WaterMARKE

Mitigating Agricultural Impacts through Research and Knowledge Exchange

Improving Water Quality on Farms
A Socio-Economic & Behavioural Perspective

Teagasc Signpost Series Oct 28 2022

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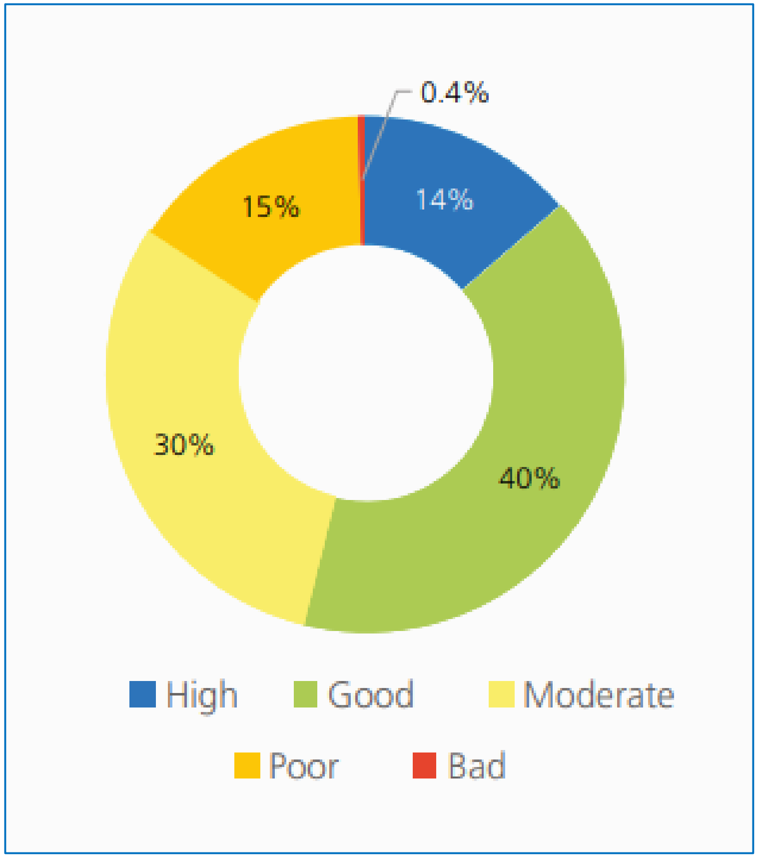
Teagasc — Agriculture and Food Development Authority

Ollscoil na Gaillimhe — University of Galway

EPA 2016 - 2021 report

- Unlikely that Ireland can meet Water Framework Directive (WFD) target of good water quality in all waterbodies by 2027 and maintain high status
- Agriculture is a significant pressure on water quality.



The Nature of the Problem

Mitigating declines in water quality is complex and challenging…

Nutrient and sediment losses are:

Context specific

Interactions between activity, local hydrology, soils and weather

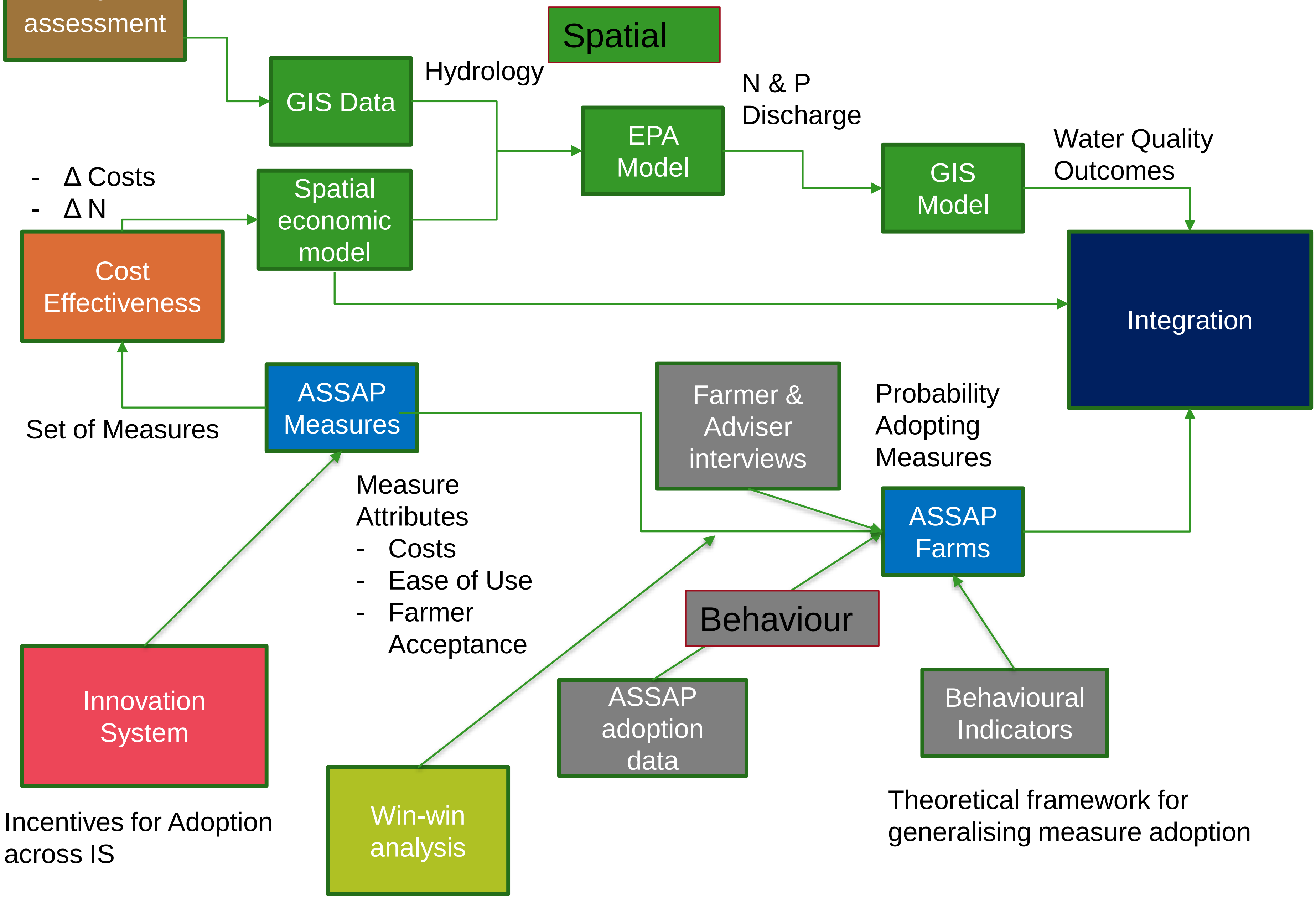
- Spatial and temporal variation
  - Varies across locations and across time

Nutrient losses largely diffuse

Difficult to link pollution outcomes directly to inputs

- Lag between polluting event and resulting pollution
- Lag between mitigation activity and resulting remediation

WaterMARKE components



Biophysical risk

Karen Daly, Owen Fenton, Thomas Moloney

- 10 pilot farms
- Detailed farm-scale risk assessment methodology for P loss risk assessment and associated measures
- Upskilling advisers re implementation of measures

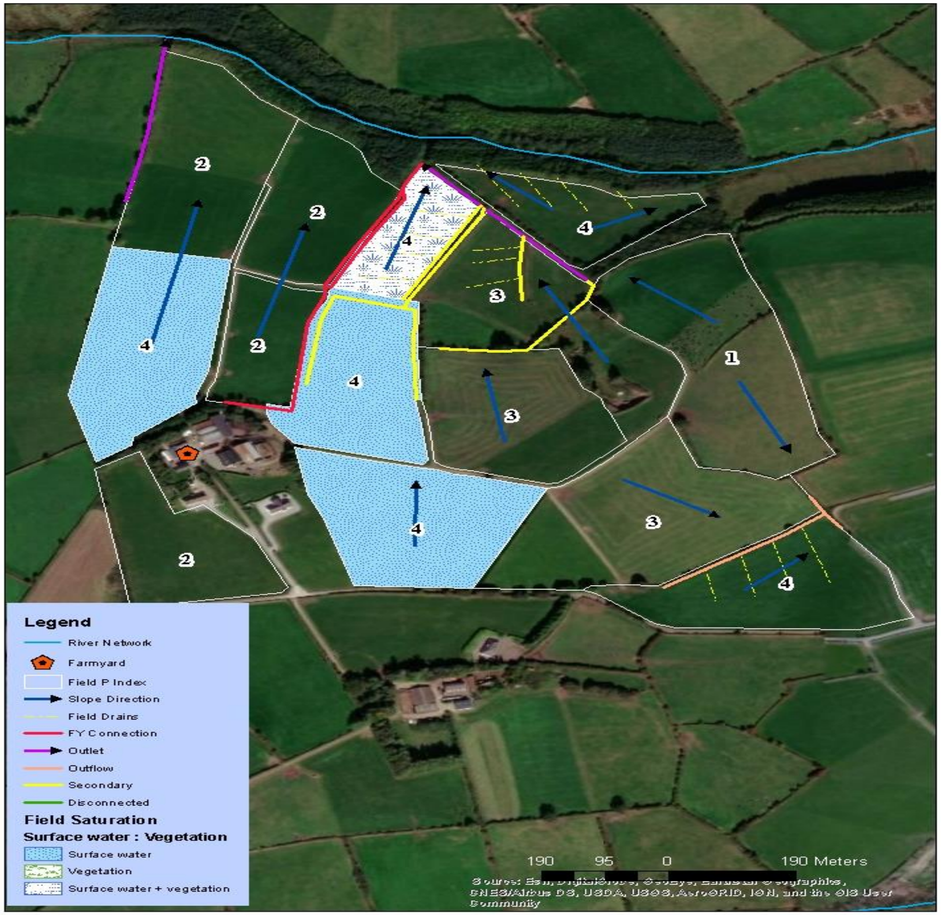

Science of The Total Environment
Available online 2 November 2019, 134556
In Press, Journal Pre-proof

Ranking connectivity risk for phosphorus loss along agricultural drainage ditches

Thomas Moloney, Owen Fenton, Karen Daly

Show more

- Ditch categories
- Field P index
- Slope direction
- Surface water
- Indicator vegetation
- Subsurface drainage
- Clear risk area



Who influences agricultural water quality? (Map of Innovation System)

Intensive Farmers

Extensive Farmers

Local Context and Risk

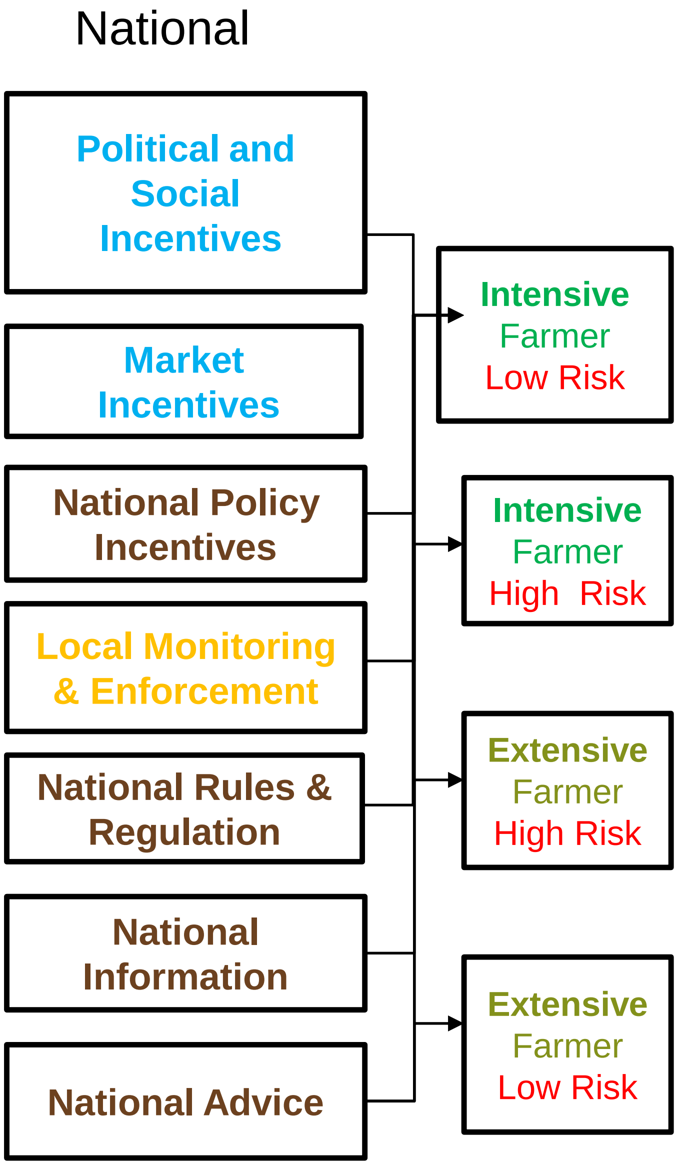
Intensive Farmer
Low Risk

Intensive Farmer
High Risk

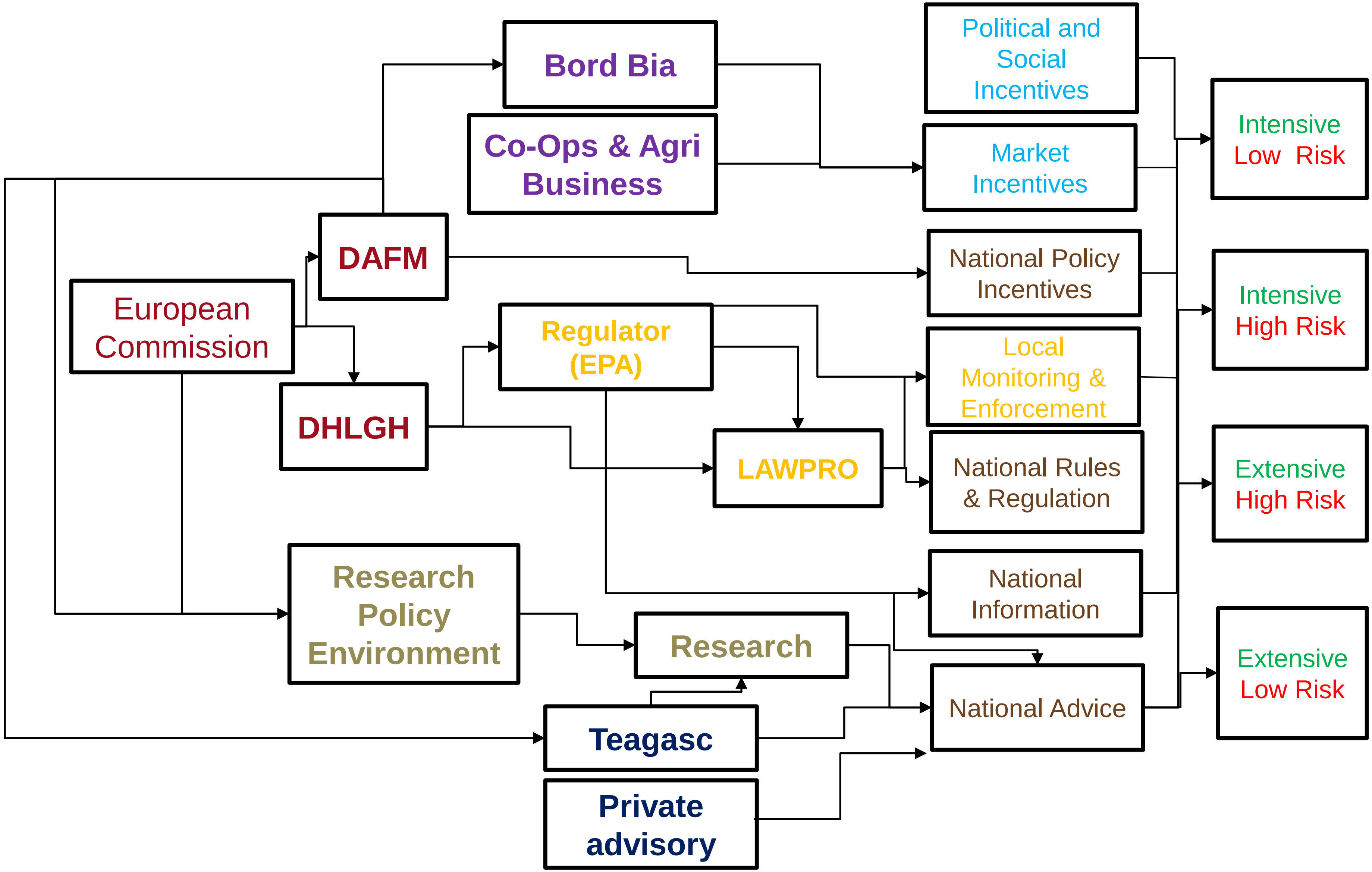
Extensive Farmer
High Risk

Extensive Farmer
Low Risk

Incentives & Regulation



Actors (influencers) in the wider Innovation System



Policy and Legal Framework; Innovation System Governance

WaterMARKE + ASSAP: What can we learn?

- ASSAP measures
- Farm/farmer characteristics
- Psychology
- ASSAP behavioural analysis

Nitrate Leaching Risks

1. Weather conditions greatly impact nitrate losses to waters. Chemical N should not be applied where heavy rainfall is forecast. Also, in drought conditions where grass growth is impacted, N application should be adjusted downwards in accordance with Soil Moisture Deficit (SMD). Contact your adviser for assistance.
2. Early N application should be delayed until grass is actively growing. Nitrate loss can occur when available nitrate in the soil is greater than grass growth demand and is potentially at greater risk of leaching to groundwater.
3. If using organic manures, apply in the spring to coincide with increasing grass growth rates. Adjust subsequent chemical Nitrogen application downwards to take account of nutrients applied in these organic manures.
4. CAN based products are at greater risk of leaching. It is recommended to use protected urea as part of your farm fertiliser programme
5. Apply fertiliser N in accordance with the regulations and observe closed periods for chemical fertiliser application. Adhere to the relevant the 2m buffer margin along all surface water drains and watercourses.

Protected Urea

1. Protected urea allows a farmer to spread urea based nitrogen throughout the growing season without needing to worry that substantial levels of N will be lost.
2. CAN is 50% ammonium and 50% nitrate. After spreading CAN, nitrate is available to grass in the soil. However, this negatively charged nitrate is open to being leached to water if heavy rainfall occurs.
3. Protected urea initially converts to the positively

For more information please visit www.teagasc/environ

Agriculture and Food Development Authority

Farming for Water Quality

Agricultural Sustainability Support and Advisory Programme – ASSAP

Early Nitrogen for Spring Grassland

On grassland farms, having enough grass available for livestock to graze is crucial to ensuring a profitable enterprise. In springtime, applying nitrogen (N) fertiliser will help to provide enough grass as livestock are turned out from winter housing. The timing and rate of fertiliser N application are key decisions to ensure sufficient supply of grass. The challenge is to achieve maximum returns from applied fertiliser N without having negative impact on water quality. Nitrate in the soil is both soluble and mobile. In free draining soils, nitrate loss can occur when available nitrate in the soil that is not recovered during grass growth in spring or autumn is removed by percolating water. If soils become saturated or are subjected to heavy rainfall, this nitrate is more likely to leach down through the soil profile. Once nitrate travels below the root zone, it will be lost to groundwater where it can have a negative impact on water quality.

The times of the year with highest risk of nitrate leaching are early spring and autumn / winter. This is due to the fact that grass growth rates are low and rainfall levels are at their highest. Any nitrate applied during times of low grass growth rate and high rainfall is at greater risk of leaching and careful application of fertiliser N is critical to reduce this risk.

Benefits of Improved Spring Nitrogen Use

- N applied in suitable conditions will help improve Nitrogen Use Efficiency
- Better grass growth response to nutrient applied
- Reduction in the level of nitrate leached to groundwater
- Reduced negative impact on water quality
- Improved financial return from fertiliser investment
- Potential to reduce fertiliser N rate required and reduce fertiliser costs on farms

TIPS WHEN APPLYING EARLY SPRING NITROGEN

- Only spread if fields are suitable for tractor work, when water is drained sufficiently and and where heavy rainfall is not forecast. Apply fertiliser N when soil temperature is greater than 6°C and rising. Typically this occurs around the end of February however, this will vary across the country and from year to year.
- Target fields for early N that are most likely to respond to an early N application: fields at optimum soil fertility (pH, P and K), perennial ryegrass swards, recently reseeded or with a grass cover of greater than 400 kg DM/ha or 5 cm grass.
- Match chemical N applied to grass growth rates as this varies across the country. Apply up to 30kg N/ha (24 units N/ha) maxiumum in 1st split and avoid fields that have received an application of cattle slurry
- Applying slurry in spring - 25 m^3/ha (2,500 gals/ac) by low emission application will supply ~25 kg/ha (~20 units/ac) of available N. It is important to reduce your chemical N application rates accordingly.
- To ensure efficient and accurate application of fertiliser, calibrate fertiliser spreaders and use GPS equipment where available
- Use protected urea for early N applications as this will help reduce the risk of nitrate leaching

Factsheet No 2

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University of Galway

ASSAP measure characterisation

Noel Meehan

- ASSAP advisors recommend measures to address 44 different issues
- Issues classified by type:
  - Farmyard
  - Land Management
  - Nutrient Management
- 90 different actions resulting in approx. 300 measure/issue combinations

ASSAP measure characterisation

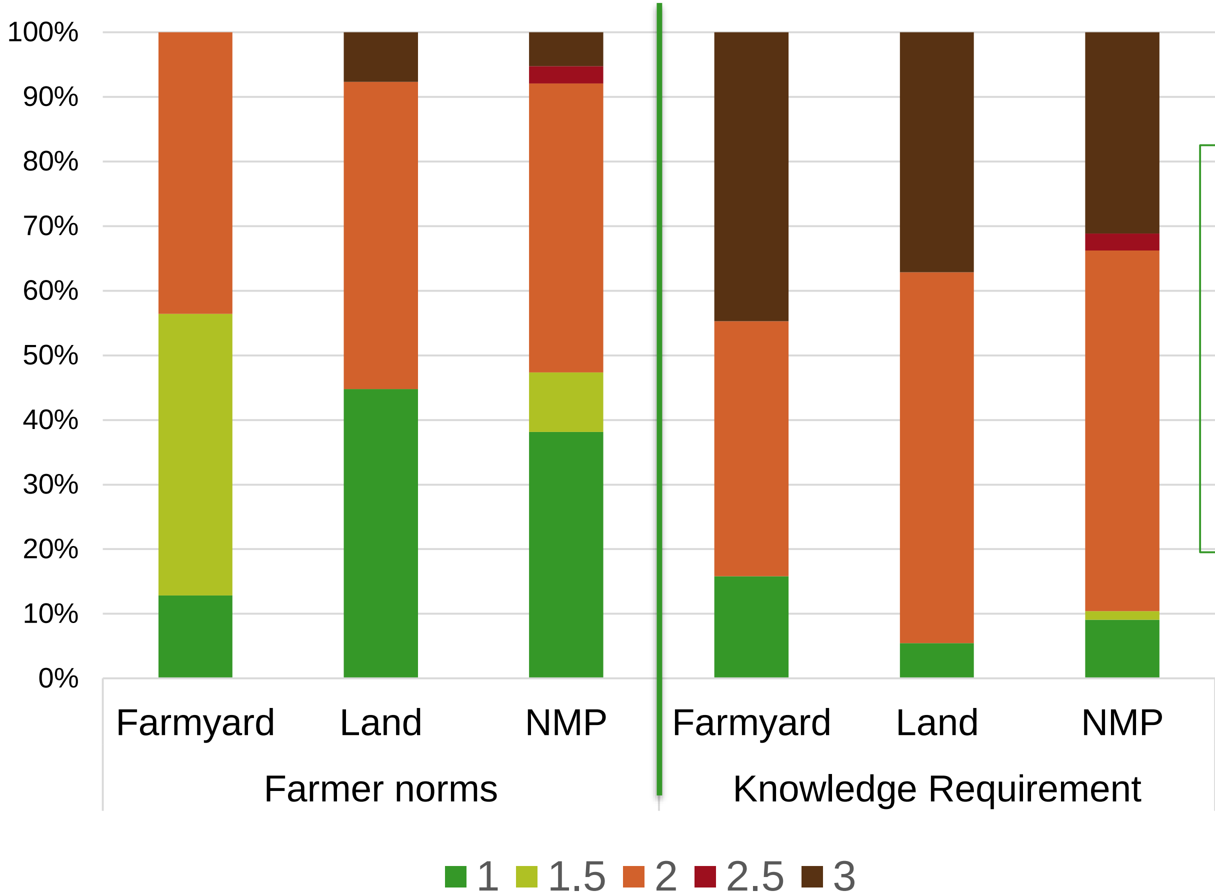
- **Knowledge**
  - Know-how, capacity, skill
- **Costs**
  - Upfront, ongoing, labour, lost area, lost productivity, farmer transaction costs (hassle, time), system transaction costs
- **Social (farmer & advisor) norms**
  - Does it align to conventions
- **Impact**
  - Scale of impact, adviser classification

ASSAP measure characterisation

44 issues | 90 actions | 300 measures

3 = aligns with farmer norms

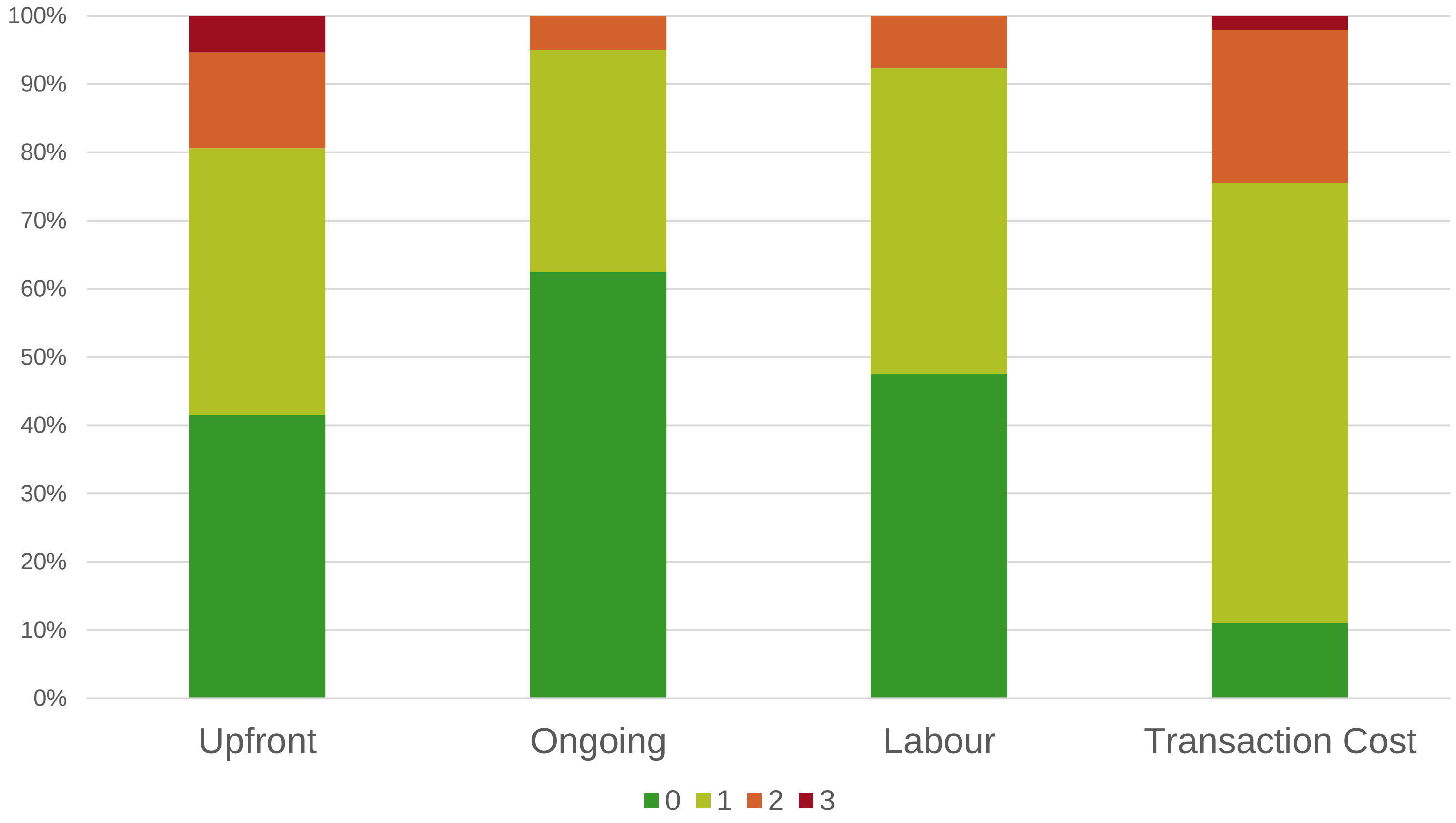
Measures assigned to farmyard issues are more aligned



3 = high knowledge required

Large number of measures require medium to high knowledge

ASSAP measure costs



ASSAP measure characterisation

Goal

- Identify measures that fit norms and have relatively low costs (or savings) compared to environmental impact
- Clustering of measures

Benefits:

- Measure priority, simplification, impact estimation

Opportunity to mainstream?

- Prioritise advisor training and farmer education

ASSAP Data Analysis: Measure Uptake + Risk

Catchment Risk	Agreed to undertake measure	Has started measure	Completed
N	8606	7797	7435
Pseudo R2	0.1062	0.1271	0.1685
Risk (High)		-***	
Risk (Moderate)		-***	-***
P Loss (Diffuse) (Y)		-***	-***
N Loss (Diffuse) (Y)		-***	
Sedimentation (Y)	-***	-***	-***
Point Source Losses (Y)	+***	+***	+***

High/medium risk farms less likely to have started than low risk

Farmers in catchments with **diffuse** P, N and sediment **losses** less likely to have engaged

Farmers in catchments with **point source losses more likely to have agreed, started and completed measures**

ASSAP Analysis: Farm characteristics

Farm characteristics	Agreed to undertake measure	Has started measure	Completed
N	8606	7797	7435
Pseudo R^2	0.1062	0.1271	0.1685
Cattle Breeding	+*	-**	
Cattle Other		-**	
Dairy		-**	
Mixed Farming		-**	
Sheep		-*	
Tillage			
Farm Size	-**		+**
Is Engaged	+***		+***
In an Agri-Env Scheme		+***	+***

Livestock systems less likely than tillage to have started

Agri-env scheme participants more likely to have started and to have completed

Cost-effectiveness of N mitigation measures

Daniel Urban (University of Galway, Scotland's Rural College

- How does cost-effectiveness of N mitigation measures vary spatially?
- Allows analysis of spatial distribution of impacts and drivers of variation in response to measures

Cost per unit (of pollution) abated (€ per kg of E*) = (Change in gross output – Change in direct costs) / Reduction in quantity of emissions (∆E)

*Emissions

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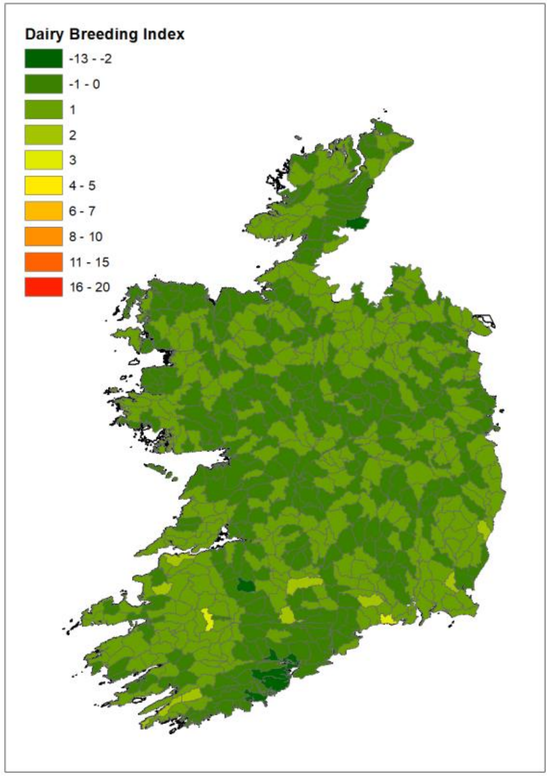
Marginal Abatement Cost by Electoral District

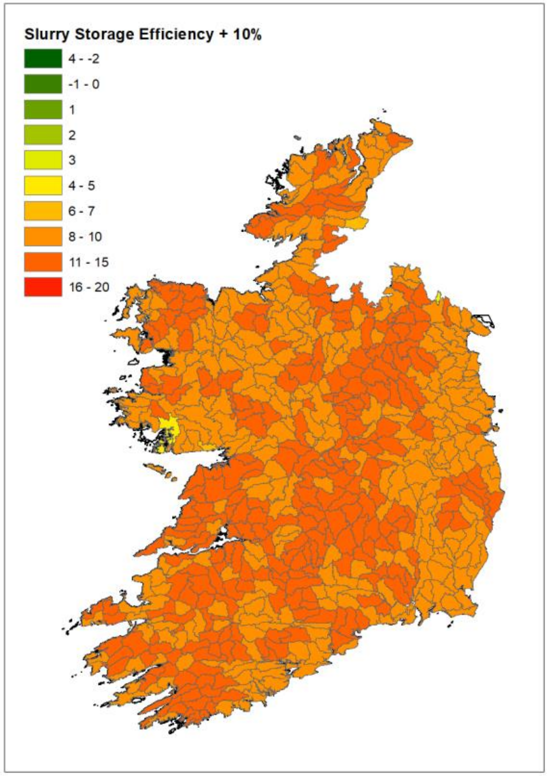
Win-win

Inc. dairy breeding index



Win-lose

Inc. slurry storage efficiency



- Green – savings per unit emission decreased
- Yellow/Orange/ Red costs per unit decrease in emission

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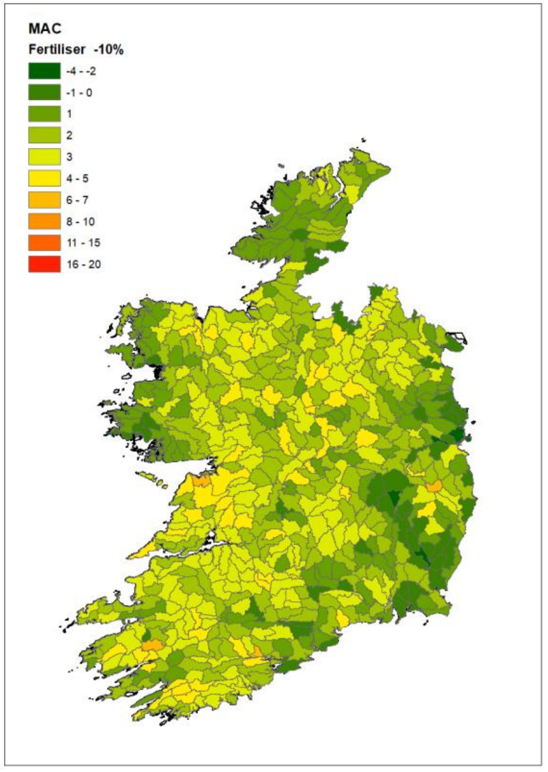
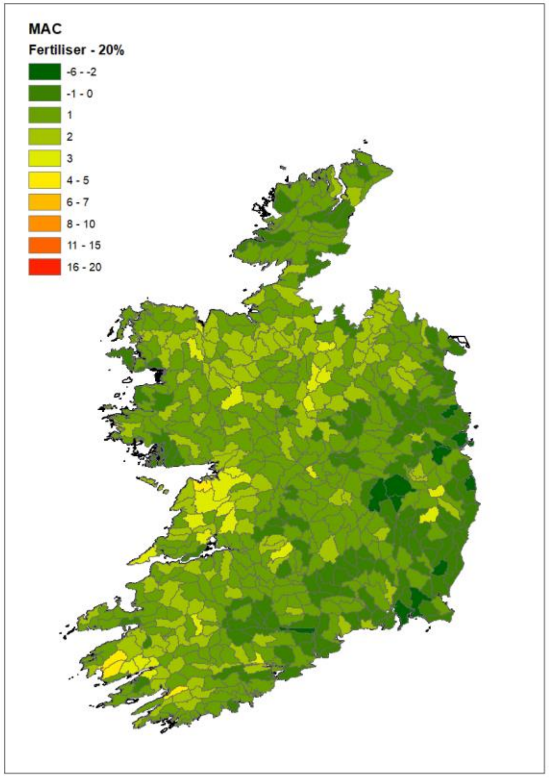
Marginal Abatement Cost (Local)

- Model suggests decreasing fertiliser use results in savings or costs
- Higher savings for 20%
- Spatial variance

Chemical fertiliser (10%)



Chemical fertiliser (20%)



Spatial MAC combined with other work (behavioural and environmental spatial modelling) can aid in identifying cost-effective combination of measures

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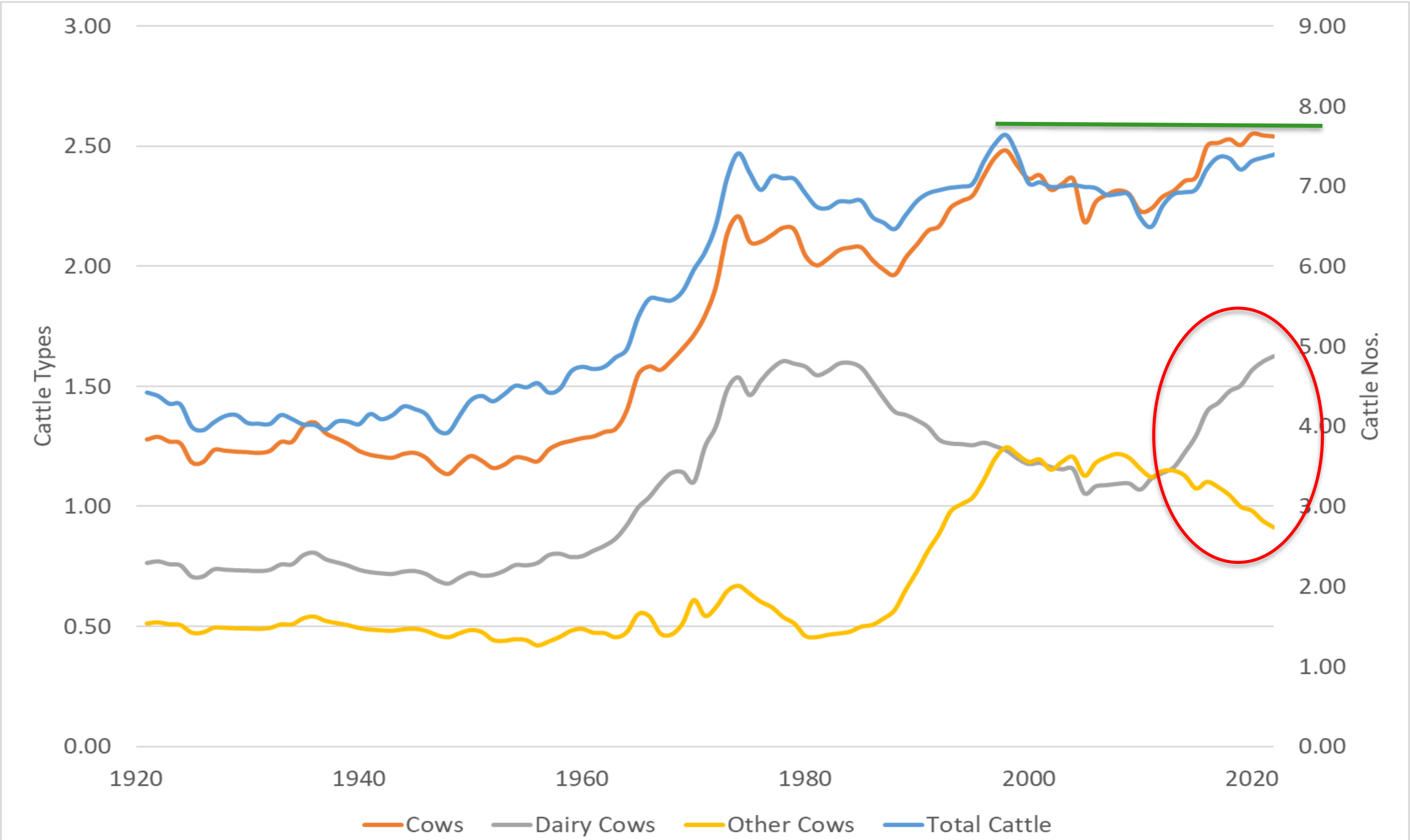
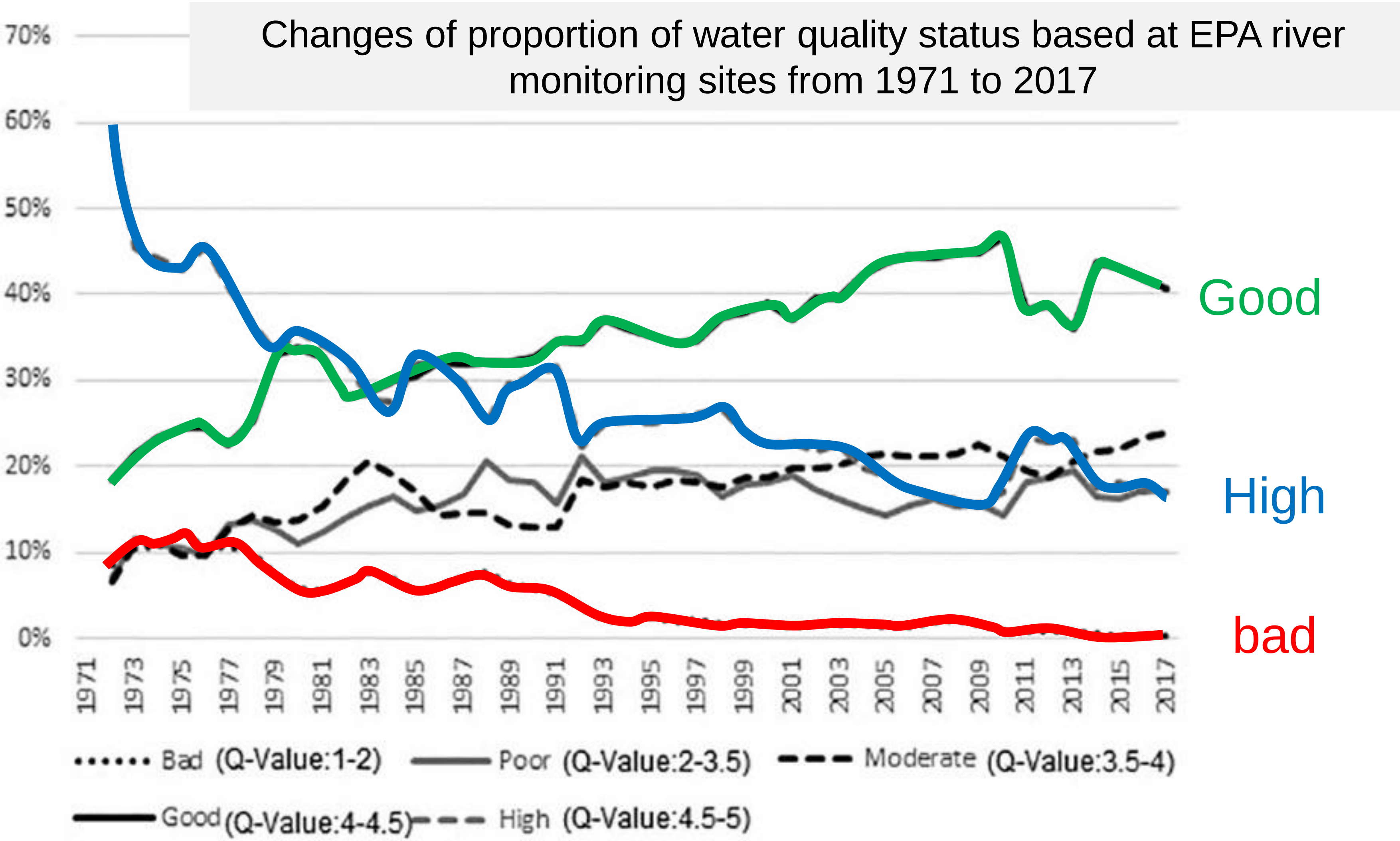
Cattle Numbers



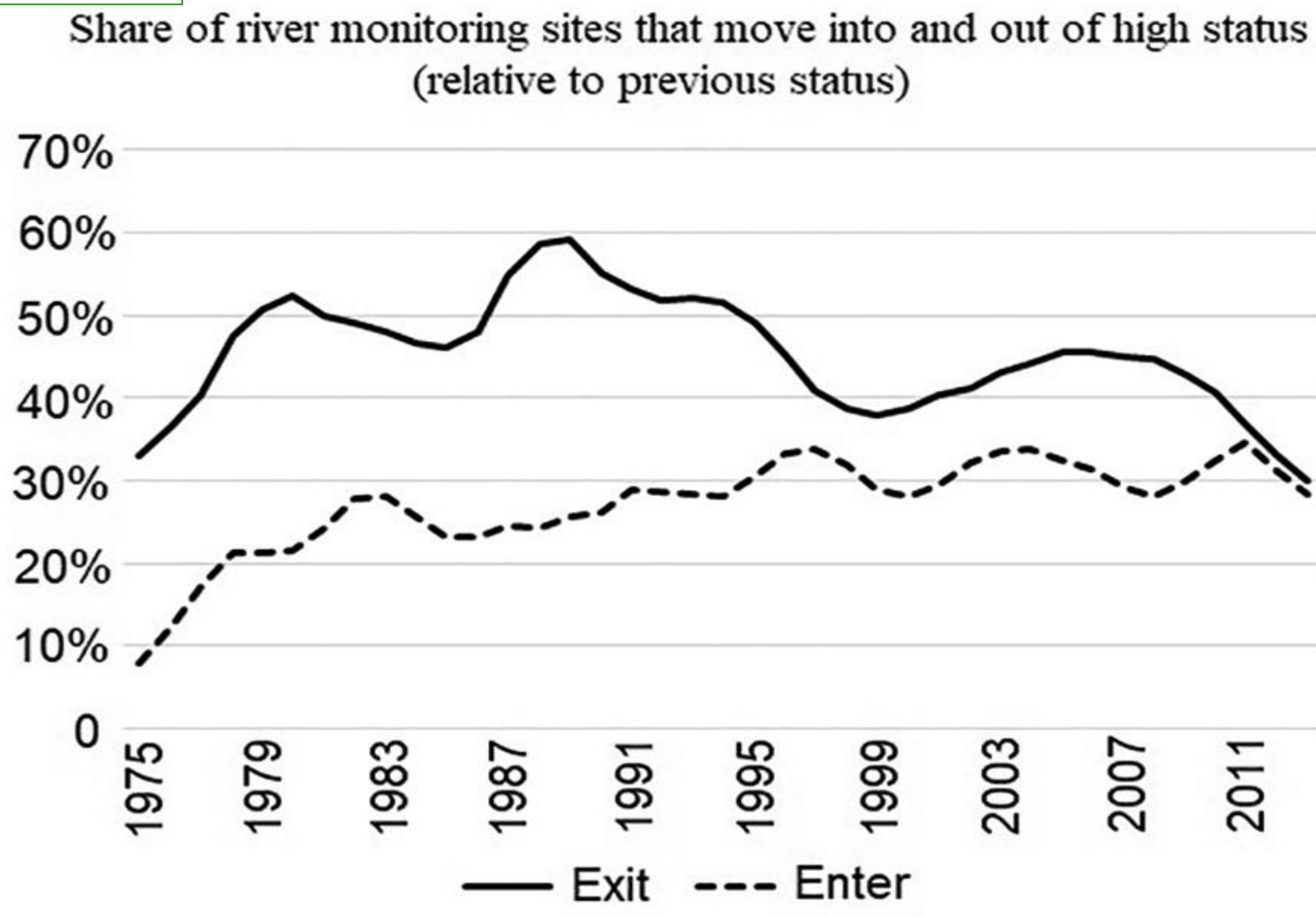
Trends in Shares of Different Water Quality Status



O'Donoghue, C., Buckley, C., Chyzheuskaya, A., Green, S., Howley, P., Hynes, S., Ryan, M. 2021. The Spatial Impact of Economic Change on River Water Quality. Land Use Policy. 103, 105322 https://doi.org/10.1016/j.landusepol.2021.105322

Mobility between High Status and Non-high Status

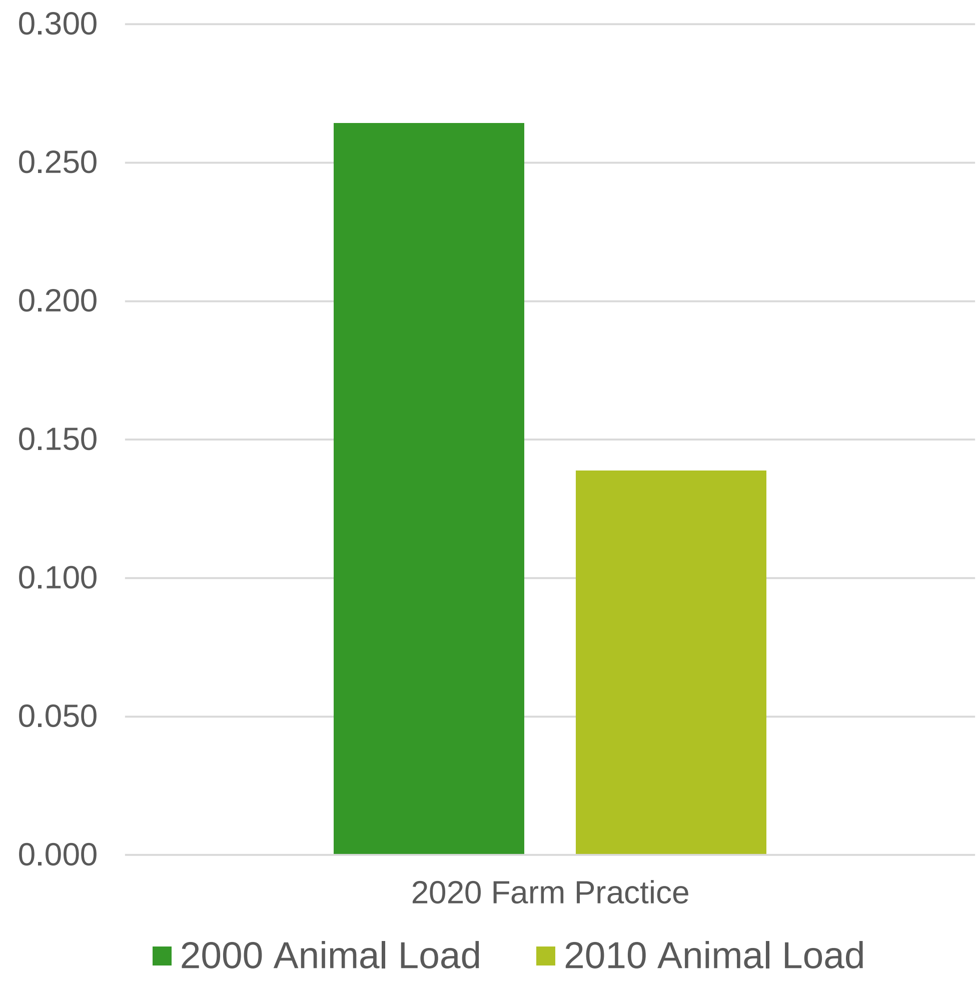
Yuting Meng



O'Donoghue, C., Meng, Y., Ryan, M., Kilgarriff, P., Zhang, C., Bragina, P., Daly, K. 2021. Trends and Influential Factors of High Ecological Status Mobility in Irish Rivers. Science of the Total Environment. 151570.

Economics: Animal Load, Farm Practices and Water Quality

- **Linking water quality** data for rivers to upstream **land use and economic activity**
- We have **published** a series of papers
- **Clear link between activity (animals & fertiliser) and water quality**
- We find that **farm management practices of 2020** would see improvements on the activity of 2000 or 2010
- Therefore **decline in WQ 2010-2020 resulted from increases in animal numbers outstripping improved practice**



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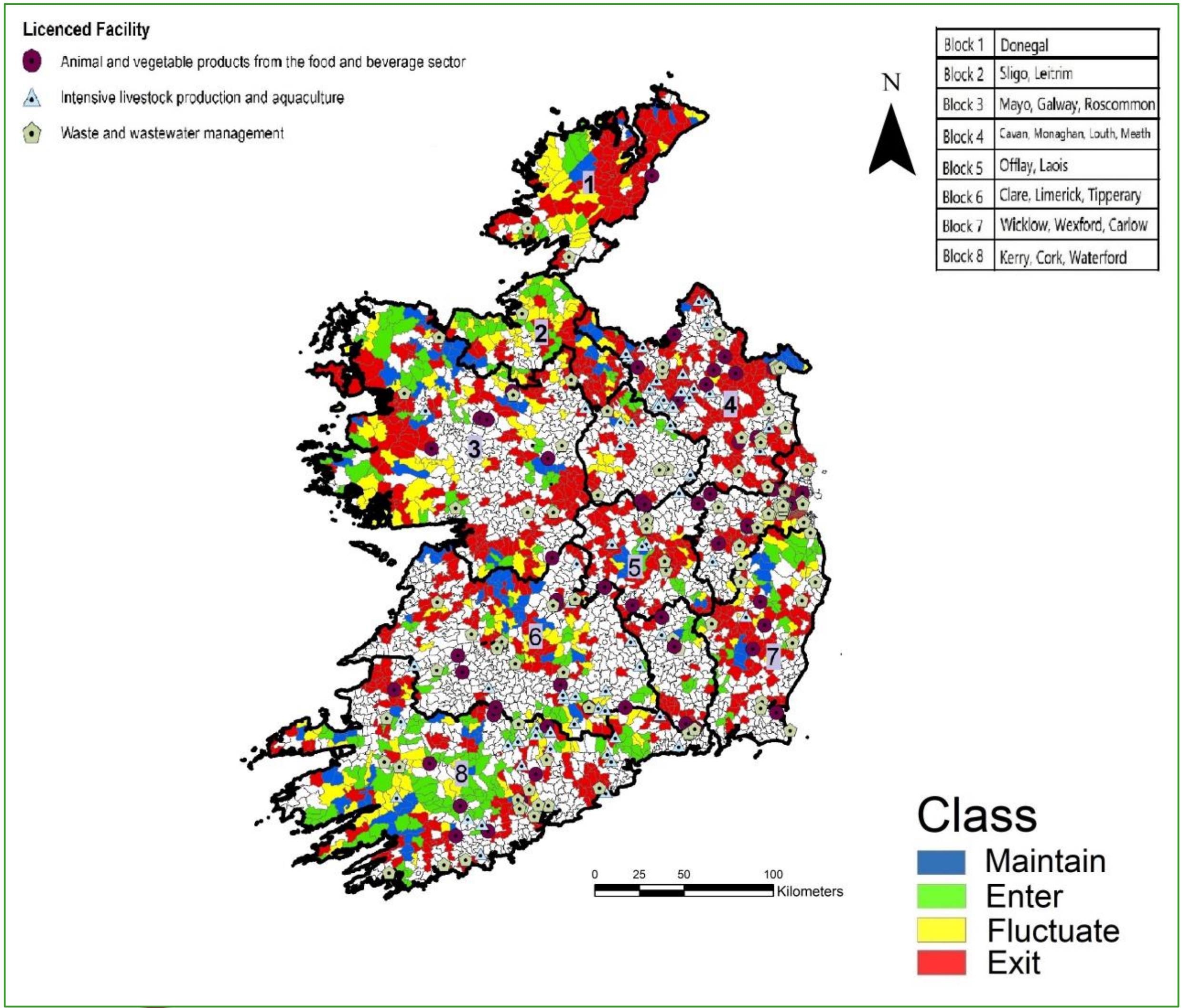
Drivers of water quality are localised

Yuting Meng

Variations in location of waterbodies exiting and entering High Status

Drivers of these fluctuations also **vary by region** Also **variation across regions**

Local situation very **important**

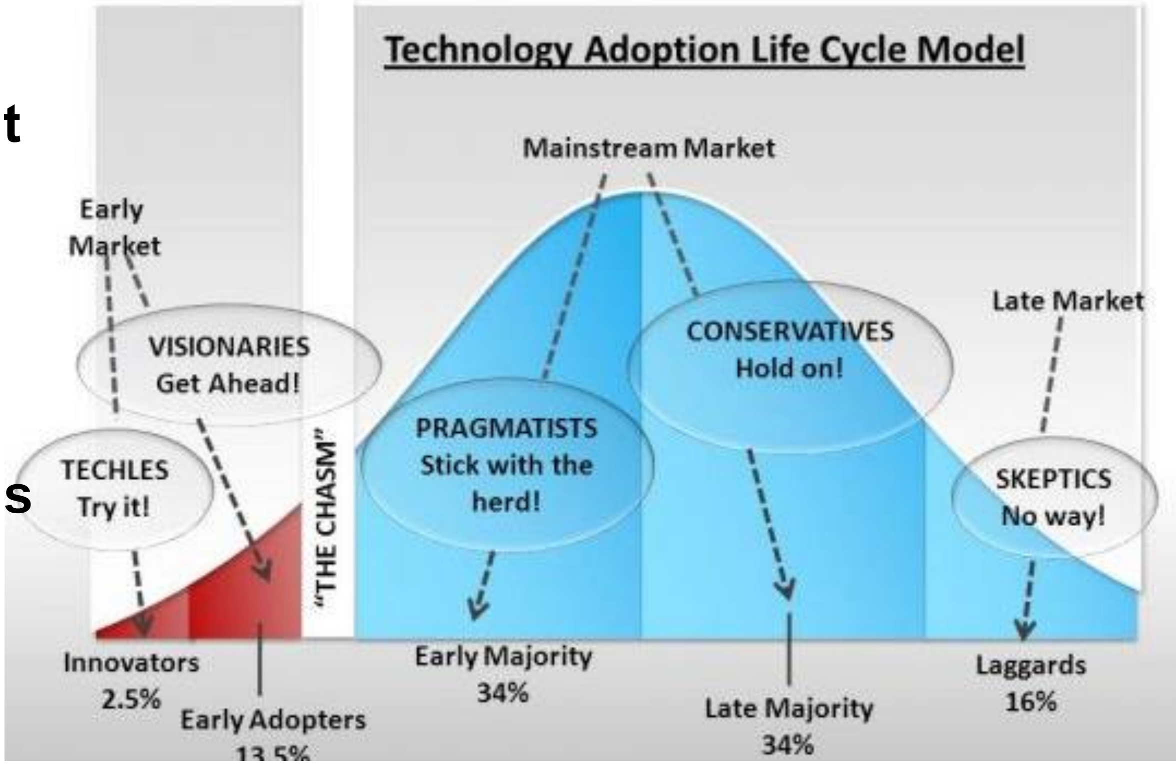


Economics

- Economically, **a national solution** (rules and regulations) to a **local problem** will result either in
  - The problem **not being solved** because the **regulations were too weak** or
  - Being **too expensive if regulations target the lowest common denominator** in applying rules to improve water quality for the most challenging environment to all farmers
- It is clear therefore that **solutions to a local problem require local solutions**.

Why don't farmers implement win-wins?

- Information failures →**haven't heard about it**
- **Income is not only driver**
  - If it takes too much **time**
  - Too much **hassle**
  - Not consistent with **norms**
- Personal Risk **attitudes**
  - **Early Adopters**
  - **Mainstream**
  - **Late Adopters**



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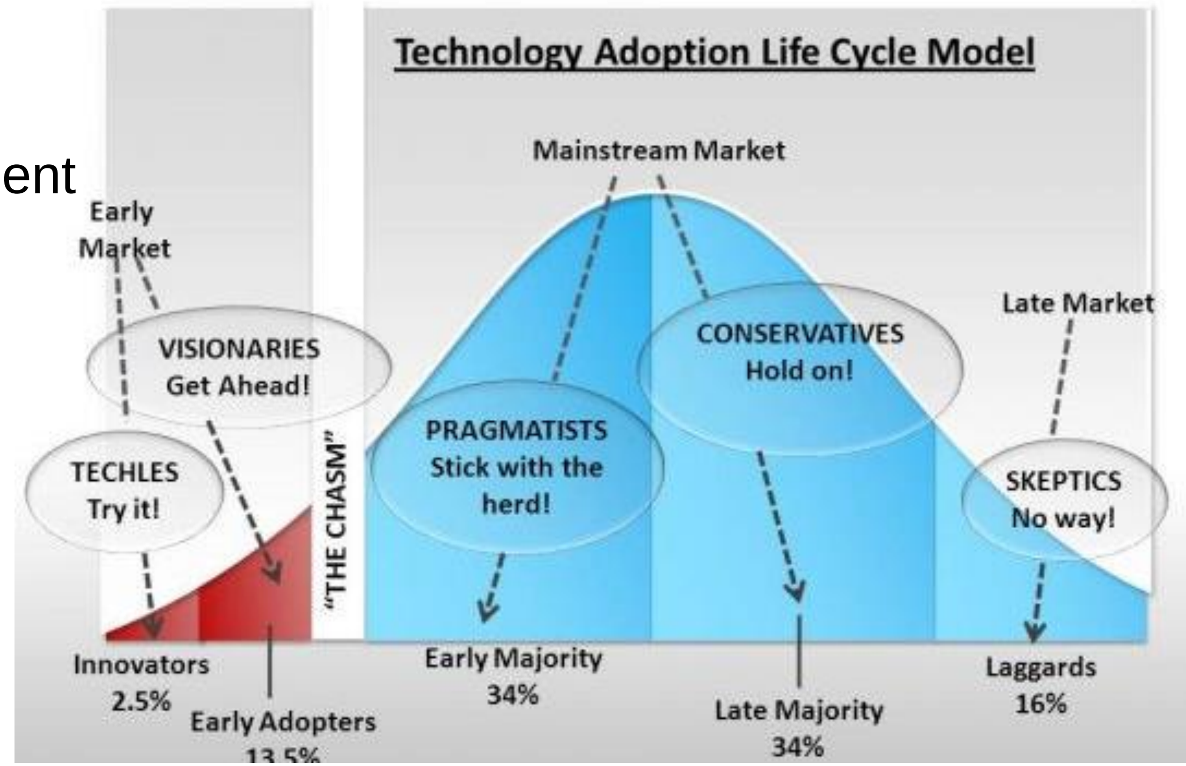
Why don't farmers implement win-wins?

- **Insufficient skills** to implement technology
- **Capital constraints**
  - Can't afford cost now
  - Can't borrow
- **Uncertain** about outcomes



Behavioural Psychology

Denis O'Hora, Jenny McSharry, Rossella diDomenico

- **2 studies (targeting Innovation System actors)**
  - **16 farmers**
  - **25 advisors (ASSAP + B&T)**
- Consistent Issues
  - Need Practical support (**time and resource limitations**)
  - Both stakeholder groups **value input of the each other** (**farmers value advisors and vice versa**)
- Particular Issues
  - Farmers **influenced by peers**
  - Farmers **feel isolated and ill-equipped**
  - Advisors feel **constrained by organisational structures**

Behavioural Drivers: Win-win v win-lose

Niall McLoughlin, ASSAP and Lakeland Dairies

	Win Win	Win Win	Win lose hassle	Win lose cost	Win win
	Nutrient Management Planning	Soil Testing	Avoid Spreading	Fencing Water Courses	Lime Application
Beliefs and Attitudes	++	+++	+		
Social Norms	+++	++	+++	+++	+++
Know How	+++	+++	+++	+++	++
Resources	++	+++		--	+++

National survey of farms

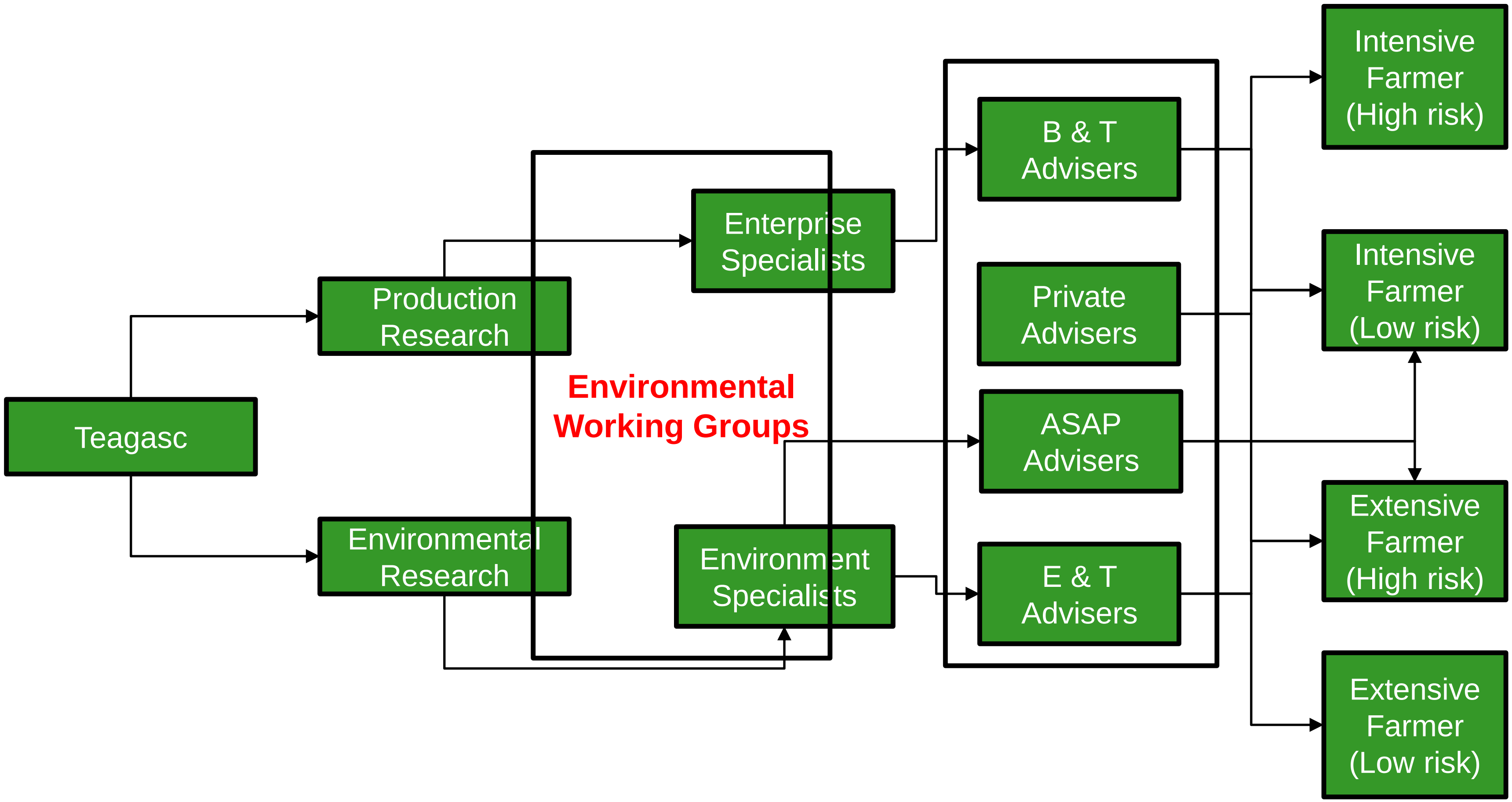
Social norms strongly positive across all measures

Positive social norms & know-how really important for win-win

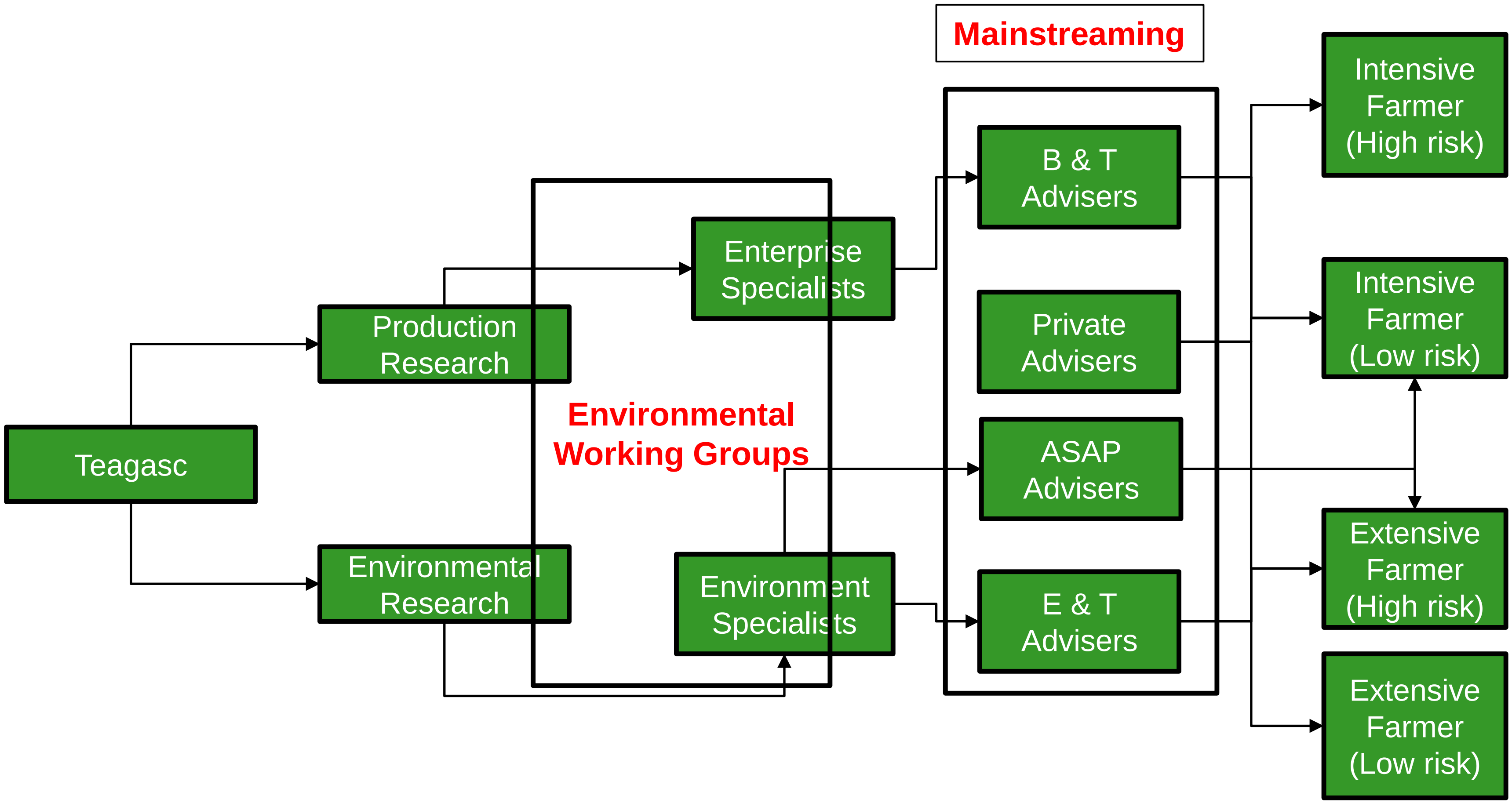
But can be outweighed by high cost -> win lose

Theory of Planned Behaviour (Ajzen, 1991). Intention to undertake translates to adoption.

Localised Advice



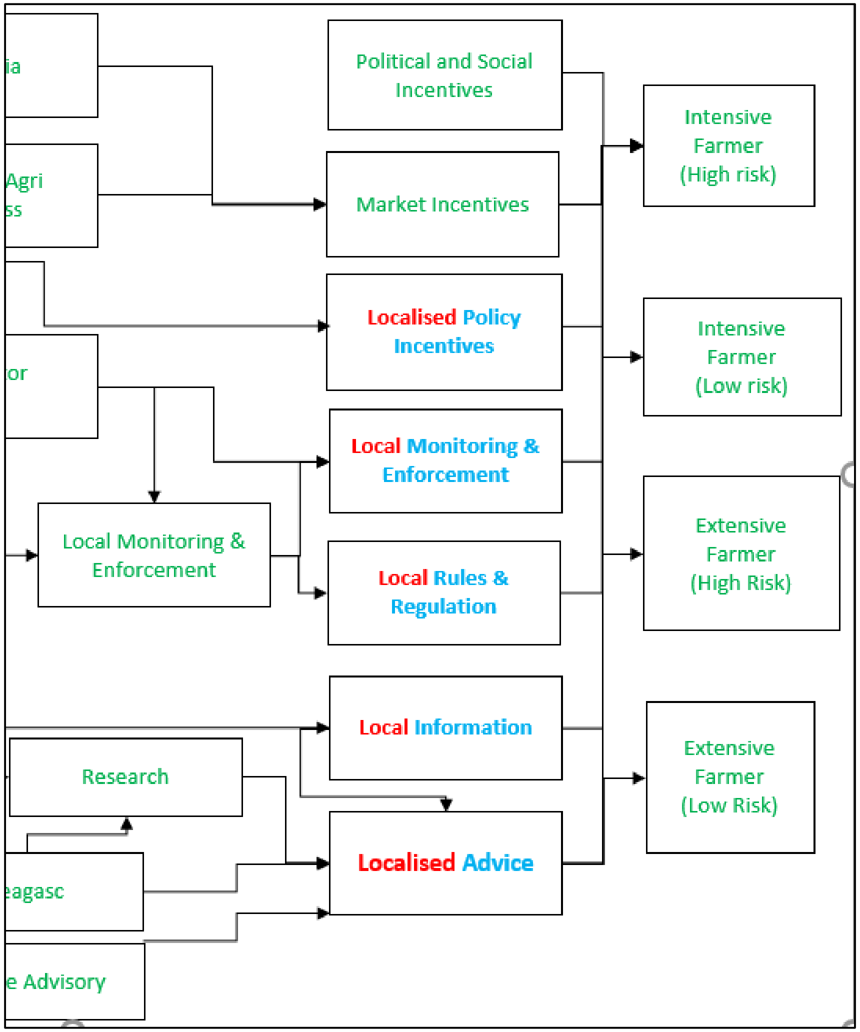
Localised Advice



Conclusions

Water quality is a complex local environmental problem

- Requires **local solutions, information and incentives**
- Taking an **Innovation System** perspective to the problem solution: changing the **behaviour of farmers** may involve changing the **behaviour of influencers**
- **Local activity and scientific data are** necessary to facilitate **local decisions**
- While solutions are local, one must by mindful of **transaction (administrative) costs**.



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