Ex ante evaluation of the benefits and costs of agri-environment measures: An integrated approach based on ecological scorecards and microsimulation

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IMA 8th World Congress – Dec. 1st, 2021

Teagasc
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Introduction

- Agricultural intensification (increased input use), land fragmentation and abandonment → biodiversity loss, pollution, landscape homogenization

- Development of incentive-based policy instruments e.g. agri-environment schemes (AESs) and measures

→ Need for cost- and environmentally effective interventions

Research question

Which measures have the highest potential to enhance the quality of semi-natural grassland habitats at lowest cost?

→ We aim to estimate benefit-cost ratios (biodiversity benefit per € spent)

→ Methodological challenges: Lack of habitat quality and cost data

Agri-environment measures (AEMs)

1	Reduced stock (by 10%)
2	Reduced fertiliser use (by 10%)
3	Reduced crop protection (by 10%)
4	Reduced purchased seed (by 10%)
5	Flail cutting (release of 1 hectare of land)

Cost-effectiveness analysis (CEA)

$$BB_{im} = \frac{\Delta Score_{im}}{\Delta Cost_{im}} = \frac{S_{im\,(after)} - S_{im\,(baseline)}}{C_{im\,(after)} - C_{im\,(baseline)}}$$

where:
BB: Biodiversity benefit (per hectare) of adopting measure m by farm type i;
ΔS: Difference in ith farm's biodiversity score between the after adoption scenario of measure m and the baseline scenario (before adoption);
ΔR: Difference in ith farm's (negative) FFI between the after adoption scenario of measure m and the baseline scenario (before adoption)

Modelling farms: Environmental data

- Environmental performance data:

  - FARM_ECOS grassland habitat survey derived by using ecological scorecards

  - 8 farms

  - Three levels of stocking rates: High [> 1.4]; medium; low [< 0.7]

  - Three levels of average grassland scores (high, medium, low)

Assessment of habitat quality: FarmEcos scorecard

Habitat significance	**(MAX = 50)**				
Positive indicators (cover)	< 5 %	6 - 10 %	11- 20 %	21 - 40 %	> 41 %
	0	10	20	25	30
Negative indicators (cover)	< 10 %	11 - 20 %	21 - 30 %	31 - 40 %	> 41 %
	0	-5	-10	-15	-20
Positive flora sps	< 2 sps	2 - 4 sps	5 - 8 sps	9 - 12 sps	> 13 sps
	0	5	10	15	20
Negative indicators	each				
	-1			Max = -4	
Structural condition	**(MAX = 50)**				
Vegetation structure	Poor		Moderate	Good	
	-10		10	15	
Cover ground flora	< 60 %	60 - 70 %	70 - 80 %	80 - 90 %	> 90 %
	0	5	10	15	20
Encroaching scrubs	< 10 %	10 - 25 %	25 - 50 %	> 50 %	
	0	-5	-10	-15	
Plant litter	> 75 %	50 - 75 %	25 - 50 %	< 25 %	
	-5	-2	2	5	
Bracken	< 10 %	10 - 25 %	25 - 50 %	> 50 %	
	0	-5	-10	-15	
Grazing	High	Medium	Low	Neglectable	
	-10	5	10	10	
Poaching	Neglectable	Low	Medium	High	
	0	-5	-10	-15	

Modelling farms: Economic data

- Nationally-representative farm data (Teagasc National Farm Survey):

→ Teagasc NFS (National Farm Survey) records data related to AEMs

→ Also cost and revenue data from similar farms

- Uncertainty analysis: Monte Carlo simulations (1,000 reps)

Methodology: Modelling ecological impacts

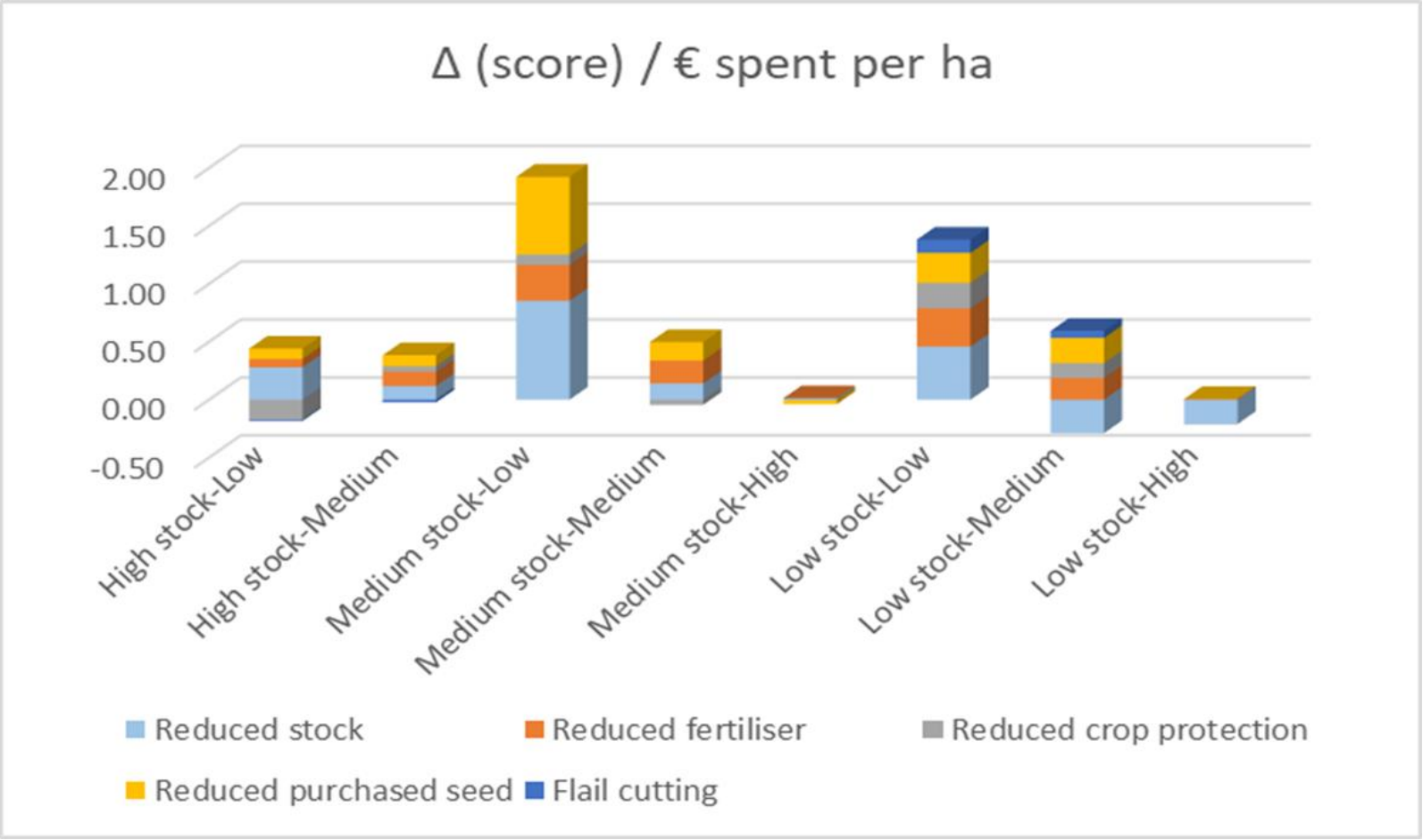
- Impacts of measures on individual score components are based on expert opinion

Modelling economic impacts

- Use of Teagasc NFS panel data (2013-17) and separate random effects models for each measure

- $$\boldsymbol{ln(Cost) = \beta_0 + \beta_1 \ln(AEM) + \beta_2\, D\_Year + \beta_3\, D\_Region + \beta_4\, D\_Soil}$$

Results: Estimated benefit – cost ratios



Results: Estimated benefit – cost ratios

	Reduced stock	Reduced fertiliser	Reduced crop protection	Reduced purchased seed	Flail cutting
High stock-Low	**0.279**	0.072	**-0.173**	0.090	**-0.010**
High stock-Medium	0.117	0.124	0.048	0.094	**-0.022**
Medium stock-Low	**0.854**	**0.311**	0.088	**0.671**	
Medium stock-Medium	0.140	0.197	**-0.044**	0.160	
Medium stock-High	0.012	0.000	-0.003	**-0.035**	
Low stock-Low	**0.458**	**0.330**	**0.220**	0.259	0.115
Low stock-Medium	**-0.288**	0.188	0.127	0.217	0.061
Low stock-High	**-0.204**	0.007	-0.004	0.000	**-0.002**

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Uncertainty analysis: Monte Carlo simulations

	Estimated mean	Simulated mean	Standard deviation	[95% Confidence Interval]	
Reduced stock	0.171	0.272	0.335	0.252	0.293
Reduced fertiliser	0.153	0.165	0.095	0.159	0.171
Reduced crop protection	0.033	0.021	0.114	0.014	0.028
Reduced purchased seed	0.182	0.334	0.201	0.321	0.346
Flail cutting	0.014	0.045	0.040	0.043	0.048

Conclusions

- Although the cost-effectiveness of conservation measures varies across farms:

→ Medium stock-Low score and Low stock-Low score farms seem to be more benefited by the measures

→ *Flail cutting* is the least effective measure

- Implications for farmers: Assist farmers to make informed conservation adoption decisions
- Policy implications: Assess the cost-effectiveness of payments (e.g. REAP payments)

Acknowledgements

International Microsimulation Association

Department of Agriculture, Food and the Marine
An Roinn Talmhaíochta, Bia agus Mara

FARM ECOS
Farming and Natural Resources: Measures for Ecological Sustainability

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