



The effects of agricultural practices on the environment: methodology used for synthesis studies (systematic review and meta-analysis)

Marta Pérez-Soba, Andrea Schievano, Jean-Michel Terres (JRC-D5)

David Makowski (INRAE)

How many new scientific papers appeared on agriculture and environment in Web of Science the last 5 years?

40,962
Scientific
papers

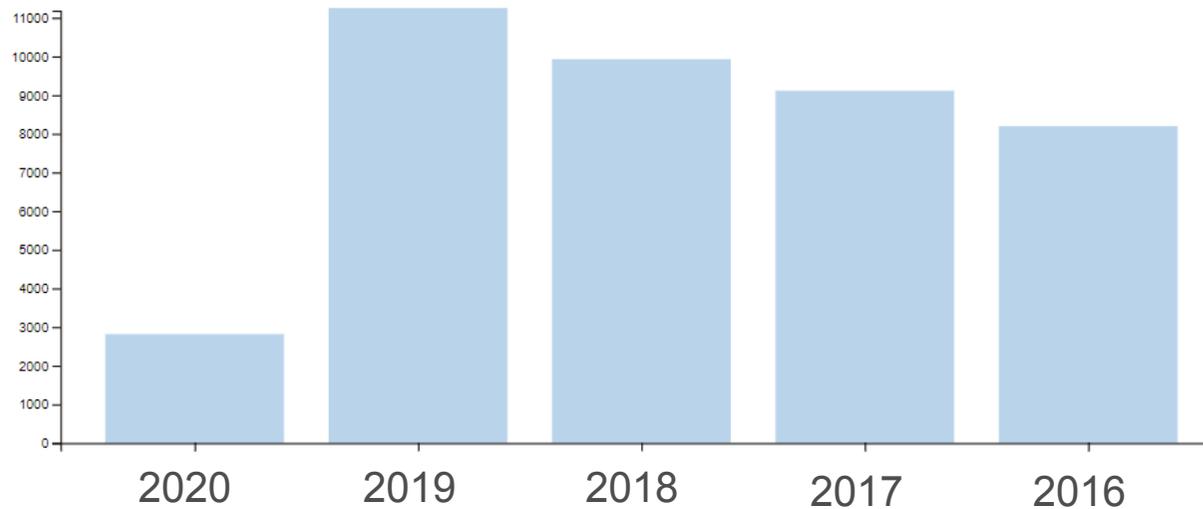
Showing 40,962 records for ALL FIELDS: (agriculture) AND TOPIC: (environment)

Citation report feature not available [?]

Visualization Bar graph

Number of results 10

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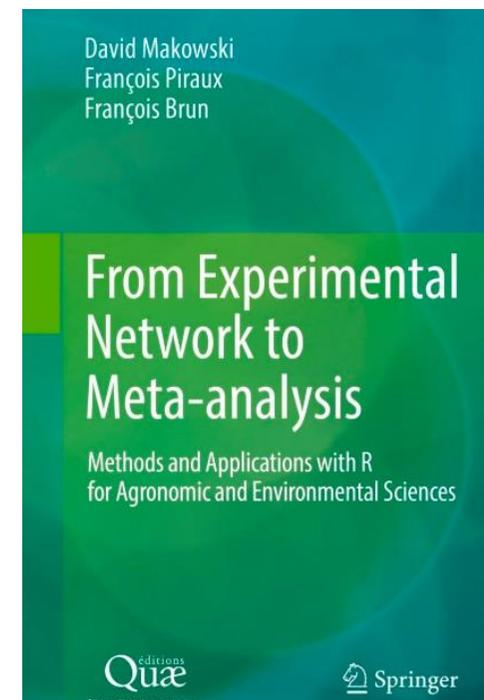
The expert team

- A complementary team consisting of experts in knowledge synthesis with agronomic, environmental and statistical expertise (JRC and INRAE)
- With understanding of the implementation of CAP measures by EU countries and the climate/env impact of the related farming practices

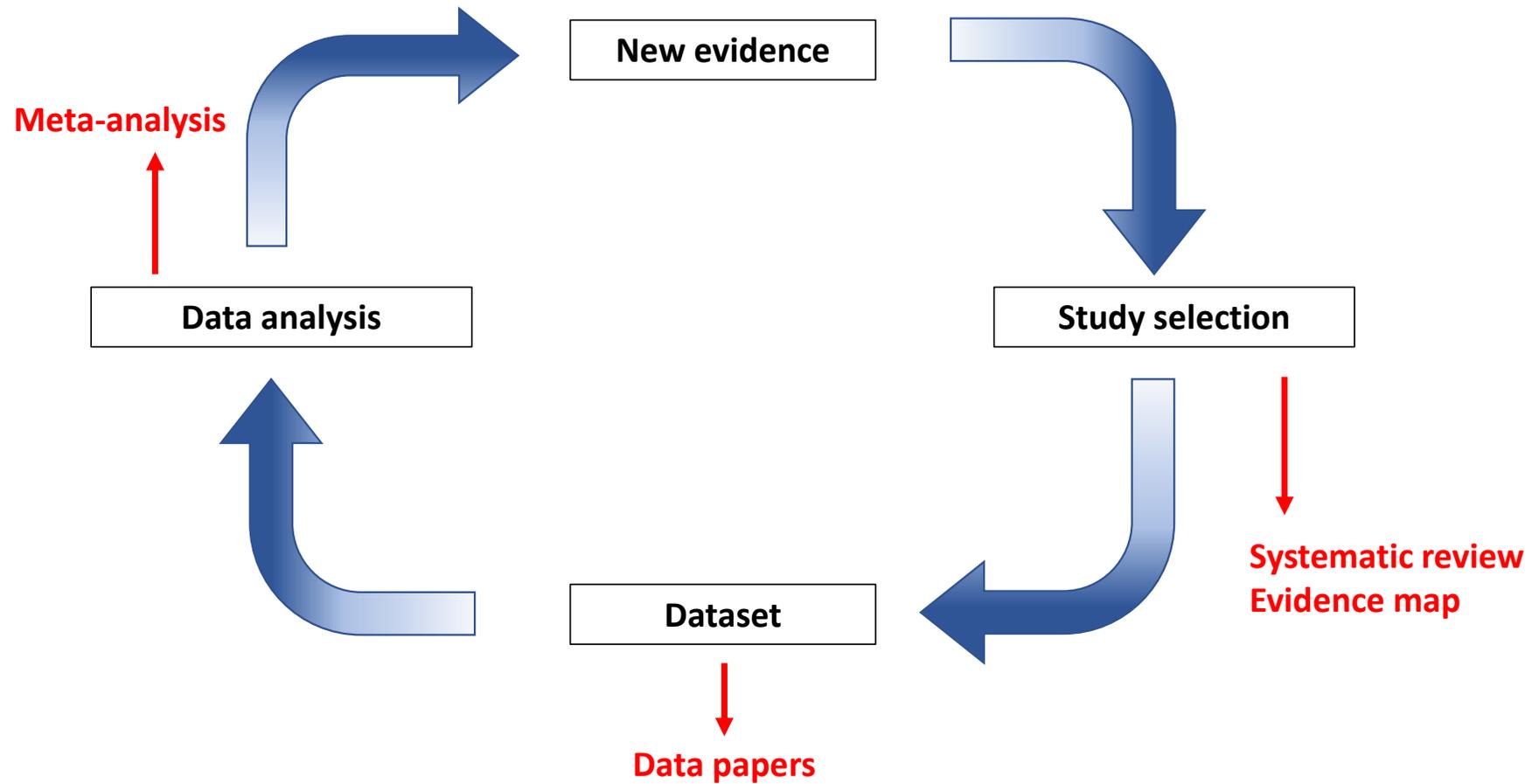
Agri-environmental measures and their implementation by Member States in Rural Development Programmes

November 2019

Authors: Franz Weiss, Marta Pérez-Soba



Virtuous cycle of meta-analysis



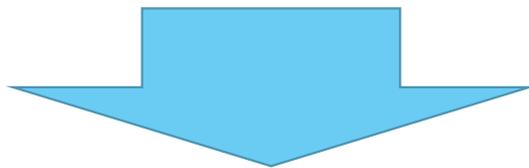
Experiments/Observations/measurements

provide **evidence** on the effects of farming practices

Experiments/Observations/measurements

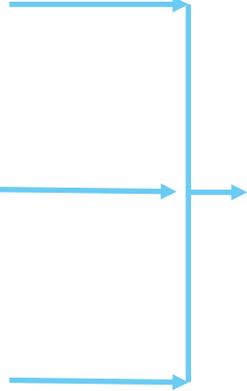
provide **evidence** on the effects of farming practices

Need to synthesize their results



Policy/decision makers

Experiment (vs simple Observation/measurement)

- Randomized design
 - Repetition
 - Control experiments
- 
- Comparative effect
 - Statistical significance
 - Avoid confounding effects

Example:

Effect of manure injection on ammonia emissions

Confounding effect:

high-temperature vs low-temperature climate conditions

Available knowledge

the effect of Manure injection on ammonia emission

Experiment 1

Manure injection decreases ammonia em. by -10% (+-4%)

Experiment 2

Manure injection decreases ammonia em. -20% (+-7%)

Experiment 3

Manure injection no effect on ammonia em.

Experiment 4

Manure injection no effect on ammonia em.

Experiment 5

Manure injection increases ammonia em. By +5% (+-2%)

Experiment 6

Manure injection decreases ammonia em. by +15% (+-2%)

Experiment 7

Manure injection decreases ammonia em. by -25% (+-10%)

Experiment 8

Manure injection no effect on ammonia em.

Experiment 9

Manure injection increases ammonia em. +7% (+-4%)

Opinion-based approach

Experiment 2

Manure injection decreases ammonia em. -20% (+-7%)

Experiment 7

Manure injection decreases ammonia em. by -25% (+-10%)

Conclusion : strong effect

Opinion-based approach

Experiment 3

Manure injection no effect on ammonia em.

Experiment 4

Manure injection no effect on ammonia em.

Experiment 8

Manure injection no effect on ammonia em.

Conclusion : no effect

Opinion-based approach

- High risk of bias
- No formal analysis of what is known
- No reliable identification of knowledge gaps

Evidence-based science

Experiment 1

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- Systematic review of all Experiments
- + Global synthesis of all their results

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Meta-analysis for evidence-based science

Experiment 1

Manure injection decreases ammonia em. by **-10% (+-4%)**

Experiment 2

Manure injection decreases ammonia em. **-20% (+-7%)**

Experiment 3

Manure injection **no effect** on ammonia em.

- Systematic review of all Experiments
- + Global quantitative synthesis of all their results

Experiment 7

Manure injection decreases ammonia em. by **-25% (+-10%)**

Experiment 8

Manure injection **no effect** on ammonia em.

Experiment 9

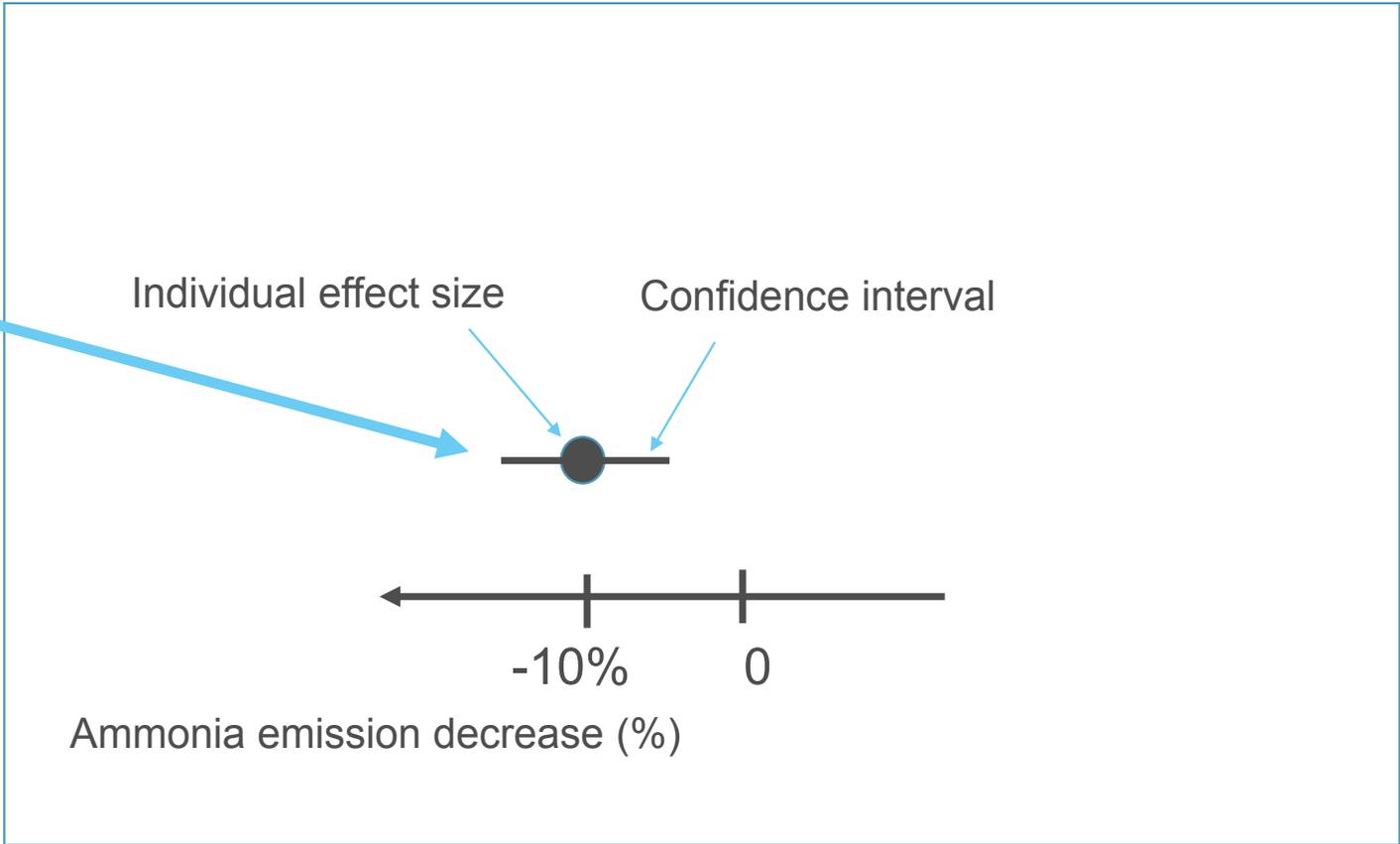
Manure injection increases ammonia em. **+7% (+-4%)**

Meta-analysis for evidence-based science

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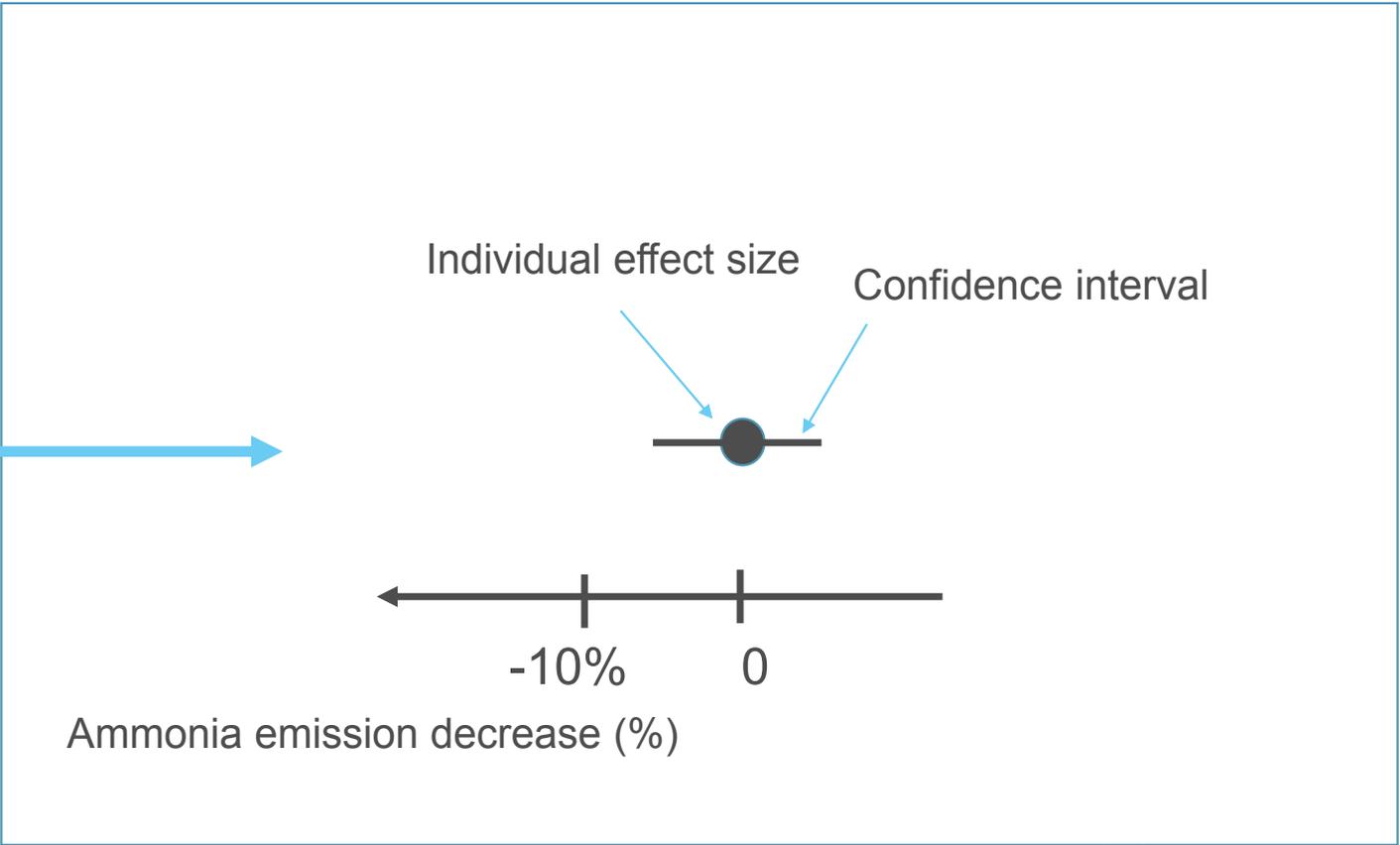


Meta-analysis for evidence-based science

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Meta-analysis for evidence-based science

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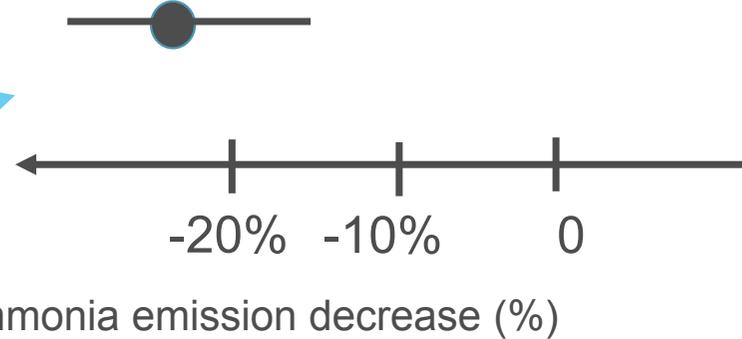
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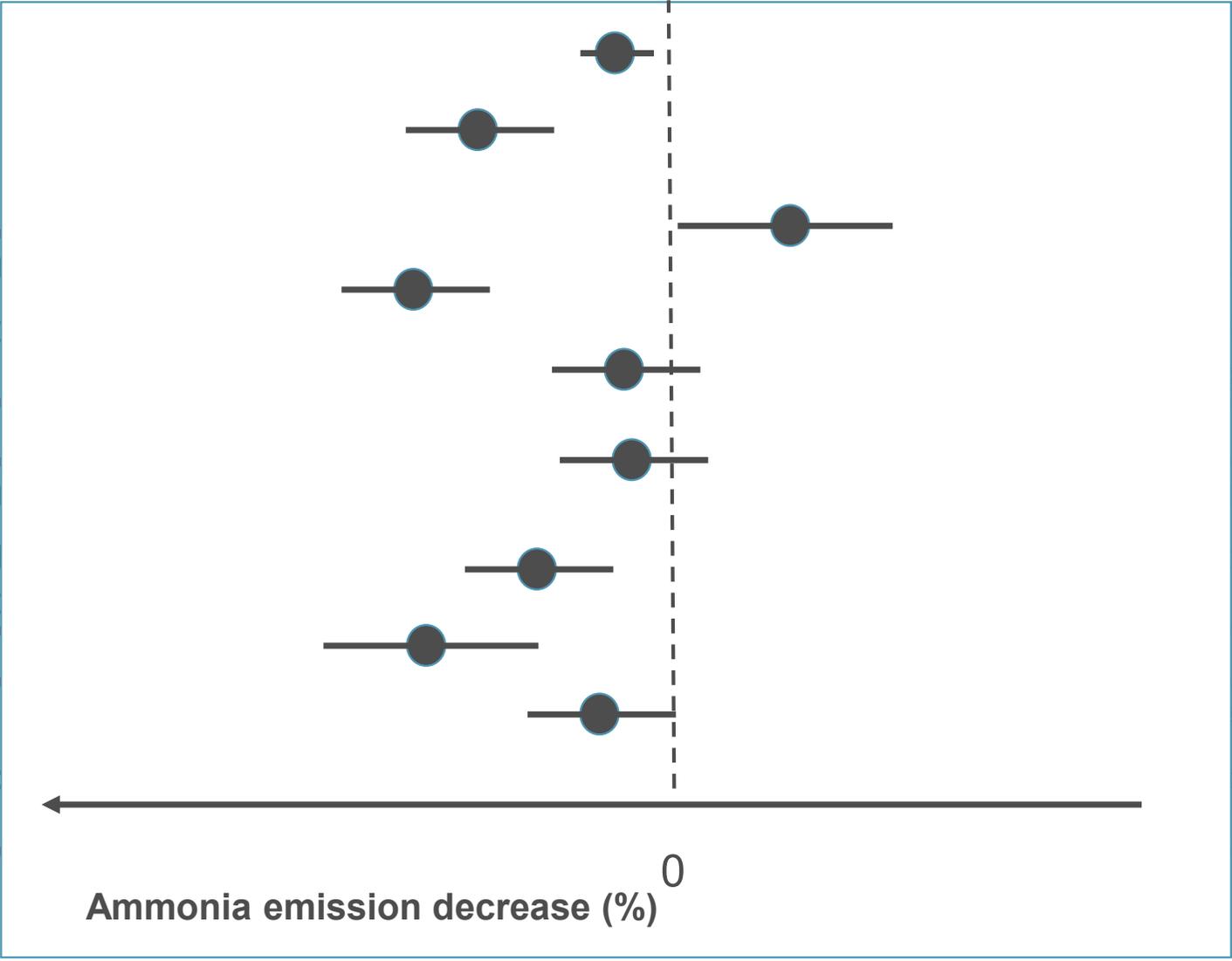
Individual effect size
Confidence interval



Experiment 1
Manure injected
ammonia em.

Experiment 2
Manure injected
ammonia em.

Experiment 3
Manure injected
ammonia em.



Experiment 3
Injection no effect on
ammonia em.

Experiment 6
Injection decreases
ammonia em. by +15% (+-2%)

Experiment 9
Injection increases
ammonia em. +7% (+-4%)

Experiment 1
Manure injected
ammonia em.

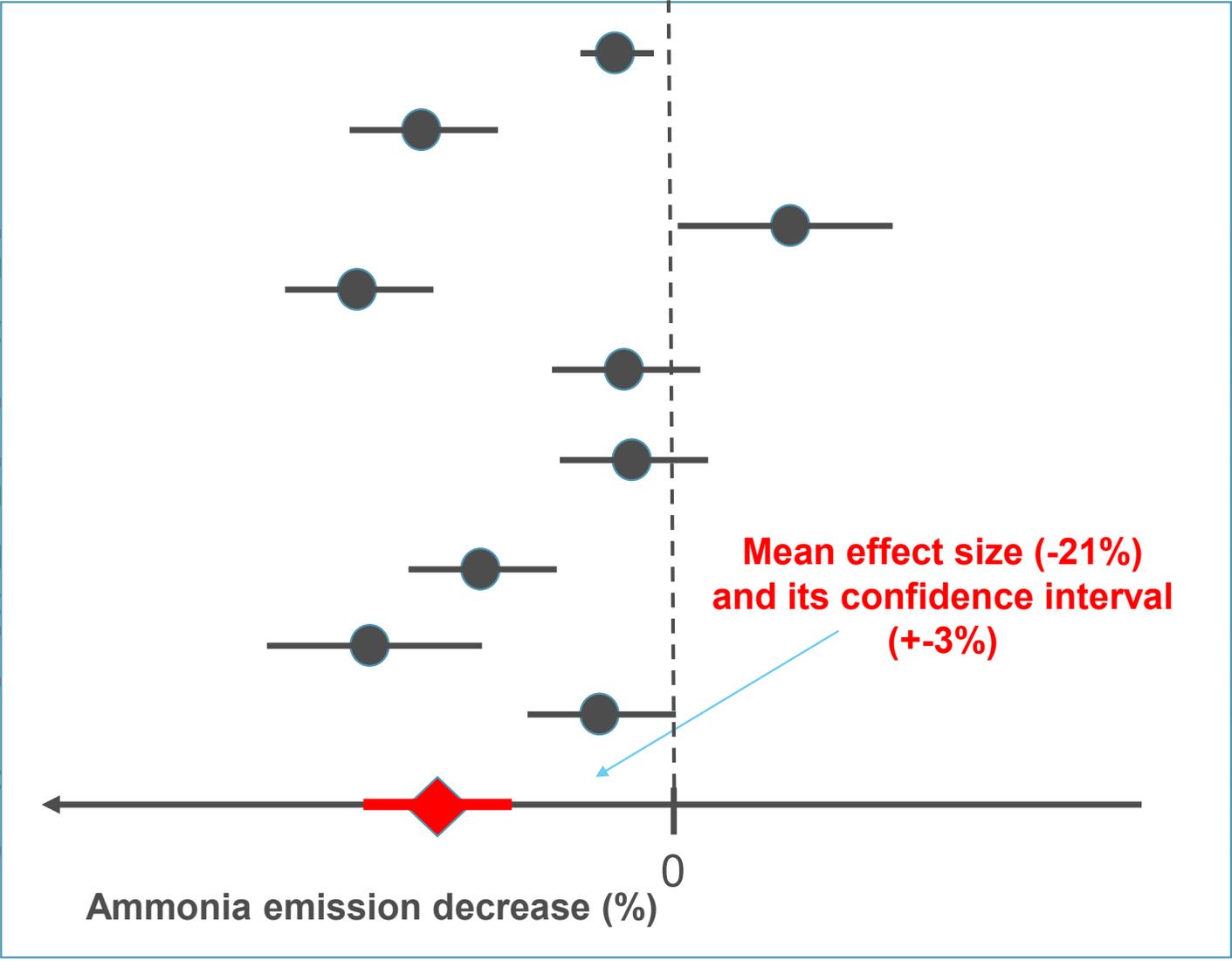
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Injection increases
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Livestock sector:

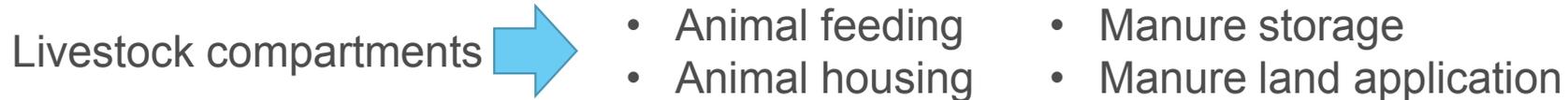
Effectiveness of available mitigation measures at farm level of different GHG and Nitrogen emissions



Structure of the meta-analysis (PICO)

- Livestock compartments 
- Animal feeding
 - Animal housing
 - Manure storage
 - Manure land application

Structure of the meta-analysis (PICO)

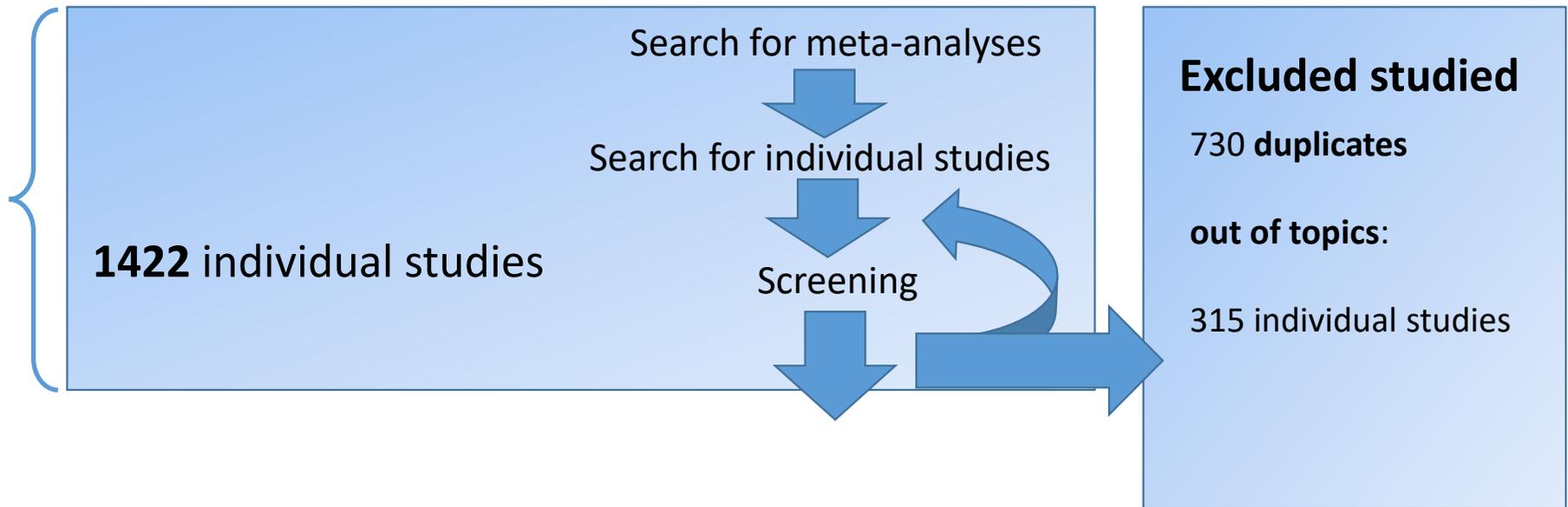


Example: Manure land application techniques

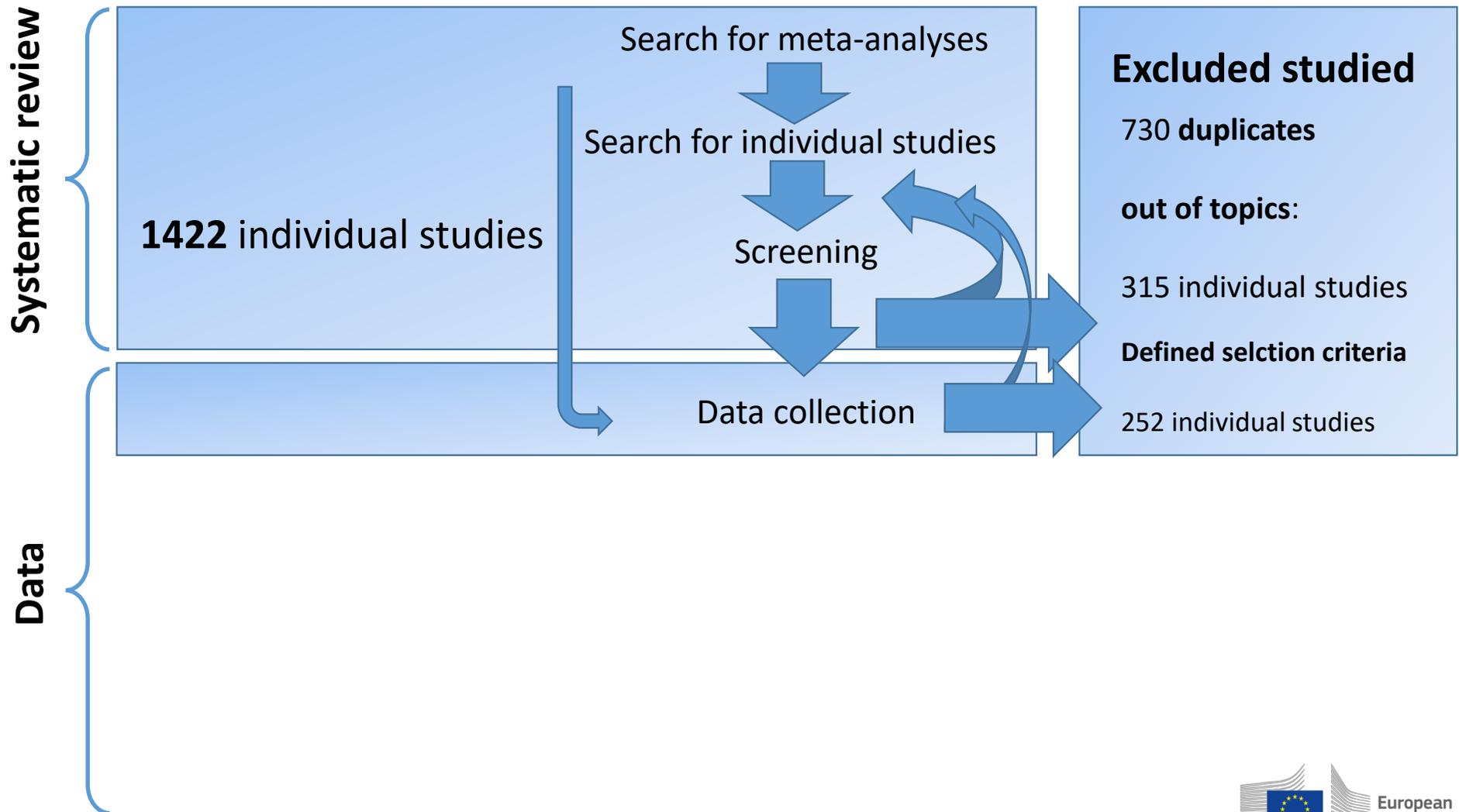
Populations	Interventions (mitigation measures)	Controls	Outcomes (emissions)
Liquid manure application		surface spreading	Ammonia Methane Nitrous oxide Nitrate leaching
	Trailing hose, shoes		
	Surface spreading + incorporation 24h		
	Slit injection		
	Deep injection		
	Injection+incorporation		
	Shallow injection		

Knowledge synthesis procedure

Systematic review



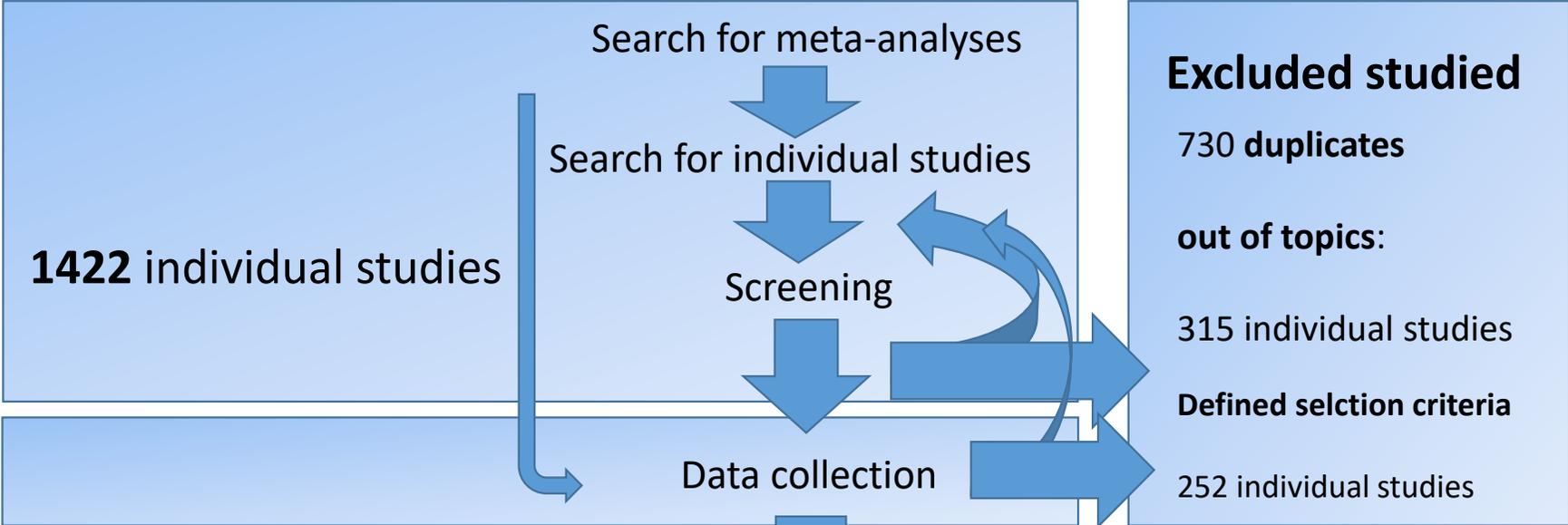
Knowledge synthesis procedure



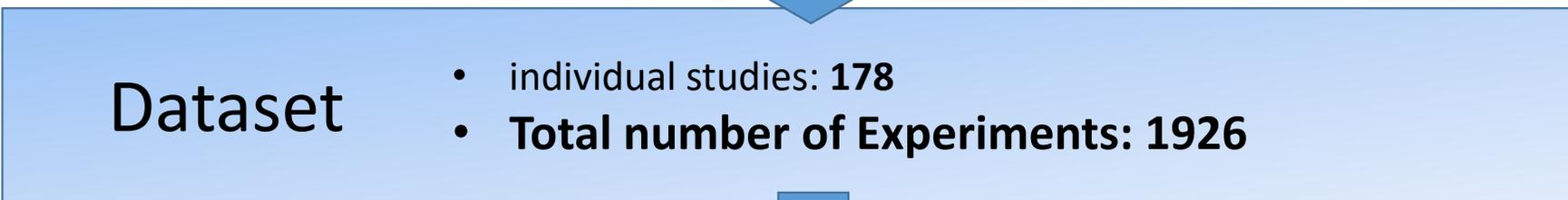
Knowledge synthesis procedure

1 person, 6 months

Systematic review

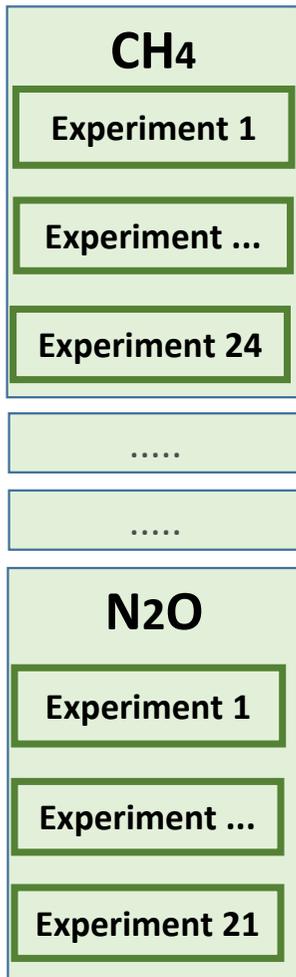


Data



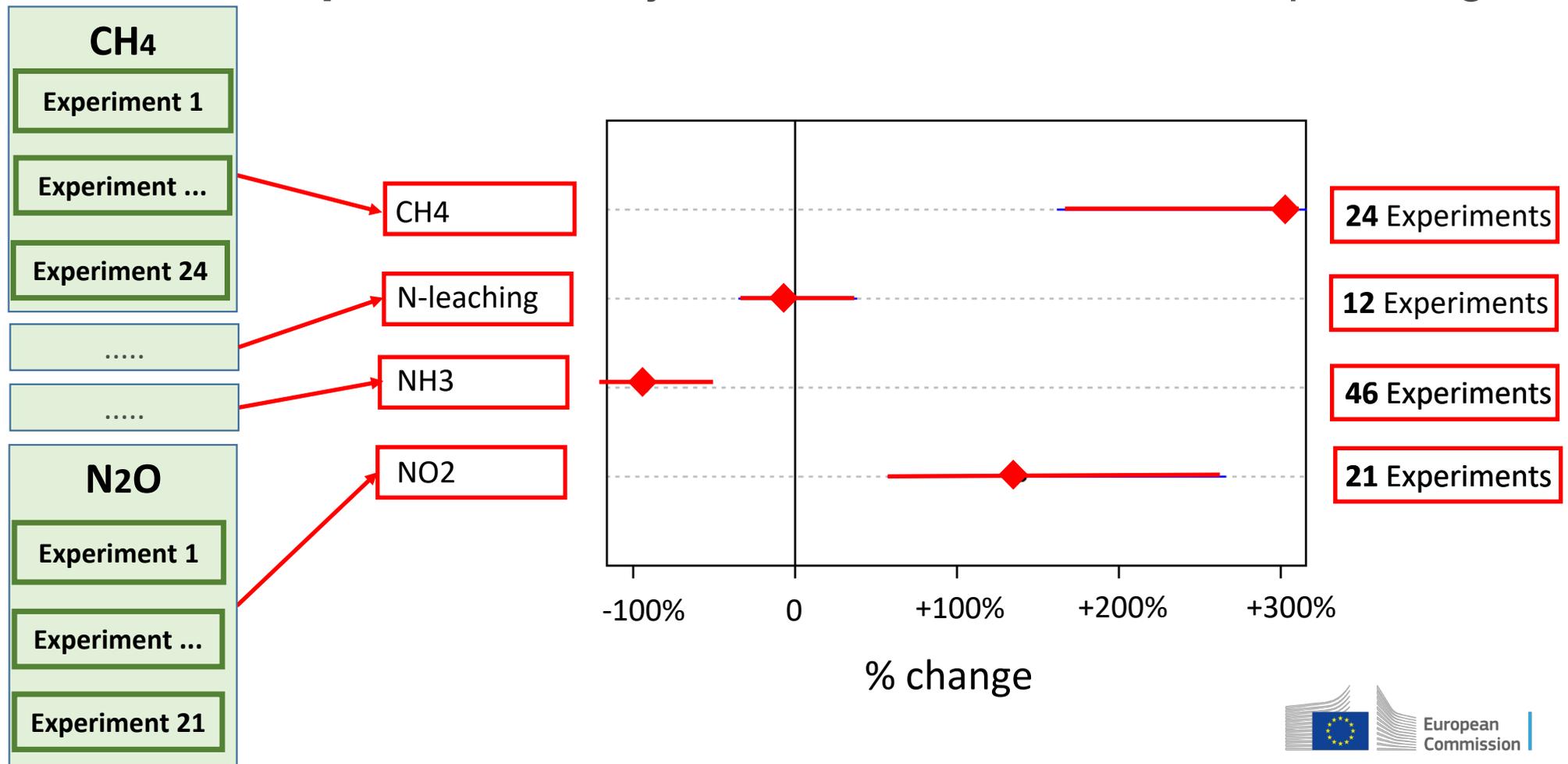
Results: mean effect sizes

Example: Manure injection to land **VS** surface spreading



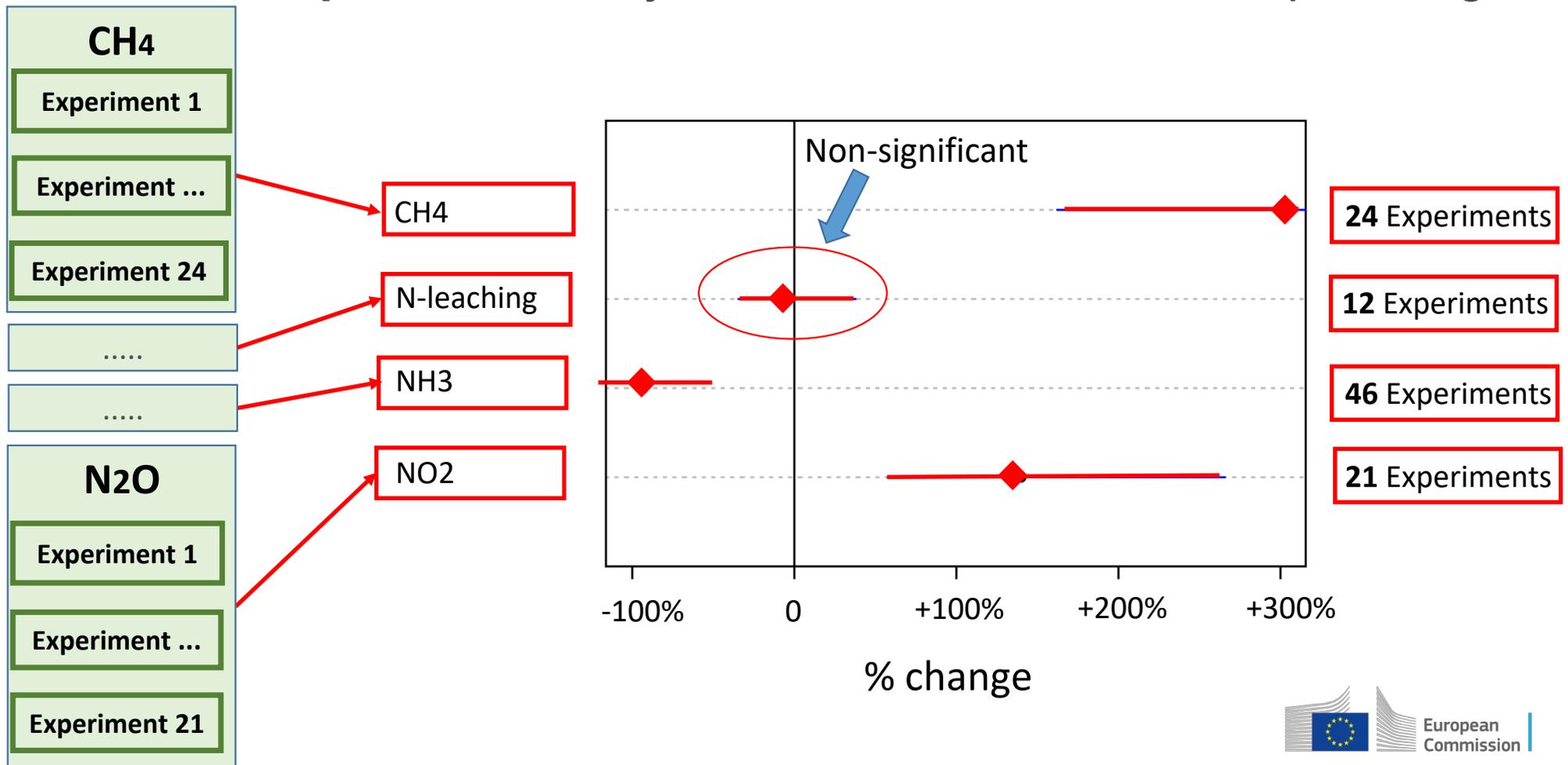
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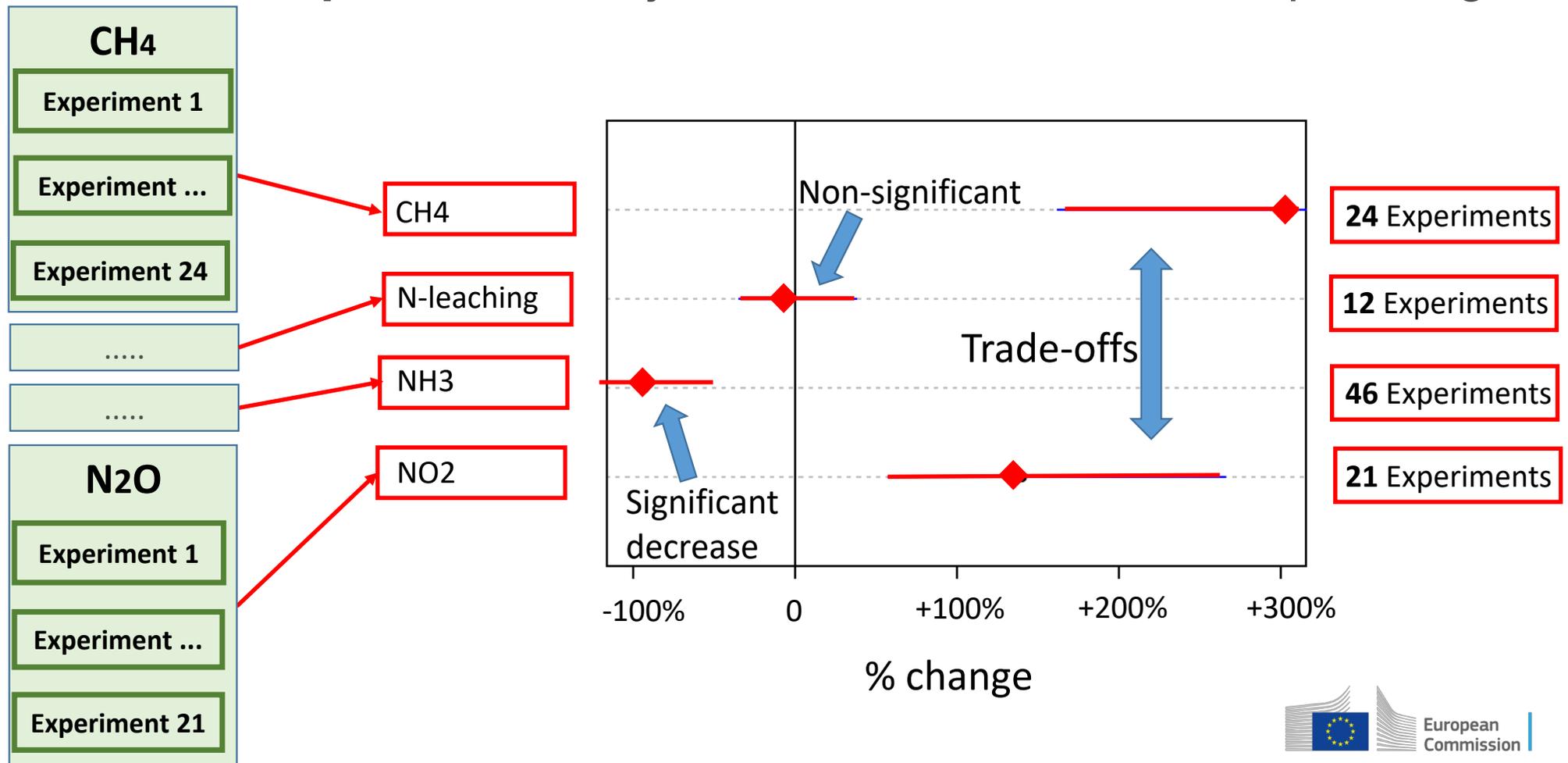
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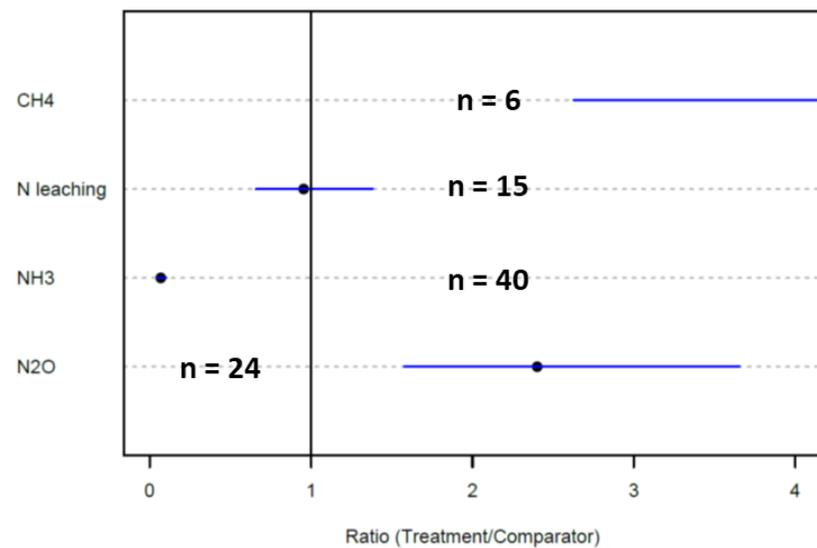
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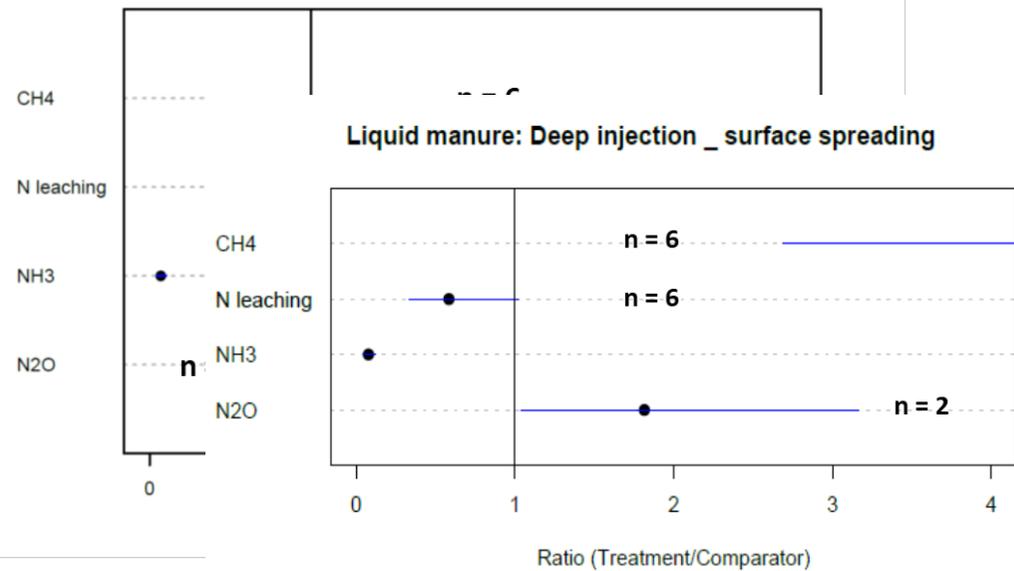
Manure Land application techniques

Injections vs Surface spreading



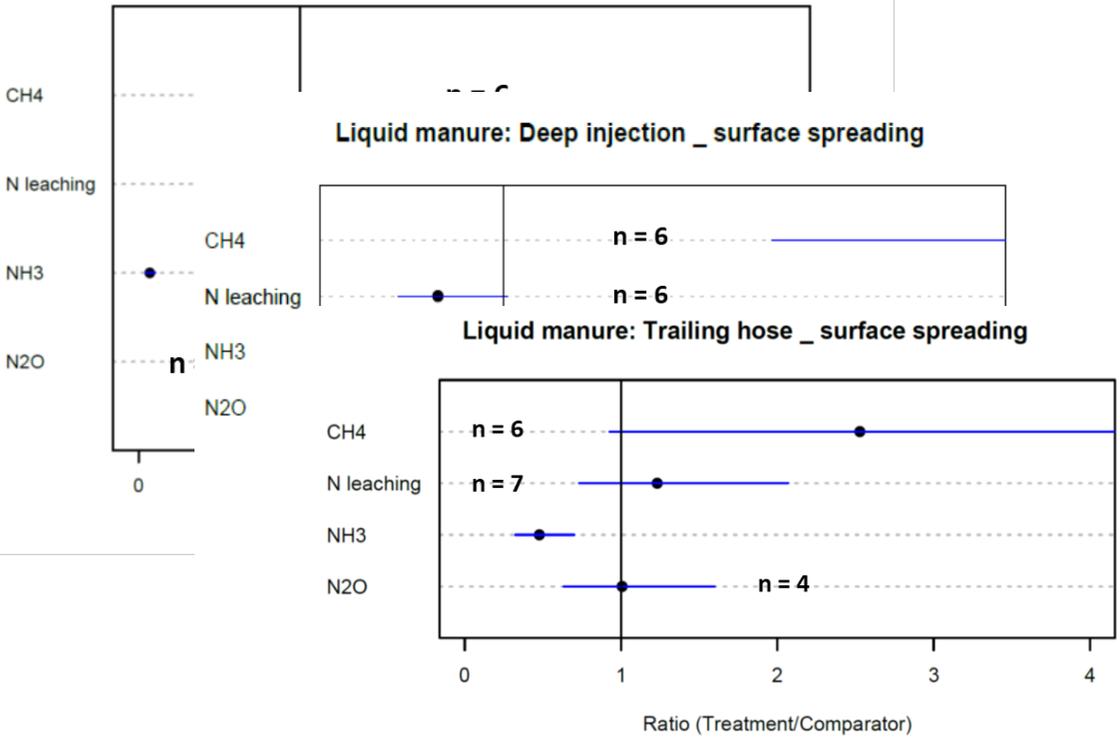
Manure Land application techniques

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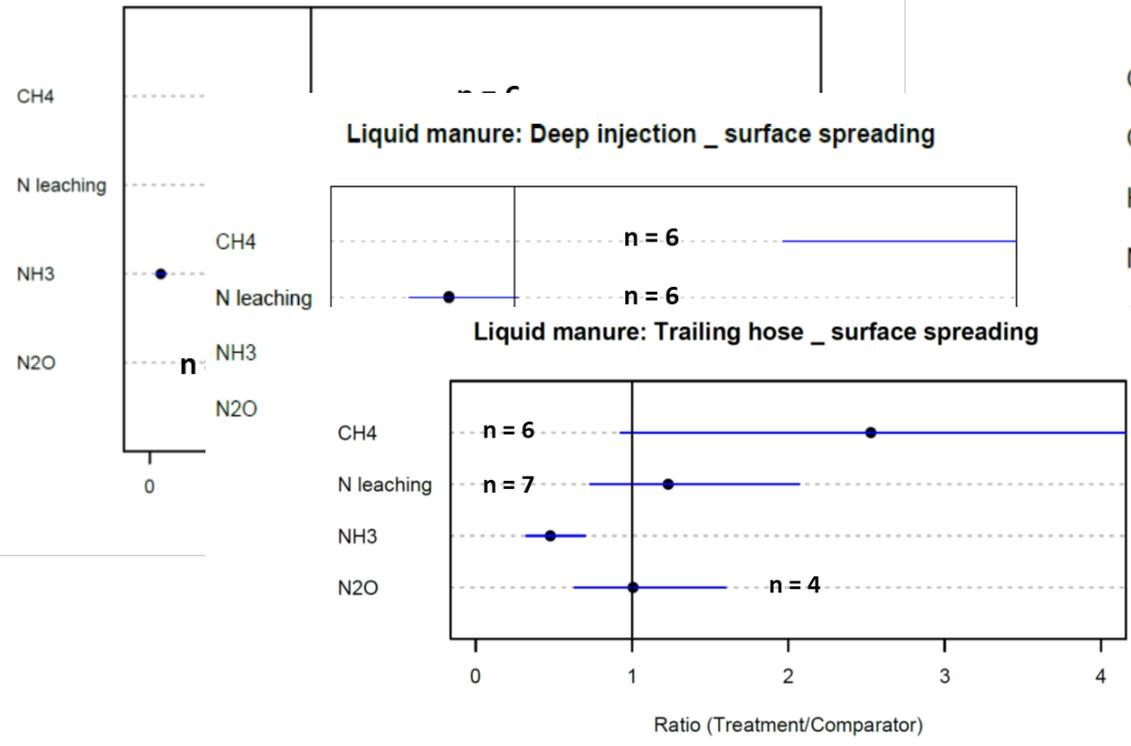
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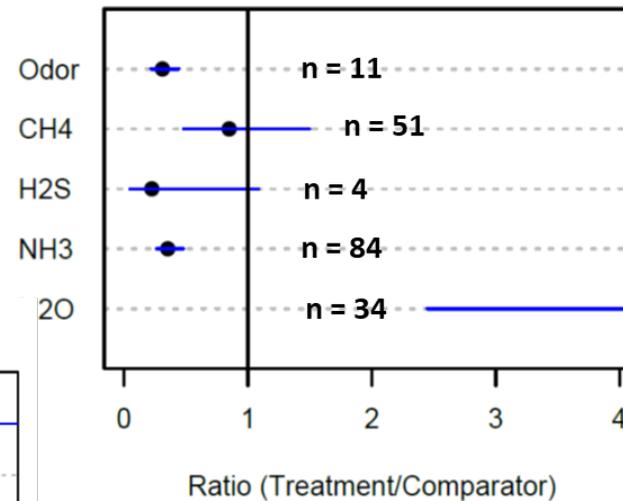
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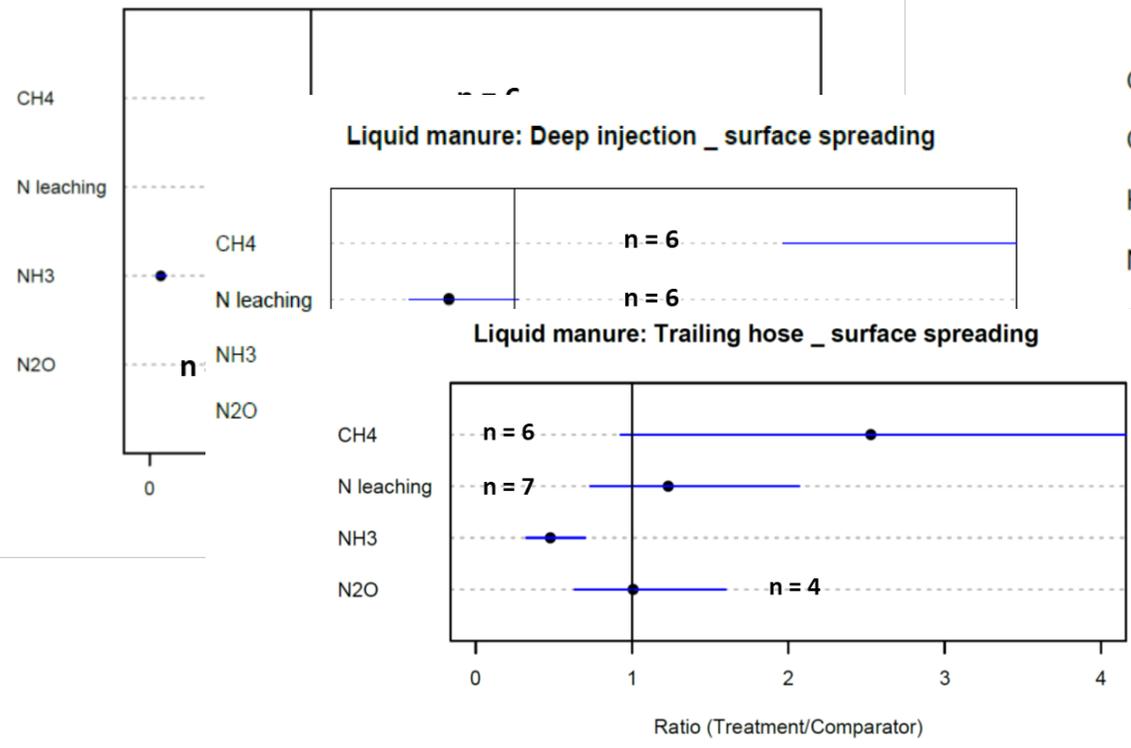
Liquid manure storage

Floating biomass crust vs No cover



Manure Land application techniques

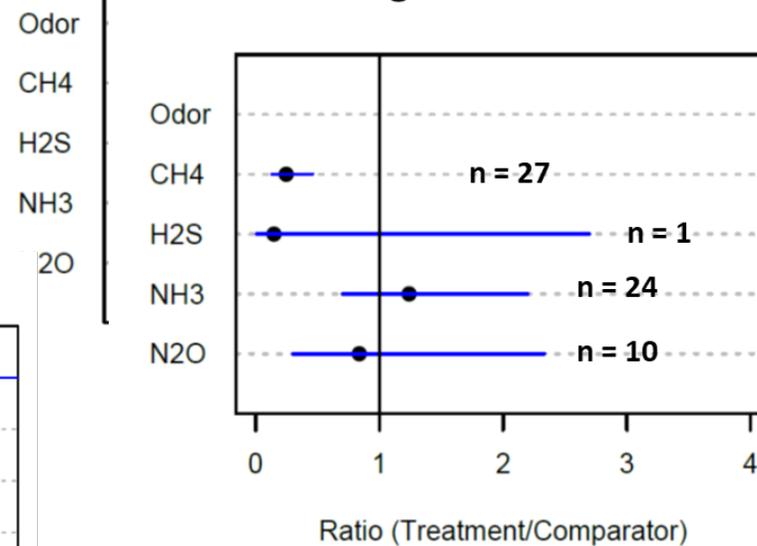
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Liquid manure storage

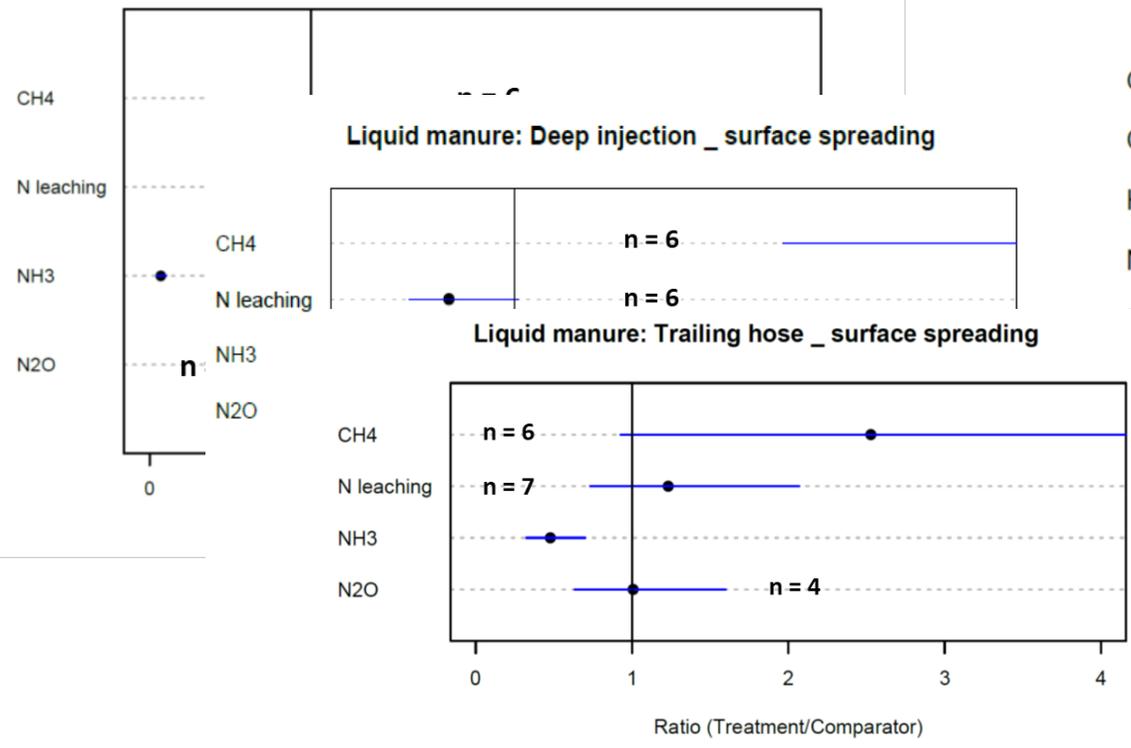
Floating biomass crust vs No cover

Anaerobic digestion vs No treatment



Manure Land application techniques

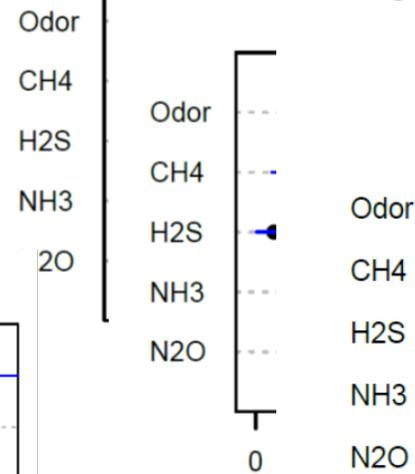
Injections vs Surface spreading



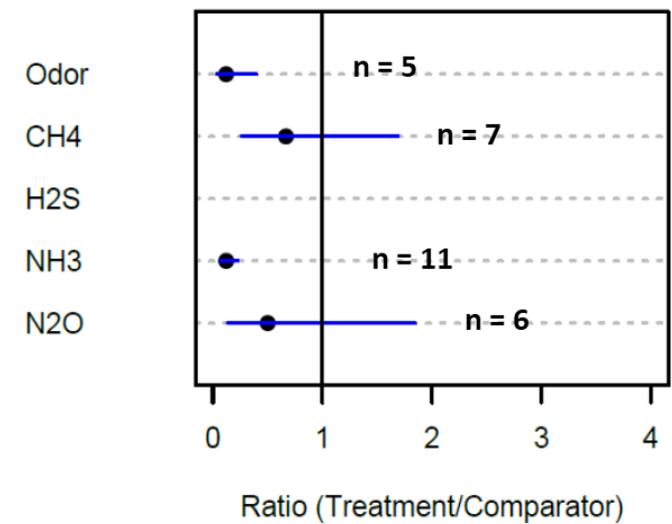
Liquid manure storage

Floating biomass crust vs No cover

Anaerobic digestion vs No treatment



Plastic sheet cover vs No cover



Conclusions

- Evidence-based science helps in reducing bias due to partial and subjective views
- Serves for evaluations in policy decisions
- Serves for building up robust data repositories
- identifies knowledge gaps and addressing research/data collection

Take home messages

Using meta-analysis for ex-post evaluations of RDP measures at MS or regional level?

- Local databases of EXPERIMENTAL EVIDENCE should be created
- Regional/national research and monitoring agencies should report data under standardized forms, in databases
- Data can be used in meta-analysis to obtain evidence
- The calculation of indicators (e.g. of emissions) should be based on evidence, instead of on expert-based or single-projects data.