Pembrokeshire Coastal Forum




Quantifying P mitigation within the BRICs Development Plan

Final Report

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Richard Gooday

ADAS Wolverhampton

1 INTRODUCTION

The BRICs Project (ADAS and EnTrade, 2020) reviewed the options for the creation of a nutrient trading platform within Pembrokeshire, including scheme design, farmer engagement, funding mechanisms, overheads and a quantification of potential nutrient benefit. This quantification consisted of the identification of a suite of mitigation measures and estimation of potential uptake rates followed by an assessment of the associated costs and benefits for nitrate pollution. The aim of this current project is to extend the quantification to include reductions in agricultural phosphorus pollution resulting from the estimated uptake of the measures.

2 METHODOLOGY

The quantification of the nutrient reductions was undertaken using the Farmscoper tool, which is extensively used by the Defra family for national policy development evaluating the environmental impact of farming activities. Farmscoper (Gooday et al., 2014) was developed by ADAS with Defra and EA funding, initially as a farm-scale decision support tool able to predict the emissions of nine different pollutants, to quantify the effect of implementation of one or more mitigation measures on those pollutant emissions and to estimate the cost of measure implementation. Updates to Farmscoper have included the development of a catchment scale version of the tool and expansion of the list of pollutants and the mitigation measures included, alongside updating of the various calculations and datasets within it.

The calculations in this project utilise summarised data from previous modelling projects around Pembrokeshire to help determine the inputs for Farmscoper and the scaling up of the results. The initial task was to develop a suite of land management systems representative of farming around Pembrokeshire to which the mitigation measures could be applied. The management systems were:

- Dairy
- Lowland cattle and sheep
- Upland cattle and sheep
- Arable
- Arable: spring cropping only

The requirement for a separate spring cropping system was due to the applicability of certain mitigation measures, notably cover cropping. A woodland only scenarios was also modelled solely for the purpose of calculating the impacts of land use change. The cropping and livestock for the management systems were taken from data for the South-West Wales Water Management Catchment summarised in Gooday and Whitworth (2017), using the data averaged by farm type for the livestock systems and the catchment scale data for the arable system. The data were modified to account for the fact that mitigation measures would not be applied to rough grazing and to remove any arable land from the livestock systems (so that the results generated would be representative of managed grassland only). The final data used are shown in Table 2-1. Manufactured fertiliser data were taken from the British Survey of Fertiliser Practice for 2020, other management assumptions were left at default values. Field connectivity values for surface runoff were set to 1 (i.e. all mobilised pollution was delivered to watercourses), so that the impacts of spatial targeting (to areas with high connectivity) could be evaluated.

These farm management systems were input to Farmscoper to calculate baseline losses for all permutation of soil and rainfall in Farmscoper relevant to Pembrokeshire. The proportion of the pollutant loss in surface runoff was calculated, so that the impacts of surface connectivity could be accounted for at a later stage.

Each management system – soil – climate combinations were then put through Farmscoper to calculate the impacts of the following mitigation measures:

- Establish riparian buffer strips*
- Establish cover crops in the autumn
- Cultivate and drill across the slope*
- Undersown spring cereals
- Fence off rivers and streams from livestock*
- Leave over winter stubbles
- Adopt reduced cultivation systems
- Construct troughs with concrete base
- Use slurry injection application techniques
- Uncropped cultivated margins
- Precision farming
- Move feeders at regular intervals

The asterisked measures were not included in the original BRICS work but have been included here due to their relatively high effectiveness for mitigating phosphorus losses. Potential uptake rates for these measures were assumed to be 500 ha for riparian buffers and cultivating across the slope (which was an approximate average value for the BRICs arable-based measures) and 150,000 ha for fencing (the typical grassland measures). Note that these uptake rates refer to the total area of the field within which the mitigation measure is applied rather than the actual land occupied by the measure itself. Nitrification inhibitors were included within the BRICS work but are not relevant to phosphorus and so were not included here. The impacts of the mitigation measures were calculated relative to a baseline of zero uptake of any mitigation measures.

The impacts of the following measures were calculated by differencing the losses between the relevant management systems:

- Arable reversion to low input grassland (Arable to Lowland cattle and sheep)
- Reduced stocking on grassland (Dairy to Lowland cattle and sheep)
- Reversion to woodland (Arable to Woodland)

The results were then expressed as a saving in phosphorus losses per hectare, so that the results could be scaled according to the relative occurrence of the different soil and rainfall categories within Pembrokeshire and the amount of uptake assumed. The distribution of the different farm management systems on the soil and rainfall categories was based on data from CASCADE and ADAS (2015), shown in Table 2-2.

Averaged impact values were derived assuming measures were spread evenly across all relevant land, with an average connectivity for free draining land of 50% and drained land of 80%. Where measures were targeted, connectivity was assumed to be 80% for all fields (i.e. only fields near watercourses would be eligible to enter the scheme) and/or the measures were only applied to soil types with the greatest

reductions (i.e. not free draining soils). It was assumed that only measures with a low uptake would be able to be spatially targeted.

Costs of measure uptake were taken from the BRICs project (WP4), except for the three additional measures where the costs were taken from Farmscoper.

Table 2-1. Cropping and livestock numbers for the land management systems

Category		Dairy	Lowland	Upland	Arable	Spring Cropping
Livestock Count	Dairy Cows and Heifers	138				
	Dairy Heifers in Calf (2 years +)	35				
	Dairy Heifers in Calf (< 2 years)	45				
	Beef Cows and Heifers		11	9		
	Beef Heifers in Calf (2 years +)		2	3		
	Beef Heifers in Calf (< 2 years)		5	5		
	Other Cattle (2 years +)		5	4		
	Other Cattle (1 - 2 years)	9	11	4		
	Other Cattle (< 1 year) & Calves	37	32	16		
	Sheep		115	140		
	Lambs		105	130		
Areas (ha)	Permanent Pasture	102	42	35		
	Rotational Grassland	34	9	3		
	Winter Wheat				46	
	Winter Barley				17	
	Spring Barley				64	64
	Winter OSR				15	
	Maize				13	13
	Potatoes				18	18
	Fodder Crops				36	36
	Other Crops				21	21
	Stocking Density (kg N ha^{-1})	169	91	106		

Table 2-2. Assumed percentage distribution of land management by Farmscoper soil and rainfall categories

Annual Rainfall (mm)	Soil	Dairy	Lowland	Upland	Arable
900-1,200	Free Draining	11.1	13.8	1.5	7.4
	Drained: Arable	1.7	2.3	0.6	1.1
	Drained: Arable & Grass	0.2	1.2	0.2	0.3
1,200-1,500	Free Draining	24.0	8.9	10.4	2.0
	Drained: Arable	2.8	1.0	0.8	0.1
	Drained: Arable & Grass	0.2	0.2	0.1	-
> 1,500	Free Draining	2.6	0.7	4.8	-
	Drained: Arable	-	-	-	-
	Drained: Arable & Grass	-	-	-	-

3 RESULTS

Figure 3-1 shows the phosphorus reductions achieved for the measures and uptake rates in the BRICS project. The first two measures have little or no impact on phosphorus, but then the shape of the phosphorus reduction curve is comparable to that of nitrate, achieving a ~1 tonne annual reduction for an annual cost of about £1m, but the highest reductions of over 4 tonnes requiring the more expensive land use change and livestock reduction measures.

When a similar cost-curve is produced, but includes the additional phosphorus measures not in BRICs, and ordering the measures on phosphorus reduction cost-efficiency, then it is possible to achieve reductions of ~1 tonne for just £100,000 (Figure 3-2) and a maximum total reduction of 5.6 tonnes. Figure 3-2 also shows that if the measures were targeted at areas of high loss and/or connectivity, then the potential reductions are over 2 tonnes for £100,000 and reach a maximum of almost 9 tonnes. Note that no assessment has been made as to whether there is sufficient land within Pembrokeshire that has such high losses / connectivity, particularly given that some of the mitigation measures would be mutually exclusive. The targeted value is thus a maximum theoretical one, and the reality of what could be achieved through targeting would lie somewhere between the targeted and non-targeted values.

Table 3-1 shows the reductions achieved by the different measures, highlighting how the majority of the initial reduction in Figure 3-2 is achieved through riparian buffers and cover crops, with fencing and reduced stocking the overall most effective measures. However, the high effectiveness for fencing and reduced stocking is in part due to the significant area of uptake assumed within Pembroke.

Figure 3-1 Annual average phosphorus reductions associated with the measures and implementation rates from the BRICS project, shown alongside the nitrate reduction cost-curve from the BRICS project.

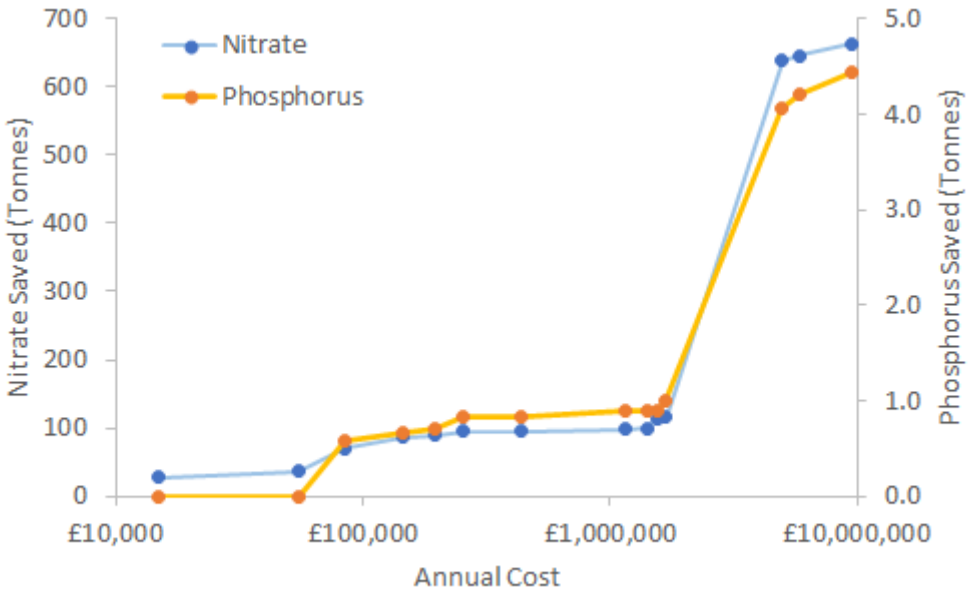

Figure 3-2 Cost-curves for annual average phosphorus reductions associated with the measures and implementation rates from the BRICS project, for a targeted and non-targeted approach to site selection.

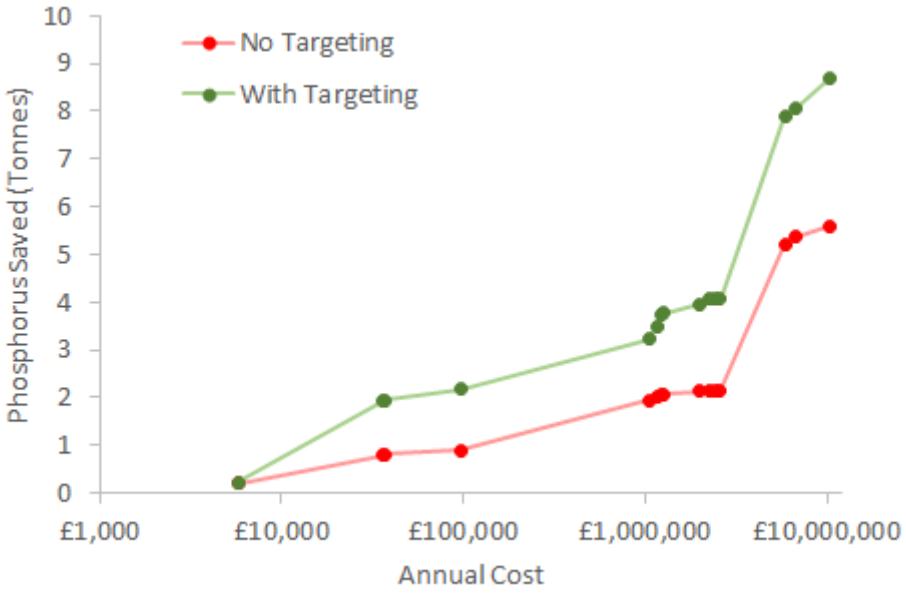

Table 3-1. Field areas to which mitigation measures were applied and phosphorus savings assuming a targeted and non-targeted approach.

Livestock	Area	P Saving (Tonnes)	Targeted	Targeted P Saving (Tonnes)
Establish riparian buffer strips	500	0.21	✓	0.22
Establish cover crops in the autumn	977	0.59	✓	1.70
Cultivate and drill across the slope	500	0.01	✓	0.02
Undersown spring cereals	326	0.08	✓	0.24
Fence off rivers and streams from livestock	15,000	1.06		1.06
Leave over winter stubbles	500	0.09	✓	0.27
Adopt reduced cultivation systems	695	0.04	✓	0.25
Construct troughs with concrete base	500	0.01	✓	0.01
Arable reversion to low input grassland	139	0.06	✓	0.21
Use slurry injection application techniques	347	0.01	✓	0.09
Uncropped cultivated margins	98	0.00	✓	0.00
Precision farming	15,000	0.00		0.00
Reduced stocking on grassland	14,957	3.07		3.83
Move feeders at regular intervals	14,957	0.15		0.15
Reversion to woodland	300	0.23	✓	0.65

4 REFERENCES

ADAS & EnTrade, 2020. Building Resilience into Catchments (BRICS) – Developing a delivery framework for a Payment for Ecosystem Services (PES) based nutrient trading scheme for the Milford Haven and Cleddau Catchment. Final report to Pembrokeshire Coastal Forum for WP4, 79pp.

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