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Resource Management, Knowledge and Internet Use on Farms in South West England: A Report for the SWARM Knowledge Hub

Allan Butler and Matt Lobley

CRPR Research Paper No 36

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May 2012

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For further information about this project, please contact Dr Matt Lobley, Centre for Rural Policy Research, Department of Politics, University of Exeter, Rennes Drive, Exeter, EX4 4RJ. Tel: 01392 264539 E-Mail: mlobley@exeter.ac.uk

CRPR Research Report No. 36
ISBN 978-1-905892-17-4
May 2012
£10

This work was completed as part of the South West Agricultural Resource Management (SWARM) Knowledge Hub project (www.swarmhub.co.uk), which is funded via the Rural Development Programme for England (RDPE) and managed by Duchy College's Rural Business School.

The views expressed in this report are those of the authors and are not necessarily shared by other members of the University, the University as a whole, the SWARM Knowledge Hub, or Duchy College.

Tests of Statistical Significance: A Note

On a number of occasions in this report, comparisons are made between characteristics of sub-groups of respondents using bivariate tabular analysis. In these cases, χ^2 has been calculated to test the statistical significance of the independence between two categorical variables. A 'significant' association between variables is taken to be one where there is less than a 5% probability of the difference arising by chance ($p < 0.05$).

This report also notes statistical significance regarding the comparison of means between sub-groups of respondents. For these, the ANOVA procedure compares the means for more than two groups of cases. A 'significant' difference between means is taken when there is a less than 5% probability of the difference arriving by chance ($p < 0.05$).

Tables with total rows may not sum exactly to 100% due to rounding.

CONTENTS

RESOURCE MANAGEMENT, KNOWLEDGE AND INTERNET USE ON FARMS IN SOUTH WEST ENGLAND

1 INTRODUCTION

This report has three aims:

- To better understand farmers' behaviour and attitudes regarding the key themes of SWARM (soil, nutrient use, energy efficiency, renewable energy, water).
- To understand how and where farmers source the knowledge that helps them to manage their resources.
- To understand how farmers interact with internet sources of knowledge to discover better information about managing farm resources.

The report is therefore set out in three main sections. After a short description of the methodology employed and data collected, each of the main elements (resource management, knowledge, and internet use) are examined before commenting on some observations and implications in providing online resource management knowledge to farmers.

2 METHODOLOGY AND DATA DESCRIPTION

Two surveys – one postal, one online - were conducted in early 2012 to examine resource management, knowledge sources and internet use. The online survey sample was less than half the size of the postal sample, 221 compared to 495. By taking this approach it was hoped that significant differences might be found with regards to internet use (see Section 5). Both samples were stratified by the proportions of holdings in each county of the South West to reflect the structure of agriculture in the region. The response rates for both surveys proved excellent. After removing incomplete questionnaires,[1] 63% responded to the postal survey and 26% to the online survey, with an overall response rate of 51%. Comparing the response rates for each county to Defra data in Table 1 illustrates the close representativeness between the sample data and the distribution of holdings across the South West. Furthermore, the area of farmland in each county is compared in Table 2. The percentage area farmed in each county resembles closely the Defra data, with most counties within one or two per cent of the equivalent Defra figure. The exception is Gloucestershire in which the surveyed area of farmed land was greater, suggesting that larger farms responded in this county.

[1] Incomplete questionnaires were those where few, if any, of the key questions on resources use, knowledge and the use of the internet had been completed.

Table 1 Response rates from the postal and the online survey compared to Defra data on farm holdings

	Response from surveys				Proportion of holdings	
	Postal		Online		Defra 2010[3]	Combined samples
County	Number	Percent	Number[2]	Percent	Percent	Percent
Avon[1]	18	5.8%	2	4.9%	5.5%	5.7%
Cornwall	46	14.8%	8	19.5%	17.9%	15.4%
Devon	112	36.1%	11	26.8%	32.1%	35.0%
Dorset	29	9.4%	2	4.9%	8.8%	8.8%
Gloucestershire	32	10.3%	8	19.5%	10.0%	11.4%
Somerset	44	14.2%	6	14.6%	16.5%	14.2%
Wiltshire	29	9.4%	4	9.8%	9.1%	9.4%
Total	**310**	**100.0%**	**41**	**100.0%**	**100.0%**	**100.0%**

[1] Avon is not a county but covers the districts of South Gloucester, Bristol and North Somerset.
[2] While 57 responded to the online survey, 16 chose not to leave their email addresses and therefore the location of their farms was unknown and they were removed from this comparison.
[3] Taken from Defra's Local Authority level key land areas / livestock numbers / labour force: 2010 (the most recent version available online).

Table 2 Comparing total area farmed to Defra data

	Survey[2]		Defra 2010[3]	
County	Area	Percent	Area	Percent
Avon[1]	2,507	5%	75,927	4%
Cornwall	6,350	12%	262,791	15%
Devon	13,324	26%	485,752	28%
Dorset	4,302	8%	197,009	11%
Gloucestershire	9,199	18%	193,129	11%
Somerset	7,395	14%	269,934	15%
Wiltshire	8,947	17%	273,555	16%
Total	52,024	100%	1,758,096	100%

[1] Avon is not a county but covers the districts of South Gloucester, Bristol and North Somerset.
[2] While 57 responded to the online survey, 16 chose not to leave their email addresses and therefore the location of their farms was unknown and they were removed from this comparison. If all respondents were included in Table 2, the total area of land farmed would have been 52,803 hectares.
[3] Taken from Defra's Local Authority level key land areas / livestock numbers / labour force: 2010 (the most recent version available online).

Respondents were responsible for farming 52,803 hectares of land in the South West. This represents 3% of the region's farmland. Over half of this area (57%) was owned. The average size of a respondent's farm was 144 hectares, although the median was lower at 94 hectares. Farm type generally reflected the structure of the region's agriculture with 36% classified as cattle and sheep, 24% classified as dairy and 26% classified as mixed. Only 7% were arable while horticulture, pigs and poultry represented a further 7%. Farms with organic registration accounted for nearly 18% of the sample. This reflects the greater propensity of organic farmers to respond to survey requests together with the sampling strategy of increasing the number of organic farmers to enable robust statistical analysis between organic and non-organic farming systems.

The age of farmers in the Survey displayed a normal distribution as both the mean and median age of farmers was 56, ranging between 23 years old and

86 years old. Educationally, 31% of farmers left school at the age of 16 (or before), 41% achieved some form of technical qualification and 19% attained a degree, with just over half of these also gaining a post-graduate qualification. For the majority of farmers with technical qualifications (88%), the qualification was related to agriculture compared to 61% with degrees and 56% with post-graduate qualifications.[2] Over half of the respondents (59%) had participated in vocational training connected to agriculture. In addition, 62% had gained experience by working off the home farm either in farming (31%) or in another sector (35%), while 4% of respondents had dual experiences.

Much of the analysis in this report uses filtered samples to enable an accurate comparison of data. As such, the sample for variables under scrutiny were reduced in number to ensure that all analysed data had no data missing. Therefore, any percentage values reported in the text are directly comparable to that presented in the corresponding figures and tables. The only variable not accounted for in this way was age. However, in most cases, preliminary analysis indicated that age was seldom statistically significant. Therefore, where percentage values are reported in Sections 3.6 and 5.5, caution is needed when interpreting the results. In part, age was captured by other variables such as education and attitude to business management. Younger farmers, aged under 46, were associated with technical and degree level qualifications as well as being more likely to be the first to try out new practices, whereas farmers over 65 preferred to stick to practices that worked well in the past.

3 RESOURCE MANAGEMENT ON SOUTH WEST FARMS

The term 'resource management' in agriculture is frequently used but rarely defined. Using a US legal definition,[3] agricultural resource management is defined as the management of "all the primary means of production, including the land, soil, water, air, plant communities, watersheds, human resources, natural and physical attributes, and man-made developments, which together comprise the agricultural community". While this definition is specific to US law, its expansive nature is relevant to this report as it places in perspective the definitions suggested by South West farmers. In total, 57% of respondents attempted to define what resource management meant in agriculture. These definitions varied from tautologies to well reasoned answers. Of the respondents that replied 5% admitted that they did not know the meaning, while 18% of answers were tautological with the inclusion of words such as efficiency. For example, "*managing the resources available to you*" or "*to manage all the resources on the farm efficiently*". Others named what these resources included: "*management of land, labour, machinery, money, water, and FYM*", "*management of natural resources like water/soil/fert/muck*" and "*management of resources relating to my farm – soil, water, wind, etc*". Some farmers remarked on the necessity of resources to provide productive capacity from the farm: "*managing the farm to utilise its production abilities to*

[2] The association between technical qualifications and an agricultural topic was statistically significant ($p<0.001$).

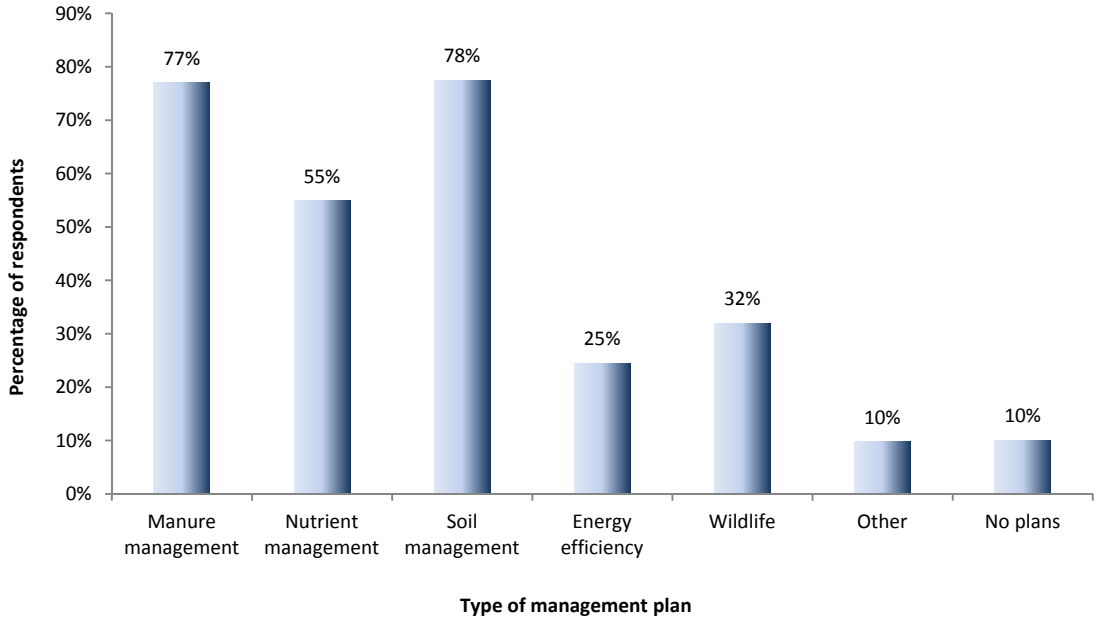
[3] American Indian Agricultural Resources Management Act, Chapter 39, Sec. 3703 – See http://www.uslegalcode.com/us-code/TITLE-25/Section-3703.php

produce food cheaply and efficiently and without destroying the 'positive' resources of the farm" or "*maintain the intensive productivity of the land on the farm*". For others, natural resources and sustainability were important factors in their definitions: "*using ones resources to the best standards of sustainability*" or "*using the farm's natural resources to make a profit, but being 100% organic, sustainability is paramount*". More reasoned answers included reference to some of the subjects in the survey: "*using materials that are local without waste, such as spreading manures at good growing time of the year minimising run off, and using electricity and machinery wisely*"; while others took an economic perspective: "*optimising the use of available resources to achieve ones personal and business objectives*". The most encompassing definition was: "*I understand 'Resource management' to mean an awareness of what resources we have available and managing them accordingly. i.e. labour, machinery and equipment and even natural resources and integrating them to maximise the business."* While there were several definitions, many respondents recognised some of the key factors of production - physical, natural, human and manufactured - that were important to manage correctly in order to continue farming from an environmental and financial perspective.

3.1 Management plans

Farmers were asked about the types of management plans they used to manage resources on their farms. These included plans for manure, nutrients, soil, wildlife and energy efficiency represented in Figure 1. Only 10% of farmers indicated they had no plans for resource management. The majority of farmers (78%) had plans for managing soil, 77% for manure and 55% for nutrients on their farms. Approximately one in ten farmers suggested they had 'other' plans, which were typically connected to animal health or government schemes such as the Entry Level or Higher Level Schemes.

Figure 1 Management plans used by farms on South West farms (n= 306)



Factors associated with resource management plans included the size and type of farm, agricultural education, farming experience and attitude towards farm management. In terms of farm structure, the largest farms were statistically associated with having management plans. For example, farms over 200 hectares were statistically associated with plans for manure (89%), nutrients (76%), soil (92%), and energy efficiency (35%). Each farm on average had 3.6 plans in place, greater than any other farm category size. Furthermore, every farm over 200 hectares had at least one management plan in place. By contrast, the smallest farms were the least likely to have management plans in place. Indeed, 22% of farms with less than 25 hectares and 20% of farms between 25 hectares and 49 hectares had no plans to manage farm resources. Typically, these farms were small owner occupied units.

Farm type also influenced the number of resource management plans. For instance, dairy, arable and mixed farms on average had a set of three plans in place compared to only two for other farm types. In particular, dairy farms were statistically associated with having management plans for manure (90%), nutrients (73%), soil (86%) and energy efficiency (35%). However, they were not statistically associated with plans to manage wildlife; only 22% had such plans compared to 40% of mixed farms, suggesting that many dairy farms are still on the margins of formal wildlife management. Arable farms were associated with plans for nutrients (76%) and soil management (92%). As might be expected, cattle and sheep farms were least likely to have management plans, perhaps because many of these farms were less than 50 hectares in size. Finally, in terms of farm type, the organic status of farms was particularly associated with manure (91%), soil (89%) and wildlife management plans (53%).

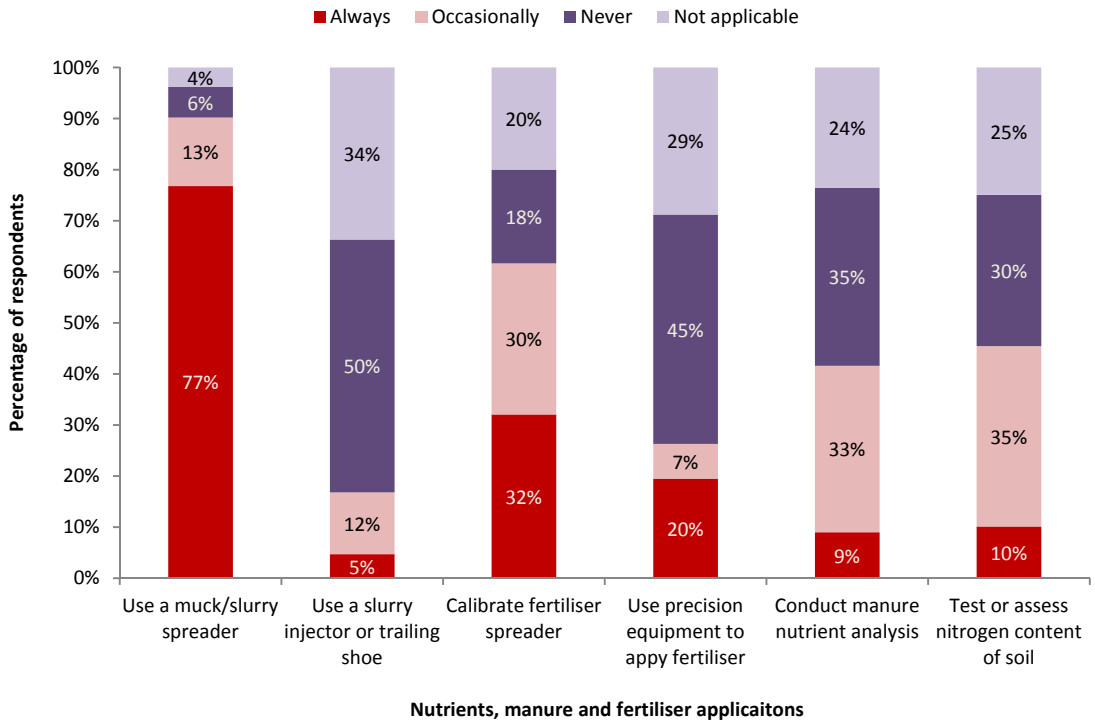
Various farmer characteristics were also associated with different resource management plans. For instance, farmers who described themselves as ‘sole operators’ tended not to have plans in place, unlike ‘farm partners’ or ‘directors’ of farms. Furthermore, their educational competence had a bearing. Farmers with technical qualifications were much more likely to have management plans particularly for manure (86%), nutrients (67%), soil (82%) and energy efficiency (31%). When the farmers’ highest level of education was connected to agriculture, this was also associated with a greater propensity to have plans. Moreover, strong statistical associations occurred between participation in vocational agricultural training and management plans for manure (84%), nutrients (65%), soil (82%) and energy efficiency (30%). Conversely, farmers without any type of management plan were associated with having no vocational training experience. Finally, the attitude of farmers towards their business management was associated with differences in the likelihood of having a management plan in place. Farmers that preferred to stick to practices that worked well in the past were most associated with having fewer or no management plans. Farmers that were willing to try new practices provided they were tested, or those that were prepared to try out new practices first, both had, on average, three management plans in place, whereas farmers who chose to stick to practices that worked well in the past had only two. Some of these differences could be connected to age as younger farmers, particularly those under 45, were more

likely to be innovative whereas those over 65 were happy to stick to their old ways.

3.2 Managing manures and fertiliser

The management of manure and fertiliser applications on South West farms is illustrated in Figure 2. The most striking observation is that 77% of farmers always apply their manure with a muck or slurry spreader, whereas only 5% used a slurry injector or trailing shoe. Including farmers that occasionally used these practices, raises the figures to 90% using muck or slurry spreaders and 17% using a slurry injector or trailing shoe. To a lesser extent, this pattern was repeated for calibrating fertiliser spreaders (62%) and using precision fertiliser equipment (27%). Conducting nutrient analysis of manure or soil was always practised by 9% and 10% respectively. Furthermore, there were strong statistical associations between those that conducted nutrient analysis and those that used precision methods of applying both manures and fertilisers. This suggests a small but highly resource efficient subset of farmers. Importantly, farmers that had manure, nutrient or soil management plans were statistically associated with the practices of always calibrating fertiliser spreaders, using precision fertiliser equipment, using a slurry injector or trailing shoe, and analysing their manure and soil nutrient contents. Larger farms also engaged with these practices. For example, 49% of farms over 200 hectares calibrated their fertiliser spreaders compared with an average of 32% across all farms (see Figure 2 for comparisons); 35% used precision fertiliser equipment; and 29% conducted nitrogen analysis on their soil. The use of more precision methods does not mean that the largest farms have ceased the spreading of slurry or muck as 70% continued to always use this method, although this exceeded 85% for farms between 100 and 199 hectares.

Figure 2 Practices when applying manure and fertilisers (n=305)



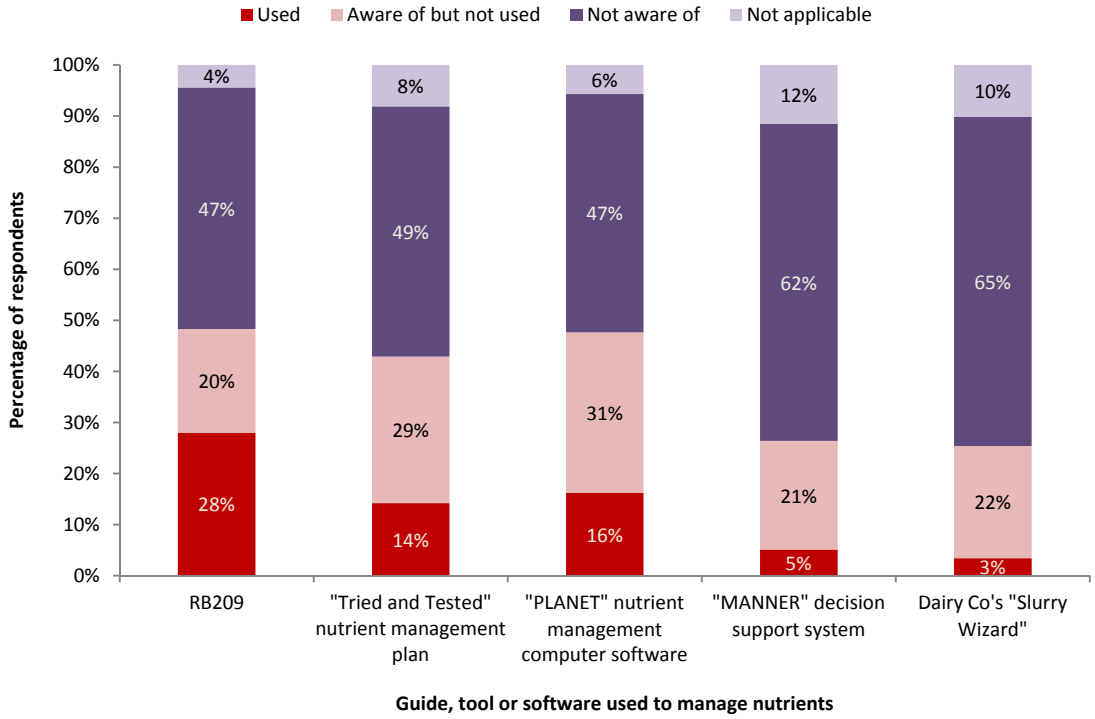
The association between farm type and education on the methods that farmers used to apply either manure or fertiliser is less clear. For instance, arable farms were statistically associated with calibrating fertiliser spreaders and the use of precision fertiliser equipment. Given that arable farms are less likely to have a readily available source of manure, perhaps this is unsurprising. Indeed, only 54% of arable farms always used muck or slurry spreaders compared to 80% of dairy farms and 78% of cattle and sheep farms. The farm types least associated with precision methods of manure and fertiliser applications were cattle and sheep farms and organic farms. Furthermore, those that had not participated in vocational training were statistically associated with the 'not applicable' and 'never' categories. Farmers with the attitude of following new practices as long as they were tested were statistically associated with occasionally carrying out all the possible manure and fertiliser application methods. On the other hand, farmers that always used a muck spreader were those that preferred to stick to practices they knew.

Farmers with plans for manure and nutrients were statistically associated with all the practices detailed in Figure 2. For example, farmers with a manure plan were more likely to use a slurry injector or trailing shoe (6% always, 13% occasionally) and conduct manure analysis (11% always, 40% occasionally), although they were also more likely to use a muck spreader (79% always, 16% occasionally). Farmers with a nutrient plan were also strongly associated with always calibrating their fertiliser spreaders (41%); always using precision equipment to apply fertiliser (29%); and assessing the nitrogen content of their soils (14% always, 46% occasionally). Those without manure or nutrient plans were less inclined (and statistically associated) with never carrying out most of these manure and fertiliser application practices.

3.3 Managing nutrients

Farmers' awareness and use of the various guides, tools and software that are available to help manage nutrients was closely associated with whether or not they had a nutrient plan. Figure 3 gives the most popular types of guides, tools and software available to farmers. In every case, farmers that had a nutrient plan were at least three times more likely to have used any one of these tools. For example, 41% of farmers with a plan had also used the RB209 fertiliser manual, compared to 12% with no plan, and 28% of all farmers. For PLANET, the difference between those with a plan and without a plan was even greater, 27% and 2% respectively, compared to 16% for all farmers. In the case of MANNER, only farmers with a nutrient plan had used this tool. While not as pronounced, awareness of every tool in Figure 3 was also greater among farmers with a nutrient plan.

Figure 3 Awareness of nutrient management guides, tools and software (n=296)



RB209 is Defra's fertiliser manual. It is designed to help farmers and land managers assess the fertiliser required for a range of crops they may plan to grow (Defra 2011). Now in its eighth version, it was first published in 1973. Given its longevity, and that it is a government document, it is perhaps not surprising it was the most widely used of the guides, tools and software considered by the survey. RB209 was more likely to be used by farmers with over 200 hectares in size (46%); by dairy farmers (40%) and by arable farmers (42%). Conversely, cattle and sheep farmers were less aware of it with 64% completely unaware compared to the average of 47%. Educationally, farmers with higher levels of education were both more aware of it and had used it more. For example, 43% of farmers with a degree had used it compared to only 21% of those with no formal education other than that attained at school. Statistically, the use of RB209 was associated with an agricultural education and participation in vocational training. Finally, farmers using RB209 were associated with following new practices as long as they were tested.

The "Tried and Tested" nutrient management plan was an industry initiative to make nutrient planning and recording 'simple' for farmers.[4] While used by fewer farmers than RB209, which has the advantage of being well established, the "Tried and Tested" nutrient plan was nevertheless used by 14% of respondents, while a further 29% were aware of its existence. "Tried and Tested" was associated with fewer variables than RB209. While not significant, it was more likely to be used by the largest farms (20%) and on

[4] The second edition of the Tried & Tested Nutrient Management Plan has been produced by a collaboration between Agricultural Industries Confederation (AIC), Farming Wildlife Advisory Group (FWAG), Linking Environment and Farming (LEAF), National Farmers Union (NFU) and the Country Landowners and Business Association (CLA), funded by England Catchment Sensitive Farming Delivery Initiative (ECSFDI) (see website: http://www.nutrientmanagement.org/The-Plan/The-Plan/).

arable (21%) and mixed (19%) farms. Again, agricultural education, participation in vocational training and attitudes to practices proved significant but in a negative way. In total, 59% of those without agricultural education, 61% that had not participated in vocational training and 70% of those who preferred to stick to practices they knew, were not aware of this nutrient plan.

PLANET (Planning Land Applications of Nutrients for Efficiency and the environmenT) is a nutrient management software tool developed by ADAS to assist the good management of manufactured fertiliser and organic manure nutrients (e.g. nitrogen, phosphate, potash, sulphur and lime) that are applied to land.[5] In many ways the responses to using PLANET were similar to that for "Tried and Tested". Of the largest farms (200 hectares or more), 36% of respondents had used PLANET. Dairy and mixed farmers were the most likely users (24% and 23% respectively), whereas 58% of cattle and sheep farmers were not aware of the tool (compared to 47% on average). Statistical associations highlight again the role of education, as farmers educated to degree level used PLANET the most (30%) compared to (7%) of farmers with only a school education. In addition, farmers with post-school agricultural education (22%) and those that had participated in vocational training (23%) were also most associated with using the tool. Finally, 68% of farmers who stuck to practices they knew were not aware of PLANET compared to 42% of those that followed new practices as long as they were tried and tested and 41% of those who preferred to be the first to try out new practices.

The last two tools considered here, ADAS's decision support system MANNER (Manure Nutrient Evaluation Routine) and Dairy Co's Slurry Wizard, were less well known with only 26% and 25% respectively, either using or aware of these systems. MANNER is a decision support system that can be used to accurately predict the fertiliser nitrogen value of organic manures on a field specific basis (ADAS undated). Slurry Wizard, on the other hand, calculates how much slurry a farm produces and highlights which areas contribute to the storage of manure throughout the year (Dairy Co, undated). Given the much lower levels of awareness of these two tools meaningful statistical analysis was difficult. However, some of the patterns related to agricultural education, vocational training and attitude to agricultural practices established for RB209, "Tried and Tested" and PLANET, were also apparent for both MANNER and Slurry Wizard. Finally, as might be expected, the greatest use (7%) and awareness (but not used) (39%) of Dairy Co's Slurry Wizard occurred on dairy farms.

Only two 'other' guides, tools or computer software were noted: Yara's computer programme to help calculate the optimum nitrogen rates for arable crops, and guides from SOYL Precision Farming.

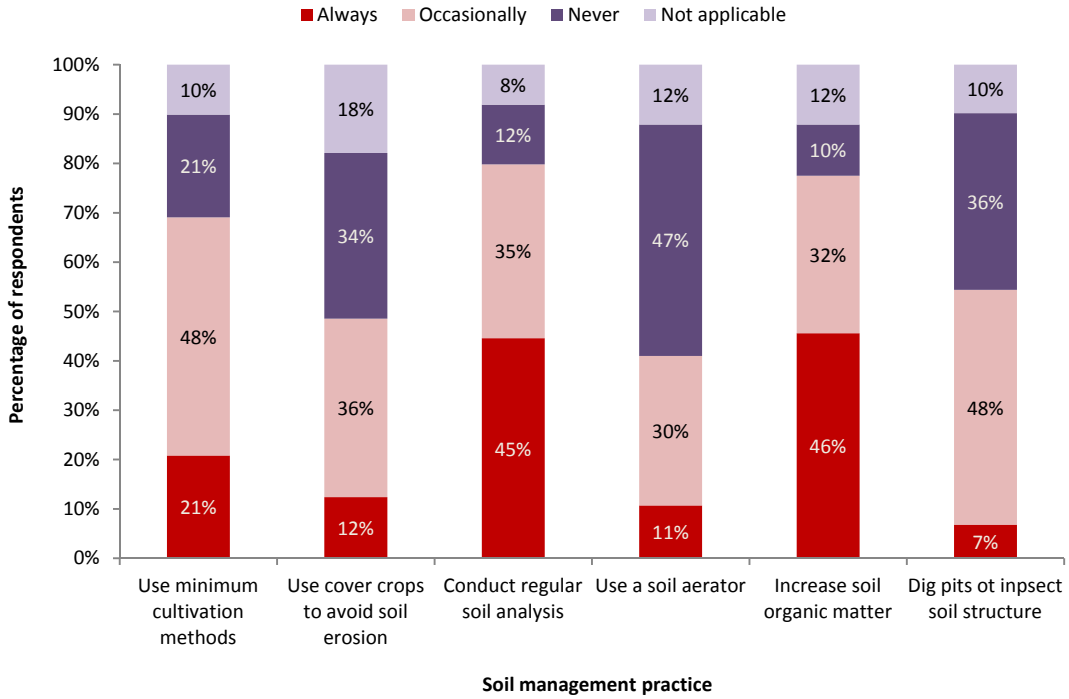
3.4 Managing soil

Conducting regular soil analysis and increasing the soil's organic matter were the two most popular soil management practices, respectively 80% and 77%, exercised on a continual or occasional basis (see Figure 4). A fifth of farmers (21%) always used minimum soil cultivation methods, while 48% used it

[5] PLANET was developed by ADAS with funding and support from Defra and the Scottish Government, in consultation with industry stakeholders, including the Environment Agency (EA) (see website: http://www.planet4farmers.co.uk/).

occasionally. Fewer respondents indicated they used cover crops to reduce soil erosion (48%); used a soil aerator (42%); or dug a pit to inspect soil structure and compaction (55%). Statistically, farms with management plans for soil were associated with always practicing these techniques. The exceptions were for increasing organic materials and digging an inspection pit to analyse soil structure and compaction. However, both of these were more likely to occur on an occasional basis on farms with a soil management plan, reflecting the periodic nature of performing these tasks. The occasional practices of using minimum cultivation methods, using cover crops, conducting regular soil analysis and using a soil aerator were also associated with farmers that had a soil management plan.

Figure 4 Soil management practices on South West farms (n=306)



Factors associated with soil management techniques included farm size and type, organic status, agricultural education and attitude towards farming practices. Three-quarters of farmers with over 200 hectares conducted regular soil analysis as compared to 45% of all farms. Arable (72%), mixed (54%) and dairy (56%) farmers always carried out this technique compared to only 28% of cattle and sheep farmers, which were less likely to cultivate land. Whilst not statistically significant, only 22% of organic farms, compared to 50% of conventional farms, conducted soil analysis. However, organic farms were more likely to carry out this practice periodically. Agricultural education and participation in vocational training were both strongly associated with conducting regular soil analysis (52% and 55% respectively) while the converse was true for those without such backgrounds. Finally, for this method of soil management, 51% of farmers who followed new practices as long as they were tested also conducted regular soil analysis. This compares to 23% of those who preferred to stick to practices that worked well in the past.

Increasing soil organic matter was the second most practiced soil management method. For this farm size and type were not so much a factor, although farmers with over 200 hectares and arable farmers were statistically associated with carrying out this practice periodically. However, a stronger association existed, as might be expected, between increasing organic soil matter and organic farming. Indeed, 72% of organic farmers practiced this method compared to 46% of all farmers and 40% of conventional farmers, although 35% of this latter group occasionally practiced increasing organic soil matter. The attitude towards practices, and this practice in particular, was significantly associated with those who tried out new practices first (64%) while those that preferred to stick to what they knew were most associated with never increasing soil organic matter (20% compared to 10% of all farmers).

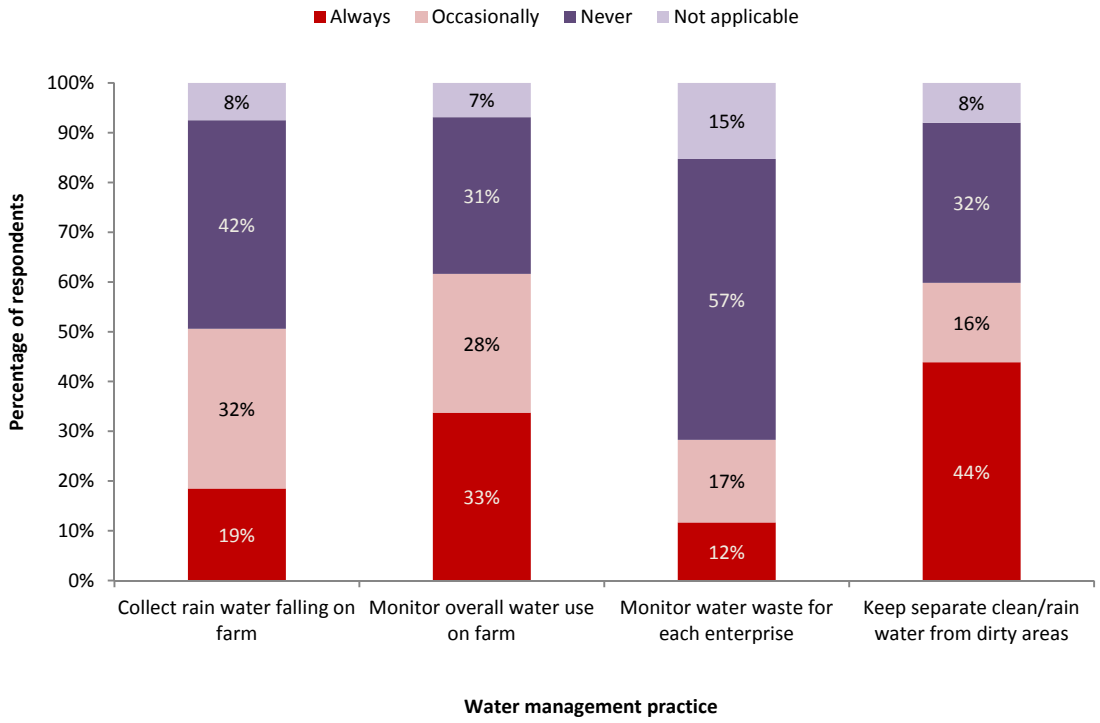
The occurrence of minimum cultivation methods was statistically associated with larger farms but only when practiced occasionally; 63% on farms between 100 and 199 hectares, and 58% on farms over 200 hectares. The survey found no association between this method and farm type or organic farming. However, attitudes towards using minimum cultivation methods were significantly associated with those who tried out new practices first (34%) compared to 21% of all farmers. Those who preferred to stick to what they knew were most associated with never using the method (32% compared to 21% of all farmers).

Few respondents always used cover crops, a soil aerator or dug an inspection pit. Clearly, the latter two are most likely to occur periodically rather than frequently given their purpose. Furthermore, it is suggested that a pit is dug before using a soil aerator (SAC, 2004). Analysis of these two practices demonstrated an association in the survey data. 27% of respondents who always dug a pit also used a soil aerator (compared to 7% of all sample respondents), while 63% who occasionally dug a pit also occasionally used a soil aerator (compared to 48% of all sample respondents). The use of cover crops tended not to be associated with any particular factor other than agricultural education. The use of a soil aerator was associated with farms between 100 and 199 hectares, dairy farms, farmers with an agricultural education, those that had participated in vocational training and those that followed new practices as long as they were tested. Digging a pit to examine soil structure and soil compaction displayed a very similar pattern to that of using a soil aerator. However, respondents that dug a pit were more associated with arable and farms over 200 hectares.

3.5 Managing water

Water management on South West farms showed a mixed picture. Many respondents reported that they always kept clean water away from dirty areas (44%) with a further 16% occasionally carrying out this practice (see Figure 5). Monitoring overall farm water use was carried out by one-third of farmers on a regular basis and by 27% less frequently. However, only 19% of farmers always collected rainwater, and 12% always monitored water use for each enterprise.

Figure 5 Practices to manage farm water (n=308)



Arable farmers were least likely to collect rainwater on the farm presumably because, with very few livestock, less water is needed. Indeed, 72% of arable farmers never collected rainwater compared to an average of 42% for all farms. Conversely, horticultural holdings, although small in number (n=9), were much more likely to always collect rainwater (44%) or collect it occasionally (44%), presumably as a resource to water their produce. The size of a farm, its organic status, farmers' education or attitudes made no difference to whether rainwater was collected on farms.

Monitoring water over the whole farm or for specific enterprises, while not statistically significant, was associated with the largest farms. For instance, 49% of these farmers monitored overall water use and 19% monitored it on a per enterprise basis, compared to 33% and 12% respectively of all respondents. In terms of farm type, cattle and sheep farmers were more likely to never monitor water use at either level, while one-third of horticultural holdings monitored water at the enterprise level, nearly three times the average. Similar to the collection of rainwater, the size of a farm, its organic status, farmers' education or attitudes made little difference to whether water use was monitored. The exception was that farmers with the attitude of following new practices as long as they were tested were marginally more likely to monitor overall water use but only occasionally.

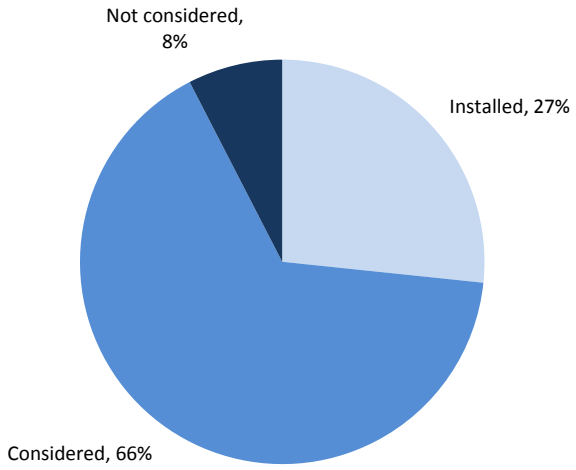
One of the reasons why farmers are perhaps not so committed to monitoring water supplies is that some have sources of water on their farms. Indeed, some farmers commented that they did not need to monitor water because “I have my own bore hole” and therefore water is presumably not regarded as a cost.

Finally, the separation of clean/rainwater from dirty areas was statistically significant in certain circumstances. Dairy farms, as might be expected, practiced this measure more frequently with 61% (compared to a sample average of 44%) always diverting clean and rainwater away from dirty areas. Cattle and sheep farmers were least likely, with only 33% always managing clean and rainwater in this manner. Post-school agricultural education was associated with water separation although the association was not strong.

3.6 Installations of renewable energy

Installations of renewable technologies on South West farms were in the minority. In total, nearly 27% of respondents had installed at least one form of renewable energy capacity, while 7% of these had installed more than one (in one case four types). By far the most popular form was solar panels to generate electricity, which presumably is as a result of the generous feed-in tariffs that were available until very recently. Installations for other technologies were much lower. For example, only 6% of farms had installed solar thermal systems for heating water, 4% had installed wind turbines and heat pumps, 3% biomass boilers and only 1% had installed hydro turbines or anaerobic digesters. Many more farmers (66%) had considered generating their own renewable energy but as yet had not converted this interest into installations (see Figure 6). Interestingly, only 8% had never considered installing renewable energy technologies.

Figure 6 Installation and consideration of renewable energy technologies (n=304)



According to the energy efficiency pyramid, generating renewable energy is at its peak above energy efficiency and energy conservation. Therefore, it is instructive to examine whether farms that had installed some form of renewable energy technology had also adhered to conserving or using energy efficiency measures. Farms with installations were weakly associated with monitoring their energy efficiency (78% compared to a sample average

response of 70%). Considering individual energy conservation and efficiency measures (in particular, turning off electrical equipment, monitoring energy use, and using and buying energy efficient equipment), no association was found between these and installing renewable energy. This suggests that some farmers had perhaps installed renewable energy as an income generating activity, subsidised by feed-in tariffs, rather than first considering more appropriate (and possibly cost effective) energy efficiency and energy conservation.

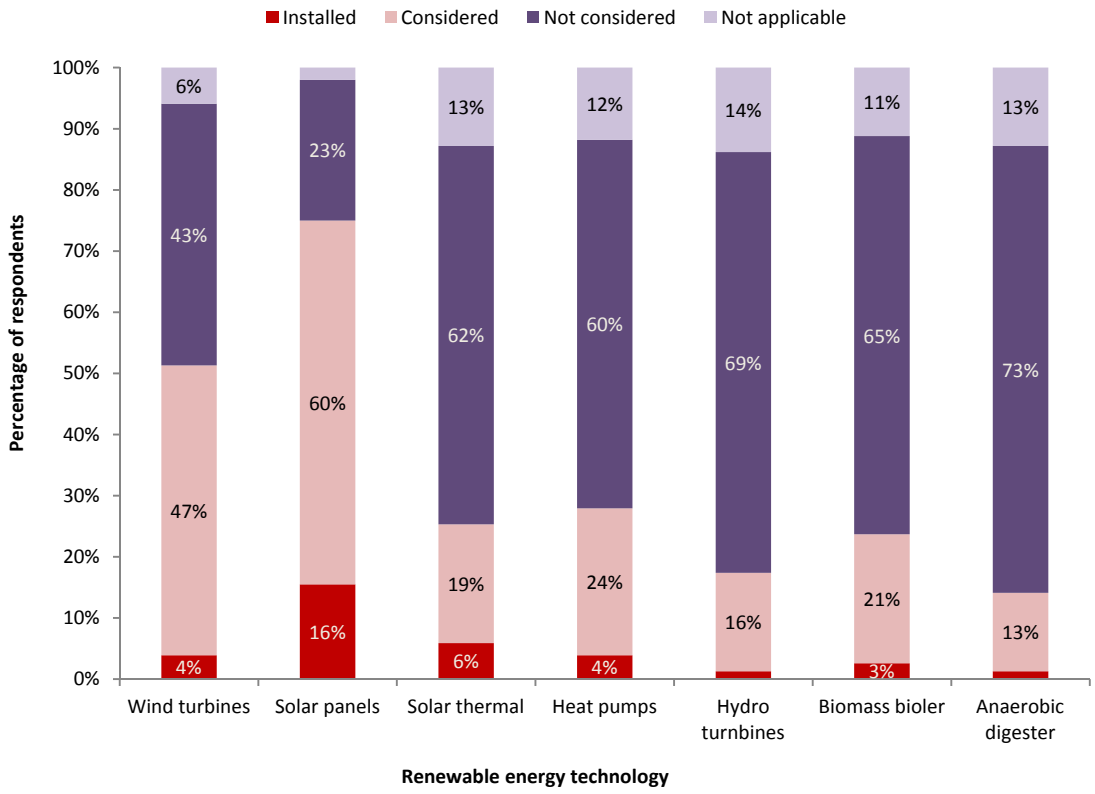
The main factor associated with installing renewable energy technologies was the general level of education of farmers rather than their agricultural knowledge. Interestingly, 60% of farmers whose highest education level was 'A' levels and 48% of respondents with post-graduate qualifications had installed some form of renewable energy technology compared to 27% of all respondents. Furthermore, 85% of farmers with degrees had considered installing technology but presently had not done so. Installations had occurred across different farm sizes and farm types. The only notable association was that cattle and sheep farmers were more likely to have never considered any form of renewable energy installation, although this was still relatively small at 14% (compared to 8% for the sample as a whole). Moreover, 19% of farmers that had the attitude of sticking to practices that worked well in the past had also not considered installing renewable energy technologies on their farms. Finally, while not directly comparable with the values in Figure 6,[6] 38% of farmers under 46 years old had installed some form of renewable energy technology while 19% of tenant farmers had not considered it.

In examining Figure 7, it is evident that photovoltaic solar panels (60%) and, to a lesser extent, wind turbines (47%) were the most frequently considered forms of renewable energy to install. However, very little association exists between any form of technology and farm size or farm type. Organic farms, while not statistically significant, were more likely to be associated with both installation and consideration of photovoltaic solar panels (28%), solar thermal systems (15%) and heat pumps (8%). Furthermore, with the exception of solar panels, organic farmers were more likely to have also considered their installation. Education, as noted above, was an important factor. Farmers whose highest education attainment was A 'levels, were associated with installing wind turbines (12%), solar panels (32%) and heat pumps (12%). Post-graduates, on the other hand, were closely associated with considering the installation of hydro turbines (44%), biomass boilers (44%) and anaerobic digesters (33%). Interestingly, farmers with only school education were more likely not to have considered nearly every form of renewable technology on their farm. Finally, the attitude of farmers to practices highlights those who preferred to stick to practices that worked well in the past were associated with not considering all the technologies, whereas those that followed new practices as long as they were tested had considered most, but particularly photovoltaic solar panels (66% compared to a sample average of 60%). Interestingly, the farmers who suggested that they liked to be the first to try out new practices were more likely to have considered the less commonly

[6] The data for age and land tenure is not directly comparable to the other variables used in the analysis as both of these variables had larger amounts of missing data. To have included them would have reduced the sample population for renewable energy to approximately 250.

considered renewable technologies of heat pumps (40%) and hydro turbines (31%).

Figure 7 Installations of renewable energy technologies (n=304)



3.7 Monitoring energy use on South West farms

The monitoring of energy on South West farms presents a mixed picture. Whilst 69% of farmers reported monitoring energy, no clear pattern emerges regarding factors or monitoring practices.[7] For example, while 30% of respondents suggested they had an energy efficiency plan, only 81% of these monitored energy efficiency on their farms. Furthermore, of the 70% that did not have an energy efficiency plan, 64% nevertheless monitored energy use on their farms. This would suggest that much of the monitoring that occurred on South West farms was on an *ad hoc* basis rather than being part of a planned strategy.

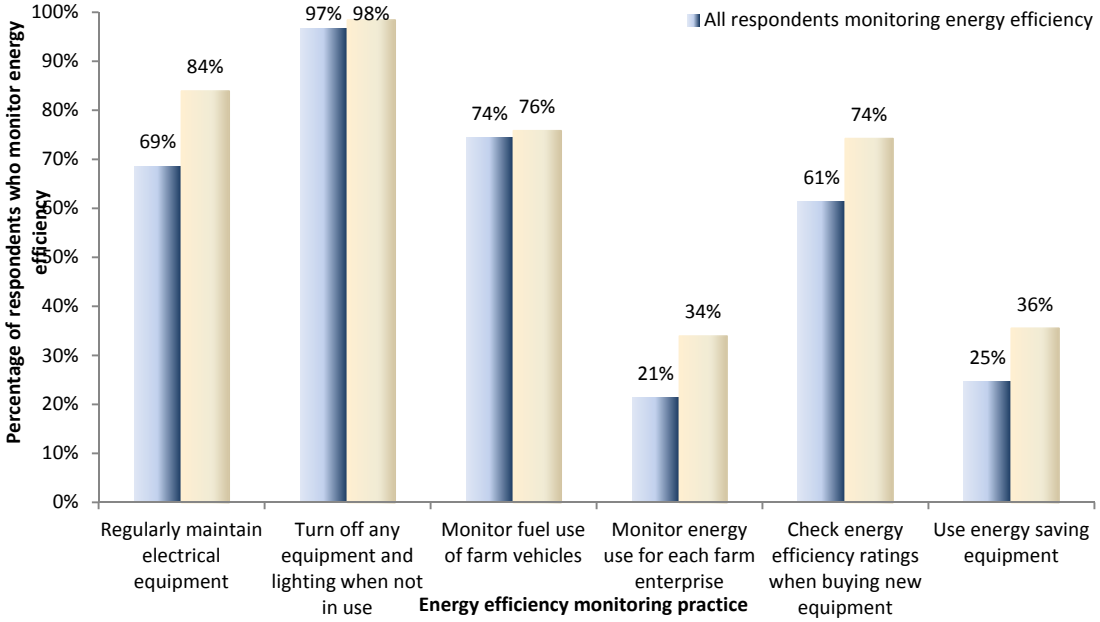
Analysis of the factors that are associated with monitoring energy on farms produces a mixed picture. That said, 81% of dairy farmers, compared to 59% of cattle and sheep farmers, and 79% of organic farmers monitored their energy use. Furthermore, 74% of farmers that had participated in vocational training and 89% of farmers with the attitude of trying out new practices first were statistically associated with being more likely to monitor energy use on their farms. This compares to 59% of those with no vocational training and 47% of farmers who preferred to stick to practices that worked well in the past.

All of the energy monitoring practices illustrated in Figure 8, except turning off equipment and lighting when not in use and monitoring the fuel use of farm

7 For this part of the analysis, n = 303.

vehicles, were statistically associated with having an energy efficiency plan. For regularly maintaining electrical equipment 84% of farmers with a plan engaged in this practice; 34% monitored energy use for each enterprise; 74% checked energy efficiency ratings when purchasing new equipment; while 36% used energy saving equipment, such as heat recovery units or heat exchangers. Thus, in general, having an energy efficiency management plan seems to be associated with increased levels of energy efficiency practice.

Figure 8 Managing energy efficiency on South West farms (n = 207)



While not reported in Figure 8, 6% offered other suggestions such as using energy efficient light bulbs, smart meters, off-peak electricity (which does not necessary entail using less energy) and only using energy when absolutely needed. Of all the six energy conservation and efficiency measures, the only significant associations occurred with use of energy saving equipment. First, 56% of dairy farmers used such equipment (compared to 6% of cattle and sheep farmers and 25% of all farmers). Second, 31% of farmers with an agricultural education were also more likely to use energy saving equipment. Among the other measures no pattern of prominent factors was discernible. Perhaps one potential explanation is that energy conservation and energy efficiency measures are more difficult to associate with any farm size or type but occur across all sectors. An alternative explanation is that these measures have received less coverage than managing nutrients or generating energy through installing renewable energy technologies.

3.8 Measuring the carbon footprint of South West farms

The final part of this section examines the number of farms that have measured the carbon footprint of their farm. Only 14% of farmers (n=298) had created a carbon footprint for their businesses. Farmers with energy efficiency management plans were more likely to create one with one-quarter doing so. Similarly, one-quarter of farmers with carbon footprints farmed the largest farms (200 hectares or more). Both dairy farms and organic farms were statistically significantly associated with measuring their carbon footprint; Of the 67 dairy farmers in this sub-sample, 27% had created carbon footprints, which probably stems from supermarkets trying to prove the green credentials of their produce. Low carbon production was also important for farmers with organic land as 37% were associated with creating a carbon footprint for their businesses. In terms of farmers' education and attitudes, 18% whose highest level of education was connected to agriculture and 36% of farmers who liked to be the first to try out new practices had also created carbon footprints. This latter group, which had the strongest statistical association, demonstrates the connection between expressing an attitude in favour of innovation and actually trying new practices. Conversely, only 5% of farmers who preferred to stick to practices that worked well in the past had measured the carbon footprint of their farm. While creating a carbon footprint provides a baseline of the farm's carbon emissions, more work is necessary on how these farms intend to shrink their footprints while maintaining profitability.

4 SOURCING UP TO DATE KNOWLEDGE ABOUT AGRICULTURE

Farmers can gain up to date information about farming practices from many sources. Excluding formal training, Table 3 (overleaf) presents some of the most common sources including family or friends, business and farming professionals, media and internet sources. In addition, respondents were asked about their three most trusted sources which are also presented in Table 3. The farming press and farming friends were the top two sources named by respondents, 89% and 78% respectively. Farming friends (70%) were also important, as were business professionals (62%). Interestingly, while 50% used internet web pages to source their information, only 9% used internet discussion boards and 6% used internet blogs. This is a theme picked up in the next section. Farmers were also asked to name the three sources they trusted most in terms of the knowledge they gave. Table 3 illustrates that farming professionals (52%), the farming press (36%), business professionals (31%) and farming friends (29%) were frequently cited.

For this analysis a relative measure has been calculated to determine which sources were more important in terms of the knowledge that they gave relative to all named sources. As such, a *source importance ratio* was created to illustrate the relative importance of particular sources, the results of which are shown Table 3 (overleaf). To calculate the source importance ratio (c), the quotient of the weighted responses to sources named as most trusted (b) and the weighted responses of all sources named (a) was calculated.

$$\text{Thus, } c = \frac{b}{\sum b} \Big/ \frac{a}{\sum a}.$$

A ratio value of 1.0 indicates that a source of knowledge is neither more nor less important to farmers as compared to the overall number of times this source was used by farmers. A ratio value over 1.0, suggests a particular source of knowledge is relatively more important, whereas a value below 1.0 suggests the source is less important. Two weaknesses of this ratio should be mentioned. First, it is sensitive to small numbers and, second, farmers were only asked for three sources they trusted in terms of the knowledge they gave. In some cases this could be more, in other cases respondents cited less than three. Therefore, while the relative measure of source importance ratio is useful, it should be treated with some caution.

Table 3 Sources to keep farming knowledge up to date (n = 308)

Knowledge source	Respondents naming sources (a)	Respondents regarding sources as one of the three most trusted (b)	Source importance ratio (c) More trusted when c > 1 Less trusted when c < 1
Farming family member	32%	15%	1.20
Farming friend	70%	29%	1.06
Business professional	62%	31%	1.30
Farming professional	78%	52%	1.73
Farming union	39%	17%	1.10
Breed society	27%	6%	0.53
Farming press	89%	36%	1.06
Radio/television programme	43%	4%	0.24
Discussion group meeting	49%	14%	0.72
Internet web pages	50%	9%	0.45
Internet discussion boards	9%	3%	0.84
Internet blog	6%	0%	0.13
Other farming organisations	16%	8%	1.25
Other sources	10%	1%	0.35

The ratio shows that, in terms of the knowledge provided, the most important sources were farming professionals (1.73) such as agronomists and vets, followed by business professionals (1.30), for example accountants. Other farming organisations (1.25), such as the Soil association and the Country Land and Business Association, and farming family members (1.20) were also relatively more important. Knowledge from organisations that were relatively less important included internet web pages (0.45), discussion group meetings (0.85) and radio and television programmes (0.24). This does not mean that these sources were not trusted for the information they gave but that other sources were relatively more important.

Different sources of knowledge are often required by different types of farmers and farms. In terms of farm size, larger farms tended to use more professional sources of advice than smaller farms. For example, the largest farms were statistically associated with using business (81%) and farming professionals (89%), farming unions (57%) and discussion groups (60%) compared to the smallest farms (less than 25 hectares) where only 34% used business professionals and discussion groups, while 59% used farming professionals.

Turning to farm type, dairy farmers were more likely to seek information from business (80%) and farming professionals (92%) as well as discussion groups (63%). Conversely, they were less likely to use internet discussion boards (6%) and radio and television programmes (35%). Arable farmers also used business professionals (84%) although they, unlike dairy farmers, were associated with using internet discussion boards (24%) as well as internet blogs (16%). Cattle and sheep farmers were less associated with using business (50%) and farming professionals (70%) and discussion groups (39%). However, as might be expected, they were more likely to seek information from breed societies (42%) but also from radio and TV programmes (49%). Other farm types, particularly horticulture, were associated with radio and TV programmes (60%) and other farming organisations (55%) such as Organic Farmers and Growers, the Soil Association, and other specialist organisations. Similarly, organic farmers were also associated with sourcing knowledge from other farming organisations (29%) but were less likely to seek information from business (48%) and farming professionals (69%) and the farming press (75%). Potentially, some of the differences between small and large farms and different farm types are perhaps related to time pressures that occur with managing different farming systems at different scales.

Farmers' educational background also illustrated some significant associations between different sources of knowledge. In particular, 87% of farmers with a technical education used farming professionals and 51% used farming unions as a source of knowledge compared to 69% and 27% respectively of farmers with only a school education. In addition, farmers with the lowest level of education were least associated with using internet web pages. Interestingly, 52% of respondents with postgraduate qualifications were associated with breed societies but were less inclined to use the farming press (63%). When a farmer's highest level of education was agricultural, they were more likely to use business (72%) and farming (83%) professionals, farming unions (48%), discussion groups (55%) and internet web pages (56%). By contrast, 76% of farmers without an agricultural education used farming friends as a source of knowledge and were less likely to use professional sources. Farmers who had participated in vocational training displayed a similar but stronger pattern to farmers with agricultural education in that they were more likely to engage with farming professionals (87%), farming unions (48%), discussion groups (61%) and internet web pages in seeking knowledge and information. In addition, 32% of farmers with vocational training were associated with sources of knowledge from breed societies.

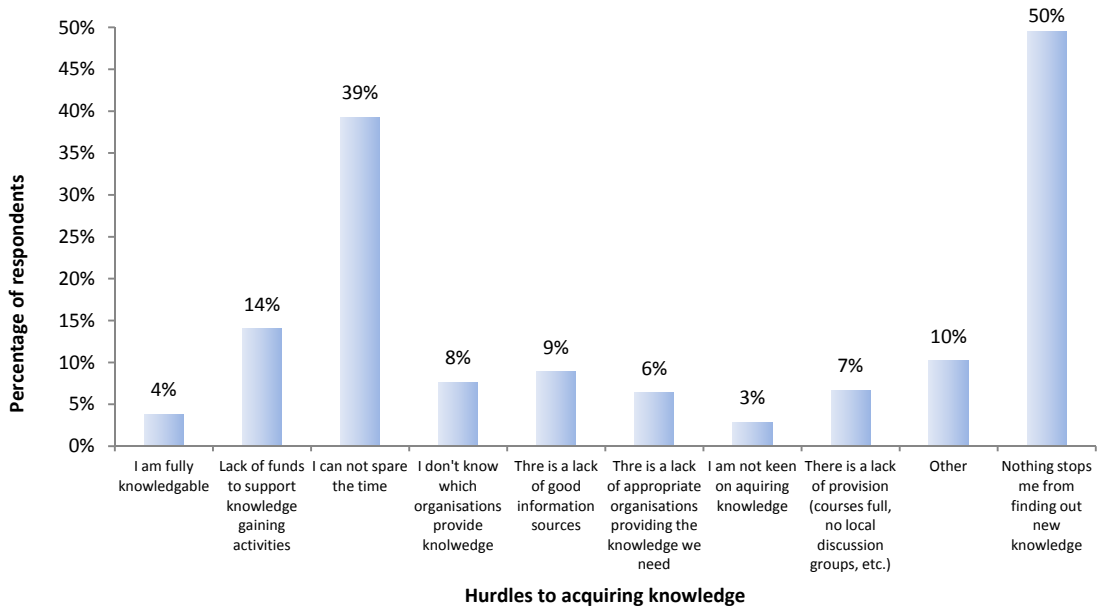
The most illuminating association is between the sources of knowledge that farmers used and their attitude towards managing their business. The general pattern shows that farmers who preferred to stick to practices that worked well in the past were least associated with using business and farming professionals (38% and 43% respectively), discussion groups (27%) and internet web pages (28%). Those that preferred to follow new practices as long they had been well tested were clearly associated with the traditional sources of knowledge from farming and business professionals (72% and 86% respectively), farming unions (44%) and discussion groups (74%). Also this group were more likely to ask members of their farming family for

information. The final group, farmers that liked to be first to try out new practices, were on a different knowledge trajectory. Only 15% of these farmers consulted family members, and they were the least associated with using farming unions. Instead, these farmers were more likely to seek information from internet web pages (69%), internet discussion boards (21%) and internet blogs (15%).

This analysis of the different attitudes towards management and sources of knowledge suggests that it is likely to be difficult to convey new knowledge and practices to farmers who are intent on sticking to practices that worked well in the past. Alternatively, farmers who preferred to follow new practices provided they were tested may be more amenable through traditional routes such as farm advisors and discussion groups. However, the innovators who like to try out new practices first are clearly already engaging in the latest modes of communication to keep their farming practices up to date.

Hurdles to acquiring knowledge are illustrated in Figure 9. For half of the farmers in the survey nothing stopped them from finding out new knowledge. Other farmers suggested, on average, fewer than two hurdles to preventing them from acquiring new knowledge. Of these, time was a clear constraint as 39% of farmers indicated that they could not spare the time. Also 14% pointed to a lack of funds to support knowledge gaining activities. Fewer suggested that there was a lack of good sources of information (9%) while 8% did not know which organisations provided knowledge and 7% thought there was a lack of local provision. Finally, 10% of respondents gave other reasons why acquiring knowledge might be difficult. These included comments about funding and research, such as “lack of funding to conduct research in agriculture in UK”, “lack of post-graduate training and lack of applied research” and “it would be good if more knowledge was available e.g. from independent trails of commodities”. Other comments were around conspiracy, “most ‘new’ knowledge is negative propaganda from HMG/Europe”; about too much information “too much information, brain overload”, and “too much information to assess/process/digest”; and personal comments particularly about age, “too old to do much”, “moving into retirement so farming activities (stock side) winding down” and “deciding how much time to take off the farm”.

Figure 9 Hurdles to acquiring knowledge (n = 317)



An analysis of whether farmers reported hurdles to acquiring knowledge or thought that nothing stopped them from finding new knowledge found very little difference between different farm types and sizes, and the type and level of education that farmers had received. However, one notable and significant association occurred between farmers and their attitude towards business management. 74% of farmers who preferred to stick to practices that worked well in the past were much more likely to indicate hurdles to acquiring knowledge. Conversely, 48% of farmers who preferred to follow new practices as long as they were tested, and 55% of those who liked to be the first to try out new practices, suggested that nothing had stopped them from acquiring new knowledge. This compared to only 28% of farmers that preferred to stick to practices that worked well in the past.

5 INTERNET USE ON SOUTH WEST FARMS

Of the farmers in the survey, the internet was used by 89% (see Table 4). This compares to 77% of households across the UK that have access to the internet (ONS, 2011). It is possible that by splitting the survey between a postal survey and a smaller online survey, some bias towards internet use is has been introduced. However, by considering the postal survey separately, a high internet use with 85% of farms online is still apparent. Furthermore, through sending out a second questionnaire printed on different coloured paper it was possible to identify those that had not originally engaged with the survey, possibly because they had no internet connection. As such, the second wave of the survey resulted in a higher response (15% as compared to 11%) reducing the bias towards internet use.

Table 4 Farm businesses using the internet (n = 274)

Wave of survey	Use internet for business	Do not use internet for survey
First questionnaire	89%	11%
Second questionnaire (reminder)	85%	15%
Online Survey	100%	-
All respondents	91%	9%

The types of farm most associated with using the internet as part of their farm business were larger farms over 100 hectares (96%). For the very largest farms with over 200 hectares this marginally increased to 97%. Contrasting this to the smaller farms, only 79% of farms between 25 and 49 hectares used the internet for their business. Age[8] was the most statistically significant factor in whether a farmer used the internet or not. All respondents under 46 years old were using the internet compared to 72% of those over 65 years. Education also had a bearing as farmers with only school education were least likely to use the internet (82%) while those who had participated in vocational training were more strongly associated with using the internet for their business. Finally, the attitude of farmers towards managing their business was also statistically significant. All farmers who liked to be first to try out new practices were also using the internet compared to 74% of farmers who preferred to stick to practices that worked well in the past.

Most farms (98%) were connected to the internet using broadband and 29% were using wireless technology. Only two farms used a satellite connection while a further two did not know how they connected. Mobile phones were used by 13% of respondents to access the internet. The speed of internet connections varied. Only 7% reported having a very fast connection, 44% suggested that their connection was normally fast while 34% suggested it was normally slow. A minority, 15%, had internet connections that they thought were very slow.

5.1 Who uses the internet and how important is it for farm business management?

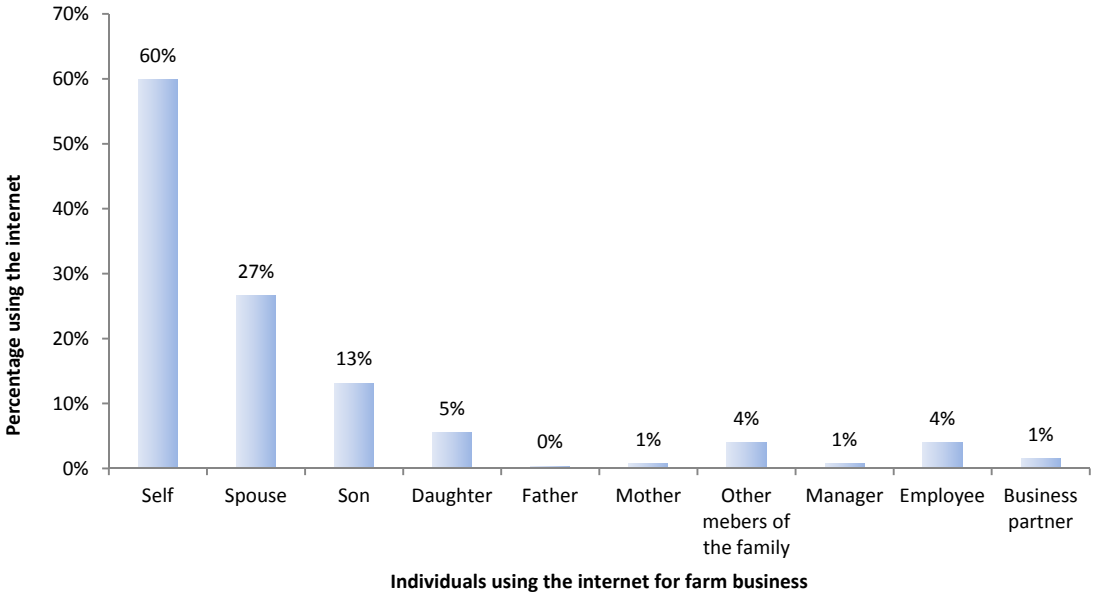
As Figure 10 (opposite) shows, the respondents to the survey were the most likely individuals to be using the internet for farm business management purposes. Furthermore, approximately 94% can be regarded as the principal farmer, with their role in the business as sole trader, farm partner or director of the business. Within the farming family, 28% of spouses and 16% of sons also used the internet for farm business. Farm employees formed the largest grouping of non-family members using the internet on the farm.

On average, each farm spent 7.2 hours per week using the internet while respondents' personal time online conducting farm business was 4.5 hours (or 68% of the total time). The median time of all farm users of the internet was 4 hours while personal use accounted for 3 hours. The most significant differences between time spent on the internet and the structure of the farms was that all users on organic farms, on average, spent 11.4 hours online compared to 6.4 hours on conventional farms. In terms of farm size, the

8 Because of the importance of age to internet use, the age variable has been used in the filtered sample for this section.

percentage of respondents' personal time spent using the internet for farm business, for the smallest farms (less than 25 hectares) was 86% compared to 61% on the largest farms. While not significant, all users on arable farms spent 9.3 hours using the internet compared to those on cattle and sheep farms who spent 6 hours. In terms of respondent characteristics, farmers with a university education spent longer using the internet, 6.3 hours, compared to only 4 hours for those with a technical qualification and 3.4 hours for those with only a school education. Finally, on farms where the respondent was keen to be the first to try out new practices, all users spent 11.4 hours online compared to only 4.6 hours on farms where the respondent preferred to stick to practices that worked well in the past.

Figure 10 Individuals using the internet for farm business management (n = 274)



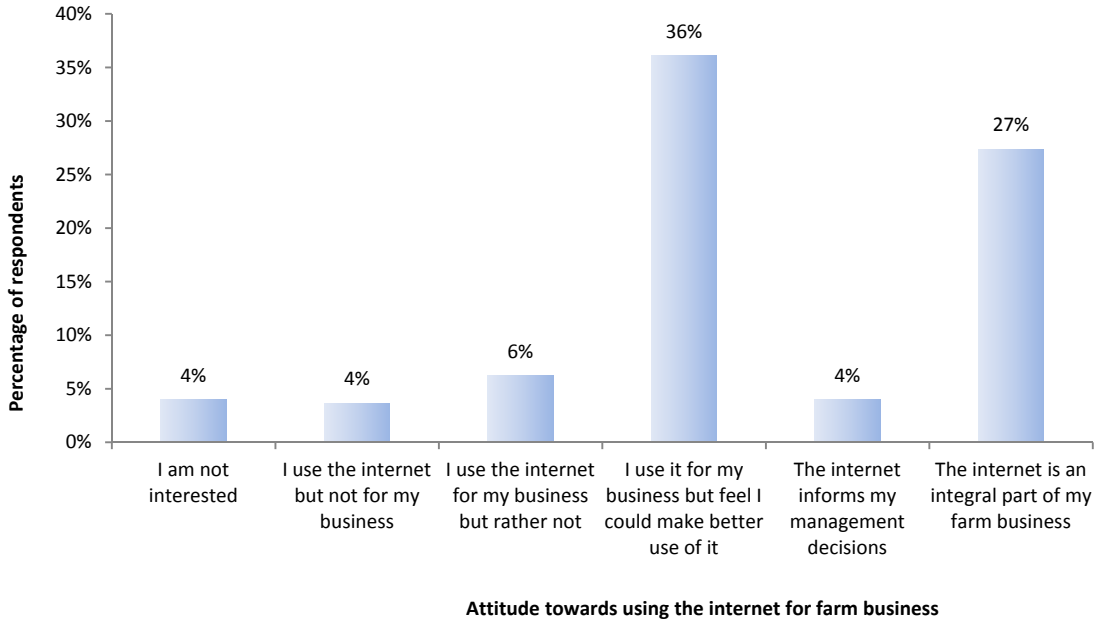
The time of day that users go online is presented in Table 5. The time pattern for using the internet is similar between respondents who used the internet themselves and farms where the main user was another family member or employee. In general, the early and late evening periods were the main peak times for using the internet, with 49% and 35% of users respectively over these periods. A third of all respondents indicated that the internet was used for farm business throughout the day.

Table 5 Time of day that respondents use the internet (n = 286)

Time of day internet was used	Main user of the internet for farm business		
	Respondent (self) (n =214)	Other family or employees (n = 72)	All internet users (n = 286)
Early Morning	21%	18%	20%
Morning	29%	25%	28%
Lunchtime	11%	13%	12%
Afternoon	13%	5%	11%
Early Evening	47%	55%	49%
Late Evening	35%	34%	35%
Various Times	33%	21%	30%

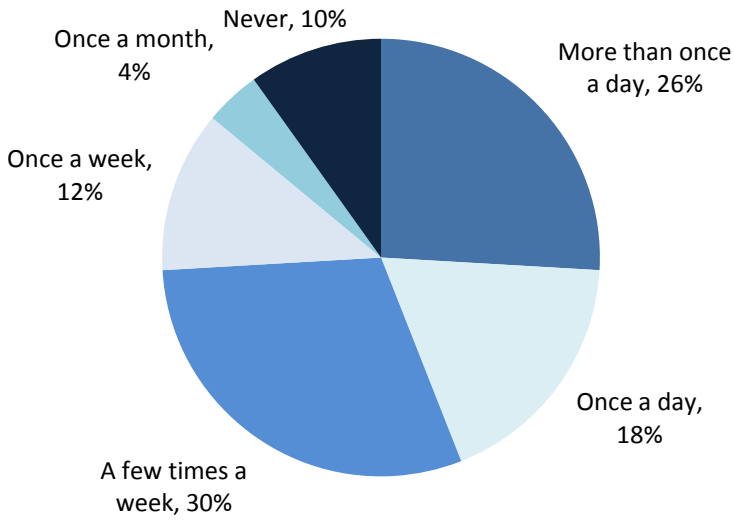
The majority of respondents using the internet as part of their business management felt that they could make better use of it (36% - see Figure 11). Only 27% felt it was an integral part of their farm business while a further 4% suggested that it informed their management decisions. 16% were more reluctant and either not interested in using the internet or would rather not use it for the farm business.

Figure 11 Attitude of using the internet for farm business management (n = 223)



Finally, respondents were asked about their personal use of the internet (see Figure 12). 44% used the internet at least once a day with 26% using it more than once a day. 16% were less frequent users, with 12% using it just once a week while a further 4% used the internet just once a month. 10% of respondents did not make use the internet for personal purposes.

Figure 12 Frequency of personal internet use (n = 243)



5.2 Farm management business tasks carried out over the internet

Farmers, their families and employees used the internet for different tasks. Table 6 illustrates these tasks and compares the respondents' internet tasks when they were the main users and with other family members or employees when the respondent was not the main user. Interestingly, respondents were statistically associated with many key tasks such as checking and sending emails, checking market prices, market research for new stock and crops, finding out information on policy and practices, applying for Government grants and keeping up with the latest farming news. Over one in four of all the respondents indicated 'other' tasks that they performed over the internet. Of these, 40% of users recorded their cattle movements with the British Cattle Movement Service (BCMS), 25% used the internet to file their VAT and tax returns, while 12% reported banking online. Other uses included checking weather reports, buying machinery, and checking milk reports.

Table 6 Farm business tasks performed over the internet by all users and by the respondent

Internet tasks	Main user of the internet for farm business		
	Respondent (self) (n =187)	Other family or employees (n = 96)	All internet users (n = 283)
Checking and sending emails*	95%	87%	92%
Checking market prices**	64%	45%	58%
Checking sales returns	27%	37%	31%
Market research for new stock or crops*	42%	27%	37%
Market research for potential buyers	18%	23%	19%
Keeping up with latest farming news*	68%	52%	63%
Finding out information about farming policies**	55%	36%	48%
Finding out information about farming practices**	52%	32%	46%
Applying for Government grants*	65%	52%	61%
Reading or taking part in farming discussion boards	13%	16%	14%
Other internet uses	25%	21%	24%

** Association between task and respondent/other internet user is statistically significant when $\rho<0.01$
* Association between task and respondent/other internet user is statistically significant when $\rho<0.05$

The size and type of farm was statistically associated with particular internet tasks. For example, the farmers on the largest farms, over 200 hectares, and arable farmers were more likely to check market prices. Indeed, 77% of farmers on the largest farms did this task, compared to only 41% on the smallest farms (under 25 hectares). Also 83% of arable farmers checked market prices compared to only 50% of cattle and sheep farmers and 63% of dairy farmers. This probably reflects the different market mechanisms for selling particular commodities. Arable farmers and those with the largest farms were also the most likely to use the internet to conduct research into new stock and crops (58% and 53% respectively).

To understand the associations between personal characteristics and internet tasks, the analysis in the remainder of this section and the following sections is restricted to the respondents who indicated that they were the main user of the internet for the farm business. To do otherwise would be misleading. Therefore, any significant associations between internet tasks and the

respondents' education or attitudes correspond to data presented in the first column of Table 6 (Respondent (self)).[9]

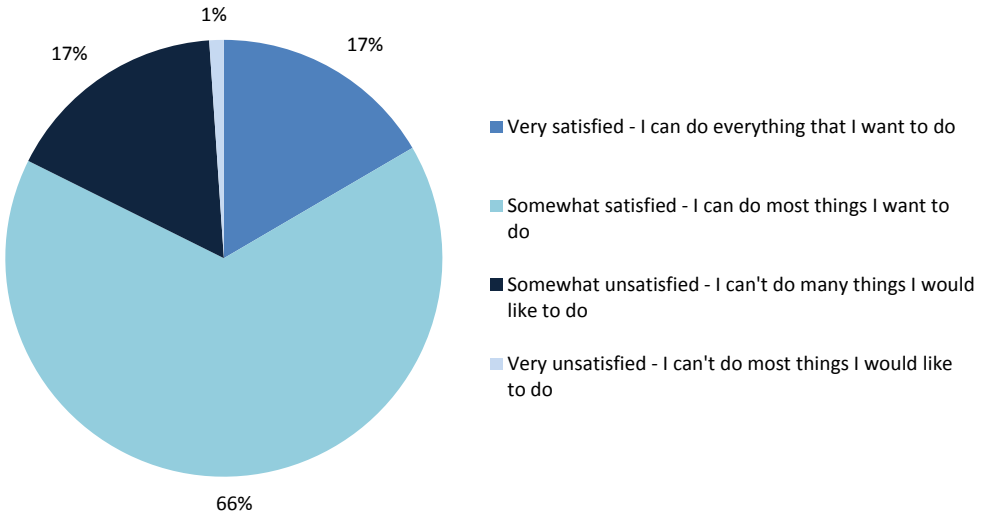
The most educated farmers used the internet to apply for government grants online; 84% of those with degrees and 94% of those with postgraduate qualifications used the internet for this purpose compared to 36% who left school at the age of 16. Of the respondents with an agricultural education, 71% used the internet to check market prices, whereas 49% of respondents who had participated in vocational training were associated with using the internet for market research into new stock and crops. In addition, 76% used the internet to keep up with farming news and 61% used it to find out information about farming policies. In terms of farmers' attitudes towards managing their farm businesses, a divergence is evident between those that preferred to stick to practices that worked well in the past and those that liked to be the first to try out new practices. Farmers that preferred to stick to practices were statistically the least likely to carry out market research into new stock or crops (16%) and find out about farming policies (36%). This contrasted with farmers trying out new practices first; 63% of this group had researched new stocks or crop and 75% had found out about farming policies online.

5.3 How do farmers feel about their internet skills?

The majority of farmers were somewhat satisfied with their internet skills (see Figure 13). Only 1% were very unsatisfied, feeling that they could not do what they would like to do. Structural characteristics of farm size and type were not associated with a farmers' ability to use the internet. However, while not statistically significant, farmers of organic land were more likely (36%) to state they were very satisfied with their internet use, being able to do everything they wanted to. The characteristics of farmers themselves showed a greater divergence of personal satisfaction with internet use. Weak associations with education and attitudes towards business management point to more educated and entrepreneurial farmers being the most satisfied with their internet use (29% with a degree and 34% who preferred to be the first to try new practices). This particularly contrasts with farmers who left school at the age of 16 and did not continue their education as these were over twice as likely (36%) to report their internet use as unsatisfactory in that they could not do most things they wanted to do.

[9] Restricting analysis to respondents who indicated they were the main users is continued in section 5.4 and 5.5.

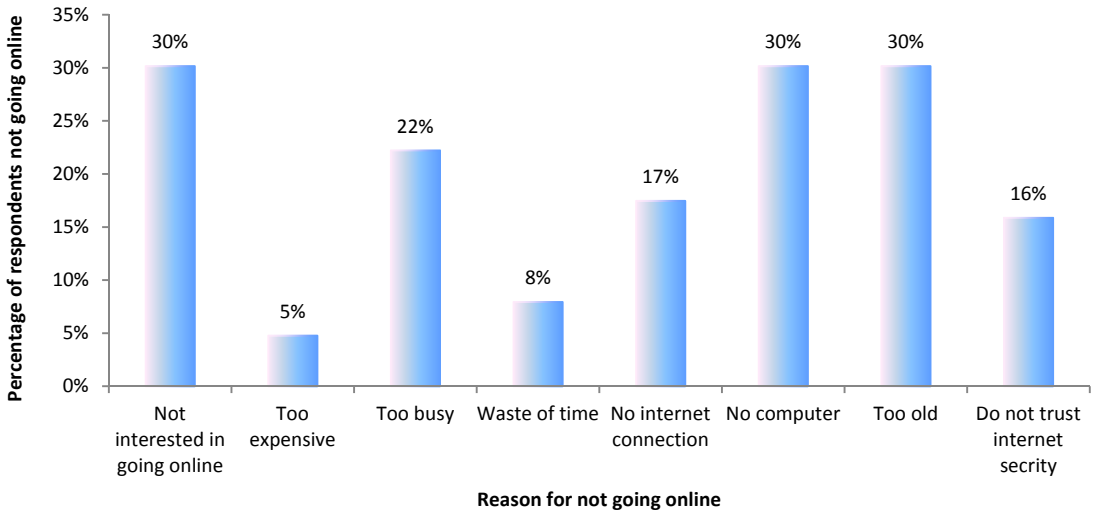
Figure 13 How satisfied are farmers with their internet use (n = 187)



5.4 What prevents farmers from using the internet?

Of all respondents, 18% did not use the internet or did not have an internet connection. Just over half (51%) of these represented farm businesses that were connected to the internet but the respondent did not personally use it. The remainder had no internet connection. Reasons for not going online are given in Figure 14. 30% of these respondents did not use the internet because they were either not interested, had no computer, or felt that they were too old. Indeed, 47% who did not use the internet were over 65 years old with a further 27% between the ages of 56 and 65. Only three respondents under 46 years old did not use the internet. Other reasons for not going online included being too busy (22%), not having an internet connection (17%) and a mistrust of internet security (16%).

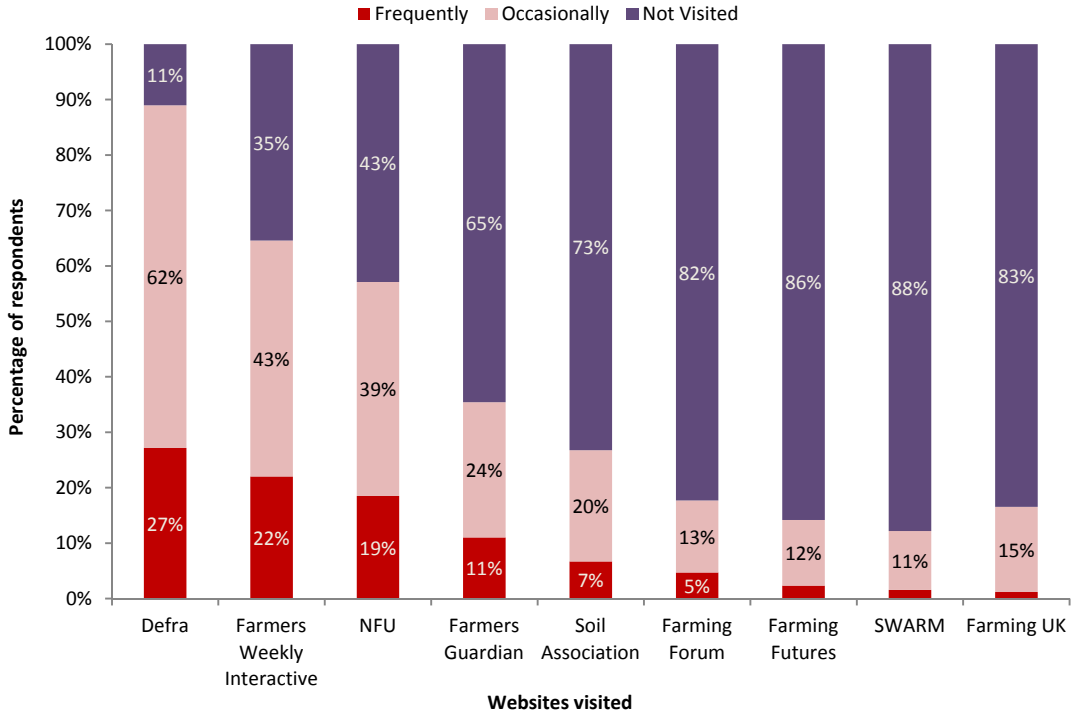
Figure 14 Reasons for not going online (n = 63)



5.5 Which websites and formats do farmers find useful?

Farmers are faced with numerous websites for finding out information about farming practices and management. Figure 15 illustrates nine such sites that are indicative of the types of websites that farmers might use and therefore the list presented only represents a small proportion of possible sites. Nevertheless, the use of the SWARM website for information can be placed in perspective in terms of how often it is used. However, caution is required in reading across Figure 15 since each website provides different types of information and therefore are not necessarily comparable. Furthermore, the frequency at which farmers visit particular sites may be related to the content of that site.

Figure 15 Websites that farmers visit to find information (n = 254)



The Defra website was the site most used for information with 89% of farmers visiting the site either frequently or occasionally (27% and 62% respectively). This is not surprising given that it is the primary source for policy information and downloads of policy documents such as the Entry Level Scheme. News organisations also feature prominently with 65% of farmers visiting Farmers' Weekly Interactive (FWI) while fewer (35%) visit the Farmers' Guardian website. The third most visited website by farmers responding to the survey was the NFU website, with 19% visiting frequently and a further 39% visiting occasionally. The types of farms and farmers that visit the Defra, FWI, and NFU websites were typically associated with those whose highest education was agricultural related and who had participated in vocational training. For example, it is significant in a statistical sense that only 25% of farmers with an agricultural related qualification did not visit the FWI website compared to 50% with other educational qualifications. Similarly, 27% of farmers with an agricultural education visited the NFU website whereas only 8% without this type of qualification did so. In terms of farm size, 60% of farmers on the smallest farms (less than 25 hectares) had not visited the FWI website, whereas 33% of farmers on the largest farms (200 hectares or more) were

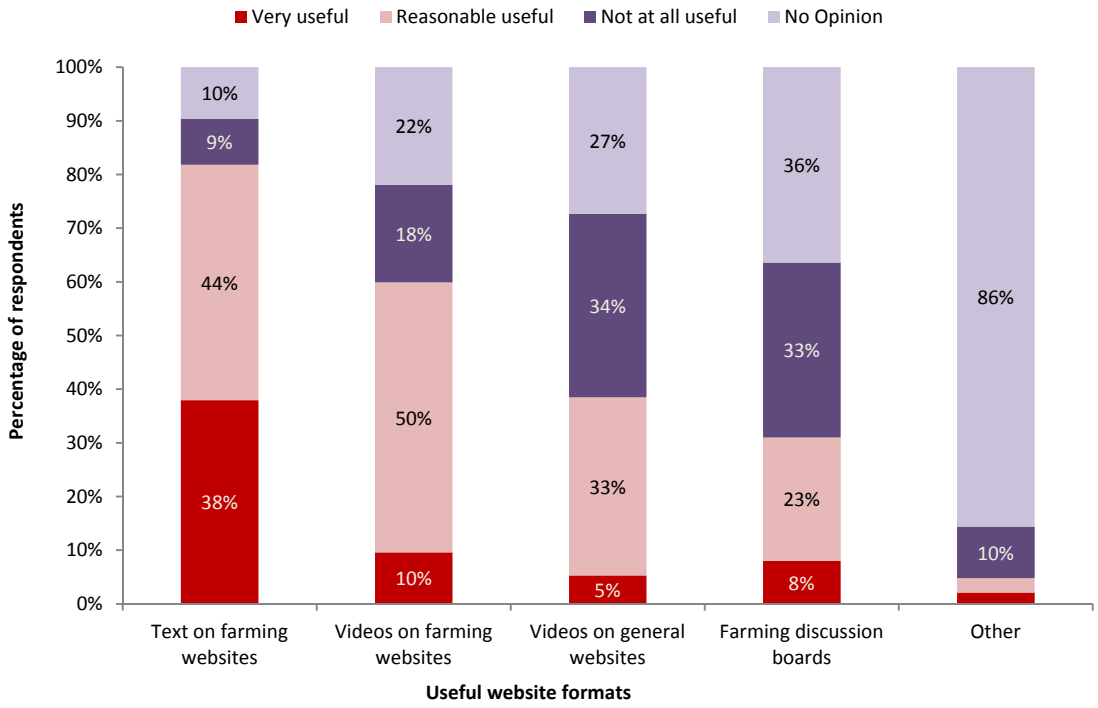
frequent visitors. Also, farmers who preferred to be the first to try out new practices were associated with not visiting the NFU website (61% compared to a sample average of 43%), while farmers who preferred to stick to practices that worked well in the past were less likely to use either the FWI or Defra websites.

Of the other websites presented in Figure 15, it is not surprising that 84% of organic farmers had visited the Soil Association site. The SWARM website was frequently visited by just under 2% of the sample while a further 11% occasionally visited it for information. Two factors were particularly associated with this website. The first was that farmers on the largest farms (over 200 hectares) were more likely to have visited the website for information, 7% frequently and 16% occasionally. This compares to an average of 2% and 11% respectively for the sample as a whole. Second, farmers who had participated in vocational training were also associated with this website, with 15% visiting occasionally. Finally, the Farming Forum website, which provides message boards on a range of farming subjects determined by its users, was frequently used by 5% of respondents with a further 13% using it occasionally. Arable farmers and farmers who liked to be first to try new practices were associated with visiting the website occasionally (respectively, 32% and 22%, compared to an average of 15% for the sample as a whole).

5.6 Website formats and farmers' opinions

Figure 16 illustrates the formats that farmers found useful when looking at information on the internet. Most farmers still preferred to view information in text format, with 38% finding this format very useful and a further 44% finding it reasonably useful. Fewer (10%) found viewing videos on farming websites very useful although 50% found it reasonably useful. Just over 30% of respondents found farming discussion boards useful although only 8% thought they were very useful. Other formats included data presented in charts and spreadsheets, pictures and internet blogs. There were no significant statistical associations between format type and both the structural variables and farmer profile variables. The only discernible pattern, while not significant, was between format type and age with younger farmers more likely to engage with discussion boards and video formats.

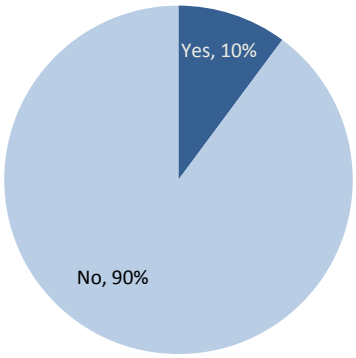
Figure 16 Formats which farmers find useful on websites (n = 187)



5.7 Mobile phones and farming apps

Ten per cent of farmers had downloaded apps connected to farming to their mobile phone (see Figure 17). Typically, these included apps giving weather details, market prices, input prices for fertiliser and geological maps. One respondent even commented on downloading a torch app.

Figure 17 Farmers downloading farming apps for their mobile phones (n = 256)



6 OBSERVATIONS AND IMPLICATIONS IN PROVIDING RESOURCE MANAGEMENT KNOWLEDGE TO FARMERS ONLINE

There are number of common threads from the preceding analysis that tie together how farmers manage their resources, knowledge and whether the internet forms part of this process. On the structural side of farm businesses it is evident that farmers on the largest farms were more attuned to managing their resources and acquiring knowledge (including via internet use). One explanation is that the scale of these businesses enables more flexibility in terms of time to acquire knowledge and use of the internet to maximise resource benefits. Furthermore, sources of external knowledge, such as that given by farming and business professionals, are integral to management operations. A consequence of these advantages is that awareness and opportunities are likely to lead to greater uptake of developments in resource management. Smaller farms, on the other hand, potentially have greater pressures on both time and financial resources, particularly if it is a small family business or operates on a sole trader basis. Under such circumstances, finding time to acquire new knowledge, to learn how to maximise the benefits of internet sources and to invest in new technology that use resources more effectively is perhaps burdensome.

Education, particularly if related to agriculture or if a farmer had participated in vocational training, was often associated with managing resources more effectively, having access to professional knowledge services, and using the internet for the farm business more adeptly. Farmers with these attributes were more engaged with managing resources more effectively. The analysis of the different attitudes towards business management has implications for resource management and the routes that are used to provide new knowledge. Farmers intent on sticking to practices that worked well in the past are likely to be difficult to reach regardless of how they are targeted. This subset were less likely to engage in more effective methods for managing resources, were more reluctant to source new knowledge and tended not to use the internet as a management tool. Alternatively, farmers who preferred to follow new practices provided they were tested were not averse to undertaking more effective and efficient methods to manage resources. Furthermore, delivering new knowledge and methods may be more amenable to this cohort through traditional routes such as farm advisors, discussion groups and vocational training sessions. The final subset, the innovators who like to try out new practices first, were clearly already engaging in best practices to manage resources and using the latest modes of communication including internet blogs and discussion boards to keep their farming practices up to date.

The increased use of the internet to deliver information on resource management is an interesting prospect. At present 89% of farmers use the internet for farm business management although most use it for sampling reading matter and sending emails, reading up on the latest farming news and applying for Government grants. One-third of users were not particularly satisfied with their internet use. A larger problem, however, is the speed of internet connections to farms. Just under half of farmers reported that their connection speed was slow, with a minority (15%) suggesting that theirs was

very slow indeed. Slow internet speeds can affect the type of content that farmers engage with, particularly videos. This may partly explain why most farmers prefer to view information in text format on websites, while fewer watched informative videos on either farming or general websites. However, improvements to broadband speeds should take place and this will make different formats more accessible to farmers. Targets exist to deliver a fast fibre optic cable to BT's street level cabinets, although connections between the cabinets and farms will still use VDSL2 over existing copper cable (Jackson, 2012). While this will increase broadband speeds, it could leave some farmers who are some distance from the street level cabinet at a disadvantage.

In managing resources, one contradictory observation stands out in particular. According to the energy efficiency pyramid, generating energy sits at its peak above energy efficiency and energy conservation. Therefore, installing renewable energy technologies before implementing appropriate energy efficiency and energy conservation measures contradicts best practice. Two reasons may explain this behaviour. First, diversification of farm income is clearly a major factor behind generating income from renewable energy sources, particularly when generous feed-in tariffs are available. The second is that it is much harder to convey to farmers the benefits of implementing energy efficiency and energy conservation measures. Renewable energy technologies can be seen as a discrete development, whereas energy efficiency and energy conservation measures are much more diffuse and their implementation depends very much on personal farm circumstances. As such, greater efforts are perhaps necessary to engage with farmers in how they can take steps to reduce energy use and how these steps can benefit their farm businesses.

Finally, while the use of the SWARM website was limited, being visited by just under 2% of the sample (a further 11% occasionally visited it for information), this should be placed in context. Since the website is relatively new, compared to the NFU or FWI websites, and since it provides specialist information on resource management, it is not surprising that it has, at present, limited use. However, compared to national websites such as Farming UK and Farming Futures, the SWARM website, given its relative newness and its regional focus, is making good progress within the region. Increasing awareness may be further enhanced through signposting in vocational training sessions or by farming advisors, although these approaches are likely to need careful consideration.

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Centre for Rural Policy Research
Politics
University of Exeter
Amory Building
Rennes Drive
Exeter
EX4 4RJ

Tel: +44(0)1392 722438

Email: crpr@exeter.ac.uk

www.exeter.ac.uk/crpr