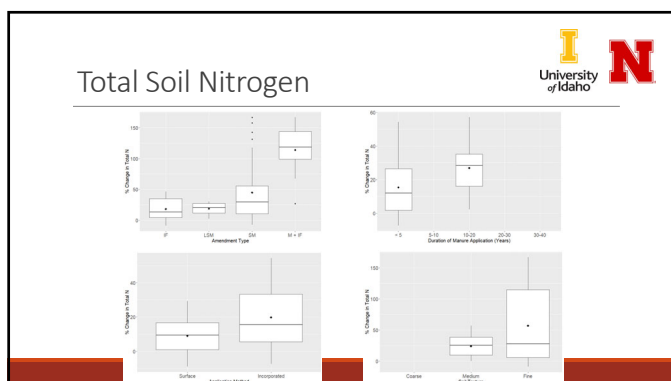


In total, 41 peer-reviewed studies were included in this review

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Soil Structure and Water

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Reference	Manure Type	Application Method	Control	Location	Duration	Soil Texture	A/P/C	A/PWP	A/WC	A/B _s
Advani et al. (2016)	LSM, 4% C (not soil stored)	Incorporated	No amendment	Canada	3	Sandy loam	16	22	12	12
Edwards (2018)	LSM, 105.0 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Canada	2	Sandy loam	40	50	13	22
Schlegel et al. (2015)	LSM, 4000 kg ha ⁻¹ (pig)	Incorporated	No amendment	Canada	10	Silt loam	1	1	1	1
	LSM, 154 kg N ha ⁻¹ yr ⁻¹	Flooded	No amendment	Canada	10	Silt loam	1	1	1	1
	LSM, 309 kg N ha ⁻¹ yr ⁻¹	Flooded	No amendment	Canada	10	Silt loam	1	1	1	1
	LSM, 92 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Canada	10	Silt loam	1	1	1	1
	IF, 48 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Canada	10	Silt loam	1	1	1	1
	IF, 120 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Canada	10	Silt loam	1	1	1	1
	IF, 152 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Canada	10	Silt loam	1	1	1	1
Zhao et al. (2009)	SM, 7000 kg ha ⁻¹ yr ⁻¹	No amendment	No amendment	China	23	Silty clay	20	20	20	20
Harris et al. (1992)	LSM, 200 m ha ⁻¹ yr ⁻¹ (feed 1)	Surface applied	No amendment	Spain	2	Silt loam	8	8	8	8
	LSM, 400 m ha ⁻¹ yr ⁻¹ (feed 1)	Surface applied	No amendment	Spain	2	Silt loam	-78	-78	-78	-78
	LSM, 800 m ha ⁻¹ yr ⁻¹ (feed 1)	Surface applied	No amendment	Spain	2	Silt loam	-70	-70	-70	-70
	LSM, 400 m ha ⁻¹ yr ⁻¹ (feed 1)	Surface applied	No amendment	Spain	2	Silt loam	-19	-19	-19	-19
	LSM, 800 m ha ⁻¹ yr ⁻¹ (feed 1)	Surface applied	No amendment	Spain	2	Silt loam	-19	-19	-19	-19
	LSM, 1000 m ha ⁻¹ yr ⁻¹ (feed 1)	Surface applied	No amendment	Spain	2	Silt loam	-61	-61	-61	-61
	LSM, 200 m ha ⁻¹ yr ⁻¹ (feed 2)	Surface applied	No amendment	Spain	2	Sandy loam	22	22	22	22
	LSM, 400 m ha ⁻¹ yr ⁻¹ (feed 2)	Surface applied	No amendment	Spain	2	Sandy loam	50	50	50	50
	LSM, 800 m ha ⁻¹ yr ⁻¹ (feed 2)	Surface applied	No amendment	Spain	2	Sandy loam	47	47	47	47
	LSM, 400 m ha ⁻¹ yr ⁻¹ (feed 2)	Surface applied	No amendment	Spain	2	Sandy loam	48	48	48	48
	LSM, 800 m ha ⁻¹ yr ⁻¹ (feed 2)	Surface applied	No amendment	Spain	2	Sandy loam	51	51	51	51
	LSM, 1000 m ha ⁻¹ yr ⁻¹ (feed 2)	Surface applied	No amendment	Spain	2	Sandy loam	47	47	47	47
	180-90-113 kg NPK, ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Spain	2	Sandy loam	0	0	0	0
	SM, 12,100 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Spain	2	Sandy loam	10	10	10	10
	180-90-113 kg NPK, ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Spain	2	Sandy loam	0	0	0	0
	IF, 180-90-113 kg NPK, ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Spain	2	Sandy loam	10	10	10	10

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Microbial Biomass

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Reference	Manure Type	Application Method	Control	Location	Duration	Soil Texture	A/MB	A/MB _s
Caron & Campbell (2005)	LSM, 40 kg N ha ⁻¹ yr ⁻¹	Incorporated	48 kg N ha ⁻¹	Canada	3	Sandy loam	6	6
	LSM, 160 kg N ha ⁻¹ yr ⁻¹	Incorporated	48 kg N ha ⁻¹	Canada	3	Sandy loam	6	6
Labadie et al. (2006)	LSM, 60 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Canada	10	Silt loam	7	7
	LSM, 120 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Canada	10	Silt loam	26	26
	LSM, 240 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Canada	10	Silt loam	39	39
	LSM, 480 kg N ha ⁻¹ yr ⁻¹	Incorporated	No amendment	Canada	10	Silt loam	58	58
Pardo et al. (2014)	LSM, 60 kg N ha ⁻¹ yr ⁻¹ (wild crop)	No amendment	No amendment	Spain	Not stated	Not stated	16	16
	LSM, 120 kg N ha ⁻¹ yr ⁻¹ (wild crop)	No amendment	No amendment	Spain	Not stated	Not stated	140	140
	IF, 120 kg N ha ⁻¹ yr ⁻¹ (wild crop)	No amendment	No amendment	Spain	Not stated	Not stated	60	60
	IF, 240 kg N ha ⁻¹ yr ⁻¹ (wild crop)	No amendment	No amendment	Spain	Not stated	Not stated	111	111
Shi et al. (2017)	SM, 200 kg N ha ⁻¹ yr ⁻¹	Surface applied	SM, 200 kg N ha ⁻¹ yr ⁻¹	South Korea	Not stated	Silt	12	12
de Boer-Correa et al. (2015)	LSM, 150 kg N ha ⁻¹ yr ⁻¹	Surface applied	No amendment	Brazil	3	Not stated	7	7
	LSM, 300 kg N ha ⁻¹ yr ⁻¹	Surface applied	No amendment	Brazil	3	Not stated	7	7
	IF, 150 kg N ha ⁻¹ yr ⁻¹	Surface applied	No amendment	Brazil	3	Not stated	27	27
	IF, 300 kg N ha ⁻¹ yr ⁻¹	Surface applied	No amendment	Brazil	3	Not stated	27	27
Xue et al. (2016)	LSM, 150 kg N ha ⁻¹ yr ⁻¹	Surface applied	No amendment	China	Not stated	Not stated	10	10
	LSM, 300 kg N ha ⁻¹ yr ⁻¹	Surface applied	No amendment	China	Not stated	Not stated	10	10
	IF, 150 kg N ha ⁻¹ yr ⁻¹	Surface applied	No amendment	China	Not stated	Not stated	10	10
	IF, 300 kg N ha ⁻¹ yr ⁻¹	Surface applied	No amendment	China	Not stated	Not stated	10	10
Phang et al. (2015)	SM, 150 kg N ha ⁻¹ yr ⁻¹	No amendment	SM, 150 kg N ha ⁻¹ yr ⁻¹	China	14	Silt loam	18	18
	IF, 150 kg N ha ⁻¹ yr ⁻¹	No amendment	IF, 150 kg N ha ⁻¹ yr ⁻¹	China	14	Silt loam	18	18
	SM, 300 kg N ha ⁻¹ yr ⁻¹	No amendment	SM, 300 kg N ha ⁻¹ yr ⁻¹	China	14	Silt loam	18	18
	IF, 300 kg N ha ⁻¹ yr ⁻¹	No amendment	IF, 300 kg N ha ⁻¹ yr ⁻¹	China	14	Silt loam	18	18
	SM, 450 kg N ha ⁻¹ yr ⁻¹	No amendment	SM, 450 kg N ha ⁻¹ yr ⁻¹	China	14	Silt loam	18	18
	IF, 450 kg N ha ⁻¹ yr ⁻¹	No amendment	IF, 450 kg N ha ⁻¹ yr ⁻¹	China	14	Silt loam	18	18
	SM, 900 kg N ha ⁻¹ yr ⁻¹	No amendment	SM, 900 kg N ha ⁻¹ yr ⁻¹	China	14	Silt loam	18	18
	IF, 900 kg N ha ⁻¹ yr ⁻¹	No amendment	IF, 900 kg N ha ⁻¹ yr ⁻¹	China	14	Silt loam	18	18
Hopkinson & Wu (2011)	LSM, 400 kg N ha ⁻¹ yr ⁻¹ (crop 1)	Broadcast	No amendment	North Carolina	7	Loamy sand	13	13
	LSM, 800 kg N ha ⁻¹ yr ⁻¹ (crop 1)	Broadcast	No amendment	North Carolina	7	Loamy sand	13	13
	LSM, 400 kg N ha ⁻¹ yr ⁻¹ (crop 2)	Broadcast	No amendment	North Carolina	7	Loamy sand	102	102
	LSM, 800 kg N ha ⁻¹ yr ⁻¹ (crop 2)	Broadcast	No amendment	North Carolina	7	Loamy sand	66	66
	LSM, 400 kg N ha ⁻¹ yr ⁻¹ (crop 3)	Broadcast	No amendment	North Carolina	7	Loamy sand	62	62
	LSM, 800 kg N ha ⁻¹ yr ⁻¹ (crop 3)	Broadcast	No amendment	North Carolina	7	Loamy sand	62	62
	LSM, 400 kg N ha ⁻¹ yr ⁻¹ (crop 4)	Broadcast	No amendment	North Carolina	7	Loamy sand	62	62
	LSM, 800 kg N ha ⁻¹ yr ⁻¹ (crop 4)	Broadcast	No amendment	North Carolina	7	Loamy sand	62	62
	LSM, 400 kg N ha ⁻¹ yr ⁻¹ (crop 5)	Broadcast	No amendment	North Carolina	7	Loamy sand	62	62
	LSM, 800 kg N ha ⁻¹ yr ⁻¹ (crop 5)	Broadcast	No amendment	North Carolina	7	Loamy sand	62	62
	LSM, 400 kg N ha ⁻¹ yr ⁻¹ (crop 6)	Broadcast	No amendment	North Carolina	7	Loamy sand	62	62
	LSM, 800 kg N ha ⁻¹ yr ⁻¹ (crop 6)	Broadcast	No amendment	North Carolina	7	Loamy sand	62	62

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Future Research

Soil health properties are inter-related, yet only one study evaluated the impact of swine manure on all relevant soil health properties

What should be included in future soil health studies:

The following soil information:

- Initial soil data, methods used to analyze soil samples, and a range of soil chemical, physical, and biological properties (same properties listed for initial soil data)

Detailed description of swine manure used in the study

- Manure type, application method, application rate, total C and N of the manure, duration of manure application, and manure application timing

Detailed description of inorganic fertilizer used in the study

- Application rate for N, P, K, duration of inorganic fertilizer application, and inorganic fertilizer application timing

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Future Research

Future research should:

- Balance nutrient applications of N, P, and K to compare the effect of manure to inorganic fertilizers on crop yield and soil health
- Focus on the short- and long-term impacts of a single application of manure to support an effort to identify optimal frequency of application for improving soil health
 - Longer term studies (building C over time)

Further discussion relating research findings to management decisions relevant to agricultural crop producers

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