

Measures to reduce nitrate losses in agriculture

Summary of literature and case study findings

WP4

Mart Ros

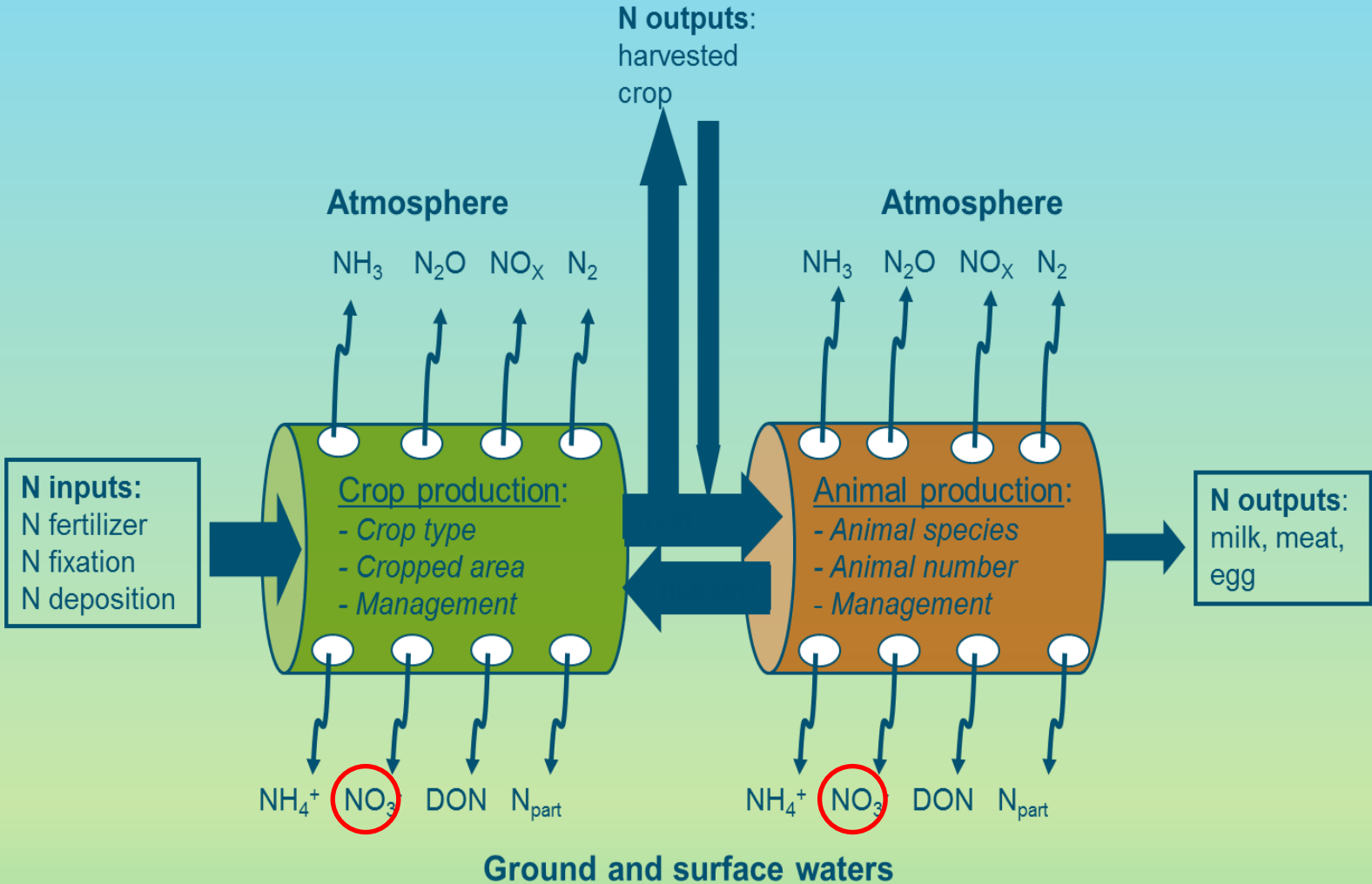
Wageningen Environmental Research



Introduction

- Access to safe drinking water is vital for public health and welfare.
- The EU maintains a guideline of 50 mg/L for NO₃ and 3 mg/L for NO₂ in drinking water sources (ground and surface waters).
- Agriculture is an important source of NO₃ in ground and surface waters.

Introduction



Introduction

- N fertilizer use in the EU has decreased since the 90s but there are still places where the 50 mg/L limit is exceeded.
- **Objective:** review the effectiveness of management measures for reducing NO₃ losses to ground- and surface water resources.

We combined:

- a synthesis of existing review papers,
- a meta-analysis of available data from literature
- practice based knowledge from ten case studies across Europe

Existing review papers

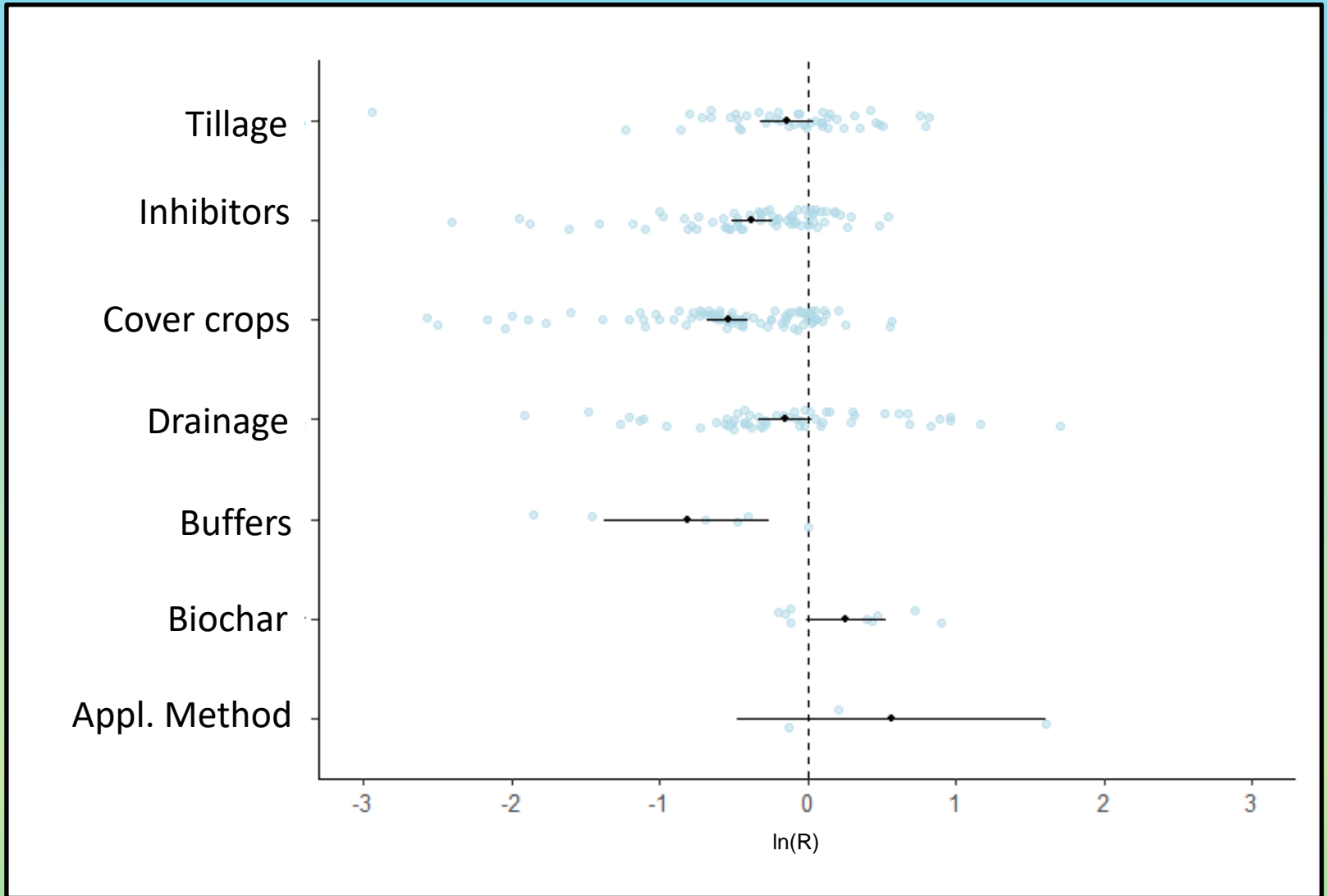
- Search query: (“Nitrate” OR “Nitrogen”) AND (“Mitigation” OR “Measure”) AND (“Meta-analysis” OR “Review”) AND “Agriculture”

Measure	Studies	Average effect	Comments
Cover crops	5	35% to 98% reduction	One study with legumes had the lowest effect.
Biochar	3	N.S. to 26% reduction	Long-term studies showed greater effect.
Inhibitors	3	46% to 55% reduction	DCD was the most used inhibitor.
No tillage	2	N.S. to 13% increase	
Organic farming	2	31% to 32% reduction	But an increase in yield-scaled leaching.
Vegetated buffers	1	68% reduction	
Improved fertilization (4R)	1	40% reduction	

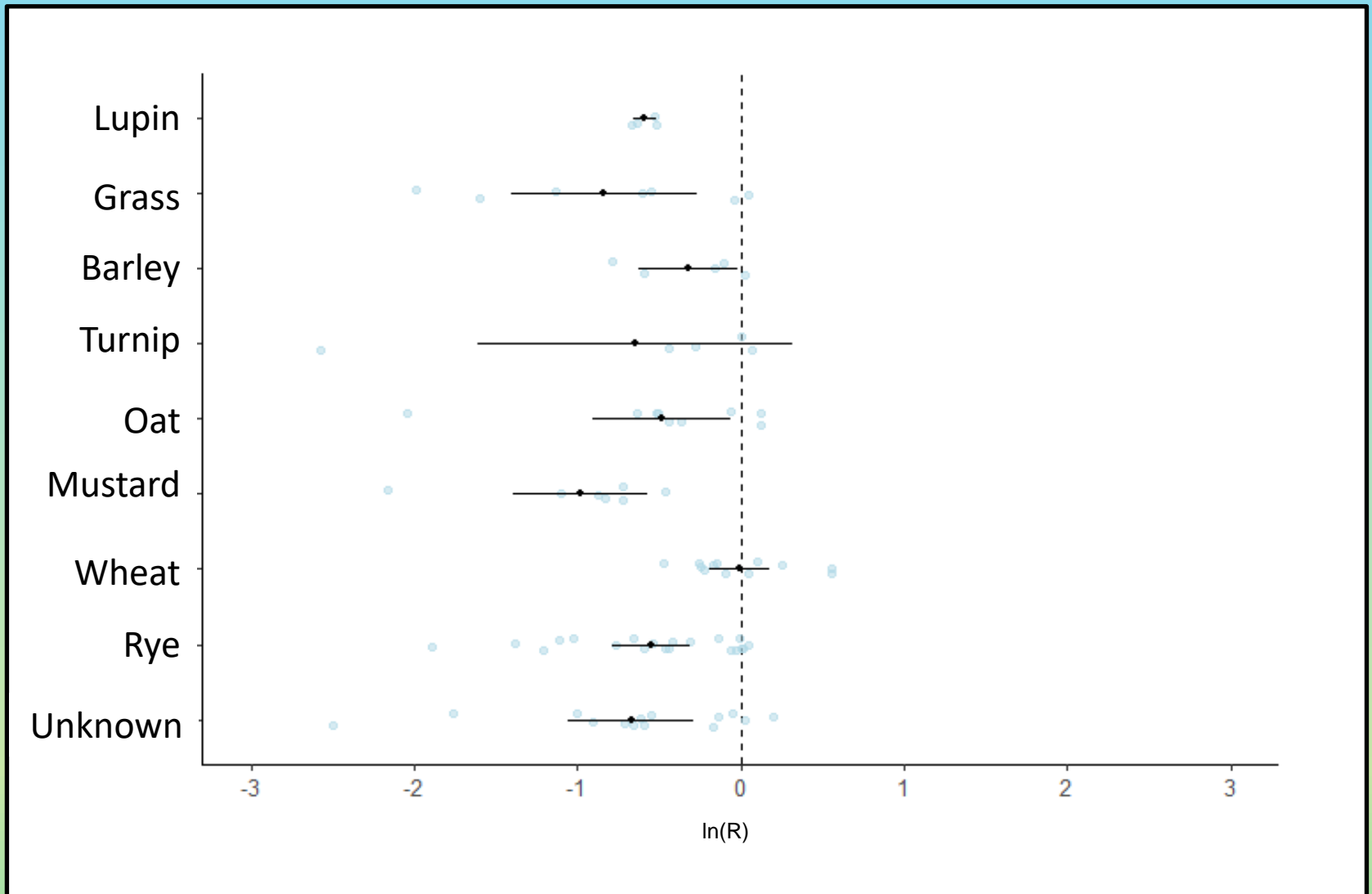
Meta-analysis

- Search query: (nitrate and (leaching or drain* or "surface water" or groundwater or "ground water" or runoff*) and (miti-gat* or measure) and (agricult* or farm* or crop* or field*) and (effect* or reduct* or decreas*) and (treatment or "field trial" or experiment) not (model*))
- Resulted in 53 studies and 278 pairwise observations
- Natural logarithm of the response ratio was used as effect size

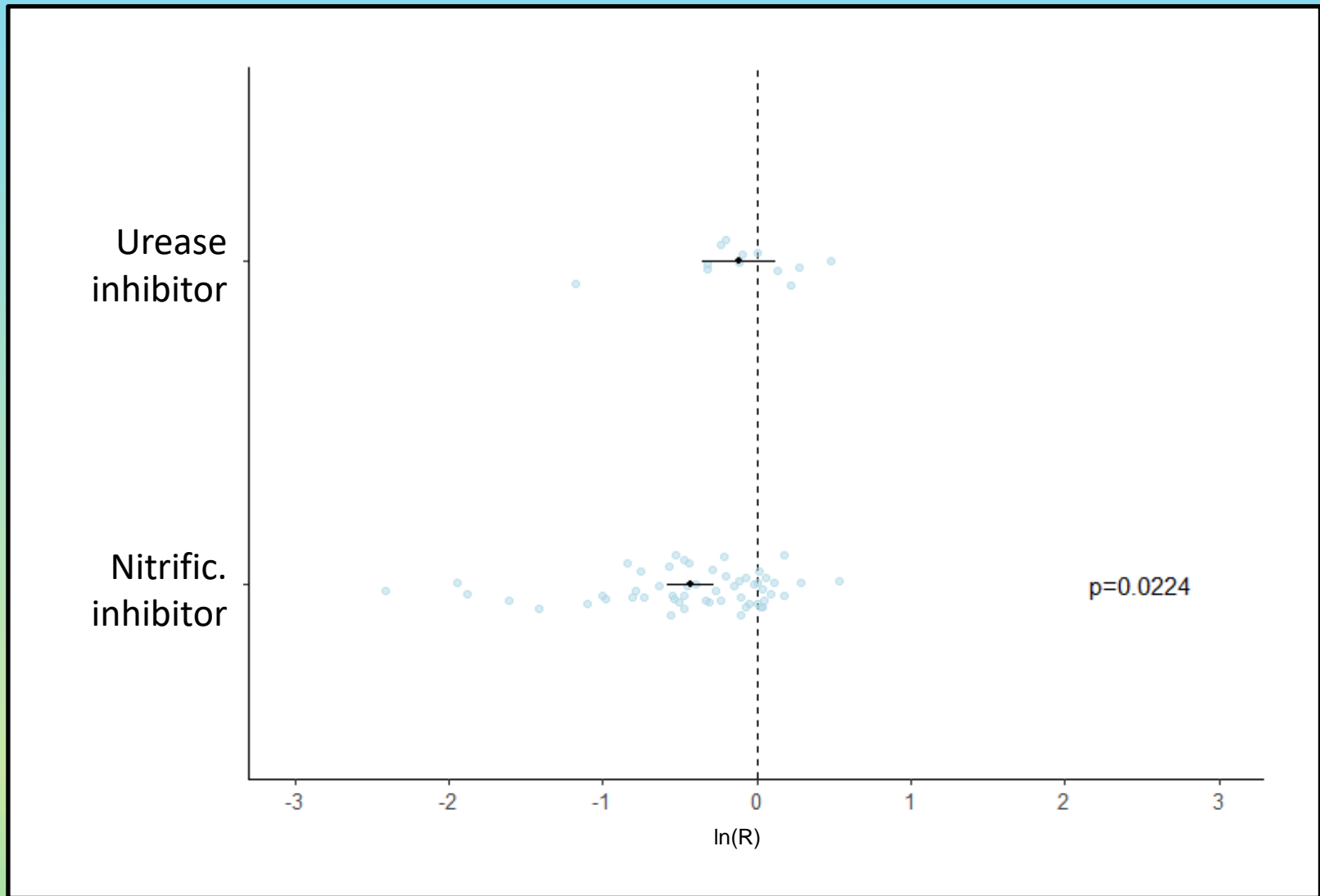
Meta-analysis



Meta-analysis



Meta-analysis



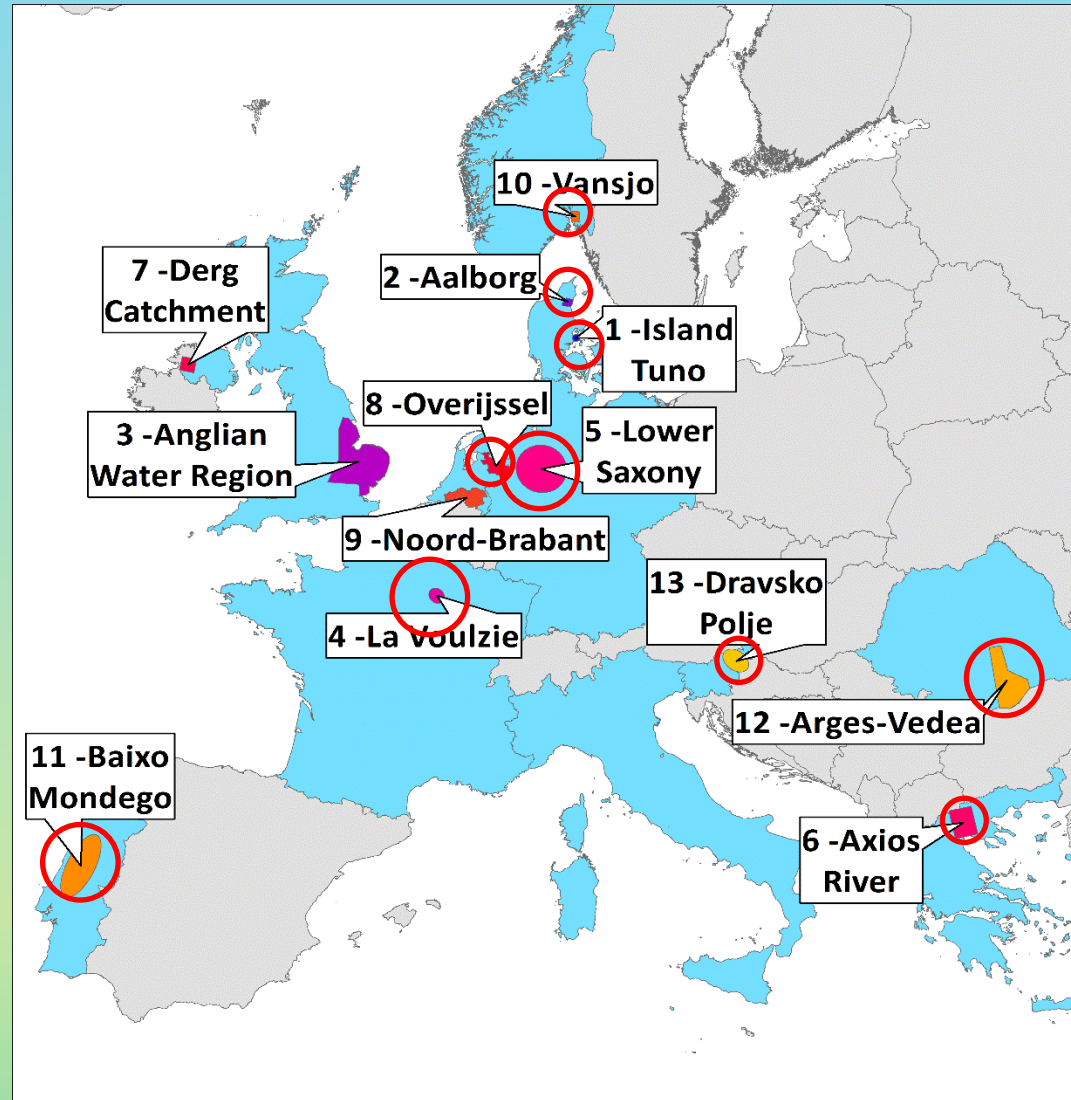
FAIRWAY Case studies

Ten FAIRWAY case studies:

1. Island Tunø, Denmark
2. Aalborg, Denmark
3. La Voulzie, France
4. Lower Saxony, Germany
5. Axios river, Greece
6. Overijssel, Netherlands
7. Vansjø, Norway
8. Baixo Mondego, Portugal
9. Arges-Videa, Romania
10. Dravsko Polje, Slovenia

Local experts were asked about:

- Effectiveness
- Cost
- Applicability/adoptability



FAIRWAY case studies

- 11 (types of) measures were identified
 - Changes in fertilization timing and dose, cover crops, buffer strips were most documented.
- Most effective: changes in fertilization timing, cover crops, grassed water ways
- Lowest cost: changes in cropping system, fertilization timing/dose, farm nutrient management tools, outreach events
- Most likely adopted: changes in fertilization timing/dose, farm nutrient management tools

Measure type	No. CS	Effectivity	Cost	Applicability + adoptability	Notes
Changes in cropping system/rotation	2	++	€	++	May improve soil health/quality, decrease chance of diseases.
Changes in fertilization timing	5	+++	€	+++	E.G. no manure spreading in the fall or splitting fertilizer applications. Expenses may increase if it demands more labour or requires additional manure storage space.
Changes in application method	2	++	€	++	Effectivity may depend on the farm, may decrease other N losses such as greenhouse gases.
Changes in application dose (reduced input, balanced fertilization, or optimal fertilization)	6	++	€	+++	May require soil testing. May be mandatory.
Cover crops	4	+++	€€	++	May increase soil OM content. Cost varies based on farm type. Less applicable/adoptable in Slovenia.
Reduced tillage	1	++	€€	++	May prevent soil erosion.
Buffer strips (either between crops and waterways, or between rows of crops)	5	++	€€	+	May contribute to landscape diversity, but decrease crop yields. Implementation costs differ per country.
Grassed waterways	1	+++	€€€€	+	May reduce erosion and contribute to landscape diversity. Reduces the amount of cropland
Farm-scale nutrient management tools	1	*	€	+++	Farmers may be obliged to use these tools.
Outreach and information events	1	*	€	++	Effectivity depends on farm type and farmer knowledge.
Other	1	?	?	?	Grassland and grazing management; improved fertilizer storage; no data available yet.

Discussion/conclusion

- There is a lot of literature information available on NO_3 losses to ground and surface waters. Particularly, the use of **cover crops**, (nitrification) **inhibitors**, and **biochar** has been well-documented.
- **Non-legume cover crops** appear an effective way of reducing NO_3 losses, but this effect is diminished when legumes are included.
- Use of **DCD** also seems an effective measure that can be profitable. Application on a broad scale might be difficult.
- For many methods results can be variable.

Discussion/conclusion

- Differences between measures described in meta-analyses/reviews and those adopted in the case studies. Effect mitigation vs. source reduction.
- Implementation of measures should consider potential **side effects**.

