



Evidence Project Final Report

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- Contractor organisation(s)
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(b) If you have answered NO, please explain why the Final report should not be released into public domain

Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

There has recently been an increase in interest amongst policy-makers in the question of whether farming provides a "public good" beyond the simple production of food, which justifies support from, for instance, EU agricultural policy.

The PG tool was developed in 2010/11 as part of a project funded by Defra through Natural England. It assesses a farm on a number of areas which may be impacted by agricultural management practices and may be related to public goods such as water quality, air quality, etc. These "spurs" were: soil management, agri-environmental management, landscape and heritage, water management, fertiliser management and nutrients, energy and carbon, food security, agricultural systems diversity, social capital, farm business resilience, and animal health and welfare management. Each spur is assessed by asking questions based on a number of key "activities". Each activity has at least one corresponding question and these allow the advisor carrying out the assessment to evaluate the detailed ways in which the farm provides each public good. The original project culminated in a pilot of the tool on forty organic farms. Following on from this the tool has been modified to remove the focus on organic farms and to enable it to carry out assessments on conventional farms.

The updated version of the tool has now been tested in a pilot on 32 conventional farms. Seven external advisors were contracted to each carry out between three and five PG tool assessments on conventional farms with which they already had an advisory relationship. As well as carrying out the assessments, the advisors were provided with feedback forms: one for each farmer being assessed and one for the advisors themselves. The feedback forms asked about the process of the assessment (quality of questions, time commitment required) and the impact of the assessment on the farmers' consideration of issues around sustainability and provision of public goods. The advisor feedback form also asked for suggestions for future development of the tool, especially with regards to its appropriateness for use in assessing conventional farms.

The farms assessed included nine dairy, seven beef and sheep and eight cereals farms with smaller numbers of other farm types including poultry, general cropping, mixed and horticultural. The highest scoring spurs on average were *soil management* and *animal health and welfare management* which both had a mean score of 4.1 and the lowest scoring was *agricultural systems diversity* with a mean score of 2.5. The highest scoring activities on average were *erosion under soil management* and *irrigation under water management* with a mean score of 4.9. The lowest scoring activity with a mean score of 1.3 was *on-farm processing under agricultural systems diversity*. The most variable activity, with a coefficient of

variation of 81% was *water management plan* under the *water management spur* and the least variable, as well as the highest scoring activity, was *erosion* under the *soil management spur*. In total 14 activities out of the total of 57 had a coefficient of variation greater than 50% indicating high variability in the responses.

The feedback from the advisors and farmers was generally positive. All seven advisors said that they would advise other farmers to use the tool and six of the seven stated that they would be interested in using the tool in their advisory work in the future. Similarly 83% of the farmers said that they would recommend the tool to other farmers. The majority of the advisors and farmers rated the tool as “good” across almost all of the quality criteria (quality of the pre-visit information, ease of understanding of the principles, length of time to complete the assessment, quality of the questions, and reporting format). In addition the majority of the farmers rated the opportunity to ask questions as excellent (the advisors were not asked this question as it directly related to their involvement in the assessment). The majority of the advisors and farmers also agreed that the tool gives relevant information and identifies area of strength and weakness in the farm’s public goods provision. The median rating the farmers gave for their understanding of public goods before using the tool was 4 and the median rating for the understanding after using the tool was 8. Two of the advisors felt the PG tool was suitable for use on conventional farms, four felt that it was mostly suitable and one that it was partly suitable.

The general comments from the advisors on the tool included:

- Some tabs look very wordy and are difficult to work through for some farmers. Some farmers commented that certain questions were "vague" and required further discussion.
- Some of the questions are focussed on arable land but could be relevant to pasture also, needs to be clearer if answers should include pasture/permanent grassland.
- Questions need to be reviewed as some are still very much relevant to just organic, review the certification schemes available. The terminology needs updating so that it does not appear so organically based. For example, references to OELS should be replaced with simply ELS.
- One of the farms which took part in the pilot had previously had a carbon audit as part of their sales through the supply chain of one of the large multiples. This farmer commented that they felt that the public goods tool gave them better information on where they were doing well and not so well in terms of sustainability on the farm. In addition, when looking at the results from the tool they were able to discuss with the advisor areas where changes could be made to their farm management and, equally importantly, areas where changes to improve a particular rating were not possible or practical on that farm. The farmer’s comment on the carbon audit was that although figures provided by the farm were used in the audit there were also a lot of standard figures and the results and recommendations were generic; not targeted to the farm.

The advisors also suggested specific changes to questions in some spurs. It was felt that the question on pesticide use in the *agri-environmental management spur* could be improved by making it more applicable to grassland as well as arable land, scoring different approaches across the full 1-5 range and extended to include e.g. herbicides, pesticides, fungicides and slug pellets (metaldehyde). There were several questions about the benchmarking data used in the *energy and carbon spur* and a suggestion to use a less extensive set of farms for the beef and sheep benchmark as the benchmark energy usage appeared to be so low as to be virtually unachievable.

All seven of the advisors said that they would advise other farmers to use the tool and six of the seven stated that they would be interested in using the tool in their advisory work in the future. In addition some of the advisors also commented that some of the farmers that they had assessed had expressed an interest in repeating the assessment in a year or two to see how planned management changes might alter the scores for their farms.

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra

to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:

- the objectives as set out in the contract;
- the extent to which the objectives set out in the contract have been met;
- details of methods used and the results obtained, including statistical analysis (if appropriate);
- a discussion of the results and their reliability;
- the main implications of the findings;
- possible future work; and
- any action resulting from the research (e.g. IP, Knowledge Exchange).

1. Introduction

There has recently been an increase in interest amongst policy-makers in the question of whether farming provides a “public good” beyond the simple production of food, which justifies support from, for instance, EU agricultural policy (Cooper *et al.*, 2009). As discussed by Cooper *et al.* (2009), a public good must be non-excludable, i.e. available to all, and non-rival, i.e. its consumption by one individual does not diminish its availability to others. As such, benefits such as an improved environment or better water quality can be perceived to be public goods. It is the provision of these sorts of benefits which may be used in the future to justify continued support of the agricultural sector through subsidies.

With funding from Defra/Natural England, ORC developed a tool for monitoring the public goods delivered by organic farmers. The tool was designed to be used by advisors to provide an overview of a farm’s performance against, and to increase the farmers’ understanding of, a range of environmental, economic and social criteria. The tool can also benchmark a farm’s performance against key sustainability criteria (e.g. fossil energy use and NPK surplus/deficit) and identify areas for improvement. The pilot study created a tool that was tested on forty organic farms. Following the pilot, Defra commented that to make the tool as useful as possible in the wider context, some of the questions should be modified to remove the focus on organic farms and to ensure that scoring is not weighted in favour of organic farming. ORC has carried out the necessary modifications and this document reports on a pilot of the tool on thirty five conventional farms and gathers feedback on the tool’s potential for monitoring conventional farms.

1.1 The PG tool

1.1.1 Spurs and Activities

The PG tool was developed in 2010/11 as part of a project funded by Defra through Natural England. Further information about the tool and its development can be found in the report on that project (Gerrard *et al.*, 2011).

As part of development process, a stakeholder workshop identified a variety of agriculture-related public goods against which the tool would assess each individual farm. These “spurs” were: soil management, agri-environmental management, landscape and heritage, water management, fertiliser management and nutrients, energy and carbon, food security, agricultural systems diversity, social capital, farm business resilience, and animal health and welfare management.

The tool has been designed to be used on farm with an advisor gathering data through an interview with the farmer. It has been constructed as an excel workbook with a worksheet for each spur. In addition there is an initial data sheet collecting general farm information used in multiple spurs and a final results sheet which provides graphical representations of the farm’s assessment as soon as the interview is completed.

Each spur is assessed by asking questions based on a number of key “activities”. Each activity has at least one corresponding question and these allow the advisor to evaluate the detailed ways in which the farm provides each public good. The activities were identified as a result of a literature review and discussion at a stakeholder workshop attended by researchers, advisors and representatives from Natural England. The choice of activities was influenced by a desire for the data collected to be of a type that a farmer would have in their farm records already, i.e. not requiring any further surveys to be carried out. Care was also taken to balance quantitative and qualitative activities. It was also necessary to maintain a balance between obtaining sufficiently detailed information to assess the spurs while keeping the assessment to a reasonable length of time. The PG Tool assessment takes two to four hours to complete depending on the size and complexity of the farm.

The individual spurs are discussed in more detail below, including information on the additional questions and alterations to make the tool applicable to conventional farms.

1.1.1.1 Soil Management

The soil management spur assesses a farm's performance in terms of monitoring of soil organic matter and nutrient levels, in addition to assessing the amount of damage done to the soil from erosion, e.g. from leaving land bare over the winter or out-wintering cattle. The questions for each of the activities are based on guidelines from the Code of Good Agricultural Practice for the Protection of Soil (MAFF, 1993), the Environment Agency Document 'Think Soils' (Davis and Smith, 2008) and the Defra Soil Protection Review (Defra, 2009). Some assessment criteria have also been based on the EMA tool (University of Hertfordshire, 2006).

1.1.1.2 Agri-environmental management

The agri-environmental management spur assesses how well the farm is managed with regards to environmental stewardship and encouraging native wildlife. The activities assessed are agri-environmental participation, Biodiversity Action Plan habitats and Sites of Importance for Nature Conservation, Sites of Special Scientific Interest, conservation plan, awards and habitat. The changes to make it applicable to conventional farms were the addition of the Entry Level Scheme as an agri-environmental participation option, and additional questions on the use of crop protection products and pesticides.

1.1.1.3 Landscape and Heritage

The landscape and heritage spur assesses how well a farm contributes towards preserving the countryside and its heritage. The activities which are used to assess this are: historic features, landscape features, and management of boundaries. No changes were required to make it applicable to conventional farms.

1.1.1.4 Water Management

The water management of the farm is assessed through the measures being taken to reduce pollution, the sources of water being used and the efficiency of irrigation systems that are put in place. The questions for each of the activities are based on guidelines from Waterwise on the Farm (Environment Agency, 2007), the Soil Association organic standards (Soil Association, 2008), Cranfield University's Improving irrigation efficiency checklist (Cranfield University at Silsoe, 2007) and the EMA tool (University of Hertfordshire, 2006). No changes were required to make it applicable to conventional farms.

1.1.1.5 Fertiliser Management and Nutrients

The fertiliser management and nutrients spur is spread over two worksheets: the first worksheet is an NPK (nitrogen, phosphorus, potassium) budget which takes information from the initial data collection sheet and calculates a 'farm gate' balance for these macro nutrients based on standard yield and standard NPK figures; the second worksheet for this spur contains more qualitative questions about the management of nutrients, manure and wastes on farms. The adaptations to make the tool appropriate for use on conventional farms included the addition of fertilisers used on conventional farms in the manure and fertilisers section of the initial data collection sheet and additional questions on fertiliser spreading.

1.1.1.6 Energy and Carbon

The energy and carbon spur is spread over three separate worksheets: the first worksheet focuses on the farm's own fuel and electricity use, recording both the total amount used and the amount attributed to the various farm enterprises: arable, beef and sheep, dairy, horticulture, pigs and poultry; the second worksheet for this spur uses the energy and carbon benchmarks contained in the Centre for Alternative Land Use (CALU) booklet 'Managing Energy and Carbon (CALU and ADAS, 2007) to compare the farm's performance in terms of MJ of energy per head of livestock, or per hectare; the final worksheet for this spur asks more qualitative questions regarding the farm's energy use. No changes were required to make it applicable to conventional farms.

1.1.1.7 Food Security

The food security spur assesses the contribution of the farm towards food quality and availability of food in the local area. The activities assessed are total productivity, local food, off-farm feed, food quality awards, food quality certification and production of fresh produce. No changes were required to make it applicable to conventional farms.

1.1.1.8 Agricultural Systems Diversity

The Agricultural Systems Diversity spur determines the extent to which the farm is incorporating a range of crop varieties and animal species in its production methods. No changes were required to make it applicable to conventional farms.

1.1.1.9 Social Capital

This spur assesses the farm's community engagement and the benefits it provides to its local community from public access to training for its employees. It is assessed through the following activities: employment, skills and knowledge, community engagement, corporate social responsibility initiatives and accreditations, public access, human health issues. No changes were required to make it applicable to conventional farms.

1.1.1.10 Farm Business Resilience

This spur assesses the financial resilience of the farm as a business and whether it is a long-term prospect. It uses two activities to assess this – financial viability and farm resilience. The questions asked were considered carefully to attempt to strike a reasonable balance between not being perceived by farmers as being too intrusive but still obtaining sufficient information to build up an idea of the farms' financial situations. No changes were required to make it applicable to conventional farms.

1.1.1.11 Animal Health and Welfare Management

The animal health and welfare management spur assesses how the farmer manages their livestock so as to ensure their health and welfare. The activities under which this is assessed are staff resources, health plan, animal health, ability to perform natural behaviours, housing and biosecurity. The questions used in assessing this spur were considered carefully to ensure that they cover a range of species and are sufficiently detailed while not causing offence to farmers by giving them the impression that they were being accused of having low welfare standards. The indicators of welfare also needed to be those that could be assessed by an interview rather than requiring advisors to see and assess the animals themselves thus ruling out the kind of indicators suggested by Leeb *et al.* (2004), and Burke (2006). The questions were developed with input from two animal welfare scientists (Nicholas, 2010; Roderick, 2010). The update for conventional farms included using the RSPCA's "Freedom Foods" standards as reference points for e.g. rating the livestock housing.

1.1.2 Scoring System

Each question is marked with score between 1 and 5 where 1 is the lowest mark, indicating that no benefit is being provided and 5 is the highest score. Some questions have a not applicable (n/a option). This is the case where a situation may arise such that the farmer cannot possibly provide that benefit, for instance, a farmer who does not have dairy cows will not include mastitis prevention on their livestock health plan but should not be scored lower for failing to do so and therefore can choose n/a as the answer for this question.

Some activities are assessed using several questions while others require only one. Where multiple questions are asked their scores are averaged and rounded to the nearest whole number to give the score for that activity. Thus an activity requiring several questions is not weighted more heavily than one requiring only a few or one question.

1.1.2 Graphical Presentation of Results

The scores for each spur are obtained by averaging the scores for all its activities. These are then shown on a radar diagram (Figure 1) allowing farmers to see in which areas they perform well and which areas could be improved. A bar chart showing the activities on each spur gives more detailed information so that if the farmer sees from the radar diagram that they scored less well on a particular area they can then identify the specific activities to work on to improve the score in the future.

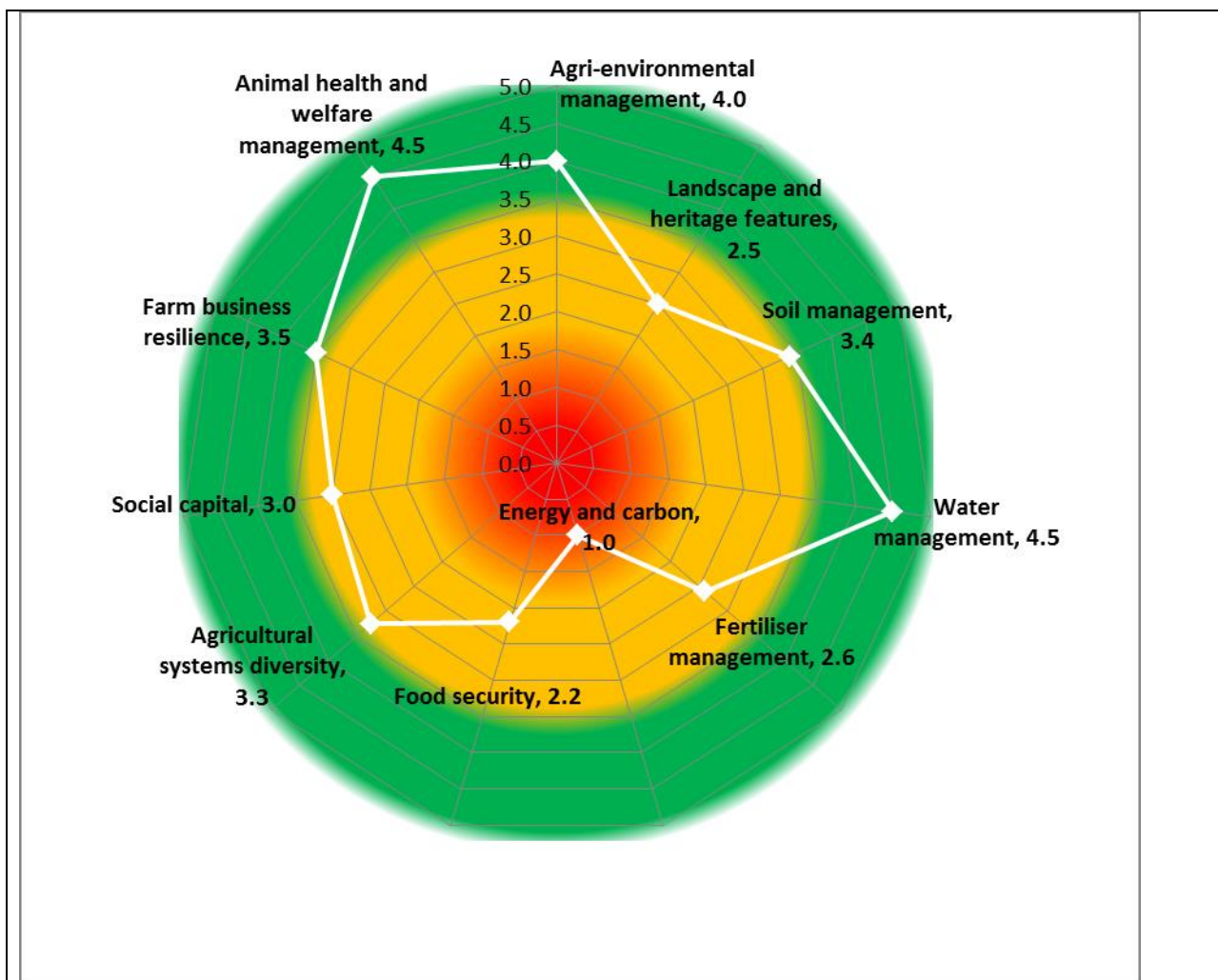


Figure 1: Example of PG tool reporting format.

2. Approach

Seven external advisors working in farm consultancy were contracted to each carry out five PG tool assessments on conventional farms with which they already had an advisory relationship. The choice of farms was left to the advisors but they were given guidance as to the geographical area and farm type that they were to cover (Table 1). There were no other restrictions with regards to e.g. farm size, as the sample is too small to be representative of all conventional farms and so there was no requirement for stratified sampling. Two of the consultants recruited were not able to carry out all assessments planned resulting in the the final sample being 32 farms.

Table 1: Breakdown of advisors and the farm types they were asked to cover

Advisor	Company	Area	Beef & sheep	Dairy	Mixed	Arable
Anna Bassett	Bassett consulting	South West	3		2	
Becky Carter	ADAS	East				5
Emily Evans	Andersons	Midlands		3	2	
Fay Francis	ADAS	Wales	3	1	1	
Tom Gill	Promar	North West/Midlands		3	2	
Will Greenway*	Smiths Gore	South/Midlands	2			3
William Waterfield*	Farm Consultancy Group	South		3	2	
Total			8	10	9	8

* Will Greenway was only able to carry out four assessments and William Waterfield was only able to carry out three assessments

The assessments were carried out in the period from 17th February to 19th March 2014. The final breakdown of the 32 farms across farm types (defined using standard gross margins) is as follows:

9 dairy,
 8 cereals,
 7 beef and sheep,
 3 general cropping
 3 mixed
 1 pigs and poultry
 1 horticulture

As well as carrying out the assessments, the advisors were provided with feedback forms: one for each farmer being assessed and one for the advisors themselves. Since the purpose of the conventional pilot was to test the performance of the tool on conventional farms the feedback from the farmers and advisors was as important as the outcomes of the assessments. The feedback forms asked about the process of the assessment (quality of questions, time commitment required) and the impact of the assessment on the farmers' consideration of issues around sustainability and provision of public goods. The advisor feedback form also asked for suggestions for future development of the tool, especially with regards to its appropriateness for use in assessing conventional farms.

3. Results

3.1 Assessments

Figure 2 summarises the data from the 32 farms, showing the minimum, mean and maximum scores on each of the 11 spurs (note that for *animal health and welfare management* there were only 24 farms in the sample as the remainder of the farms in the pilot were stockless). It can be seen from this that for some spurs (e.g. *agri-environmental management, landscape and heritage*) there is a large range between the minimum and maximum scores whereas for others (e.g. *animal health and welfare management, fertiliser management*) there is a much tighter range of scores.

The highest scoring spurs on average were *soil management* and *animal health and welfare management* which both had a mean score of 4.1 and the lowest scoring spur was *agricultural systems diversity* with a mean score of 2.5.

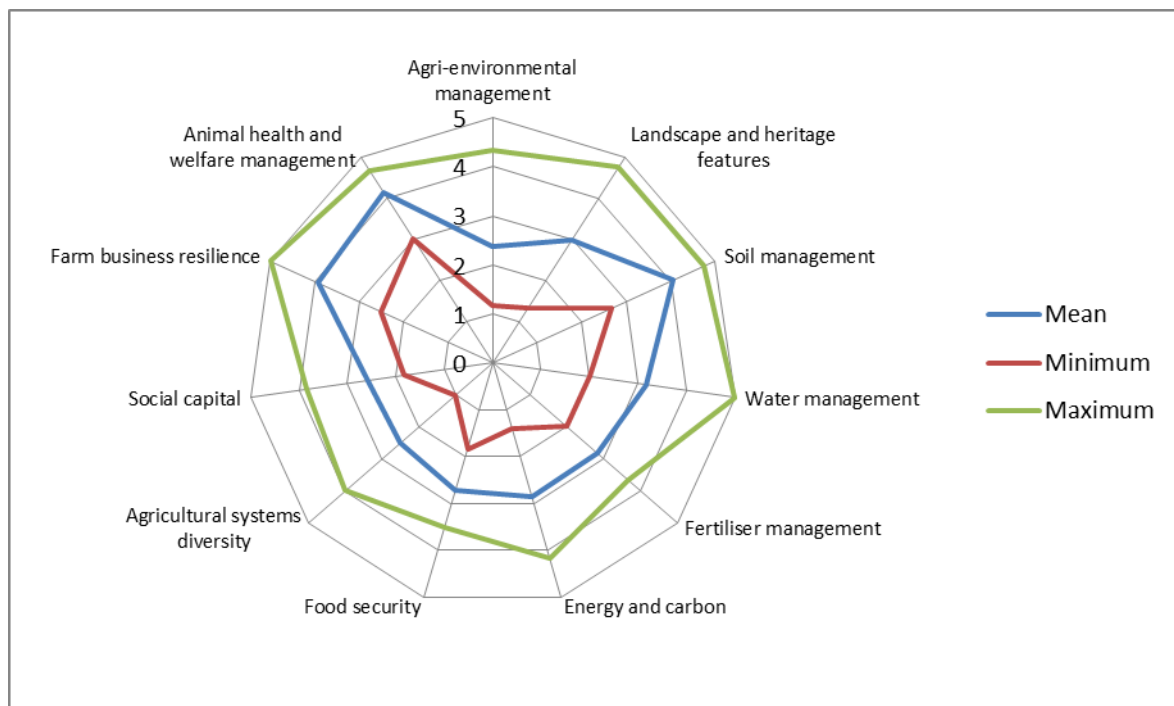


Figure 2: Summary spur data for the 32 farms.

Figure 3 shows the mean score for each activity within the spurs and Table 2 shows the mean, median, minimum and maximum scores on each activity as well as their standard deviation and coefficient of variation (standard deviation divided by the mean) which shows the extent of variability in the results with respect to the mean.

The highest scoring activities on average were *erosion* under *soil management* and *irrigation* under *water management* with a mean score of 4.9. The lowest scoring activity with a mean score of 1.3 was *on-farm processing* under *agricultural systems diversity*. The most variable activity, with a coefficient of variation

of 81%, was *water management plan* under the *water management* spur and the least variable, as well as the highest scoring, was *erosion* under the *soil management* spur. In total 14 activities out of the total of 57 had a coefficient of variation greater than 50%. The *agri-environmental management* spur had the largest proportion of activities with high coefficients of variation with 4 out of its 8 activities having a coefficient of variation greater than 50%. Four spurs have no activities with coefficients of variation greater than 50%: *soil management*, *fertiliser management*, *farm business resilience* and *animal health and welfare*.

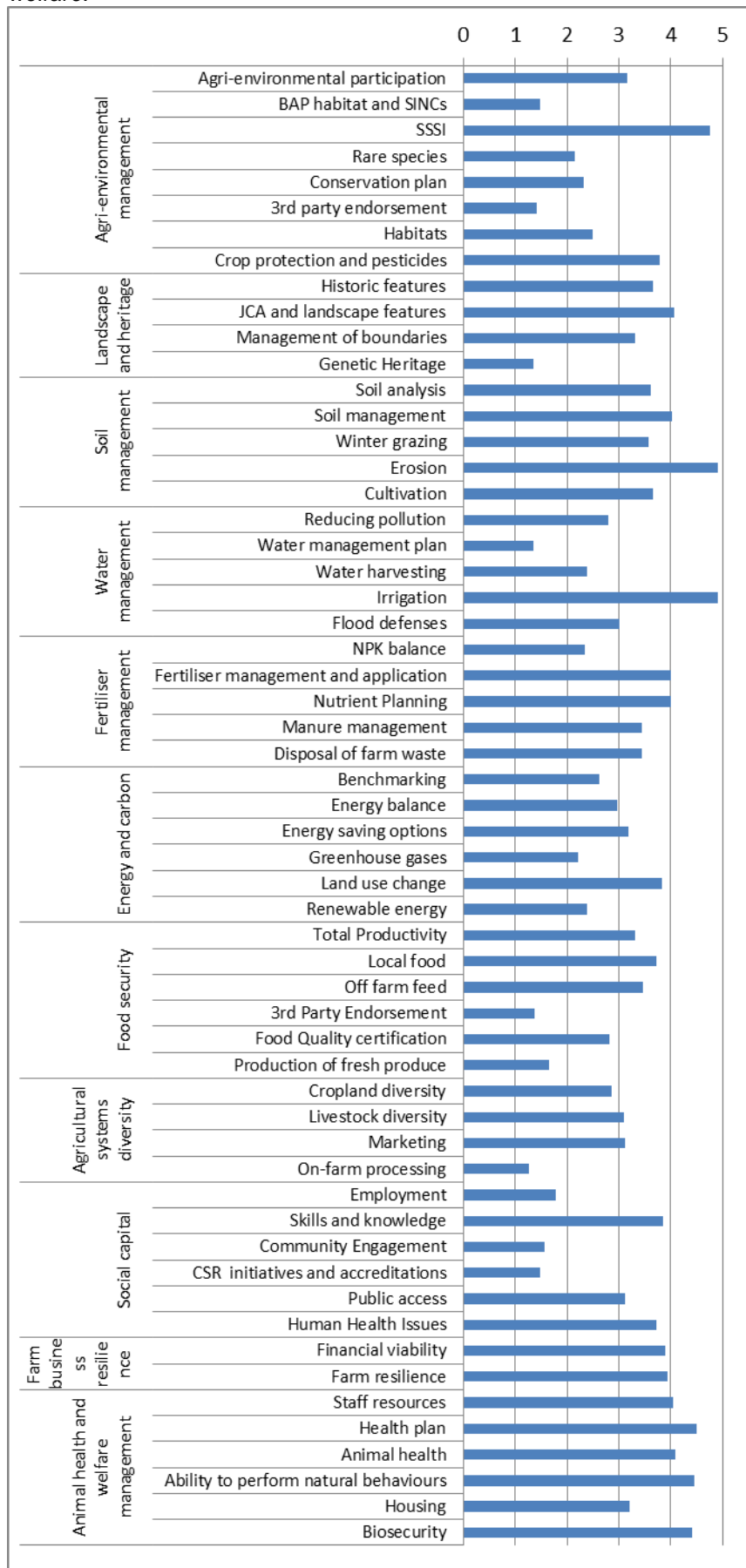


Figure 3: Mean scores on each activity.

Table 2: Summary of activity scores showing the mean, median, minimum, maximum, standard deviation and coefficient of variation.

Spurs	Activities	Mean	Median	Minimum	Maximum	Standard Deviation	C of V
Agri-environmental management	Agri-environmental participation	3.2	3	1	5	1.1	36%
	BAP habitat and SINC	1.5	1	1	5	1.1	73%
	SSSI	4.8	5	4	5	0.5	11%
	Rare species	2.2	2	1	5	1.3	62%
	Conservation plan	2.3	1	1	5	1.7	74%
	3rd party endorsement	1.4	1	1	5	0.9	65%
	Habitats	2.5	2	1	4	0.8	30%
	Crop protection and pesticides	3.8	4	1	5	1.0	25%
Landscape and heritage	Historic features	3.7	4	2	5	0.8	23%
	JCA and landscape features	4.1	4	1	5	1.0	24%
	Management of boundaries	3.3	3	1	5	1.1	34%
	Genetic Heritage	1.3	1	1	5	0.9	64%
Soil management	Soil analysis	3.6	4	1	5	0.9	26%
	Soil management	4.0	4	1	5	1.2	29%
	Winter grazing	3.6	4	2	5	1.0	27%
	Erosion	4.9	5	4	5	0.3	6%
	Cultivation	3.7	4	1	5	1.3	37%
Water management	Reducing pollution	2.8	2.5	2	5	0.9	33%
	Water management plan	1.4	1	1	5	1.1	81%
	Water harvesting	2.4	2	1	5	1.1	48%
	Irrigation	4.9	5	3	5	0.4	8%
	Flood defences	3.0	3	1	5	1.8	58%
Fertiliser management	NPK balance	2.3	2	1	5	1.0	44%
	Fertiliser management and application	4.0	4	2	5	1.0	25%
	Nutrient Planning	4.0	4	1	5	0.9	23%
	Manure management	3.4	4	1	5	0.8	25%
	Disposal of farm waste	3.4	3	2	5	0.8	24%
Energy and carbon	Benchmarking	2.6	3	1	5	1.5	55%

	Energy balance	3.0	3	1	5	1.6	52%
	Energy saving options	3.2	3	1	5	1.4	43%
	Greenhouse gases	2.2	2	1	5	1.1	48%
	Land use change	3.8	4	2	5	0.9	23%
	Renewable energy	2.4	2	1	5	1.0	44%
Food security	Total Productivity	3.3	3	2	5	0.9	26%
	Local food	3.7	4	1	5	1.3	35%
	Off farm feed	3.5	3	1	5	1.2	35%
	3rd Party Endorsement	1.4	1	1	5	1.0	76%
	Food Quality certification	2.8	3	1	5	0.8	28%
	Production of fresh produce	1.7	1	1	3	0.9	52%
Agricultural systems diversity	Cropland diversity	2.9	3	1	5	1.0	34%
	Livestock diversity	3.1	3	2	5	1.1	35%
	Marketing	3.1	3	1	5	1.5	49%
	On-farm processing	1.3	1	1	5	1.0	79%
Social capital	Employment	1.8	1.5	1	5	1.2	65%
	Skills and knowledge	3.8	4	3	5	0.8	21%
	Community Engagement	1.6	1	1	4	1.0	63%
	CSR initiatives and accreditations	1.5	1	1	4	0.7	46%
	Public access	3.1	3	1	5	1.4	45%
	Human Health Issues	3.7	4	2	5	0.8	21%
Farm business resilience	Financial viability	3.9	4	1	5	1.1	29%
	Farm resilience	3.9	4	3	5	0.4	11%
Animal health and welfare management	Staff resources	4.0	4	2	5	0.8	19%
	Health plan	4.5	5	2	5	0.8	19%
	Animal health	4.1	4	3	5	0.7	18%
	Ability to perform natural behaviours	4.5	5	3	5	0.7	15%
	Housing	3.2	3	2	4	0.5	16%
	Biosecurity	4.4	5	2	5	1.0	23%

It is not possible to investigate the impact of farm type on the scores as the extremely small sample sizes (the dairy farm type has the most coverage but its sample is only eight farms) will not allow statistical analyses to be carried out.

Similarly it is not advisable to compare the results of this conventional pilot of the PG tool with the previous

organic pilot: neither sample was selected in such a way as to be representative, both samples are very small and some changes were made to the tool in the period between the two pilots.

3.2 Feedback

3.2.1 Farmers

Of the 32 farmers who participated in the pilot, 30 returned feedback forms giving a very high response rate of 94%. Of these 30, 60% were male, 23% were female and 17% did not choose to give their gender. The majority of the farmers were 40 or older (57%) but 10% were under the age of 25. The farms covered a range of farm types as discussed previously. They also covered a range of farm sizes with 27% of the farms in the “101-200ha” category and 27% in the “300ha or over” category. One farm had less than 10ha. The vast majority of the farms (80%) were lowland farms. With regards to agri-environment scheme participation 20% were not in any scheme, 53% were in ELS (Entry Level Stewardship) and 20% were in HLS (Higher Level Stewardship). Two of the farms were in the Welsh Glastir scheme.

Figure 4 summarises the feedback from the 30 farmers with regards to the quality of the tool. The majority of the farmers answered excellent to the majority of the questions. The quality of the questions was probably the lowest rated with 11 farmers saying that they were “fair”. The opportunity to ask questions and the reporting format were the two questions for which all of the farmers answered either “good” or “excellent”. Indeed the opportunity to ask questions was rated as “excellent” by the majority of the farmers.

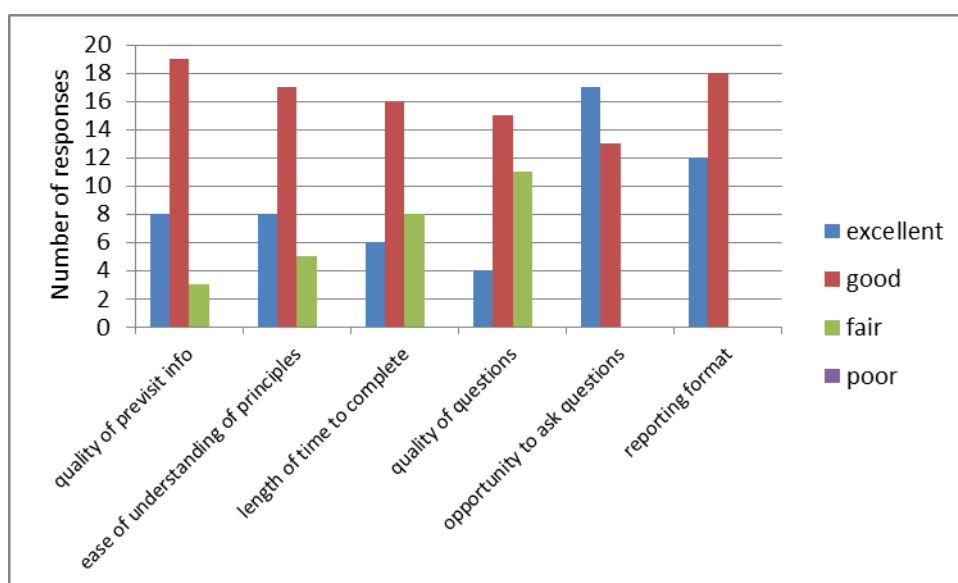


Figure 4: Farmer feedback on the tool

Figure 5 summarises the farmers’ responses to questions about the usefulness of the tool. The majority answered “yes” to questions about whether the information was relevant, whether the tool identified strong and weaker areas of public goods provision and whether it helped to improve their understanding of public goods. There was less certainty in the answer to the question about whether the tool would help to demonstrate to the wider community the public goods that can accrue from farming with the same numbers of farmers answering “yes” or “partly”.

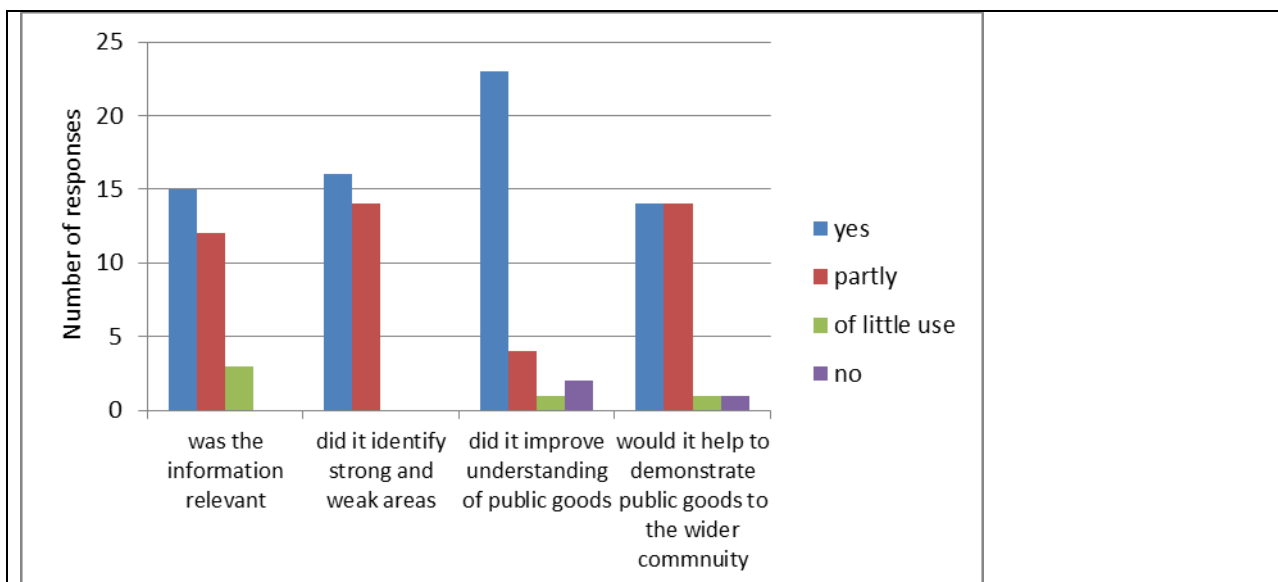


Figure 5: Farmer feedback on the usefulness of the tool.

The farmers were asked to rate their understanding of public goods before and after using the PG tool on a scale of 1 to 10. The median score for their understanding before the assessment was 4 and the median score for their understanding after the assessment was 8, suggesting that the farmers did feel that the PG tool assessment had improved their knowledge and understanding of public goods.

83% of the farmers stated that they would recommend the PG tool to other farmers and 67% said that they thought it should become web-based.

Very few farmers made additional comments. Those that were made are copied in full below:

- I feel it would be really useful to tweak some of the questions and even expand the scope in certain areas, in order to better reflect the activities of a non-organic farm (I understand and was involved in the development in organic systems). Also if given as a "free to use web based tool" explanations would have to be made to clarify the questions as an advisor was most helpful in this role.
- probably a little too long to complete
- some of the questions could be better worded
- Would use it if there were benefits for selling stock i.e. higher payments
- The energy and carbon audit is weighted a little too favourable.
- There are public goods in the landscape value of farmland and its ability to buffer against urban development - these should be assessed and included.
- I really liked the results graphic and the tool is very positive and made me think about farm management

3.2.2 Advisors

Seven advisors carried out the pilot assessments. Of these 5 were female and 2 were male. One advisor was under 25, three were between the ages of 25 and 40, and three were over 40.

Figure 6 summarises the feedback from the advisors with regards to the quality of the tool. From this it can be seen that the majority of the advisors rated the tool as "good" across almost all of the quality criteria. The length of time to complete the assessments was rated as "good" by three of the advisors and as "fair" by three. The quality of the questions was rated as good by four advisors and as "fair" by three of them. The reporting format was rated most highly with four advisors rating this as "good" and three rating it as "excellent".

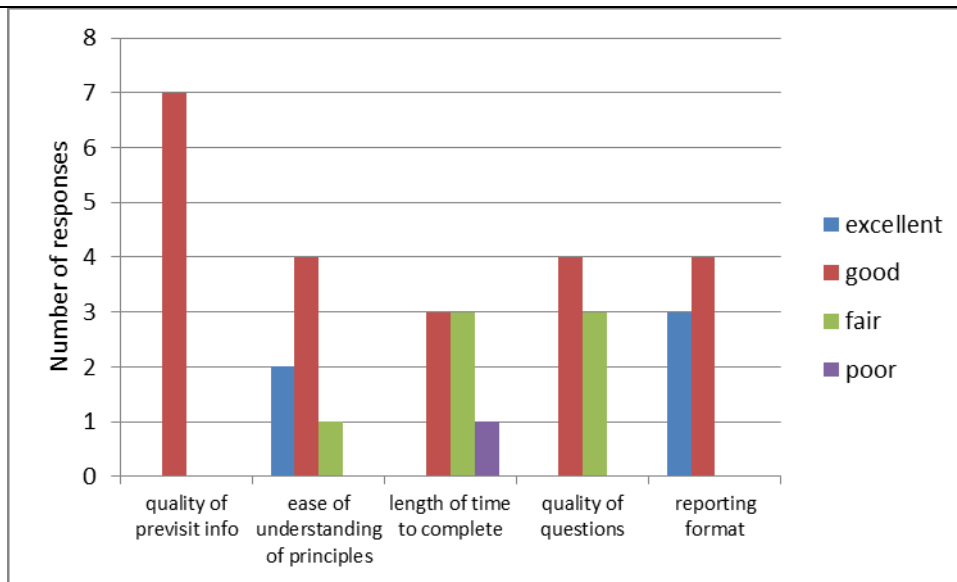


Figure 6: Advisor feedback on the tool.

Figure 7 summarises the feedback with regards to the usefulness of the tool. The majority of the advisors felt that the tool gave relevant information and identified stronger and weaker areas of provision of public goods. It was felt, in general, that the tool partly improved the farmers' understanding of the different areas that can contribute to public goods. The area on which the feedback was least definite was in terms of the tool's contribution towards demonstrating to the wider community the public goods that accrue through management practices on farm. One of the advisors felt that the tool was of little use in this and four felt that it partly contributed.

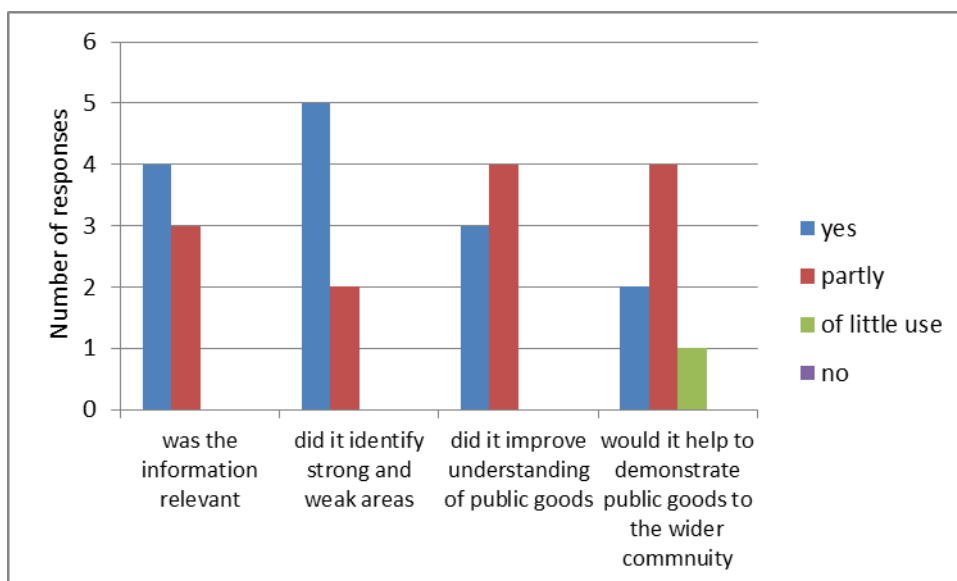


Figure 7: Advisor feedback on the usefulness of the tool.

All seven advisors said that they would recommend the PG tool evaluation to other farmers. Six of the advisors said that they would be interested in continuing to use the tool as part of their advisory work and the other one said that whether they used it or not would depend on the farmer and farm system.

Two of the advisors felt that the PG tool was suitable for use on conventional farms, four felt that it was mostly suitable and one that it was partly suitable. Their suggestions for improvements to the tool, especially with regard to making it more applicable to conventional farms, are given in the Discussion and Conclusions section of this report.

4. Discussion and Conclusions

The public goods tool was originally developed for use on organic farms and has been developed further with the aim of being able to use it on all farms. To test whether the adaptations which were made are sufficient to make it a useful tool for assessing the public goods provision across a wide variety of farms the tool was piloted on 32 conventional farms. Seven advisors carried out the pilot assessments and they

and the farmers provided feedback on the tool.

The farms assessed included nine dairy, seven beef and sheep and eight cereals farms with smaller numbers of other farm types including poultry, general cropping, mixed and horticultural. The highest scoring spurs on average were *soil management* and *animal health and welfare management* which both had a mean score of 4.1 and the lowest scoring was *agricultural systems diversity* with a mean score of 2.5. The highest scoring activities on average were *erosion* under *soil management* and *irrigation* under *water management* with a mean score of 4.9. The lowest scoring activity with a mean score of 1.3 was *on-farm processing* under *agricultural systems diversity*. The most variable activity, with a coefficient of variation of 81% was *water management plan* under the *water management* spur and the least variable, as well as the highest scoring, was *erosion* under the *soil management* spur. In total 14 activities out of the total of 57 had a coefficient of variation greater than 50%.

The feedback from the advisors and farmers was generally positive. All seven advisors said that they would advise other farmers to use the tool and six of the seven stated that they would be interested in using the tool in their advisory work in the future. Similarly 83% of the farmers said that they would recommend the tool to other farmers. The majority of the advisors and farmers rated the tool as “good” across almost all of the quality criteria (quality of the pre-visit information, ease of understanding of the principles, length of time to complete the assessment, quality of the questions, and reporting format). In addition the majority of the farmers rated the opportunity to ask questions as excellent (the advisors were not asked this question as it directly related to their involvement in the assessment). The majority of the advisors and farmers also agreed that the tool gives relevant information and identifies area of strength and weakness in the farm’s public goods provision. The median rating the farmers gave for their understanding of public goods before using the tool was 4 and the median rating for the understanding after using the tool was 8. Two of the advisors felt the PG tool was suitable for use on conventional farms, four felt that it was mostly suitable and one that it was partly suitable.

4.1 Advisor comments and suggestions for future updates to the tool

The advisors were asked to give detailed comments and suggestion for updating the tool and improving its applicability to conventional farms and these are given below. Where there were comments on programming etc. (e.g. typographical errors, minor formulae errors) they have not been included below.

4.1.1 General

The simpler the format is, the more likely farmers are going to complete. Simple formatting would help i.e. if you were able to select enterprises on the spreadsheet that are applicable to the farms being assessed. Need to make changes to speed up the process as time is of the essence for farmers e.g. if a farmer doesn't irrigate then next lot of boxes should automatically be N/A. Some tabs look very wordy and are difficult to work through for some farmers. Some farmers commented that certain questions were “vague” and required further discussion. Some questions needed more options - not just yes/no e.g. is your woodland grazed (could be both grazed and un-grazed sections, same with historic features management).

There were a couple of loaded questions – e.g. “do you have a soil protection review” and “when using pesticides do you consider and avoid contaminating areas of special environmental risk e.g. ponds” and “do you take actions to prevent contamination of water courses ponds and lakes”. The former is a requirement of claiming SPS so while not a legal requirement for all farms (as of course they can choose not to claim SPS) in reality it is a requirement for nearly everyone. The latter two are legal requirements.

Some of the questions are focussed on arable land but could be relevant to pasture also, it needs to be clearer if answers should include pasture/permanent grassland.

Questions need to be reviewed as some are still very much relevant to just organic farms, review the certification schemes available. The terminology needs updating so that it does not appear so organically based. References to OELS should be replaced with simply ELS.

Perhaps the tool could give ideas or suggest ways to improve individual farm performance after the results have been calculated e.g. if social capital was scored 1 give reasons why improving this would be a good thing and positively impact their business. However, if the tool was available just for public use i.e. farmers could complete it themselves, it is far too complex and daunting with too much room for error.

One advisor said that “The tool was on the whole well-received. The results page was a fantastic way of depicting how the business is doing and where areas of concern appear. Some clients asked if the results data could be over-laid against other similar businesses to view how they were performing.”

One of the advisors said that they had found the tool very interesting to work through with farmers and it prompted good discussion about potential future management changes to improve particular areas of farm sustainability.

Most of the advisors would be very keen to continue to use the tool; and some of the farms assessed expressed an interest in annual re-assessment to demonstrate the effects of changes they were either implementing now or thinking of implementing.

One of the farms which took part in the pilot had previously had a carbon audit as part of their sales through the supply chain of one of the large multiples. This farmer commented that they felt that the public goods tool gave them better information on where they were doing well and not so well in terms of sustainability on the farm. In addition, when looking at the results from the tool they were able to discuss with the advisor areas where changes could be made to their farm management and, equally importantly, areas where changes to improve a particular rating were not possible or practical on that farm. The farmer's comment on the carbon audit was that although figures provided by the farm were used in the audit there were also a lot of standard figures and the results and recommendations were generic; not targeted to the farm.

The radar diagram results figure is a really great way to get a lot of information across to the farmer in a way that is informative but not overwhelming. The results page of the tool then made more detailed examination of particular areas very easy using the bar chart breakdown. It was also interesting (and easy) to go back into the tool and change one or two answers to particular questions as a "what if" and then see the instant result (whether this made any difference or not).

4.1.2 Initial data collection

Suggest moving the livestock to just beneath the "summary of land use" then move on to seeds, feeds and fertilisers.

Energy and nutrient figures should be checked for conventional farms.

Cropping options - forage rape, rye etc. need to be added.

4.1.3 Agri-environmental management

Need references to the Welsh situation e.g. glastir agri-environment scheme + remove references to England only schemes. (*Author note: for use of the tool outside England, suggest removing all references to agri-environmental schemes*)

The section on "crop protection and pesticides" could also perhaps be amended. The questions in this section felt like they were really geared towards arable farms and although some advisors tried to answer these questions for grassland farms that use herbicides the questions didn't really fit.

For the section on crop protection and pesticides, suggest to rename this section "herbicide and other pesticide use" and start with the questions "do you use herbicides, insecticides, fungicides or other products (e.g. straw shorteners)" with proposed answers: yes on a field scale = score 1; yes, but only spot treatments = score 3 and no = score 5"

The question "do you take action to prevent contamination of water courses..." is either "yes" (level 5) or "no" (level 1). The "yes" answer lists a range of things a farm could be doing for safer spraying and so perhaps the scoring here could have gone into more detail with different scoring levels based on the number of actions the farm was taking.

With the concern about metaldehyde slug pellets and water contamination a prompt to remind about the use of these granular pesticides (not just liquid sprayed products) in the question on action to protect water courses might be helpful too. These quite often will just be spread on the surface and will potentially be a risk for small mammals as well as birds (not sure how many farmers consider this when using these) so additional questions may also be needed.

On the question about the safety of bees, perhaps a broader question could be asked about whether the farm or their advisor considered bee safety when selecting pesticides – there are obviously products that are more or less potentially harmful that can be used to achieve the same end result. This could be another yes, no or N/A question like the existing question on whether spraying takes place late in the evening or when plants are in flower.

Take out/rephrase leading questions i.e. "when using pesticides do you consider/avoid contaminating

areas of special environmental risk?”

Rephrase “when using pesticides do you monitor impact on beneficial species?” as some farmers assessed didn’t monitor species but did target applications so that they had as little environmental impact as possible.

For the question “when using pesticides how do you decide on amounts to use?” some farmers used a BASIS qualified advisor and looked at pest thresholds – could an option combine the two options? (*Author note: In this case the advisor should select the highest-scoring of the different methods that the farmer uses*).

For the question “how often do you calibrate and maintain the sprayer?” it would be useful to have options for “every time the sprayer is used”.

4.1.4 Landscape and heritage

The question about high environmental value boundaries caused confusion with farmers. What this means needs to be clarified in the PG tool spreadsheet.

The question relating to how many hedgerow trees there are per 100m of hedge on the farm also caused confusion and some farmers had to give an estimated answer and were unsure of the question value.

Arable farmers were unsure about the definition of “heritage crop varieties” in the question about genetic heritage. They all stated that they used up-to-date varieties from the HGCA recommended list.

4.1.5 Soil Management

The section on winter grazing in the soil management tab could be improved. The first question is “do you out-winter cattle” and the second question is “is there any poaching over winter”. The first question really needs to be “do you out-winter any livestock” because if you answer “no” to the out wintering cattle question then the whole section scores n/a - and whatever is put for the answer to the second question is not counted. Could one option be to have the question: “Do you out-winter any livestock” and then the answers could be scored as follows: no = score 5; hens = score 4; sheep/goats = score 3; cattle = score 2 and pigs = score 1? The second question could then stay the same as at present (about the extent of the poaching).

4.1.6 Water management

The question on disposal of medicines gives a level three response for “returns to supplier” and a level five response for “clinically incinerated”. If a farmer returns any waste medicines to the vet (return to supplier) and the vet clinically incinerates it then which option is selected makes a small difference to the scoring of this section. Does the fact that the farmer knows that the end result is clinical incineration justify giving that answer for this question? (*Author note: This question should be clarified in the future but in the meantime we suggested to the advisor that they should select “clinical incineration” in this case*).

For the question “what intensity of actions are being undertaken for water resource protection?” the example given for the “low intensity” option is only suitable for livestock farmers. It would be useful to have a separate table with livestock and arable options. (*Author note: The questions will be reviewed. However, this may reflect the fact that certain practices are unsustainable in the long-run*).

It would be good to clarify the wording of the following question: “what is the condition of your flood defences?” as many farmers didn’t know to what this question referred i.e. ditches or something more robust? This might be better as a qualitative question or a question where farmers can choose from a series of options.

4.1.7 Fertiliser management

Some farmers may use more than one measure to determine the nutrient applications to crops i.e. they might be in an NVZ and abide by Nmax rules for each crop but have a FACTS qualified advisor to determine how many nutrients may be applied. (*Author note: In this case the advisor should select the highest-scoring of the different methods that the farmer uses*).

The question relating to soil sampling seems to be entered into the spreadsheet twice: once in soil management and one in fertiliser management – can this be auto-filled in the fertiliser management tab from the answer given in the preceding soil management tab?

Storage of manures - options not very relevant to conventional situation.

NPK seems very skewed to organic farms. Very difficult to get more than a 1 for nitrogen. (*Author note: the N,P, and K figures are not altered between the organic and conventional version of the tool therefore both types of farm are scored on the same scale*).

4.1.8 Energy and carbon

Even farms with very low energy usage come out with a high usage compared with benchmark.

The energy and carbon benchmark for beef and sheep meant that even farms that the advisors thought had very low usage of energy came out with a very high rating against benchmark. This was difficult as the farmers were asking why they were so high against benchmark – and what they could do to reduce their figures – and the advisors didn't have an answer as they felt that there wasn't anything they could really cut. The advisors and farmers wanted more information about the sort of farms that were used in the benchmarks. (*Author note: the benchmark data comes from a study by CALU and ADAS (2007) and they have confirmed that the beef and sheep figure was for extensive farms*).

The fuel statistics look high on a dairy farm. This may be because all the energy use is allocated to the dairy enterprise as there is no arable land but the consumption benchmarks do not account for the forage production fuel use.

An additional "other" enterprise could be added to the fuel use input sheet for farms with goats, horses, deer or additional enterprises not covered in the main categories.

Young dairy cattle should be identified separately from young beef cattle in the initial data collection sheet so that sales of young dairy cattle don't cause a divide by zero error in the "beef and sheep" energy ratio.

If you complete the form as if the farm is a beef only farm then the energy and carbon benchmarks tab just says "no sheep" under the beef and sheep benchmark. Need to correct formula in Cell D30 to allow a beef-only farm to see their energy use and so be scored by the advisor.

4.1.9 Food security

It would be useful with the question "how would you describe your yields compared to average yields of similar types of farms?" to give examples of average UK yields and have a scoring system depending on how high/low their yields were compared to UK average.

The question, "Approximately what % of your produce by weight is sold to local sales, county sales, regional, national, international sales?" was difficult for farmers to answer particularly if they just sold grain to one grain merchant who then transported the crop UK/internationally. It was very difficult for the farmer to estimate the proportions in this case.

4.1.10 Agricultural systems diversity

It would take an unusual dairy farm to score well in some areas e.g. agricultural system diversity.

4.1.11 Social capital

The question "How well qualified are your staff?" is quite vague – it might be better to give examples of "average" and "above average" training e.g. FACTS/BASIS, just basis, no formal qualifications, telehandler licence etc.

For the public access questions it would be useful to have a n/a option for those people who don't have a legal public right of way through their farm. (*Author note: since we include permissive rights of way we believe that a N/A option would be inappropriate here. However it may be advisable to add an option for farms (such as poultry farms or those with TB) where biosecurity measures may need to take precedence over public access*).

For the public access question it might be useful to add a score 2. At the moment we have the options for: no public access score 1; public footpaths score 3; permissive access score 4 and open access score 5. How about limited or occasional access for score 2?

For the question "How exposed are you/your workers to hazardous chemicals?" it would be better to ask "what measures do you take to protect yourself and your workers from hazardous chemicals?" and have a drop down list as all farms have to handle potentially hazardous chemicals i.e. pesticides as part of their job but what is important is the measures taken to reduce their risk and protect themselves and their staff.

4.1.12 Farm Business resilience

One advisor commented that she liked the farm business resilience questions which she felt gave a good indication of the farm's position without being too intrusive into farm accounts and income.

4.1.13 Animal health and welfare

At present the tool scores low if the farm has a high culling figure but culling could be utilised to speed up genetic improvement not due to having problems with disease.

With regard to disease prevention when selecting stock – one farmer said that he was very careful to find out about rearing conditions and health of the flocks the hens are bred from. Extend this question to include this type of approach.

With regard to the question on management methods to reduce parasite burdens while minimising the use of anthelmintics one of the farmers was not using natural anthelmintics in pasture (as the prompt for the score suggests) but was doing more than just taking faecal egg counts (FEC) (as for level 3). He was individually monitoring FEC using a FECPAK on farm and only selecting for breeding those ewe lambs that show resilience to internal parasites. Allow a score of 5 for this type of approach.

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References

Burke, J. (2006) Welfare benchmarking and herd health plans on organic dairy farms, Final report to DEFRA.

CALU and ADAS (2007) Managing Energy and Carbon: The farmer's guide to energy audits.

Cooper, T., Hart, K. and Baldock, D. (2009) The provision of public goods through agriculture in the European Union, report prepared for DG Agriculture and Rural Development, Contract No 30-CE-023309/00-28. Institute for European Environmental Policy: London.

Cranfield University at Silsoe (2007) Improving Irrigation Efficiency Checklist.

Davis, M. and Smith, R. (2008) Thinksoils - soil assessment to avoid erosion and runoff.

DEFRA (2009) Soil protection review 2010.

Environment Agency (2007) Waterwise on the Farm.

Gerrard, C.L., Smith, L.G., Padel, S., Pearce, B., Hitchings, R., Measures, M., Cooper, N., (2011), OCIS Public Goods Tool Development, Report for DEFRA

Leeb, C., Main, D. C. J., Whay, H. R. and Webster, A. J. F. (2004) BWAP Cattle Assessment.

MAFF (1993) Code of Good Agricultural Practice for the Protection of Soil.

Nicholas, P. (2010) Private communication.

Roderick, S. (2010) Private communication.

Soil Association (2008) Soil Association Organic Standards.

University of Hertfordshire (2006) <http://sitem.herts.ac.uk/aeru/ema/old/index.htm>. [Accessed 1/12/2010].

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.