Factors Influencing Farmer Uptake of Water Pollution Mitigation Measures: The Role of Farm Advice

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Abstract

A range of interventions are available to influence the uptake of farm practices which mitigate water pollution. Deciding which are the most appropriate for particular mitigation measures poses a challenge to policy makers. Whilst many measures remain voluntary, implementation will only be effective with the co-operation of stakeholders and evidence regarding the factors influencing measure uptake is crucial to aid policy design.

The research conducted for this PhD explored the factors influencing farmer adoption of water pollution mitigation measures through three related surveys. Over two hundred farmers and farm advisors participated in interviews from three contrasting regions of England: the grassland dominated North West; the arable dominated East Anglia and the mixed and dairy farming of the South West.

Results from the two farmer surveys provided a baseline of current agricultural practices, insights regarding farmer attitudes to the adoption of other mitigation measures in the future and understanding of the motivations and barriers to the adoption of specific measures. Results from the farm advisor interviews revealed the types of mitigation measures recommended by various advisors, which mechanisms (regulatory advice, financial incentives, signposting or voluntary approach) were being used to influence the uptake of measures, and whether differences occurred between sources of advice.

The results illustrate the great diversity amongst the farming community, the range of factors influencing mitigation measure uptake and the differing complexities of farmers' decisions to change their behaviour. Different combinations of interventions are required not only for each mitigation measures but also within the different regions surveyed. The importance of advice is illustrated but knowing which advisors are most suitable to deliver information and how is highlighted as being essential for policy design. Policy recommendations are provided as to what needs to change to influence adoption of specific mitigation measures to improve catchment management and advice provision.

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Table of Contents

List of Figures

List of Tables

List of boxes

List of Acronyms and Abbreviations

ADAS	Agricultural Development Advisory Service
AES	Agri-environment scheme
AHDB	Agriculture and Horticultural Development Board
AMP	Asset Management Plan
BACI	Before-After, Control-Impact
BE	Behavioural Economics
BPS	Basic Payment Scheme
BQE	Biological Quality Elements
CaBA	Catchment Based Approach
CAP	Common Agricultural Policy
CMP	Catchment Management Plan
CS	Countryside Stewardship
CSF	Catchment Sensitive Farming
CSFO	Catchment Sensitive Farming Officer
DEFRA	Department for Environment, Food and Rural Affairs
DTC	Demonstration Test Catchment
DWPA	Diffuse water pollution from agriculture
EA	Environmental Agency
EFA	Ecological Focus Area
EU	European Union
FC	Forestry Commission
GAEC	Good Agricultural and Environmental Condition
GHG	Greenhouse Gas Emissions
NE	Natural England
NGO	Non-governmental organisation
NVZ	Nitrate Vulnerable Zones
OFWAT	The Water Services Regulation Authority
RPA	Rural Payments Agency
RSPB	Royal Society for the Protection of Birds
RT	Rivers Trust
SAC	Special Area of Conservation
SFP	Single Farm Payment
SMR	Statutory Management Requirements
SSSI	Site of Special Scientific Interest
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
WFD	Water Framework Directive
WPA	Water pollution from agriculture
WT	Wildlife Trust

Chapter 1

Chapter 1 Agriculture and water policy: The need for sustainable farming practices to reduce water pollution

The need for sustainable agriculture has never been greater. As global populations rise and diets, consumption levels and global markets change, increasing demands are placed on the world's food supply (Godfray et al., 2010). The challenges of producing more food in a world with increasing demands for limited resources such as water, energy and land include issues of environmental degradation, yield plateau, and pesticide resistance (OECD, 2012a). The urgent need to address key environmental challenges which can be exacerbated by agriculture such as soil degradation, climate change, air pollution, deforestation, biodiversity loss, water availability and quality means that food security is increasingly threatened (FAO, 2014). To tackle both environmental and food security challenges, more sustainable agricultural systems are needed worldwide.

Agricultural land has the ability to deliver a wide range of essential goods and services for society, including food, fibre, timber, clean water, energy, wildlife habitats, carbon storage, flood management, employment and recreational opportunities (CISL, 2014). It can also provide other ecosystem services which benefit agriculture itself: soil formation, nutrient cycling, water regulation and purification, genetic resources, pest regulation and pollination (Food and Environment Research Agency, 2012). However, such services will only be achieved if agricultural land is managed sustainably. The Millenium Ecosystem Assessment (2005) provided important evidence of the ongoing global degradation of ecosystem services and Bateman et al. (2013) claim land use decisions often ignore the value of such services, hence changes in governance are needed. It is imperative that policy makers seriously consider the best methods to influence and improve farming practices to ensure environmental, economic and social sustainability (National Research Council, 2011).

Rachel Carson's Silent Spring in 1962 was a landmark in environmental literature, bringing attention to the detrimental effects the overuse of agricultural pesticides was having on the rural environment. Over the years, literature on the damage caused by agricultural intensification has greatly increased, focusing on a comprehensive range of topics, including climate change (Smith et al., 2007), loss of biodiversity and habitat (Robinson and Sutherland, 2002), soil erosion and degradation (Boardman and Poesen, 2006), loss of genetic variability (National Research Council, 2011) and wasteful water consumption and pollution (OECD, 2010). These challenges threaten to become insurmountable, with devastating consequences. The realisation of the negative impacts modern farming can have on the environment and society, has contributed towards the great push for sustainability in the political arena.

Water pollution caused by agriculture is one example of environmental degradation receiving urgent political attention. Internationally, citizens have expressed great concern over water pollution (European Commission, 2015; Gallup, 2008) and there has been a growing realisation of the importance of protecting drinking water resources, reducing harmful effects on aquatic habitats and the costs to recreational activities and commercial fisheries (European Environment Agency, 2010). Whilst agricultural production has intensified, and urban, industrial and sewage treatment improvements have occurred in developed countries, the contribution of farming to the deterioration of water quality has become more prominent. The increasing awareness of the strong link between farming practices and water pollution has led to greater scientific research and political focus on water quality and agriculture.

1.1 Water quality and agriculture

Water pollution is caused by an array of human activities, such as septic tanks, industrial waste, garden usage of chemicals, hydrocarbons from transport networks, and leaching from landfills, mines or quarries (Goel, 2006). However, an increase in the use of fertilisers and crop protection chemicals along with livestock intensification over recent decades, has led to the agricultural sector in many countries contributing to over 40% of the nitrates and phosphorus pollution in surface and coastal waters (OECD, 2008a). It is also the culprit for rising concentrations of sediment and chemical compounds found in many surface and groundwaters (European Environment Agency, 2010; OECD, 2012a).

Box 1 provides a definition of the different types of water pollution with an explanation of agriculture's contributions, whilst Figure 1.1 illustrates how farming (in a UK context) can contribute to water pollution.

Box 1 Point and diffuse source pollution from agriculture

Sources of water pollution are generally distinguished as point or diffuse (also known as nonpoint). Pollutants from point sources are discharged directly into receiving waters at distinct identifiable locations, such as sewage treatment works and industrial sites, whereas diffuse sources follow indirect, diffuse, and often complex pathways to water bodies. Examples of diffuse pollution from agriculture include runoff from fields and pollutants leaching into water systems from excessive application of agri-chemicals nutrients, pesticides, and other contaminants (e.g. veterinary products), as well as from soil erosion caused by land left bare over winter, the use of heavy machinery and high livestock densities. Agriculture can also be point source pollution, for example, through discharges of animal wastes from pipes into streams.

In the farming context the phrase 'diffuse water pollution from agriculture' (DWPA) is often used when discussing agriculture's contribution to water pollution, however determining whether an agricultural source of pollution is point or diffuse can be difficult and at times comes down to scale. What is considered to be diffuse at a landscape scale may be a cluster of point sources at a farm scale. Therefore this thesis will use the phrase 'water pollution from agriculture' (WPA) to refer to all sources of water pollution from agriculture.

Source: Environment Agency, 2004; Global Food Security, 2014a; OECD, 2012a.

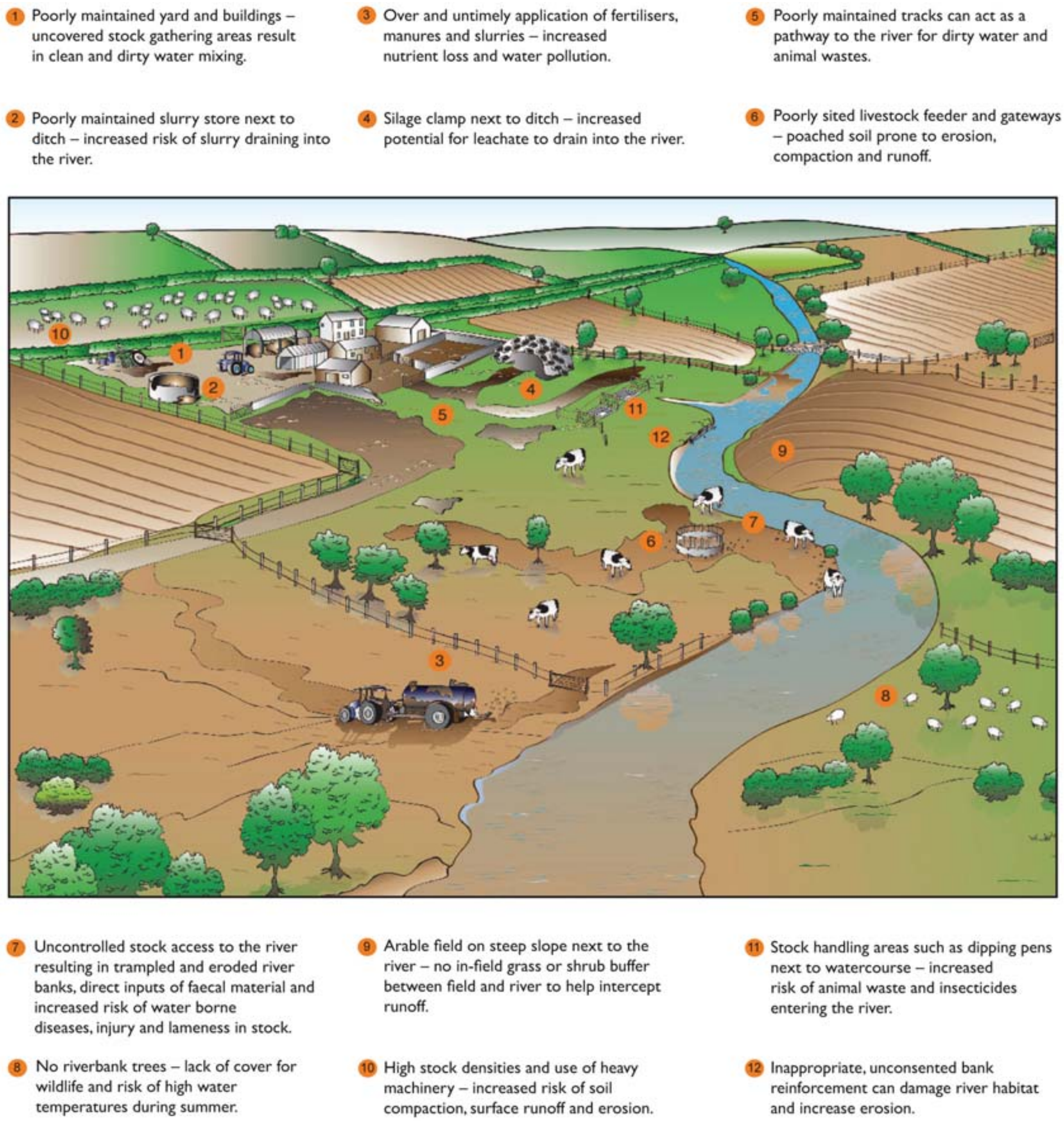

Figure 1.1 Potential ways in which agriculture can contribute to water pollution. Adapted from Eden Rivers Trust, 2011.

Agriculture's contribution to water pollution varies greatly between areas due to the different soil types, agro-ecological conditions, climate, farm management practices, and policies. Not only do spatial differences occur but also temporal variations in WPA. Changes in input costs, disease and pest pressures and crops grown all affect agri-chemical application rates, whilst varying weather conditions impact the amount of run-off and leaching that occurs (Cardenas et al., 2011; OECD, 2008a).

Controlling WPA is a complicated matter, with one difficulty concerning source attribution. The processes by which nutrients and pollutants leave the land are complex, involving elaborate interactions (often with a time lag) between characteristics of the area e.g. slope, rainfall, soil type, and land management practices such as ploughing, input regimes and field margin management (OECD, 2012a). Technical developments of monitoring methodologies e.g. sediment fingerprinting are helping to clarify processes (Cooper et al., 2014). However, identifying WPA sources remains problematic within the agricultural sector, with issues created by: the large numbers of farmers; emissions being highly spatially and temporally variable; increasing transaction costs of policies to control pollution, and control sometimes requiring co-operation and agreement across different sub-national jurisdictions or countries. Given such difficulties it is appropriate for management to be preventative rather than reactive (Global Food Security, 2014a).

Extensive research has been carried out to determine the best agricultural practices for pollution control (e.g. Deasy et al., 2010), however the implementation of such practices will only be effective with the cooperation of land owners and managers. Interventions are therefore needed to influence farmer decision making and change behaviours to increase the uptake of appropriate mitigation measures. Measures to tackle water pollution (as summarised in Newell-Price et al., 2011) can be classified according to the point at which they take effect along a continuum (Haygarth et al., 2005):

- Source control – controlling inputs (e.g. reducing fertiliser applications).
- Mobilisation control – controlling how transport of pollutants begins (e.g. reducing soil compaction to limit run-off).
- Pathway interception – controlling how pollutants are transported to the water course (e.g. tramline disruption).
- Protecting receptors (e.g. riparian buffers or fencing alongside watercourses).

To date, there appears to have been a relatively limited level of success from initiatives to address agricultural pollution in rivers across Europe, Australia and the US (McGonigle et al., 2012; OECD, 2012a; Oenema et al., 2009; Sutton et al., 2011). The progress that has been made generally falls short of what is required to meet water protection policy goals. To add to such shortcomings, it is also acknowledged that enhancements in water quality have begun to slow in the last decade as many of the most damaging agricultural practices of the past have now been changed or reduced (Johnson et al., 2011). While initiatives and the use of policy mechanisms to reduce WPA and improve catchment management are common to many developed economies e.g. USA, Australia, Denmark (Aue and Klassen, 2005; OECD, 2012a; Smith et al., 2015), great diversity occurs in: the types of farming; how the farming and water industry are structured and the range of policy contexts and policy mechanisms used. For the purposes of conducting meaningful empirical research, it is necessary to focus on one particular setting. Therefore this research focuses on the situation in England, though recognising some issues are UK-wide.

1.1.1 Water quality and agriculture in the UK

To set the context, agriculture is estimated to contribute around 60% of nitrates, 25% of phosphorous (NAO, 2010; White and Hammond, 2009) and 75% of sediments in water bodies in the UK (Collins and Anthony, 2008). The use of pesticides such as metaldehyde for eradicating slugs is also of great concern as water treatment methods struggle to remove such chemicals from drinking water. Currently 49% of Surface Water Drinking Water Protected Areas are at risk due to such pesticides (Environment Agency, 2015).

In order to understand how the issues of water pollution associated with agriculture have arisen and what impacts on farmer decision making today, it is vital to appreciate some of the changes the farming industry has undergone.

The nature and scale of change during the past sixty years has been labelled the 'Great Acceleration' with unprecedented increases in population, consumption, waste emissions and land conversion (Steffen et al., 2011). Many practising farmers today have first-hand experience of the dramatic changes, which in turn will have contributed to and influenced their behaviours. This section discusses such changes in the UK, but for information on the industry prior to sixty years ago please see Dewey (2008) and Overton (1996).

Since the 1950's, agricultural yields have risen (Figure 1.2a) thanks to improved plant and livestock breeding, mechanisation, increased use of fertilisers and pesticides due to a greater understanding of agronomy, coupled with incentives to produce more through supported prices. After the UK joined the European Union (EU) in 1972, agricultural policy fell within the remit of the Common Agricultural Policy (CAP) which encouraged wasteful surpluses through the notion 'if you produce it, you will be paid a minimum amount for it'. The average farm size increased (Blackstock et al., 2010) and the partial demise of mixed farming occurred – eastern England specialising in arable and western regions in livestock (Britton, 1990). The trends in the area of crops grown can be seen in Figure 1.2b showing wheat and barley which both experienced expansion from the mid 1960's. Wheat continued its growth into the 1980's, whereas barley declined after its peak in the 1960's and 70's. This was largely due to the collapse in cereal prices and the greater potential of wheat productivity (Bolton et al., 2015). More recent trends show an increase in area sown to oilseed rape and maize. The popularity of oilseed rape is mainly due to its profitability as a break crop (BBC News, 2012), and for maize it's increase is due to the introduction of more resilient varieties which can be grown in cooler climates and its use as a biofuel and cattle feed (Soil Association, 2015).

The specialisation, intensification and mechanisation of the agricultural industry led to rises in yields, but this did not always lead to an associated increase in farm profits (Figure 1.2c).

Numerous (constantly changing) factors impact the economic context in which farming operates. Increasing yields has occurred worldwide resulting in increased supply and reducing prices. Moreover, a greater exposure to world markets occurred through an increase in liberalisation of world trade, developments in transportation technology and general globalisation, heavily impacting farm profits through food commodity prices, currency exchange rates and the stock market (Defra, 2015a). Changes in EU agricultural policies since the 1990’s have also influenced farm income, shifting from quotas and product price support to producer support through direct payments. Such changes in the CAP are discussed further in Section 1.2.2.

Factors influencing the agricultural industry can greatly vary within short timeframes, on a yearly, monthly and even weekly basis. Extreme weather conditions, pest and disease outbreaks, changing regulatory requirements, availability of crop protection chemicals, consumer and supermarket demands and animal health risks, all contribute to the volatility of the industry. This creates a plethora of daily challenges facing farmers and thus impacts their decisions, behaviours, their farm businesses and the environment (Defra, 2012a). Take, for example, the impacts such factors can have on the relative economics of the different farming sectors. An improved UK harvest and increased global supplies saw cereal prices fall by 21% in 2014 compared to 2013 with the average price of crop products falling by 16.2% (Defra, 2015a). Figure 1.2d demonstrates the short-term fluctuations in the net farm income for the dominant farm types in four areas of England (2010-2014).

The volatility within the agricultural sector means that farmers are frequently faced with having to make difficult and even risky business decisions. Such decisions might not benefit the long-term viability of their business or help preserve the environment, but they might ensure that the business can survive in the short-term.

During the Great Acceleration (Steffen et al., 2011), deterioration of the natural environment increased. It is clear changes in water management and agriculture are necessary to improve water quality, but before investigating what needs to change, past and current efforts are examined particularly focusing on policy in the water and agricultural sectors.

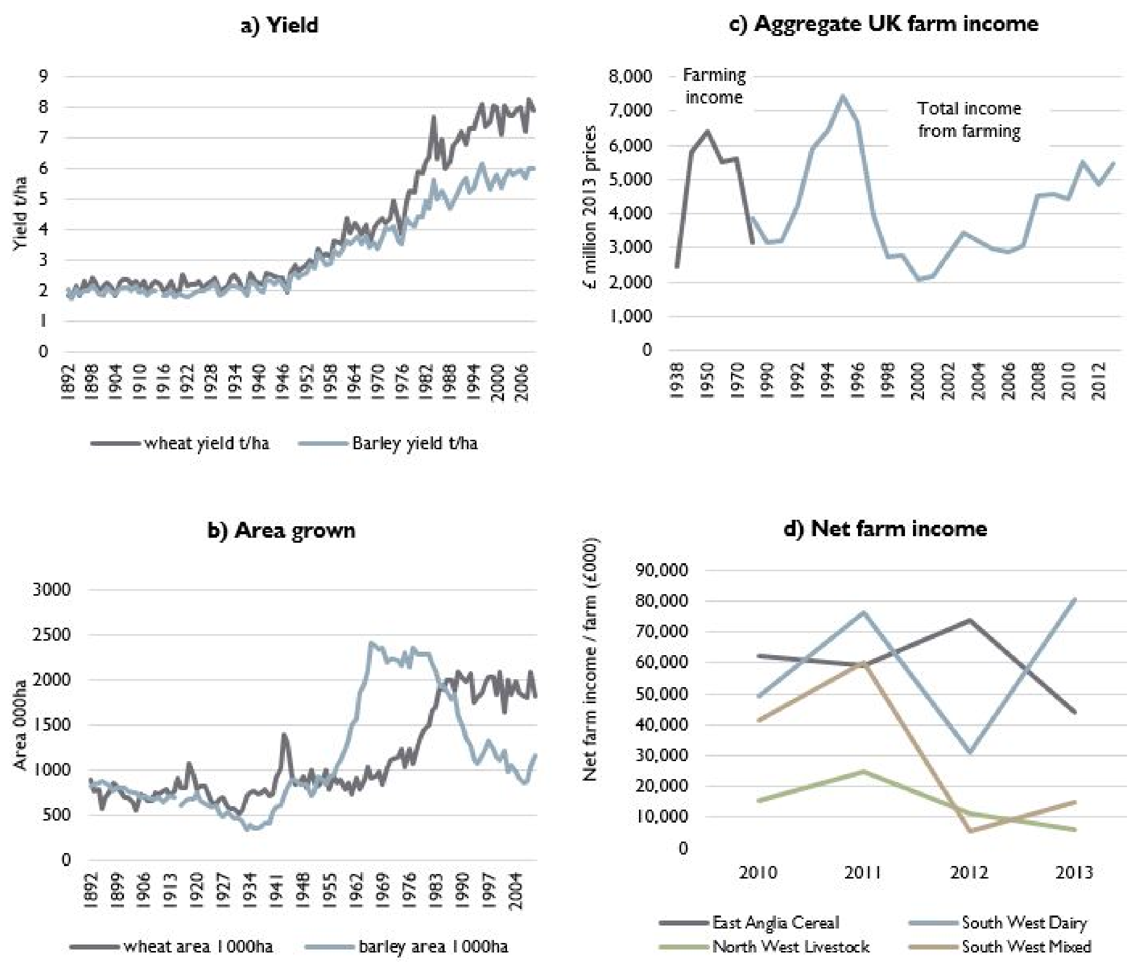

Figure 1.2 a) The yield of wheat and barley over 100 years, b) The area of wheat and barley grown over 100 years, c) Aggregate farm income 1938-2012 (farming income includes the income of farmers and their spouses only. Total income from farming also includes income of non-principal partners, directors and family workers). Source: Bolton et al., 2015. d) Net farm income for: East Anglian cereal farms; North West lowland livestock farms; South West dairy farms; and South West mixed farms (2010-2013). Source: Defra, 2015b.

1.2 Water and agricultural policy in England

In England, the Government has made multiple commitments to enhance the environment, the economy and societal benefits as a whole. With regards to water and agriculture, the 2011 White Paper 'The Natural Choice', made a commitment to bring together government, industry and environmental partners to reconcile the goals of improving the environment and increasing food production. Building on this, in 2015, the Government was advised to implement a 25 year plan to improve the natural environment (Natural Capital Committee, 2015). Such advice was supported by all the main political parties, with commitments made including: marine habitat protection; enhancing England's countryside through improved agricultural policy; planting an additional 11 million trees; tackling air and water pollution; and ensuring Green Belts and Areas of Outstanding Natural Beauty, National Parks, Sites of Special Scientific Interest (SSSIs) and other environmental designations are appropriately protected (Defra, 2015c). Such commitments are positive for the environment, however challenges remain as to who will champion, coordinate, and deliver such a plan, as well as oversee the quality and timeliness of its implementation (Natural Capital Committee, 2015). Further assurances from the Government can be found in the EU's Environment Action Programme, in addition to accelerating the delivery of objectives for plans such as the Blueprint to Safeguard Europe's Water Resources. In order to fulfil the numerous commitments made by the Government, specifically those associated with sustainable agriculture and water quality, various policies have sought to change farmers' behaviours to help reduce water pollution.

Behaviour change interventions are defined by Michie et al. (2011a:1) as 'coordinated sets of activities designed to change specified behaviour patterns.' Successful desirable behaviour and culture change is achieved when actions and behaviours become habit and the social norm (Dolan et al., 2010). To achieve such changes often requires a variety of policy interventions applied at different scales. Figure 1.3, taken from McGonigle et al. (2012) demonstrates, with examples, the various scales at which different mechanisms can be used, from nationally applied baseline regulations through to locally targeted incentives.

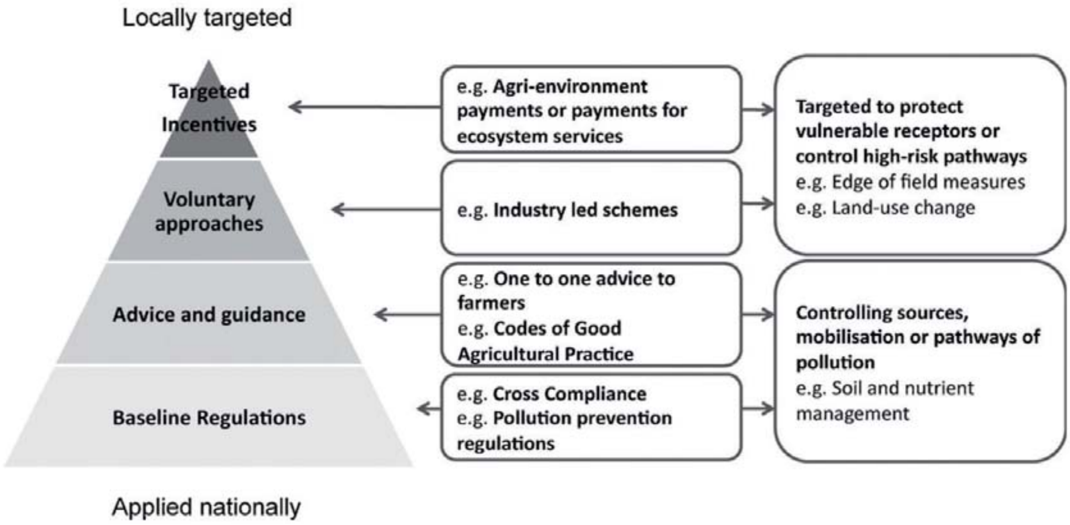

Figure 1.3 Policy mechanisms to influence the uptake of measures to tackle agricultural water pollution. The base of the triangle represents approaches that are applied generally. The top of the triangle illustrates the targeted application of approaches to tackle localised issues. Source: McGonigle et al., 2012:5.

In England the government department currently known as Defra (Department for Environment, Food and Rural Affairs) is responsible for implementing such mechanisms and is tasked with safeguarding the natural environment, supporting the food and farming industry, and sustaining a thriving rural economy. As of December 2015, Defra worked with 34 different agencies and public bodies covering a wide remit of topics. Of the 34, the most relevant to the issue of water pollution mitigation are shown in Figure 1.4, with their roles and responsibilities summarised in Table 1.1.

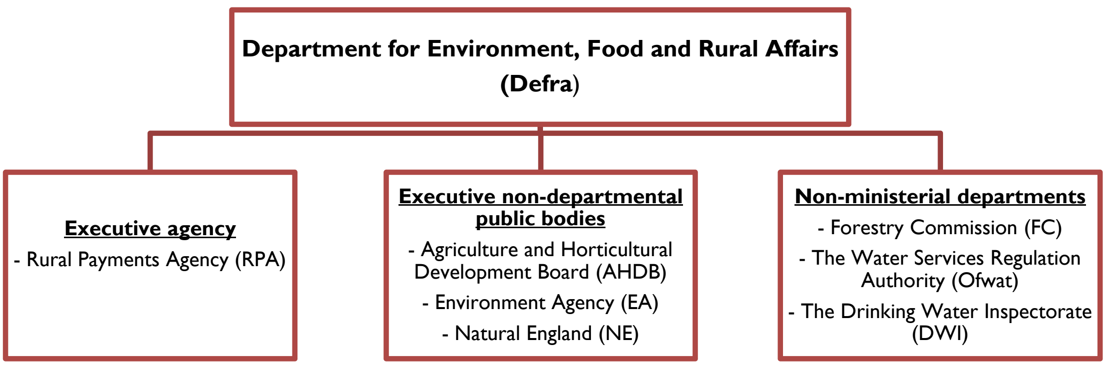

Figure 1.4 Structure of agencies and public bodies relevant to the issue of water pollution working with Defra.

Table 1.1 Roles and responsibilities of agencies and public bodies working with Defra linked to water pollution mitigation.

Agencies and public bodies working with Defra	Roles and responsibilities
Rural Payments Agency	The RPA makes payments to support farmers, traders and land owners. It is the paying agency for the EU's Common Agricultural Policy, as well as for payments on behalf of Natural England.
AHDB AGRICULTURE & HORTICULTURE DEVELOPMENT BOARD	AHDB is a statutory levy board, funded by farmers, growers and others in the supply chain and managed as an independent organisation (independent of both commercial industry and of the Government), delivering extensive research and development for levy payers.
Environment Agency	The EA was established in 1996 to protect and improve the environment. The EA's responsibilities include: regulating industry and waste; water quality and resources; fisheries; and conservation.
NATURAL ENGLAND	NE advises the Government on the natural environment in England, with responsibilities including, helping land managers and farmers protect wildlife and landscapes, and managing programmes that help restore or recreate habitats.
Forestry Commission	The FC is responsible for protecting and expanding Britain's woods and forests and for managing nearly one million ha of public forest.
OFWAT	Ofwat is the economic regulator for the water and sewage sectors in England and Wales, making sure the companies regulated by Ofwat provide consumers with a good quality and efficient service at a fair price.
dwi	DWI provides independent reassurance that water supplies in England and Wales are safe and drinking water quality is acceptable to consumers.

In recent decades, changes have occurred in water and agricultural policy in an attempt to modify behaviours whilst reducing administrative burden and costs, increasing cooperation within the industry, decreasing coercion and improving policy effectiveness. Predominantly policy mechanisms have transitioned from hard mechanisms of enforcement - the 'stick' approach, to softer mechanisms of targeted incentives and advice – the 'carrot' approach. The following sections describe the key changes in water management and agricultural policy in England with the key developments highlighted on a timeline in Figure 1.5.

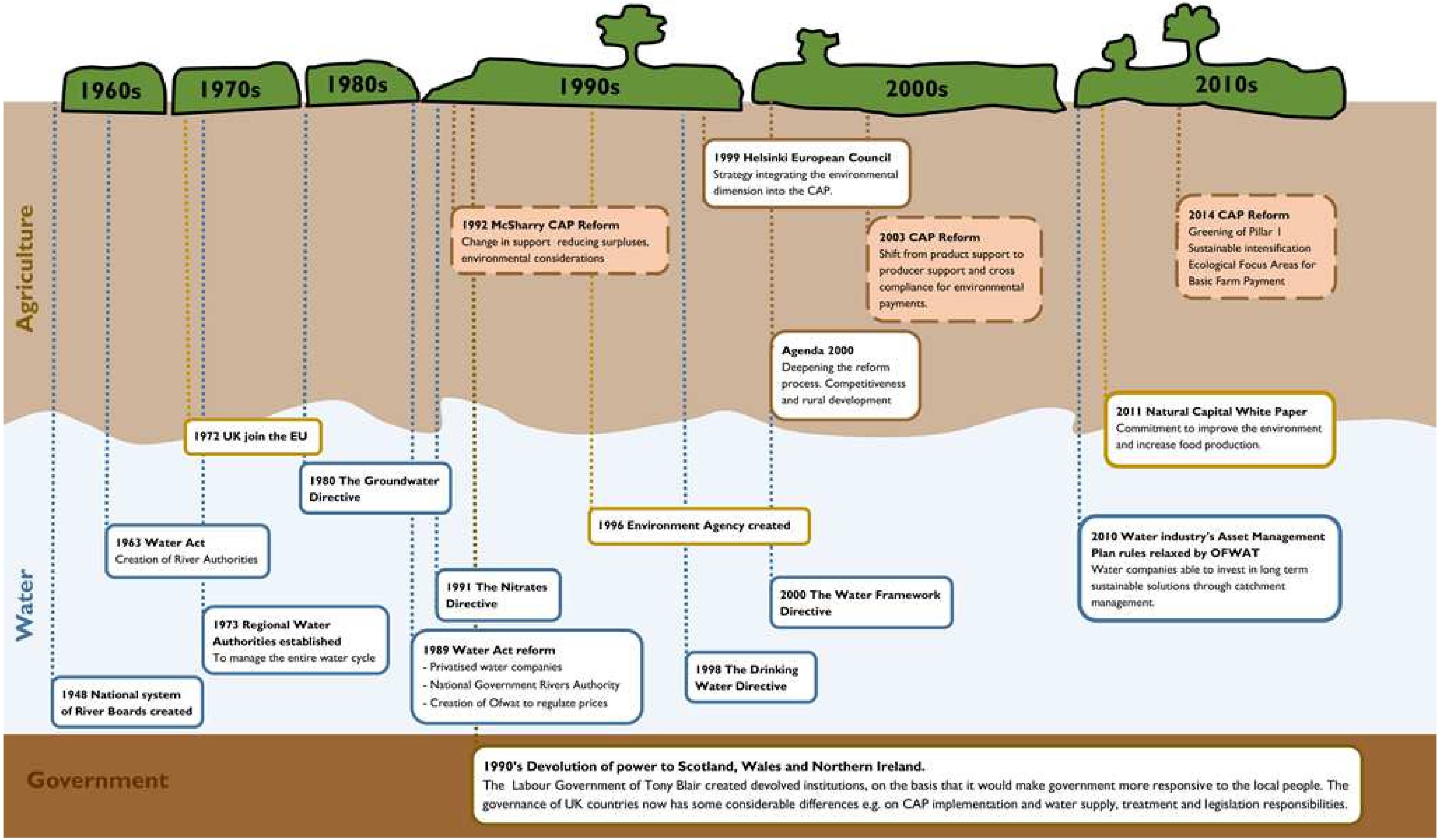

Figure 1.5 Timeline of policy changes in England linked to water quality management and agriculture.

1.2.1 Changes in water management

Since WWII, the UK Government's water management strategy has undergone drastic changes. Post-war institutional arrangements, created a national system of catchment-based River Boards (River Boards Act, 1948) followed by River Authorities which controlled all water tasks, apart from supply and sewage treatment (Water Act, 1963). In 1973, control in England and Wales shifted to regional Water Authorities with comprehensive management of the entire water cycle. Financial problems arose due to such changes and led to more restructuring in the Water Act 1989 (Ofwat, 2006). A set of privatised water companies were created to provide services, whilst a new national government agency, the National Rivers Authority was formed to police water pollution. The Water Services Regulation Authority (Ofwat) (see table 1.1) was also created during this time. Further restructuring in 1996, created the Environment Agency (EA) combining several organisations including the National Rivers Authority. The distribution of responsibility between private water companies and the EA remains the same to this day, with the EA taking the role of command and control, penalising those who pollute (Ofwat, 2006). Ultimately, water governance in England has become regionalised and privatised for supply and treatment but moved towards a greater central agency for pollution control.

Throughout the changes in water governance, water quality issues have persisted and remain a challenge. Strict EU Directives were created such as the Water Framework Directive (WFD) which required Member States to substantially change policies to achieve targets and avoid EU fines. An explanation of the WFD requirements is provided in Box 2, however for a comprehensive description of the WFD's history see Benson and Jordan (2008). To place England in the context of the WFD requirements, in 2012, water quality monitoring sites in England and Wales found an estimated 73% of water bodies failing to reach good status under the WFD standards, with 33% of known failures believed to be due to agriculture (POST Note 478, 2014).

In the past, the UK's response to clean up its water was very much a top-down, hierarchical system (i.e. regulatory), with the role of the public and other stakeholders limited to commenting on and responding to initiatives imposed from the Government (Benson and Jordan, 2008). Since the 1980s, the UK's conventional approach has transitioned into more collaborative management approaches (Defra, 2013a). However, despite the WFD's emphasis on public engagement for water management (Article 14), the reality of such implementation has been questionable. Compared with some EU countries (e.g. Germany) the UK lags behind with public engagement (Aue and Klassen, 2005), however in recent years the UK has become an exemplar to other member states through its adoption of the Catchment Based Approach

(CaBA) which is discussed below. Lessons have been learnt from international comparative studies, some of which are summarised in Benson et al. (2012) and Smith et al. (2015). A mixture of water management approaches are used across many parts of the world, with some focusing on bottom-up 'polycentric' approaches (e.g. in the USA: Smith and Porter, 2009), and some integrated catchment-based approaches which have drawn upon a combination of both top-down and bottom-up (e.g. Australia's Landcare: Curtis and Lockwood, 2000).

Box 2. The Water Framework Directive

The purpose of the Water Framework Directive (WFD) (2000/60/EC) is to reduce water pollution, promote the sustainable use of water, enhance the status and prevent further deterioration of aquatic ecosystems. EU Member States must aim to reach good chemical and ecological status in coastal and inland waters by an initial target date of 2015, though in reality it will take much longer. Prior to the WFD, the EU had numerous Directives for water related environmental standards such as the Drinking Water Directive (80/778/EEC) and the Nitrates Directive (91/676/EEC). The WFD established a strategic framework for bringing together many of the Directives aiming to manage the water environment (inland surface waters, estuaries, coastal waters and groundwater).

The WFD is characterised by its cyclical planning process, requiring a management plan for each river basin to be developed every 6 years (Article 13, Article 4.3). Plans must provide detailed accounts of how the objectives set for each river basin (ecological status, quantitative status, chemical status and protected area objectives) are to be reached within the timescale required and outline a programme of measures for achieving the environmental objectives cost-effectively (Article 11). In December 2009 the EA (responsible for the implementation of the WFD in England and Wales) published the first set of the River Basin Management Plans (European Commission, 2015) to coincide with the first cycle of the WFD (2009-2015).

The WFD not only aims to achieve cleaner waters in Europe, it aims to involve citizens in the process. Member States are obliged to 'encourage the active involvement of all interested parties in the implementation of the Directive and development of river basin management plans' (Article 14). By placing public participation centre stage of water management, it is considered to increase the legitimacy, democracy, quality, effectiveness and efficiency of the public policy-making process and its policy outcomes (Benson et al., 2013, 2012; Bishop and Davis, 2002; Cook et al., 2012; Green et al., 2013).

In England, the Government's promotion of CaBA since 2012 has been an essential catalyst for pollution prevention initiatives. Land and water management has increasingly engaged in a coordinated and sustainable way to balance environmental, economic and social demands at a catchment[1] scale (Defra, 2013a). CaBA aims to incorporate many elements of the WFD, enabling local knowledge to identify and improve understanding of issues within a particular catchment and hopes to ensure that priorities for action are appropriately targeted and collectively identified (Defra, 2013a). Additional to the promotion of catchment management, and inter-related with CaBA, the Government has increased the use of non-regulatory 'carrot' policy mechanisms to reduce pollution. Mechanisms used include, advice provision through Catchment Sensitive Farming (CSF) (Box 3), targeted incentives such as Agri-Environment Schemes (AES) and multiple voluntary initiatives.

[1] Also termed catchment area, drainage area, river basin, water basin and watershed. Referring to an area of land where surface water converges to at a lower elevation, usually the exit of the basin, where the waters join another waterbody, such as an estuary, wetland, sea, or ocean,

Box 3. Catchment Sensitive Farming

A clear solution for farmers

CATCHMENT SENSITIVE FARMING

Catchment Sensitive Farming (CSF) is an initiative run since 2006 by NE in partnership with the EA and Defra, aiming to raise awareness of, and reduce, water pollution from agriculture. CSF provides free training and advice to farmers, and offers grants for infrastructure improvements. The initiative operates in selected priority catchment areas in England, where improvements in water quality will make the greatest contribution under the WFD objectives. Each of the current 69 CSF priority catchments has a CSF Officer (CSFO) responsible for delivering confidential advice to farmers within the area. CSF works in a further 11 catchments in partnership with others e.g. water companies and charity organisations such as Wildlife Trusts (WTs). Advice is tailored to the area and farming sector but includes:

- Manure management – slurry and manure storage facilities and farm yard infrastructure; slurry and manure sampling and analysis; assistance with manure management planning; recommendations on application methods and rates.
- Nutrient management – soil sampling and analysis; assistance with nutrient management planning using programmes such as PLANET, Tried and Tested and other farm management software; precision farming technology; fertiliser spreader calibration.
- Soil condition – management of soils with different structures and uses; methods of diagnosing soil condition and reducing the risk of run-off and erosion; soil organic matter testing and advice on improving organic matter levels; farm infrastructure improvements to reduce soil run-off.
- Pesticide management – improving sprayer handling and wash down areas, sprayer calibration, advice on best practice delivered jointly with ADAS (an agricultural consultancy) and the Voluntary Initiative.

As well as advice, until 2015, CSF operated a Capital Grant scheme providing financial aid to help farmers make relatively low-cost infrastructure investments to improve or install facilities that would benefit water quality. Grants up to £10,000 per holding were awarded to pay 50% of the actual costs. Due to the limited funds, the scheme was competitive and acceptance depended on the quality of all applications assessed against the objectives of the scheme. Changes to the Capital Grant during 2015 are discussed in Section 9.2.1 as they occurred after this PhD's research was conducted.

CSF collects large quantities of data, measuring overall effectiveness and outcomes from the initiative which is used to help target, track and manage delivery. Data collected includes:

- Telephone surveys exploring farmer awareness and attitudes,
- A database of farmer engagement and advice delivery activity by CSFOs,
- Follow-ups with farmers to ascertain the extent of advice uptake,
- Water quality and ecological monitoring,
- An ecosystem services assessment of wider project benefits and outcomes,
- Modelling to assess reductions in pollutant losses and improvements in water quality.

Evaluations have shown that CSF has delivered significant improvements in water quality within representative catchments subject to enhanced water quality monitoring. Pollutant loads and concentrations within these catchments have been reduced, by around 30%, in the case of pesticides. Predicted reductions in pollutant loads are generally between 5% and 10% across targeted areas. The environmental improvements result from: the high level of farmer engagement achieved; an increased awareness of water pollution amongst engaged farmers and the resulting implementation of measures to control pollution. The latest available figures indicate that CSF has engaged with 16,133 farm holdings (2006-2014). Over 80% of farmers receiving advice have confirmed their knowledge of water pollution has increased and that they have taken, or intended taking action to reduce water pollution. 62% of the 167,788 recommended farming practices to mitigate water pollution have been implemented by farmers that engaged with the project.

Source: Catchment Sensitive Farming, 2012; CSF Evidence Team, 2014.

As part of CaBA, additional government funds were made available to help deliver WFD objectives (2011-2015). Part of this support established a Catchment Restoration Fund which aimed to make more resources available to third sector organisations (Defra, 2014). Many Rivers Trusts (RTs) were subsequently set up in catchments and applied for such funds. RTs strategies have varied between catchments, from a narrow focus on river channel restoration, to broad approaches of stakeholder engagement across the whole catchment. Many RTs now have strong local farmer involvement and conduct a variety of different farmer engagement activities, including the provision of farm practice advice to mitigate water pollution (The Rivers Trust, 2012). Having discussed examples of how the Government has sought to reduce water pollution by focusing on non-regulatory mechanisms and CaBA, changes in strategies from the water industry in charge of supply and treatment are described below.

The private water companies responsible for water supply and treatment works initially concentrated resources on end of pipe solutions, treating polluted water. This did not solve the issues as it was not sustainable, protecting the environment or helping achieve WFD standards. The economic and social costs associated with end of pipe solutions of treating water to meet drinking water standards also rose appreciably. During the 1990s, the water industry undertook a number of pesticide and nitrate removal schemes, resulting in the construction of 120 plants for pesticide removal and 30 for nitrate removal (Ofwat, 1998 as cited by Pretty et al. 2000). Ofwat predicted capital expenditure for pesticides would fall to £88 million/yr, and for nitrate to £8.3 million/yr at the end of the 1990s/early 2000s (Pretty et al., 2000). However, in 2002 it was estimated that the water industry spent at least £225 million/yr to treat potable supplies of pesticides, nutrients, faecal organisms and suspended matter from soil erosion (Defra, 2002). Additional to the costs of treating water, there are associated risks to society, with pollution incidents compromising the provision of safe drinking water (United Utilities, 2015). With such issues occurring, a more upstream approach of pollution prevention has gained momentum in recent years. Before discussing such preventative approaches, it is important to understand how water company investment decisions are made, as recent changes over the past five years have impacted water quality strategies across the country.

The water industry is managed in five yearly cycles known as Asset Management Plan (AMP) periods. During each cycle, Ofwat review the AMPs and place limits on the prices the water companies can charge for services. For the first four AMP cycles (1990-2010), capital expenditure was the primary focus for the water industry, investing in new infrastructure to meet EU legislation for water discharge and to reduce impacts on wildlife habitats. Despite the infrastructure improvements made, this approach did not tackle long-term sustainability. With the growing end of pipe costs and emerging evidence from other countries, the fifth cycle (AMP5- 2010) saw a shift from Ofwat, relaxing rules on projects water companies could fund.

This encouraged a move away from capital expenditure investment towards existing infrastructure and operational expenditure (Ofwat, 2010). Such a shift facilitated investment by water companies in longer-term sustainable solutions such as those offered by catchment management. There have been a growing number of projects where water companies have engaged with the agricultural sector to reduce pollution at the source rather than in treatment works. Upstream Thinking is a project run by South West Water, the private company responsible for water supply and treatment in the South West of England. It is claimed that this project has successfully reduced water pollution, financially benefitted the farmers (by offering free advice and grants), and provided a 1:65 cost-benefit ratio for South West Water's investment (through direct savings in treatment infrastructure and indirect benefits to society)(POSTnote, 478, 2014; Westcountry Rivers Trust, 2013.). Other examples of the water industry engaging with land managers include, United Utilities' Sustainable Catchment Management Programme (SCaMP)[2], and Anglian Water's Slug it Out campaign[3].

Further efforts of pollution prevention through catchment management have come from changes in agricultural policy. Changes at the EU level as well as national level are discussed below, particularly focusing on the CAP and the UK's implementation of the CAP.

1.2.2 Changes in agricultural policy

In a similar manner to water management, decisions at an EU level provide a framework within which UK agricultural policy is set. Although many international policies, agreements and commitments (OECD, 2008b:523) influence UK agriculture, especially related to global markets, trade and tariff barriers, this section particularly focuses on the changes in the CAP due to its overarching influence on agriculture.

CAP was initially designed and launched in 1962 to increase food production and farm incomes in response to the post-war shortages. These short-term aims were achieved through market price support, however, over time, the CAP has evolved with changing objectives and a growing EU (Skogstad and Verdun, 2013). Moving away from the traditional production subsidies, the CAP now focuses more on competitiveness, sustainability and the provision of public goods, with its environmental priority areas including biodiversity, water management, and climate change. *'The CAP is about our countryside…Farming is not just about food. It is about rural communities and the people who live in them. It is about our countryside and its precious natural resources.'* (European Commission, 2012a:4).

[2] http://corporate.unitedutilities.com/cr-scamp.aspx

[3] http://www.anglianwater.co.uk/environment/our-commitment/our-plans/slug-it-out.aspx

The CAP can be divided into three main areas which are administered by a set of legal regulations: Income support (Pillar I), rural development (Pillar II)[4], and market support[5]. Over recent decades, particular key changes have occurred in the regulations surrounding the three main pillars. Those worth noting here include the CAP reforms of 1992 and 2003 (as shown in the timeline Figure 1.5). In 1992, the McSharry reform scaled down price support, and replaced it with direct aid payments to farmers for which they were encouraged to be more environmentally-friendly. The reform coincided with the 1992 Rio Earth Summit which launched the principle of sustainable development. Similarly, in 2002, the Curry Report on the Future of Farming and Food, paralleled the CAP reforms which decoupled the link between subsidies and production. Farmers started to receive income support in exchange for respecting strict food safety, environmental and animal welfare standards (European Commission, 2012b). The changes in funding distribution can be observed in Figure 1.6, demonstrating the significant change from coupled to decoupled payments.

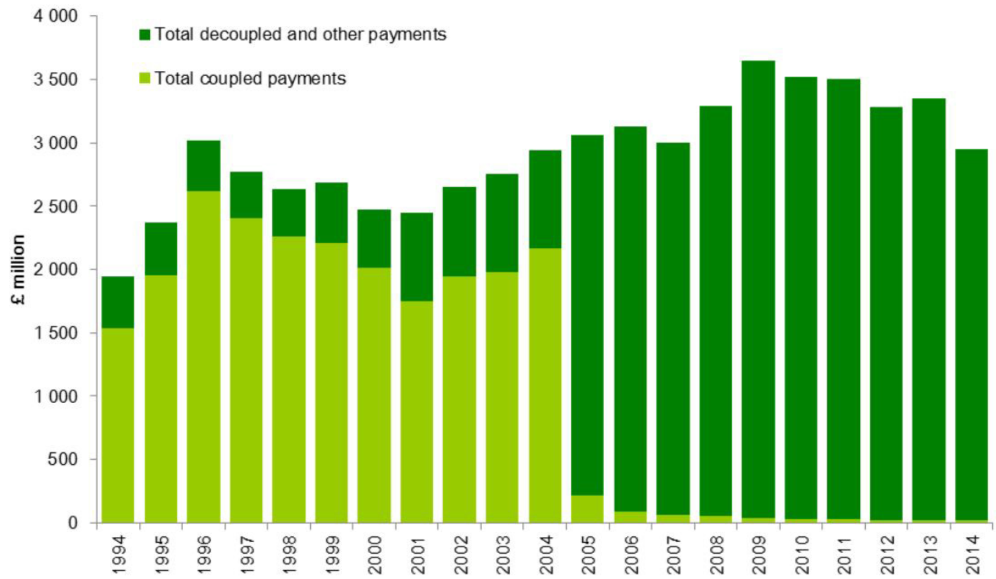

Figure 1.6 Direct payments made to farmers from the CAP budget (1994 - 2014). Source: Defra, 2015a.

Further changes to the framework of 'regulations' which determine how CAP finances are spent were being negotiated during the initial stages of this research. Final decisions were confirmed in 2015, after all research data had been collected. Certain elements of the CAP have remained the same, but the most recent changes and developments are discussed within

[4] For improving competitiveness, the environment and rural community's quality of life and economic diversification.

[5] A very small percentage of the budget is used for mechanisms to control the market of agricultural goods in and out of the EU, such as intervention and private storage, export subsidies and import duties.

Section 9.2.1 as they post-date the research presented in this thesis. The framework of the CAP during the data collection period is explained in the remainder of this section.

Pre-dating the CAP reform of 2014, farmers could receive CAP funding via income support (Pillar I), known as Single Farm Payments (SFP) in England. In order to receive such funds, farmers needed to abide by Cross Compliance rules. The legal conditions of the rules involved Statutory Management Requirements (SMRs) and Good Agricultural and Environmental Conditions (GAECs). The Cross Compliance framework included statutory requirements related to water protection and management arising from the implementation of the Groundwater Directive and Nitrates Directive. One example of a requirement was the Soil Protection Review, for which farmers had to annually conduct on-farm checks. This was to maintain soil structure and organic matter, prevent erosion, compaction and damage to landscape features. If such conditions were not met by the farmer, their SFP could be reduced.

To go beyond Pillar I legal requirements, farmers could voluntarily opt for further payments under the rural development Pillar II. By committing to an environmental agreement, for a minimum period of five years, farmers would adopt agri-environmental measures and received payments to compensate for additional costs and income foregone. The level of uptake of AES has increased dramatically over the past 20 years (Figure 1.7), with schemes in England under Pillar II during the start of this research consisting of: the Entry Level Stewardship; Higher Level Stewardship; Uplands Transitional Payment; Organic Farming Scheme and the Woodland Management Grant (RPA, 2012).

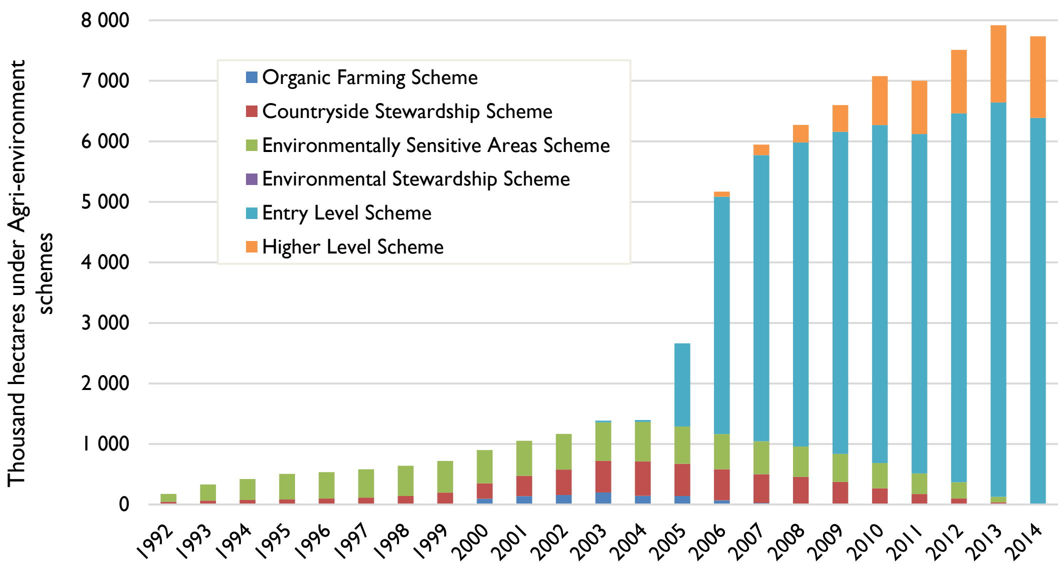

Figure 1.7 The number of hectares under an agri-environment scheme in England. Source: Defra, 2015a.

It is important to emphasise that despite changes in policies which have encouraged uptake of environmental measures such as those discussed, water pollution has persisted and continues to be an urgent challenge needing to be addressed. Revising AES is one method which has been recommended (Lawton et al., 2010), however another strategy referred to as 'sustainable intensification of agriculture' is also being promoted by the Government (Sustainable Intensification Platform, 2015). This strategy builds upon the concept that certain areas should be intensively farmed and others set aside for nature. Various landscapes have different advantages for the production of societal benefits, such as food and non-food crops (to be intensively farmed), or particular ecosystem services or types of biodiversity (set aside for nature). In principle, there is political appetite for a move away from policies that adopt a 'one size fits all approach' and a move towards the idea of 'the right management for the right place' (Global Food Security, 2014a). It is the Government's general intention to develop policies that support land-owners to manage their land in a way that delivers the greatest benefit to them and society at large (Defra, 2012a). However, to successfully achieve such objectives, knowing not only what the right management is and where, but how to influence such management and through whom is vital and needs substantial research. The next section describes the political challenges faced by policy makers in designing and implementing future agri-water policies.

1.3 Policy challenges

Policy makers face great challenges to ensure food security whist protecting the environment and improving water quality. Unfortunately the inconvenient truth for policy makers is that the magnitude of water pollution is severe (Section 1.1). Solutions currently used to reduce land use pressures and water pollution have limitations in their ability to achieve great improvements, however many alternative policy scenarios would be very costly or have drastic consequences. One example would be a national ban on particular agri-chemicals. Causing high exchequer costs for enforcement and policing, greater risks to the farmer with potential loss of income due to decreases in yields, and possible knock on effects jeopardising food security. Compromises need to be made and challenges overcome, to achieve environmental legislative targets, develop sustainable land management practices and ensure optimal provisions of multiple ecosystem services. Some of the most difficult challenges to consider for improving policy interventions are discussed below.

A major challenge for policy is that it operates at different scales: the European and national regulatory scale; river basins or catchment thinking and planning scale; and the sub-catchment, water body, farm or site implementation scale (Global Food Security, 2014a). Despite many options of policy mechanisms and programmes of measures targeting farmers to address specific issues, integrating policies at a national level so as to provide land managers with coherent guidance at a local level is problematic (Farming Regulation Task Force, 2011). Dolan et al. (2010:29) question how far techniques should be employed by central government or left to local policymakers, professionals and communities. A related challenge is that of scaling up scientific evidence from plot to catchment scale, particularly when extrapolating knowledge from well-studied to poorly studied areas.

Another issue is complexity of the interactions between agriculture and water resources. Substantial knowledge and research is needed to ensure sufficient consideration of the possible interrelationships whilst integrating policies (Dicks et al., 2013; Macleod et al., 2007; McGonigle et al., 2012; OECD, 2015a). Relating to such an issue is the matter of competing political objectives. One example is the competing demands on land use. Such demands include: bioenergy targets; increased housing for a growing population; improving wildlife and habitat protection through increased areas managed for nature; greater woodland cover to deliver a range of benefits; land dedicated to improved water management infrastructure (e.g. increased wetlands and new reservoirs); as well as improving food security through replacing key imports where viable and increasing exports with a competitive advantage (CISL, 2014). In addition to increasing demands on land use, policies must consider the additional societal and environmental issues which will place even greater pressures on an already vulnerable and degraded water infrastructure, such as predicted rises in water use and extreme weather events of flooding and droughts (Smith et al., 2007).

Further challenges exist, even once policy makers have considered how different policies are interrelated and at what scale governance should occur. The economics and practicality of mechanisms need to be realistic, within a constrained government budget, and avoid overly inflating the costs of policy implementation (Bateman et al., 2013). The availability of scientific research is another challenge, as lack of evidence can hinder policy development. On the other hand, even when research has been conducted, much of it stays within the realm of academia. There have been many requests for closer engagement between all parties involved (e.g. researchers, policy makers and farmers) to reduce fragmentation and make full use of research results (Collins and McGonigle, 2008; Gerrits and Edelenbos, 2004; Hewett et al., 2009; Macleod et al., 2007).

In summary, to overcome the key challenges, policy needs to:

- Design effective mechanisms at the correct spatial scale,
- Improve policy integration with sufficient consideration of interrelationships, and competing objectives,
- Avoid overly inflating the costs of policy implementation and ensuring cost effectiveness,
- Advance scientific knowledge,
- Translate and transfer knowledge between researchers, policy makers and farmers.

Having outlined the key challenges and the political landscape which influences agriculture and water quality in England, it is clear that initiatives to date have only had limited success and the situation remains problematic. There is an obvious need to do more to support policy makers, enabling effective strategies to be designed for reducing WPA.

1.4 The importance of social sciences for reducing water pollution from agriculture

As WPA can be reduced in a number of ways (Newell-Price et al., 2011), knowing which measures should receive government attention and the resources and mechanisms that would be most effective in encouraging uptake is important (Dolan et al., 2010:29). To increase the uptake of mitigation measures, policy has shifted over recent years to favour mechanisms of advice provision, voluntary initiatives and targeted incentives (Barnes et al., 2013). It is crucial policy changes are developed upon a strong evidence base (Shaxson, 2014; UKWRIP, 2011), therefore research is required to inform policy decision makers developing and implementing policies to tackle WPA (McGonigle et al., 2012).

The argument for the importance of social sciences within catchment management is increasingly being recognised (Anthony et al., 2009; Macleod et al., 2008; Zhang et al., 2012). Evidence from the ‘hard sciences’ (such as water quality and soil chemistry) is no longer regarded as a definitive ‘ace up one’s sleeve’, and many authors advocate the need for interdisciplinary approaches, incorporating social science aspects to complement such data (Adams, 2003; Barr, 2002; Biogas Info, 2014; Lowe et al., 2013; Macgregor and Warren, 2006; McCracken et al., 2015; Pahl-wostl et al., 2008; Phillipson and Proctor, 2010). Reducing agriculture’s contribution to water pollution is an inter-disciplinary challenge with policy design and evaluation relying upon not only established economic and statistical techniques, but also an understanding of farmer behaviours and the influencing factors contributing to such behaviours. Numerous datasets exist from the ‘hard sciences’, however, rather less attention has been given to the social sciences regarding farm activities and their influence on water quality.

An abundance of literature has examined farmer behaviours and attitudes to AES and general pro-environmental behaviours e.g. Dwyer et al. (2007) and Mills et al. (2013). However, much less has focussed on catchment management measures. The literature which does exist (Section 2.2.2), does not strongly relate to decisions as to *why* farmers do or don’t implement particular mitigation measures. There is consequently a need to conduct empirical research to understand farmer behaviour and attitudes, learning how best to increase the uptake of certain farm practices (Global Food Security, 2014b) and to understand the likely effectiveness of policy levers (McGonigle et al., 2012).

Behavioural science has increasingly received attention from the Government, with recognition of its importance in helping influence behaviour to achieve positive policy outcomes (Darnton, 2008; House of Lords, 2011). The Cabinet Office commissioned a report, exploring the application of behavioural theory to public policy (Dolan et al., 2010), making a strong case for governments to actively be involved in encouraging behaviour change. Numerous research reports have been commissioned to advise various government departments e.g. public health (NICE, 2007), energy and climate change (Chatterton, 2011) and transport (Savage et al., 2011), focusing on improving knowledge of behaviour change and interventions to influence such change. Defra, the department responsible for the environment, has also conducted similar research (Darnton et al., 2006; Defra, 2008; Dwyer et al., 2007; Morris et al., 2012; Pike, 2008). Investing funds in a multitude of research projects (Defra, 2015d). Despite such efforts, the knowledge gained has either been insufficiently applied or failed to correctly inform, as policy implementation has not led to fully desirable behaviour and cultural changes. Such relevant work needs to be married with empirical research which investigates and engages with farmers on water pollution mitigation measure in order to develop greater insights.

Research informing policy design which engages with stakeholders is argued to have many economic, environmental and social benefits, resulting in policies with: greater acceptance, trust, cost savings, greater policy and social coherence, knowledge development and validation, and conflict avoidance (Collins and McGonigle, 2008; Gerrits and Edelenbos, 2004; Macleod et al., 2007; OECD, 2015a; The Rivers Trust, 2012). Despite acknowledgement of the benefits e.g. Cook et al. (2012), and the increasing support for stakeholder engagement in catchment management decisions[6], it has been reported that true deliberative engagement is rare rather than the norm (Petts, 2007). Some also see the process as a hindrance with a lack of clarity and having too few or too many voices (OECD, 2015b). A further negative outlined by McIntosh et al. (2011) is the considerable investment involved which can drain resources from a project with limited funding, and thus damage its success. On the other hand, if stakeholders are not engaged, some argue this can lead to poor acceptance of imposed policies, particularly when they do not accord with personal experiences and practices (Burgess et al., 2000; Riley, 2009, 2006). Policymakers have increasingly sought farmer consultation in policy design (Davies and Hodge, 2006; May and Winter, 2001, 1999; Taylor et al., 2013), therefore it is important that research informing policy continues to engage with stakeholders (Dicks et al., 2013; Phillipson et al., 2012).

1.5 Implications and thesis outline

This chapter has argued that to address the wider issues of farming and water quality it is important to study the social science dimension of catchment management. By engaging with stakeholders, the overall objective of this thesis is to inform and improve agri-environmental policy that seeks to influence farmer uptake of water pollution mitigation measures.

Seven key implications for policy outlined by Pike (2008:21) provided the initial building blocks for structuring and designing this research, ensuring its relevance for policy makers. Pike (2008) emphasises the importance of recognising diversity within the farming community and understanding the rationale for decisions and factors influencing such decisions.

Three qualitative surveys were conducted in light of the recommendations made by Pike. The data collected have been examined using different units of analysis, which Figure 1.8 displays as axes on a cube: Chapter 4 analyses results by farm type; Chapters 5 and 7 examine results by study area and Chapter 6 explores the data separately for each mitigation measure.

[6] Stakeholder engagement and public participation in policy making has been stressed by several international treaties linked to environment and water quality improvements such as the 1992 Dublin Principles, The United Nations Rio Declaration, Chapter 18 of Agenda 21, and the 1998 UN Aarhus Convention.

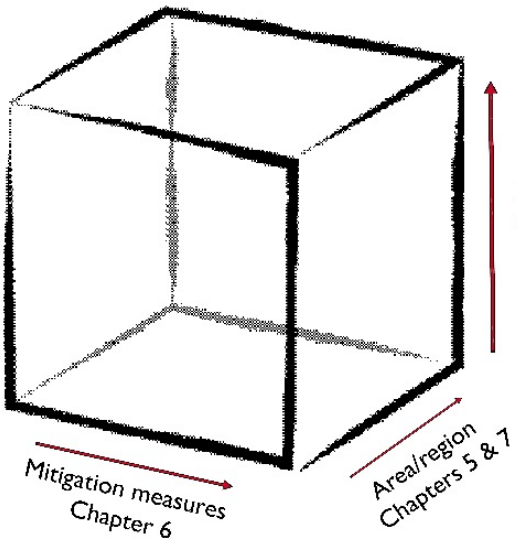

Figure 1.8 The three different dimensions by which this thesis analyses survey results, showing the chapters which focus on each form of comparison.

The flow diagram in Figure 1.9 provides a clear summary of what is included in each chapter of this thesis. Chapter 1 began setting the context for this research by explaining the political landscape which influences agriculture and water quality in England, outlining the key political challenges and arguing the need for social science. A summary and review of the existing literature on behavioural theories and frameworks is provided in Chapter 2, followed by the literature on farmer attitudes and uptake of farm practices which mitigate water pollution. Key research on the current knowledge of behaviour change mechanisms and their effectiveness along with their current use within policy is then discussed. Gaps in existing knowledge are identified, highlighting research which requires further development. Chapter 3 describes the research programme and characteristics of the four river catchments within which this research was conducted. Once the context has been set, the empirical research comprising three separate qualitative surveys is presented across four chapters (Figure 1.9).

In Chapter 4, farmers were surveyed to gather baseline information about their current uptake and attitudes to future uptake of a wide range of mitigation measures, providing a sense of what farmers are currently doing or considering doing. This chapter informs those later in the thesis, highlighting which mitigation measures would be beneficial to investigate in greater depth. Chapter 5 investigates the provision of one-to-one mitigation measure advice, examining current efforts to influence uptake of measures, as advice provision can effect uptake and attitudes towards measures. What motivates and creates barriers to farmer uptake of particular measures is discussed in Chapter 6, whilst Chapter 7 assesses farmer attitudes towards advice providers, seeking to discover who is best placed to provide advice on such topics.

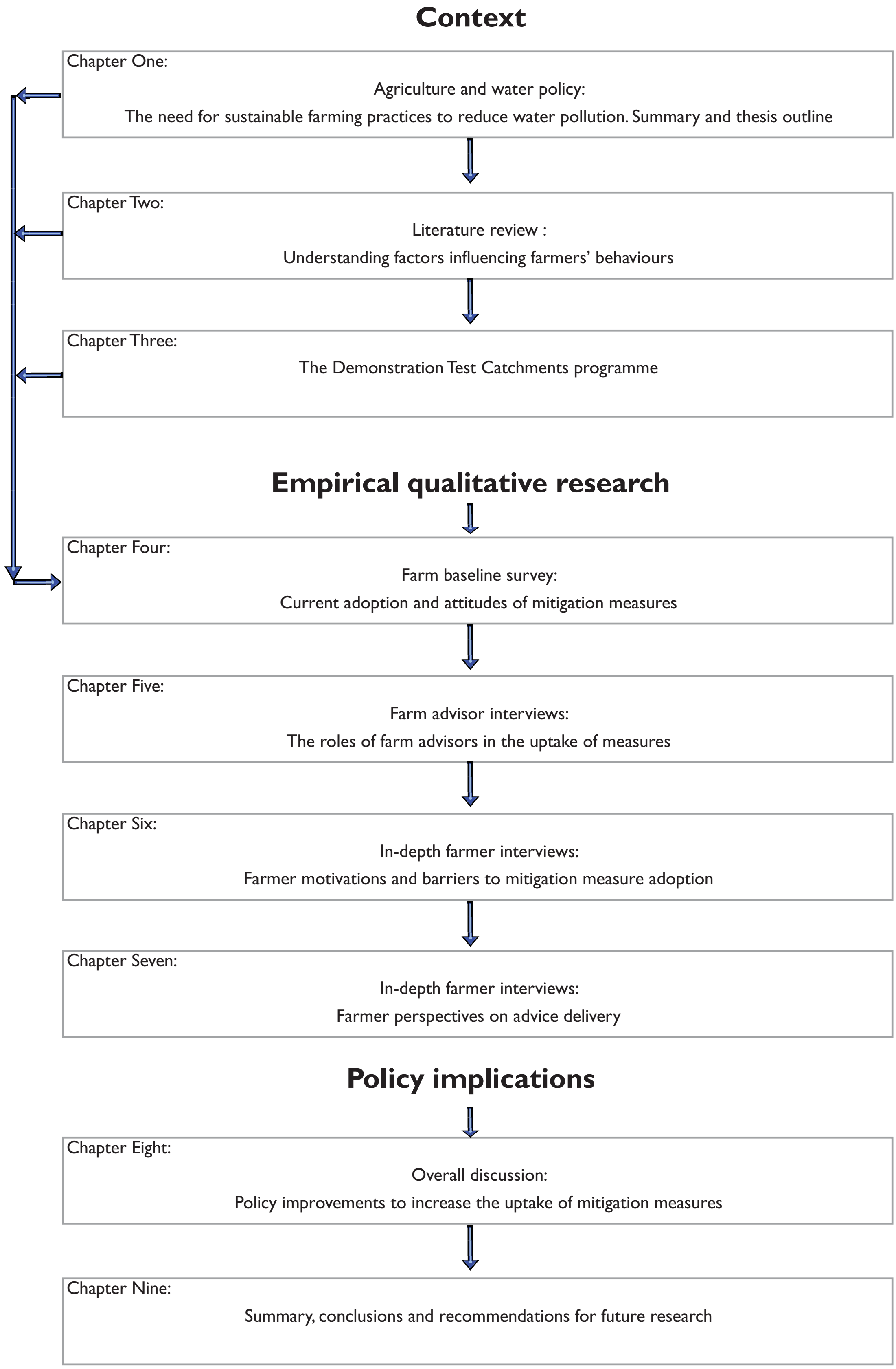

Figure 1.9 Outline and structure of chapters within this thesis.

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The detail of the research is limited to England's political framework, however, as governance and mechanisms are transferable, lessons can be learnt and applied to other countries where agricultural intensification is resulting in an increasing amount of pollution and there is a need to improve water quality and agricultural sustainability. Chapter 8 therefore presents an overall discussion, suggesting what needs to change within policy to influence further uptake of water pollution mitigation measures amongst farmers. Finally Chapter 9 summarises the conclusions, recommendations for policy and suggests possibilities for future research.

Chapter 2

Chapter 2 Literature Review: Understanding factors that influence farmers' behaviour

Chapter 1 set water pollution in its agricultural context, and discussed the changes in England's water management and agricultural policy which have contributed to both the rise in catchment scale management of the water pollution challenge and the efforts to change farmers' behaviour.

The overall objectives of Chapter 2 are to:

1) Identify what is already known about the factors which influence behaviour and behaviour change, by exploring relevant theories and frameworks;
2) Assess relevant frameworks to determine whether any are appropriate for framing this research;
3) Review the literature surrounding farmers' pro-environmental behaviours, to highlight key influences on such actions;
4) Examine the various policy interventions which have been used in an attempt to change farmer behaviour. Such an examination goes beyond the outline presented in Chapter 1, with Chapter 2 looking in detail at the wide range of mechanisms used in England and abroad, and discussing their effectiveness.

Chapter 2 concludes with a summary of the gaps in the existing knowledge, setting the context for this research.

2.1 Behavioural theories and frameworks

To understand how best to change farmer behaviours, it is important to firstly comprehend the factors which influence their decisions. Many theories and frameworks exist which either focus on predicting or influencing human behaviour. Essentially, such theories are a way to explain action according to a set of rigorously defined criteria that have been theoretically justified, whereas frameworks are more general, often conceptualising behaviour, and based less on theoretical understanding and more on 'what works' (Barr, 2002:74). This section defines key terminology within behavioural research and provides examples of behavioural theories and frameworks. Subsequently, an evaluation is presented of particularly relevant frameworks which have previously been used by the Government to develop understandings of behaviour and to design policy interventions.

To begin with, it is important to clarify that human behaviour is defined as the action or reaction of a person, simply anything a person does. Research studying human behaviour often considers a plethora of different elements which are believed to influence actions, such as, attitudes, beliefs, values, willingness and ability. Without entering a long debate on terminology, it is worth noting that words such as attitudes, values and beliefs are sometimes used interchangeably but differences exist between them. *Attitude* reflects personal factors and can be defined as a persons' positive or negative evaluation of performing a behaviour. Attitudes are not entirely permanent and can be recreated each time an individual responds to a question, a behaviour or a specific occurrence (Mills et al., 2013). *Values* are cognitive constructs of the ideals and desired outcomes to be striven for, being socially and culturally conditioned and tend to be stable over time (Rokeach, 1973). *Beliefs* are much stronger, essentially being convictions which can originate from values but are not necessarily always based on reflection and conscious objective thinking (Mills et al., 2013). To summarise the definitions of beliefs, values and attitudes, Figure 2.1 provides descriptions along with examples of factors which influence each.

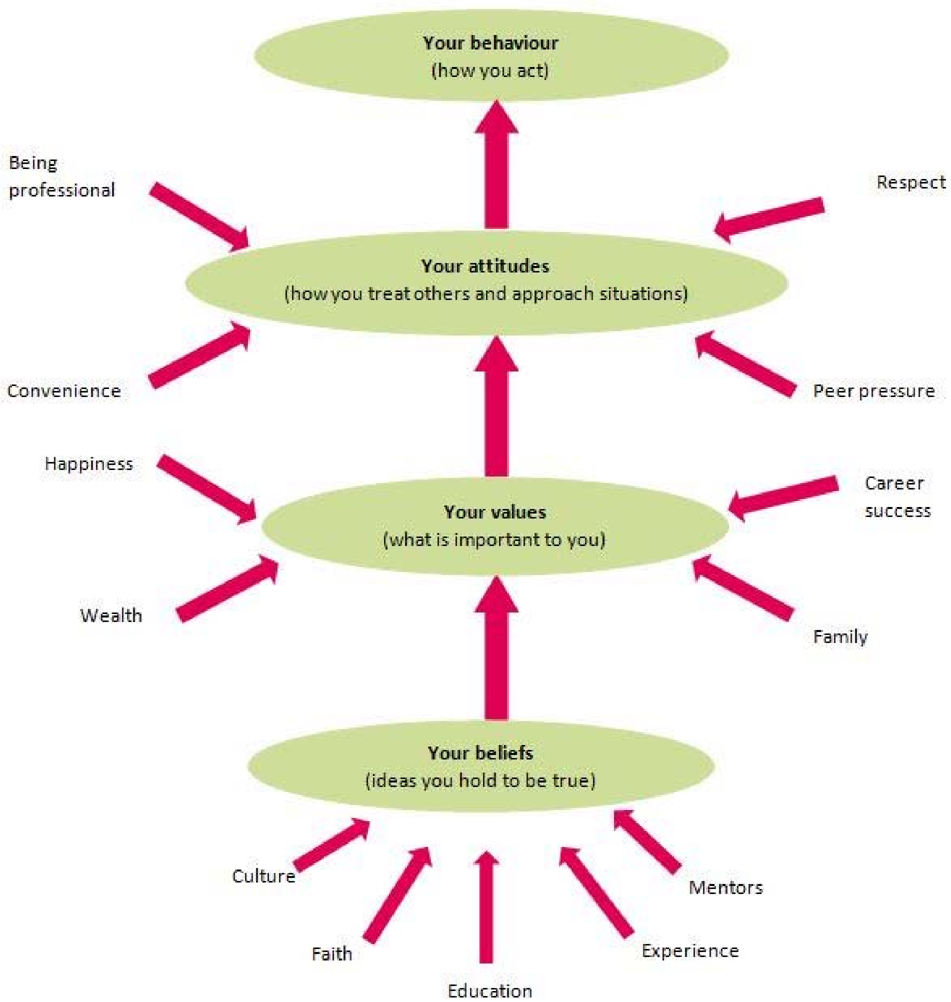


Figure 2.1 Definitions of beliefs, values, attitudes and behaviours, with examples of influential factors. Source: IAA, 2015.

For decades, the link between attitude and behaviour has been questioned and examined within research. With regards to farmers' behaviours, Gasson and Potter (1988) showed farmer attitude to be a key determinant of behaviour, whilst Petty et al.'s (1992) application of persuasion theories dealt with the issue of how behaviour can be altered by changing the beliefs underlying attitudes. However, 'attitude-behaviour inconsistency' and the 'value-action gap' have been widely observed in studies of environmental behaviour (Barr, 2004; Blake, 1999; Darnton, 2004; Huddart-Kennedy et al., 2009; Kollmuss and Agyeman, 2002). Burton (2004a) argues that there is no direct relationship between positive attitudes and behaviour, and McHenry (1997) questions the simplicity of research which concludes that changing a single belief or attitude to the environment will result in more appropriate behaviour.

Another topic area frequently discussed in such literature surrounds *motivations* - the reasons and driving force for carrying out an action (Mills et al., 2013). Whilst attitudinal research attempts to relate attitudes to behaviour, studies on motivation examine the reasons behind particular behaviours or actions. Motivations can be categorised into two variants. The first category 'internal' or 'intrinsic' motivations are essentially inherent reasons for interest or enjoyment and directly relate to attitudes, values and beliefs. The second category is 'external' or 'extrinsic' motivations, which refer to behaviours in response to external pressures or rewards and can consequently influence attitudes, values and beliefs, thus indirectly impacting behaviour. The examples of influential factors in Figure 2.1 can all be considered as motivations shaping behaviour. Understanding how such a wide range of motivational components and other factors relate to and influence one another is one of the overarching objectives of behavioural research. Theories and frameworks attempt to tackle such objectives.

Behaviour theory has come a long way since Simon (1959:273) claimed *'a real life decision involves some goals or values, some facts about the environment, and some inferences drawn from the values and facts.'* Many theories have been developed over the years (Colman, 2015), with Michie et al. (2014) providing an encyclopaedia of 86 behavioural theories. This literature review does not attempt to discuss all the relevant theories which exist, nor does it endeavour to test or evaluate them. Many of the 86 theories derive from certain key approaches, and by far the most widely cited of these are the Theory of Reasoned Action (TRA) (Ajzen and Fishbein, 1980) and the Theory of Planned Behaviour (TPB) (Ajzen, 1991). Due to their practicality and applicability to different contexts, the TRA and TPB are frequently referred to in the literature discussing pro-environmental behaviour (Bamberg, 2003; Darnton, 2004; Jackson, 2005; Neal and Walters, 2007; Sawang and Kivits, 2014;

Willock et al., 1999). Reid et al. (2009) list many more who have attempted to build upon or refine either the TRA or TPB specifically to study pro-environmental behaviours. The TRA was designed to predict volitional behaviours (i.e. behaviour that people carry out if they want to). Assuming that people behave rationally in accordance with their beliefs and their intentions. The prerequisite that a studied behaviour must be under volitional control limits the use of the TRA, therefore an extension was proposed to include considerations of non-volitional factors as determinants of behaviour - the TPB. The TPB incorporates social influences as a determinant and attempts to predict behaviour by including personal attributes (behavioural beliefs), subjective norms (social influences) and perceived behavioural control (perception of ease or difficulty of the action). The TPB is often used for predicting behaviours which are considered to be simple to measure. For example, evaluating someone's intentions of cycling during a month, by first asking how many times they plan to cycle next month and later comparing it to how many times they actually cycled. Despite the TPB's improvements on the TRA, it has been criticised for not addressing the important role of impulsivity, habit, self-control, associative learning, and emotional processing (West, 2006).

After decades of research attempting to 'predict' behaviours - for a comprehensive review on such research see Michie et al. (2014) – it can be questioned, is this even possible, given the enormous variability in humans? Theories, such as the two described above, provide a useful understanding of behaviours but often over simplify the complex mechanisms at work. Jackson (2005:23) sums up this problem in his discussion of consumer behaviour:

'Beyond a certain degree of complexity, it becomes virtually impossible to establish meaningful correlations between variables or to identify causal influences on choice. Conversely ... simpler models run the risk of missing out key causal influences on a decision, by virtue of their simplicity ... this means that there will always be something of tension between simplicity and complexity in modelling consumer behaviour. More complex models may aid conceptual understanding but be poorly structured for empirical quantification of attitudes or intentions (for example). Less complex models may aid in empirical quantification but hinder conceptual understanding by omitting key variables or relationships between key variables'.

The concept that humans are exclusive entities that must be understood as individuals is a rational argument by Barr (2002), and he states that this generates a daunting conclusion that studying human behaviours is futile given the endless diversity of individuals. As a solution, Barr (2002) claims that using frameworks may offer a middle ground between determinism and defeatism. Their flexibility allows fewer assumptions to be made concerning the behavioural process and the addition or omission of factors is acceptable in different situations

(Barr, 2002). Although such frameworks still form generalisations of the studied population, the framework approach has been favoured by multiple researchers for their flexibility and generality as a means of examining human behaviour (Darnton, 2008; Kollmuss and Agyeman, 2002; Michie et al., 2011a, 2011b; Pike, 2008).

One example of a behavioural framework is provided by Behavioural Economics (BE) (Figure 2.2). BE considers the effect of economics, sociology and psychology, and suggests that human decisions are strongly influenced by context. It is an extension of traditional economic theories which often assume individuals behave rationally to maximise benefits to themselves (see Dawnay and Shah, 2005). BE identifies three main components to consider: internal factors, such as cognitive processes and habitual behaviours; external factors, such as monetary and non-monetary costs; and social factors such as social norms and cultural attitudes. BE suggests that not only do numerous factors influence behavioural outcomes, the majority of everyday behaviour is habitual, with cognitive limitations resulting in the inability to process too much complex information thus relying upon rules of thumb instead, '*people… often aren't actually all that "rational" in their behaviours and decisions… they are just as likely to do what they have always done, what impulse tells them to do or what their neighbours or friends generally do… they're often well aware that their own actions aren't in their best interests"* (Social Market Foundation, 2008:6).

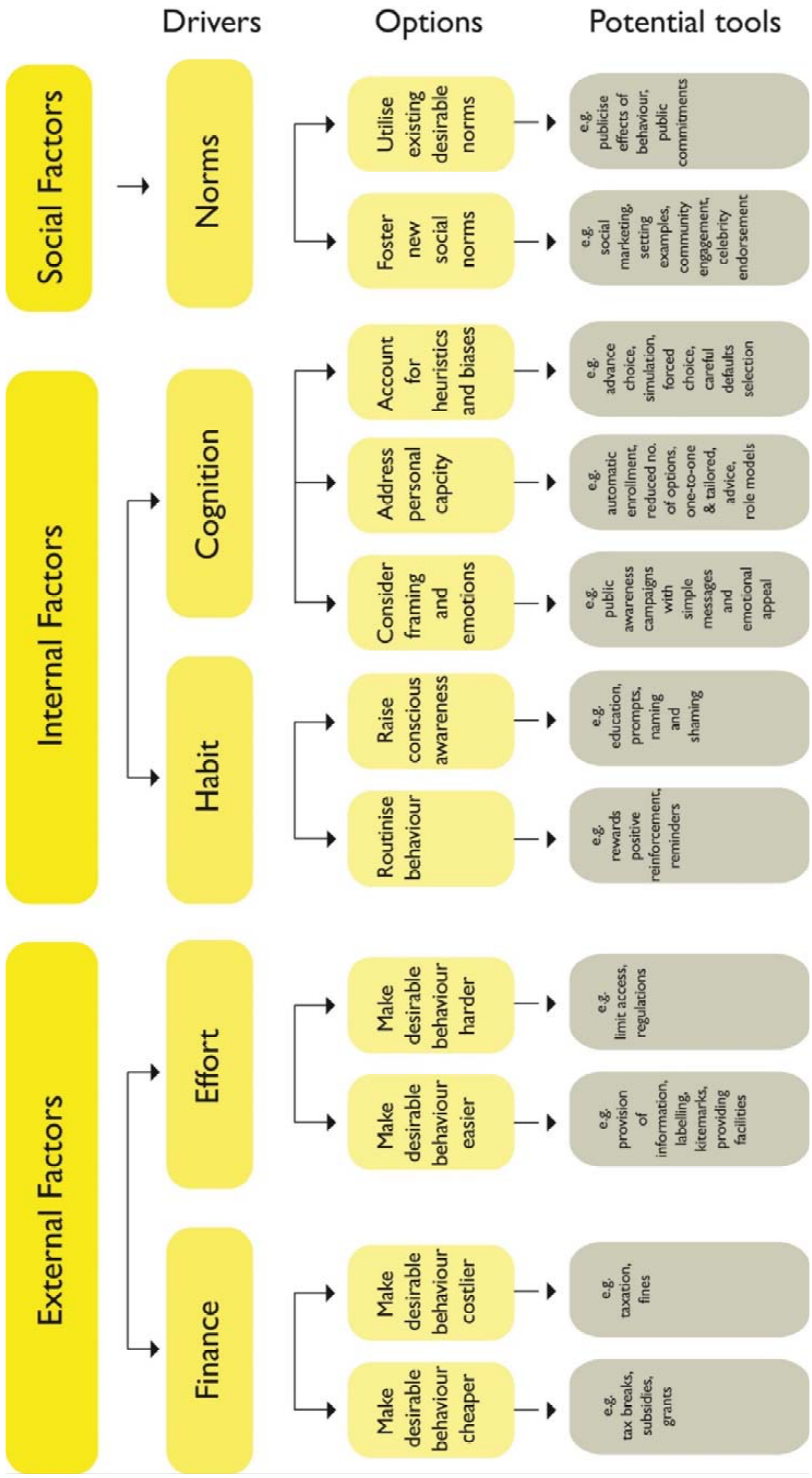


Figure 2.2 The components which make up the framework for Behavioural Economics. Source: Social Market Foundation, 2008.

BE is a framework which suggests numerous factors influence behaviours. Influential factors can be considered as positive elements which motivate and improve ability and willingness to adopt a behaviour, or they can be negative considerations which create barriers, decreasing ability and willingness to adopt. A broad review of factors which influence pro-environmental behaviour (i.e. conserving energy, recycling or planting trees), is presented in Kollmuss and Agyeman (2002). Figure 2.3 is reproduced from their paper and highlights the barriers to pro-environmental behaviour, displayed in a framework which depicts inter-relationships between internal and external factors and their connection to pro-environmental behaviour (Kollmuss and Agyeman, 2002:257).

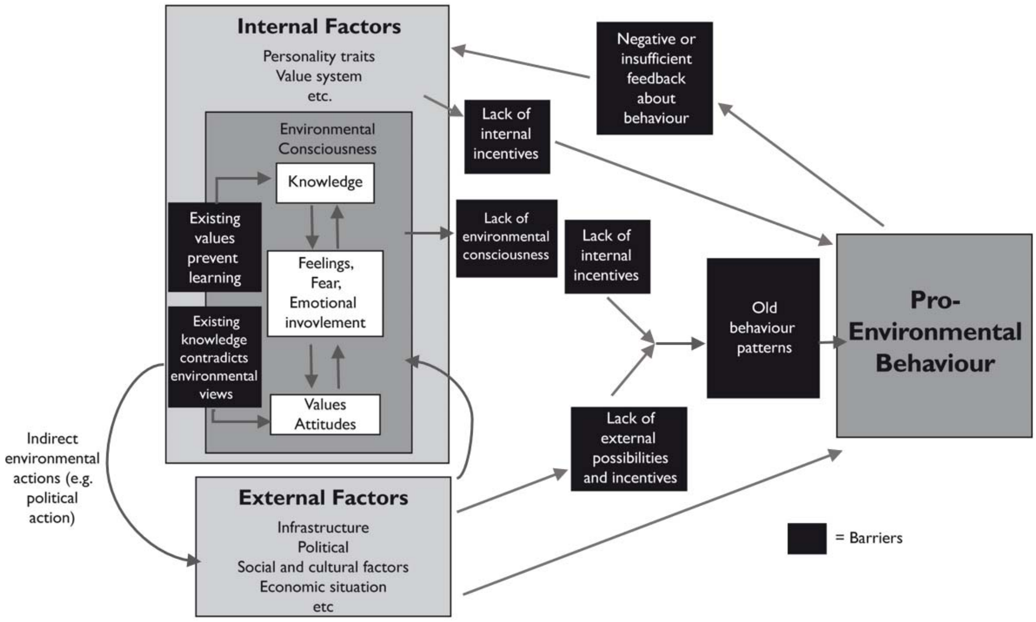


Figure 2.3 Barriers and influencing factors on pro-environmental behaviours. Adapted from Kollmuss and Agyeman, 2002:257.

Certain frameworks identify factors which influence behaviours (e.g. BE and Kollmuss and Agyeman's model), whereas another group of frameworks set out to identify the *process* of decision making, highlighting the order of stages which lead to the adoption of a behaviour. One example, shown in Figure 2.4, is discussed by Hoffman (2011:41) who suggests five stages lead to innovation adoption (behaviour change):

1) *Knowledge*, when the individual is exposed to the innovation's existence and gains an understanding of how it functions,
2) *Persuasion,* when the individual forms a favourable or unfavourable attitude towards the innovation,
3) *Decision,* when the individual engages in activities that lead to a choice to adopt or reject the innovation,

4) *Implementation,* when the individual puts an innovation into use,

5) *Confirmation,* when the individual seeks reinforcement for an innovation-decision already made but may reverse the decision if exposed to conflicting messages about it.

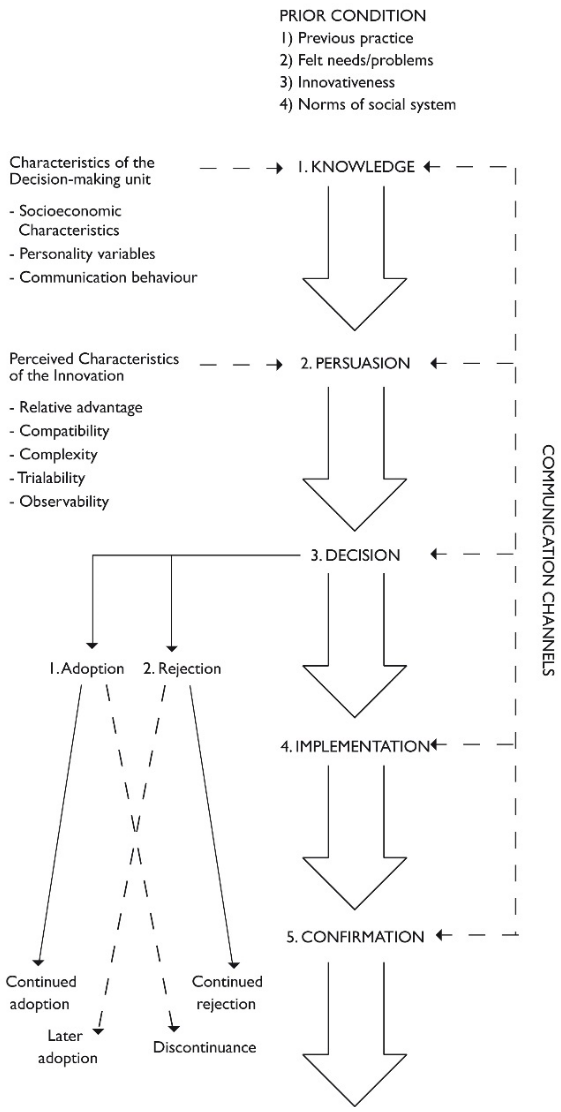


Figure 2.4 Five stages in the innovation decision process. Adapted from Hoffmann, 2011.

In another similar framework, Andreasen (2006) outlines six stages: 1) pre-contemplator, 2) contemplation, 3) self-assurance, 4) competition, 5) action, and 6) maintenance. Research in decision processes and staged models complements the work on frameworks of influential factors, with the rationale that individuals at the same stage face similar 'problems' and 'barriers' therefore the same type of intervention or motivating factor could help create behaviour change (Nisbet and Gick, 2008). For example at the 'contemplation' stage it is important to understand how an individual is actually considering involvement, with the belief that the influence of others will be very powerful at this stage (Andreasen, 2006). Such frameworks can therefore help guide policy by indicating where to target mechanisms most effectively in the decision process.

2.1.1 Evaluation of frameworks and models for addressing water pollution

Numerous frameworks, tools and checklists have been created in an attempt to integrate core components from the complex literature on behaviour, with the intention of informing research, policy and intervention design. For a comprehensive overview of such behaviour change models and their uses, please see Darnton (2008).

Kollmuss and Agyeman's (2002) article which investigated why people act environmentally and what the barriers are to pro-environmental behaviour, describes some of the most influential and commonly used analytical frameworks, including: early US linear progression models; altruism, empathy and prosocial behaviour models; and finally sociological models. They state that '*the question of what shapes pro-environmental behavior is such a complex one that it cannot be visualized through one single framework or diagram*' (Kollmuss and Agyeman, 2002:239). Many agree with this stance but also argue that models and frameworks nevertheless aid understanding and structure thinking about behaviours and the role policy mechanisms have in influencing them (e.g. Blackstock et al., 2010; Dwyer et al., 2007; Pike, 2008). Specific frameworks developed to guide policy interventions are reviewed below, to assess their relevancy for framing the research within this thesis.

Firstly, the MINDSPACE approach (Table 2.1 from Dolan et al., 2010) used frequently within the Government, attemps to create a checklist of key non-coercive influences on behaviours, and strongly focuses on the individual as a target for interventions.

The approach offers useful guidelines for policy makers. For example, MINDSPACE claims that *'we are heavily influenced by who communicates information'* (Table 2.1), and suggests that consideration should be given to matters such as who should communicate with whom and how best to communicate (Dolan et al., 2010).

Table 2.1 The MINDSPACE approach: a checklist of influences on our behaviour for use when designing policy. Source: Dolan et al., 2010.

Messenger	we are heavily influenced by who communicates information
Incentives	our responses to incentives are shaped by predictable mental shortcuts such as strongly avoiding losses
Norms	we are strongly influenced by what others do
Defaults	we 'go with the flow' of pre-set options
Salience	our attention is drawn to what is novel and seems relevant to us
Priming	our acts are often influenced by sub-conscious cues
Affect	our emotional associations can powerfully shape our actions
Commitments	we seek to be consistent with our public promises, and reciprocate acts
Ego	we act in ways that make us feel better about ourselves

MINDSPACE has been criticised for its omission of all the important intervention types and its lack of consistency in mixing modes of delivery, stimulus attributes, recipient characteristics, policy strategies, mechanisms of action and psychological constructs (Michie et al., 2011a). Since MINDSPACE was developed, the Behavioural Insights Team within the Government has designed a simpler, pragmatic framework referred to as EAST (Service et al., 2014). EAST was specifically designed for policy makers to understand and encourage behaviour. EAST's principles consist of:

1) Make it **E**asy – Harness the power of defaults, reduce the 'hassle factor' and simplify messages.
2) Make it **A**ttractive – attract attention and design rewards and sanctions for maximum effort.
3) Make it **S**ocial – Show that most people perform the desired behaviour, use the power of networks and encourage people to make a commitment to others.
4) Make it **T**imely – Prompt people when they are likely to be most receptive, consider the immediate costs and benefits and help people plan their response to events.

The EAST framework is said to complement the MINDSPACE report by focusing more on how to apply behavioural insights in practice (Service et al., 2014:8). Service et al.'s (2014) report on the EAST framework explains the importance of understanding the context of the behavioural problem, as an intervention which works well in one area of policy might not work so well in another. This framework provides clear messages to policy makers for developing behavioural interventions, however as it requires considerable understanding of the behavioural issues (Service et al., 2014), it does not provide guidance for research which aims to investigate and enhance such behavioural understandings.

Another framework to consider is the 4Es model, which groups behaviour change strategies under four categories: Enable; Encourage; Engage and Exemplify (Figure 2.5). In addition to the 4Es, the model also states the Government may need to 'catalyse' people to behave differently, especially in circumstance where behaviour is entrenched or habitual (Defra, 2008). Behaviours and attitudes of individuals are central to this model with many interventions (e.g. information; education; incentives) aimed at affecting the individual. However the social context is also incorporated, with interventions such as 'deliberative fora', 'leading by example', and 'community action' (Defra, 2008). In Figure 2.5 each of the Es is illustrated by several examples of interventions. Key intervention types can be mapped against the Es, so that *Enable* relates to the provision of core infrastructure, *Encourage* to fiscal, legislative and regulatory measures, *Engage* to communications and *Exemplify* to the Government demonstrating its commitment to the behaviour in question (Defra, 2008). The 4Es model provides a valuable framework for policy makers, however, it does not help consider how individuals will react to the policy interventions created (Morris et al., 2012). In isolation, the 4Es model is also limited as it neglects many other factors, such as societal influences and social-psychological factors. Darnton (2008) recommends the 4Es should be used alongside relevant behavioural models to determine which policy instruments would most likely achieve effective behaviour change.

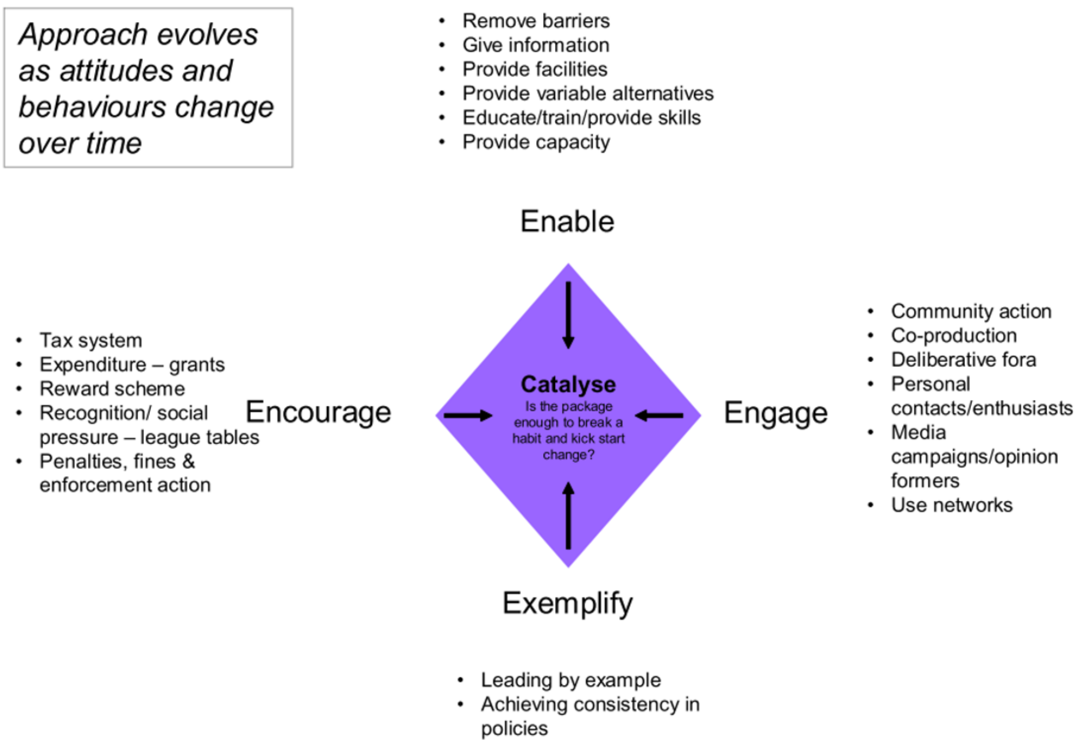
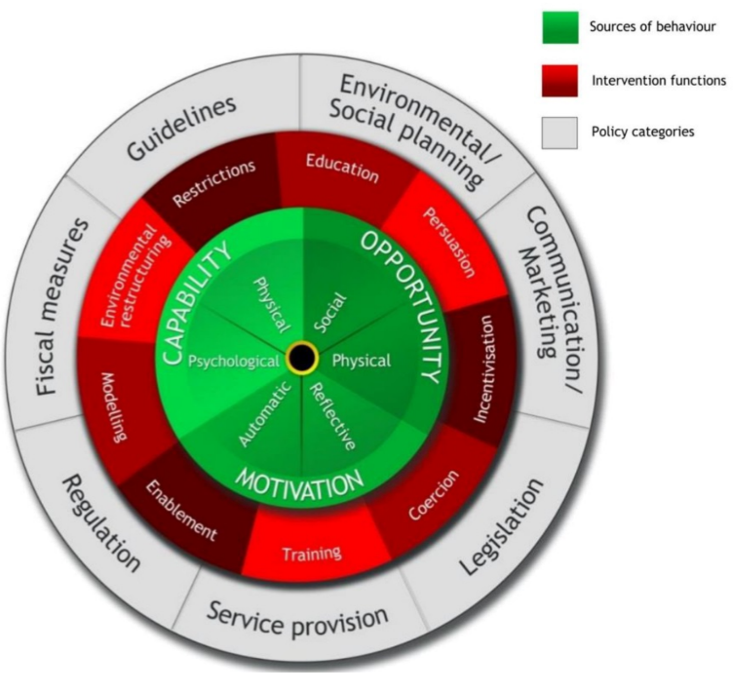


Figure 2.5 Defra's 4Es model. Source: Defra, 2008.

The 4Es model has been expanded and incorporated within other frameworks. One example is the Cultural Capital Framework which sets the 4Es in the wider social context of culture change (see Knott et al., 2008). Knott et al. (2008) considered the social context which prevents individuals from changing their behaviour, therefore interventions should address social/cultural norms. The Cultural Capital Framework represents a circular process, acknowledging the relationship between an individual's behaviours and the social/cultural norms. It suggests that to build cultural capital requires individual level behaviour change interventions as well as upstream interventions designed to change the societal context for behaviour (Darnton, 2008). This advancement of the 4Es helps set it in the wider context however, it fails to acknowledge many of the internal factors which influence behaviours.

So far, the frameworks discussed in this section, have been designed for practitioners and serve as practical, applied tools, aiding public campaigns. They fail to address and identify the specific underlying factors which cause the particular target behaviour (in the way BE does). Michie et al.'s (2011a) paper provides a framework based upon an evaluation of 19 existing frameworks (including MINDSPACE, 4Es and the Cultural Capital Framework). The evaluation discusses the various advantages and disadvantages of different frameworks and assesses their ability to fulfil three criteria identified as being essential for practicality: 1) fully comprehensive, 2) coherent and 3) linking to an overarching model of behaviour. Michie et al. (2011a) draw upon the best features of the evaluated frameworks to create an additional approach which they claim can be applied to any behaviour and setting – the Behaviour Change Wheel (BCW) (Figure 2.6).



COM-B model component *Definition*
Physical capability *Having the physical skills, strength or stamina*
Psychological capability *Having the knowledge, psychological skills, strength or stamina*
Physical opportunity *What the environment allows or facilitates in terms of time, triggers, resources, locations, physical barriers, etc.*
Social opportunity *Including interpersonal influences, social cues and cultural norms*
Reflective motivation *Involving self-conscious planning and evaluations beliefs about what is good or bad*
Automatic motivation *Processes involving wants and needs, desires, impulses and reflex responses*

Figure 2.6 Behaviour Change Wheel and definitions of the COM-B model components. Source: Michie et al., 2011a.

The BCW consists of three layers. The centre of the wheel identifies the sources of the behaviour, using the COM-B model (Capability, Opportunity, and Motivation all linking to Behaviour). Each of these components is divided in two (with Figure 2.6 providing an explanation for each of the six segments). The factors represented by these segments contribute towards behaviour and provide a target for the nine types of interventions which surround the inner layer, whilst the outer layer identifies seven types of policy to deliver the interventions (Michie et al., 2011a). The key benefit of the BCW is that it encourages policy makers to consider a comprehensive range of options and, through a systematic evaluation of theory and evidence, choose options that are likely to be most promising (Michie et al., 2011a). In Michie, Atkins and West's (2014) book *The Behaviour Change Wheel: A Guide to Designing Interventions*, the authors provide an eight step approach for intervention design with useful worksheets for the reader to complete. The first four steps of the approach help develop understanding of the behaviour, whilst steps five through to eight identify intervention and implementation options:

Step 1 - Define the problem to be addressed in behavioural terms.

Step 2 - Select the target behaviour(s), i.e. the behaviour(s) most likely to bring about change to address the problem.

Step 3 - Specify the target behaviour in as much detail as possible.

Step 4 - Identify what needs to shift in order to achieve the target behaviour.

Step 5 - Identify appropriate functions of interventions likely to bring about the desired change e.g. education and persuasion.

Step 6 - Identify specific policy categories e.g. communication and service provision.

Step 7 - Specify the intervention's content.

Step 8 - Specify the mode of delivery of how it will be implemented.

Michie, Atkins and West (2014:29) emphasise the great importance of devoting time and effort to fully understanding the target behaviour (Steps 1 to 4). They believe it is a critical element often overlooked in intervention design, stating that the more accurate the analysis of the target behaviour is, the more likely it is that the intervention will change the behaviour in the desired direction. The BCW is of great use for guiding research and policy makers, however because it aims to be fully comprehensive, such breadth results in a loss of detail when studying specific topic areas and behaviours. The general fields and context of the BCW provide the wider picture, established from the source of the behaviour through to the interventions and policies required, nevertheless it does not focus on the underlying and most prominent elements which influence the sources of specific behaviours.

Pike's (2008) framework shown in Figure 2.7 was designed for the farming context and incorporates BE (Figure 2.2), a psychology-based approach to behaviours, and a role for government intervention (the 4Es - Figure 2.5). Pike regards the adoption of a particular behaviour as a function of attitudes (practical expression of beliefs and values), norms (socially defined expectations of conduct), habits (frequency of past actions) and agency (real and imagined capacities to act), represented by a series of additional influences, including those internal to the farm and farm household (e.g. size, tenure, age of decision makers) or external such as market conditions (Pike, 2008).

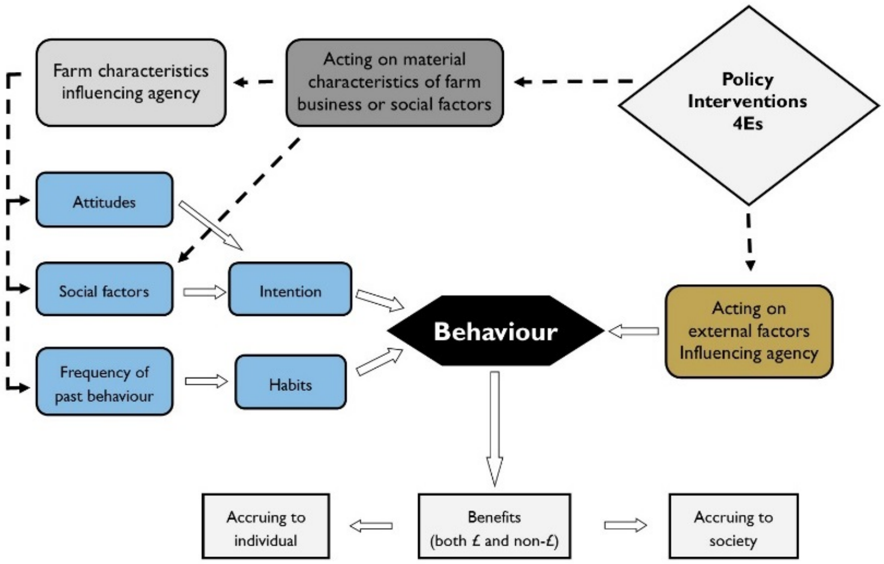


Figure 2.7 An integrated framework encompassing behavioural economics, a psychology-based approach to behaviours and, the role of government intervention. Source: Pike, 2008.

Pike considers a wide range of factors and has a clear link through to policy interventions and motivations. As the framework was created for a policy audience in the agricultural context and implies a need to understand the role of internal, external and social factors, the synergies between them and the key influencing components of each (Pike, 2008), this framework helps provide guidance for research.

This review of behavioural theories and frameworks suggests that both Pike (2008) and Michie et al.'s (2011a) BCW are useful frameworks which should be built upon and carried forward rather than reinvented. Pike informs structure and guidance for research, whilst BCW provides the wider picture of determining what needs to change and aids intervention design. In order to distinguish which elements of Pike's framework require greater research, Section 2.2 examines the literature of knowledge on farmers' pro-environmental behaviours.

2.2 Studies of farmers' pro-environmental behaviours

2.2.1 Methods of investigating farmers' behaviours

Current knowledge of farmer behaviour is largely derived through the use of farmer surveys and focus groups, consultation with experts and the development of modelling tools. Farmers are surveyed by researchers, the Government and industry to document and assess the complexities of farming systems and provide ground-truthing regarding adoption of different measures. Anthony (2011) highlights the importance of such surveys for checking modelling assumptions, whilst Pike (2008) notes that they provide 'business as usual' snapshots which facilitate opportunities to observe behavioural change once new policy mechanisms have been enforced. Farm surveys are not only used to discover current farmer behaviour, but many researchers have used them to interpret an array of questions relating to environmental attitudes. Through understanding 'what do farmers think?' and 'why do farmers think that?' it is hoped that there will be better understanding of how to encourage improvements in farming practices (de Snoo et al., 2013). Mills et al. (2013) and Fish (2014) provide recent reviews of the literature on such issues, with examples including research which has focussed on attitudes towards land use (Sutherland et al., 2011), the Single Farm Payment (Garforth and Rehman, 2006), and AES uptake (Wilson and Hart, 2001, 2000; Wynne-Jones, 2013).

Some investigations of farmer behaviour have summarised their findings by developing typologies of farmers (e.g. Dwyer et al., 2007; Fish, 2014; van der Ploeg, 1993; Wilson, 2014), with van der Ploeg suggesting such categories are real, tangible and discretely identifiable. However, Vanclay et al. (2006) argue they are rarely so distinctive, and others have suggested a need for caution when using a segmentation approach to enhance the design and implementation of policies (Burton, 2004a; Wilson et al., 2012). A further caveat noted by Fish et al. (2003) is that typologies are not mutually exclusive as land managers use different practices across their farms for a variety of reasons, indicating that which category someone is assigned can depend upon the practice in question, and van der Ploeg (2010) presents a discussion on the evolving debate as a whole.

The development of modelling tools and the use of expert guidance are other techniques employed and often aim to predict farmers' behaviours and attitudes. To aid the design and implementation of WPA polices in recent years, an inventory of possible mitigation measures (Newell-Price et al., 2011) and a decision support tool known as FARMSCOPER were created for Defra. The inventory (hereafter the Defra User Guide) provides a detailed assessment of a wide variety of mitigation measures for WPA, air pollution and greenhouse gas (GHG) emissions. FARMSCOPER is a tool with the capability to model farm scenarios, providing outputs such as the amounts of pollution mitigated by changing various farm practices (Zhang et al., 2012). The data sets used to estimate the likely uptake of measures during the creation of the Defra User Guide and the earlier versions of FARMSCOPER were however quite limited and not based on any formal auditing or monitoring scheme (ADAS, 2008). As many different factors influence adoption of measures (Blackstock et al., 2010), any data collected by surveying farmers on the likely uptake would help improve the reliability of information included in such decision support resources (Anthony, 2011).

2.2.2 Knowledge of current farmer behaviours

The annual Farm Business Survey and Farm Practice Survey, along with assessments of the current and historical uptake of environmental farm practices included within AES, are all conducted by Defra and provide snap shots of farmer behaviours. In terms of farmer adoption of water pollution mitigation measures, limited knowledge exists within the literature. The partial data that does exist comes from parts of the aforementioned surveys and those carried out by initiatives such as CSF. This initiative collects data on current WPA mitigation measure uptake by recording which measures are recommended by their advisors and adopted by farmers (see Box 3 in Section 1.2.1). Nevertheless it has become evident that a greater understanding of current mitigation measure uptake is needed to contribute to the knowledge of specific behaviours which could potentially be influenced by policy interventions. McGonigle et al. (2012) note that improved baseline information is needed regarding land management practices and the extent to which current policies will achieve policy targets. Additionally, Anthony et al. (2009) and Zhang et al. (2012) argue there is a need for more information on the realistic assessments of farmer uptake of prospective measures, and of the potential future rates of implementation (ADAS, 2008:48).

2.2.3 Knowledge of factors influencing farmer behaviours

It is one thing to gather data on current uptake of measures but, in order to discover what needs to change to influence greater uptake, the frameworks discussed in Section 2.1 indicated that it is important to understand the factors which influence behaviours. Chapter 1 highlighted that farmers are faced with volatile external environments which impact their choices and decisions regarding the running of their businesses. The consequences of their decisions can impact on a wide range of elements, such as profit margins, work load, family dynamics, business vulnerability and social status. Impact on the environment is just one additional element they need to consider. In the context of this thesis, knowledge of farmer’s decision making processes and the factors influencing behaviour are critical to understanding how policy can influence change to mitigate agricultural impacts on water quality.

A vast amount of literature exists which studies factors influencing pro-environmental farmer behaviours. Since OXERA (2003) and Garforth et al. (2003) stated that further investigation is required to determine how farmers make decisions, identify the constraints to change, and examine the factors driving land managers decisions, a plethora of research has been conducted. Extensive literature reviews can be found in Dwyer et al. (2007), Prokopy et al. (2008), and Mills et al. (2013), and a qualitative meta-analysis in Lastra-Bravo et al. (2015). However, such research often examines farmer attitudes towards a broad set of farm practices, generalising results and highlighting a wide range of factors which influence farmers.

Chapter 1 touched on some of these factors, such as: environmental pressures, changes in social or economic processes, and policy alterations, but many other factors exist. Factors can be categorised in different ways. Firstly, they can be considered as factors which originate from external or internal influences. Secondly, they can be categorised as factors which influence an individual's willingness, ability or motivation to act in a certain way. Thirdly, they can be thought of as factors which influence particular stages of the adoption process, and finally they can be characterised by the way in which they influence individuals e.g. encourage or enforce. This section will now discuss the key factors found to influence pro-environmental behaviour and have been regarded by others to impact upon farmers' decisions. Internal factors are initially discussed followed by external factors.

Internal factors are considered as endogenous and influences which resonate from within. Perception of ability to change and to adopt a specific behaviour can prevent or encourage action, otherwise known as locus of control[7] (Newhouse, 1991). Many other internal factors can influence behaviours, including the ability to comprehend, need for cognition, tendency towards self-monitoring (Pornpitakpan, 2004), risk perception (Reading University, 2011), levels of self-esteem (O'Keefe, 2002) values (Schneider et al., 2010), perceptions of the social norm (Ahnström et al., 2009), fear of constraint (Reading University, 2011; Prager and Posthumus, 2010), willingness to change (Dwyer et al., 2007), morals (Aquino et al., 2009), strong stewardship ethic (Greiner and Gregg, 2011) and openness or extraversion (Willock et al., 1999). The demographic characteristics of a farmer such as their age, sex (Mills et al., 2013), education level (Bielders et al., 2003) and intelligence (O'Keefe, 2002) are also considered significant factors for decision making.

External factors influence and can be influenced by internal factors. For example attitudes, values, beliefs and habits of individuals influence social norms, while decisions and actions

[7] People with a strong internal locus of control believe their actions bring about change. On the other hand, people with an external locus of control, feel their actions are insignificant, and change is created by powerful others.

are linked to and influenced by social constructs (Knott et al., 2008). Standing within the community and respect amongst peers, as well as recognition in wider society can influence farmers to farm more environmentally and participate in AES (Dwyer et al., 2007; Greiner et al., 2009). Burton's (2004b) findings show that measures providing signs of a successful productive enterprise (e.g. new fences) were more popular than measures such as overgrown buffer strips. Peers within the community can also act as key providers of information which contribute to farmers' decision processes (Isaac et al., 2007).

Not only does society impact behaviour, but so can the physical environment, especially with regards to farming practices. Environmental factors can impact a farmer's ability to perform particular farming operations. Some practices may not be appropriate or even relevant if they are located in an area with certain characteristics. Factors to consider include: topography, climate, soil composition and experience of erosion problems. It would be irrational to dig a large pond on a farm to act as a sediment trap if the farm is situated in an area of minimal rainfall and uniform flat ground, where sediment runoff would be an unlikely issue. Additionally, farm size, ownership, enterprise size, whether new infrastructure is required, and size/shape of fields all dictate practicality, technicality and economic feasibility of behaviours (Dwyer et al., 2007). Such factors are to some degree out of the farmers control and therefore considered as external influences. Other external factors such as the spread of pests, weeds and diseases (e.g. Bovine TB, blackgrass and blight) have solutions which the farmer can decide to implement. For instance, to reduce the impact of blackgrass on cereals, farmers are changing their rotations, swapping areas of winter wheat for spring barley or spring beans (O. Hill, 2015). In North Lincolnshire, farmers have been planting beetroot as a solution, however, this has caused detrimental environmental impacts with harvesting (pers. comms. Will Cleasby, Cumbrian farmer and farm advisor, 24^{th} Oct 2014).

Another type of external factor relates to economics e.g. commodity prices, exchange rates, tenancy rents and energy feed-in tariffs. There is a long standing argument that economics is one of the over-arching factors influencing farmer behaviour (Posthumus and Morris, 2010; Robinson, 1999). Mills et al. (2013) and Siebert et al. (2006) list a number of studies which emphasise farmer's economic reasons for participating in pro-environmental behaviours. Such studies found economic motivational factors arise in various forms, including profit maximisation, security, risk minimisation and investment in capital. Both reviews go on to describe how such motives can be thought of as long-term, securing the future of the farm or as a response to a short-term financial incentive. However, economic factors are by no means the only influences on farmer behaviours, as demonstrated by the previous discussion. The influences of different policy mechanisms will be discussed in Section 2.3.

It is important to bear in mind that external conditions do alter through time, and with them the internal and external influences on behaviours. Take, for example, changes in cultivation methods in the UK. An article in Farmers Weekly in August 2014 presented a graph of cultivation trends across all soil types from 2000-2012 (Figure 2.8). Over the twelve years, a large rise in the use of minimum tillage was apparent (Impey, 2014). This is generally regarded as driven by the desire for greater efficiency, the shrinking workforce, timeliness, technological advances and resource costs (Ingram, 2010). The rise in ploughing experienced in 2009 was attributed to the rising prices of crops such as wheat. Farmers returned to ploughing to rectify structure issues and drainage (some of which had been caused by previous bad weather), and therefore ensuring higher yields (pers. comms. Ben Myhill, Frontier agronomist, 8th Oct 2015). Such an example demonstrates how changes in weather, commodity prices, technology, societal trends and many other interrelated factors influenced farmer behaviours regarding cultivation methods.

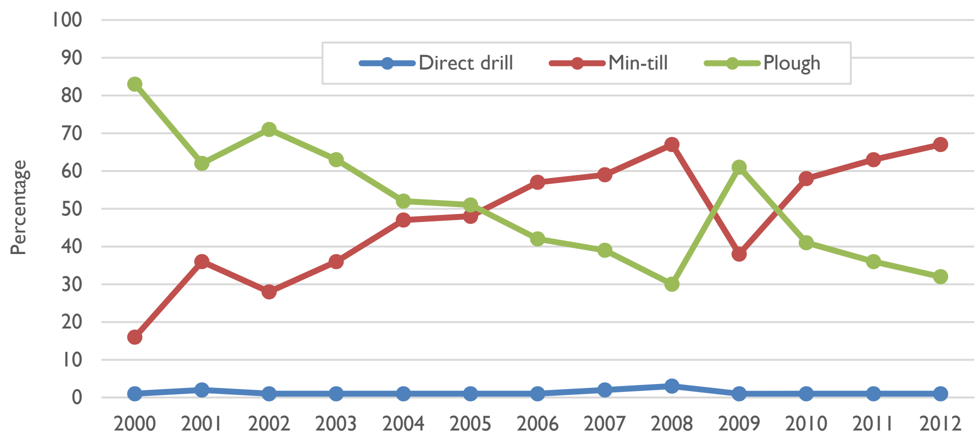


Figure 2.8 Changes in cultivation methods (direct drill, min till and plough between 2000 and 2012. Source: Impey, 2014.

Table 2.2 provides a summary of the most important internal and external factors discussed in the literature. The table highlights the importance that has been placed on: farm household characteristics; values, beliefs and attitudes; internal and external motivations; farm structure, and practice/scheme/innovation factors. It is important to note that some factors do not neatly correspond to a single category. The factor of time, for example, can be considered as an internal belief of not having enough time, or an external factor of truly not having enough time.

Within the literature, there has been an interest in discovering the balance between internal and external influences of behaviour (e.g. Chouinard et al., 2008). However, many authors agree it is the interplay of all the different factors which really matter (Dwyer et al., 2007; Mills et al., 2013; Prager and Posthumus, 2010).

Table 2.2 Factors which influence farmer behaviour. Source: Mills et al., 2013; Dwyer et al., 2007.

Internal	**External**
Farm household characteristics: personal, social and situational characteristics of farmers and household: • Education • Succession status • Age • Length of residency • Pro- environmental knowledge Values, beliefs and attitudes: • Direct attitudinal variables, (feelings and beliefs towards the environment); intrinsic values and motivations • Indirect attitudinal variables (farming philosophies i.e. utilitarian, neutral or conservationist) • Orientations: stewardship, technological beliefs or profit maximisation • Openness to new ideas • Subjective norms or normative beliefs (the perceived social pressure to behave in an environmentally friendly way) • Personal attitude or behavioural beliefs (the farmer's evaluation of environmentally friendly behaviour) • Perceived behavioural control or control beliefs/ locus of control (the extent to which AESs are perceived as easy or difficult to adopt) • Belief in efficacy of their actions (level of confidence in conventional intensive farming and in environmental actions) • Perception of risk, responsibilities, time and priorities • Emotions Intrinsic motivations • Personal sense of environmental responsibility and accountability • Commitment and interest in the environment	Farm structure: physical farm factors and the farm operation (farming system and business factors) including structural characteristics: • Farm size • Farm type • Tenure • Dependency on farm income • Amount of non-intensively used farmland • Staff and labour • Work load and time availability • Contractor and retail capture • Bio-geographical conditions of the farmland, endowments of natural habitat • Current infrastructure Innovation/scheme factors: nature and qualities of the scheme, practice or innovation: • Payments offered • The scheme duration (and the time lag involved in scheme renewal), • Logistics (information availability and flow; follow up and monitoring) • Eligibly and relevancy • Lack of compatibility with existing management plans and extent of adjustment required • Complexity, comprehensiveness and effectiveness • Financial constraints • Income • Technological infrastructure • Administrative burden Extrinsic motivations • Financial incentives • Profit maximisation • Security, long-term farm viability and/or risk minimisation, securing the family fortune and its continuity • Capital investment • Community image, standing within the community, respect amongst peers • Advice provision • Regulation (fear of penalty) • Recognition in wider society

As mentioned earlier in Section 2.1, factors can also be divided into either motivations that positively influence behaviours or those which act as barriers constraining behaviours. The literature which has specifically focussed on farmer pro-environmental behaviours has frequently studied barriers and attitudes in order to understand what needs to be overcome to increase activities such as general environmental practices (Del Corso et al., 2015; Garforth and Rehman, 2006; Prokopy et al., 2008; Widdison et al., 2004), and AES participation (Calatrava et al., 2008; Lastra-Bravo et al., 2015; Morris and Potter, 1995; Wilson and Hart, 2001, 2000; Wynne-Jones, 2013). Such work has highlighted a multitude of barriers e.g. a lack of compatibility with existing management, practicality of measures, other influencing policies, financial reasons, education, lack of clear and consistence guidance, and perceived complexity.

2.2.4 Knowledge of factors influencing uptake of WPA mitigation measures

While many studies have been conducted on pro-environmental behaviour amongst farmers, research focusing specifically on water pollution mitigation measures is scarcer. Much of the literature in Section 2.2.3 is applicable to WPA mitigation measure behaviour, as demonstrated by Fish (2014) who draws upon the wider literature in his introductory guide *Influencing farmers to engage in catchment sensitive farming.*

Water quality is similar to many environmental concerns, with the benefits of reducing pollution more for society as a whole rather than the individual. This is believed to impact farmers' willingness and motivations to act. Posthumus et al. (2008) found farmers did not feel they will personally benefit from their actions towards catchment management and Barnes et al. (2009) discovered farmers thought their actions would not benefit the environment. Such themes dominate the literature which focuses on farmer behaviour and attitudes towards water pollution, along with the topic of farmers lacking ownership and responsibility for the issue (CSF Evidence Team, 2014; Macgregor and Warren, 2006; Posthumus et al., 2008) and even failure or resistance of acknowledging WPA as a problem (Christen et al., 2015; Martin-Ortega and Holstead, 2013).

Barnes et al. (2013) found that farmers least likely to adopt water quality management regimes are those who do not accept the underlying causality between farming and pollution. Contrary to this, CSF reported successfully encouraging farmers to take action without full acceptance of agriculture's contribution to water pollution (CSF Evidence Team, 2014), however such success is questionable for long-term behaviour change (Ahn and Ostrom, 2002). This raises the question, should policy focus more on internalising the water quality issue, educating farmers of pollution sources and thus solutions, rather than externally influencing farmers' behaviours through incentives and regulations?

Despite the fact research has been conducted to study farmer attitudes and behaviours towards WPA mitigation, studies have not investigated, in-depth, a range of specific practices and what precisely influences farmers' adoption of each farm practice. Studying the umbrella term of 'pro-environmental' farmer behaviour provides a general overview, however research is needed to focus on factors influencing specific behaviours (WPA mitigation measures) to fully understand the implications future policy changes may have on farmer uptake (Michie, Atkins and West, 2014).

Having identified an appropriate framework (Section 2.1) and discussed the various internal and external influences on behaviour (Section 2.2), Section 2.3 discusses different mechanisms which have been used to influence farmer behaviours and decision making.

2.3 Mechanisms to influence farmer decision making

To help inform future policy, this section focuses on policy mechanisms used to increase the uptake of WPA mitigation measures amongst farmers. An explanation of some of the different policy interventions is provided, with examples of their use from the UK and international literature. Subsequently, an assessment of the advantages and disadvantages of each is presented.

The various policy interventions considered in this chapter are often grouped into four categories of mechanisms within the literature: regulation; targeted financial incentives; advice and education; and voluntary initiatives (McGonigle et al., 2012's triangle in Figure. 1.3). It is important to note that although these categories are often separated as a convenient way of characterising them, even quite specific instruments seldom fit exclusively into one type of mechanism (Frey, 1997). For example, advice can help to identify cost savings or profit opportunities, as well as signposting to financial incentives such as grants. Regulatory instruments backed up with the threat of prosecution also provide a financial incentive to not be prosecuted. The voluntary approach can also be considered to cross category boundaries as farmers will voluntarily agree to participate in schemes with financial incentives as well as voluntarily accept forms of advice.

A number of reports and articles describe a multitude of different instruments used within the UK (Inman, 2011; McGonigle et al., 2012; OXERA, 2003), the EU (Brouwer et al., 2003; Aue and Klassen, 2005), further afield (Environment Protection Agency, 2010, Smith et al., 2015), and even hypothetical instruments (Barnes et al., 2013).

Typically, in developed economies, water quality policy is formed of different levels of intervention, consisting of baseline regulations to achieve minimal environmental protection requirements, with additional targeted mechanisms (Figure 1.3). Ultimately, the selection of mechanisms is driven by government criteria such as environmental effectiveness, efficiency, equity, feasibility, consistency and secondary objectives (OXERA, 2003:18), bearing in mind the available resources, political acceptability, economic costs and benefits, practicability and scientific evidence (McGonigle et al., 2012). Table 2.3 provides a description of each of the four main policy mechanism categories. Whilst this section discusses the mechanisms with examples from England, Table 2.3 highlights international examples from the literature.

Within England, a mixture of mechanisms have been adopted by the Government to tackle WPA. At the national scale, regulatory baselines have been set, predominantly to comply with EU rulings such as the WFD (Box 2 in Section 1.2.1). Examples include Nitrate Pollution Prevention Regulations 2015, the Water Resources (Control of Pollution) Regulations 2010 and CAP Cross Compliance. Since baseline regulations have not been sufficient in themselves to achieve objectives such as the WFD's 'good status' (Kay et al., 2012), additional targeted interventions have been applied at a local scale (UKWRIP, 2011). These include, but are not limited to, financial support through AES payments and the provision of advice through the CSF initiative. A timeline presented in Figure 2.9 provides examples of interventions used in England to influence farming practices related to the mitigation of WPA over the past 60 years.

Table 2.3 Characteristics and examples of the four categories of policy mechanisms to influence the uptake of WPA mitigation measures.

	Description	Terminology used	Examples of interventions	International examples
Regulation	Either eliminate or restrict choice of behaviour, requiring change with risk of penalty for non-compliance.	Budge, non-choice architecture, command and control, stick.	Legislation and regulations.	• Scotland - General Binding Rules. • Denmark - Action Plan for the Aquatic Environment (APAE) enforce obligatory rules such as cover crops, buffer zones, maximum livestock numbers (Gachango et al., 2015).
Financial incentive	Incentivise change, encouraging investments or to compensate for losses. Impact can depend on type, magnitude and timing of incentive.	Carrot.	Taxes on inputs, Levies on products, asset or activities, Grants, Subsidies.	• Germany and Denmark - Raising local taxes to fund improvements to water quality (Aue and Klassen, 2005). • The Netherlands - Cooperative Agreements. Farmers are paid to reduce the level of pesticides. The level of reward is dependent upon the reduction level of pesticides. • AES CAP Pillar II payments across European countries.
Advice	Providing information to raise awareness and facilitate change.	Nudge, choice architecture, hug, sermon, information instrument.	On-farm advice, Product labelling schemes, Facilitate information exchange, Benchmarking, Education and training, Demonstration farms.	• New York State, USA - Chesapeake Bay catchment Voluntary farm assessments and recommendations to improve management and practice in the region. Recommendations included: rotational grazing for livestock, fencing of streams and precision feeding (Curatolo and Zhu, 2005). • Denmark - Water companies hire farm liaison officers who have good relationships with farmers to provide advice. • Scotland – 'Prevention of Environmental Pollution from Agricultural Activity' and 'The 4 Point Plan' information booklets/packs for farmers offer practical guidance for reducing pollution (Scottish Government, 2002).
Voluntary	To encourage change. Often strongly linked to other interventions. E.g. threat of a statutory scheme, or advice on benefits.		Quality assurance schemes, Management standards, Agreements with water companies	• Australia - Government sponsored community-based initiative known as Landcare. The initiative supported voluntary and farming groups in their efforts to tackle environmental issues e.g. soil erosion (Curtis and Lockwood, 2000). • Germany, The Netherlands and France Co-operative agreements in (Brouwer et al., 2003). • Denmark - Contracts under the Voluntary Cultivation Agreements between farmers in groundwater protection areas with waterworks.

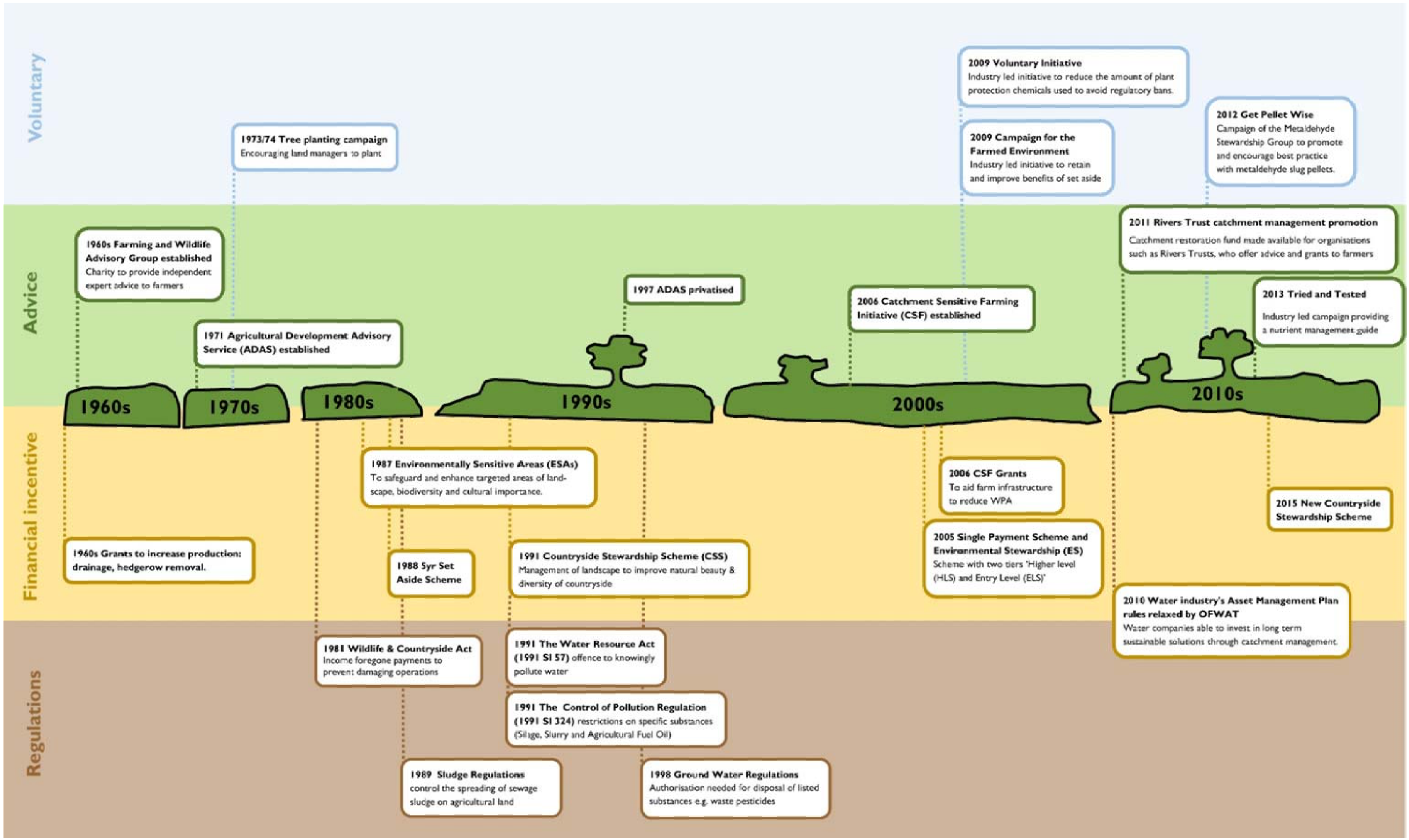


Figure 2.9 Timeline of mechanisms influencing farmers' behaviour in England.

The use of regulatory mechanisms eliminates choice, making a mitigation measure compulsory. Many of the key regulatory mechanisms, predominantly from the EU (such as CAP and WFD), were discussed in Chapter 1 and displayed on a timeline of policies in Figure 1.5. However, additional examples impacting on farmers can be seen in Figure 2.9, with many environmental protection regulations created in the 1980s and 1990s. Regulations are considered an effective method of ensuring uptake (Uzzell et al., 2006), however the use of further regulations is unpopular within the UK Conservative Government, and reducing red tape has been a key priority (Defra, 2015e).

Financial mechanisms come in two forms. They can be incentive payments to the farmer for changing their behaviour (e.g. grants and subsidies) or disincentive costs to the farmer (e.g. taxes and levies). The reasoning behind implementation of financial incentives in agri-environment policy is based upon the market's failure to deliver the socially desirable level of environmental standards (Baylis et al., 2008; Pearce and Turner, 1990). Financial incentives have been used to influence farmers over the decades. Grants were originally offered for the removal of hedges and to improve drainage in the 1960's, whereas now, payments encourage tree planting and establishing wetlands (Figure 2.9). AES payments have changed on several occasions since their creation in the 1980s. Environmentally Sensitive Areas (ESA) (launched in 1987) offered incentives to farmers for appropriate agricultural practices in targeted areas of high environmental value. The ESAs were followed by the Countryside Stewardship Scheme (CSS) established in 1991, which opened up the opportunity for more farmers to apply for payments across the country. In 2005 the Environmental Stewardship Scheme was then launched, building upon ESA and CSS. It was open to all farmers, encouraging simple environmental management options under its Entry Level Stewardship.

A more targeted Higher Level Stewardship scheme was also established which paid higher compensation for more demanding land management options in specific areas. This scheme was most similar to the original ESA with regional targeted environmental objectives.

In the past there have been numerous requests to revise AES in order to achieve greater environmental benefits (e.g. Lawton et al., 2010). At the start of this PhD, NE requested evidence and research to help inform the design of the new Rural Development Programme and AESs (Natural England, 2013), affirming that a strong evidence base was necessary to ensure the re-design of schemes was effective and efficient. Since then, a new scheme has been launched in 2015 and is discussed further in Chapter 9.

Voluntary initiatives and advice provision are often used to raise awareness of an issue and to encourage uptake of measures to reduce the problem. In England a number of voluntary initiatives have been established e.g. The Campaign for the Farmed Environment (Clothier and Pike, 2013) and Get Pellet Wise (www.getpelletwise.co.uk). The Government also provide advice on WPA mitigation measures through the CSF initiative (Box 3 in Section 1.2.1), with other efforts including the Farm Advisory Service[8] and provision of funds to private and third sector organisations.

From the timeline in Figure 2.9 it is possible to observe an overall trend away from the use of regulations in the 1980s and 1990s towards more incentives, voluntary initiatives and advice provision over the past two decades. This has not always been the case, and is illustrated by the example of Nitrate Sensitive Areas (NSA). NSAs were established in 1990 as a voluntary scheme to protect groundwater from nitrate pollution. NSAs provided farmers with payments for managing their land in ways which would reduce pollution (Parsisson et al., 1995), however with pressures from the EU the scheme was superseded. A programme of uncompensated mandatory measures was created under the Nitrate Vulnerable Zone (NVZ) rules in accordance with the 1991 Nitrate Directive. The Nitrate Directive required Member States to designate NVZs by 1999 to all known areas of agricultural land that drained into waters where the nitrate concentrations exceeded 50 mg/l N, or where there was evidence of nitrate limited eutrophication (Osborn and Cook, 2010).

2.3.1 Evaluating mechanisms and interventions

To inform future designs of policy mechanisms, it is important to learn from the past and determine how successful they have previously been at changing behaviour. Ultimately, it is assumed that an intervention is an attempt to cause an enduring change in behaviour (Dolan et al., 2010:74-75), where the behaviour becomes standard practice amongst farmers without the need for further interventions. EU-level guidance for intervention evaluation is still strongly influenced by basic economic theory and evaluation methods (Dwyer et al., 2007), with one of the most common concepts central to policy evaluation known as the 3 Es (not to be confused with the 4Es model discussed earlier): Effectiveness; Efficiency and Equity. Additional components of evaluation also exist, including: transparency; cost-effectiveness, accessibility; affordability, compliance; political acceptability; practicality and assessment of unintended side effects or consequences (FEA, 2004; Michie, Atkins and West, 2014).

[8] The Farming Advice Service is funded by Defra to help farms understand and meet the requirements of CAP Pillar I, Cross Compliance, and the European Directives on both water protection and sustainable pesticide use and is a requirement of the EU (https://www.gov.uk/government/groups/farming-advice-service).

In order to evaluate interventions which have been implemented, difficulties occur as direct comparisons between observed changes, and what might have happened without the policy intervention cannot be made. Time lags between altering attitudes or raising awareness and actual behaviour change add a further challenge to monitoring success. Additionally, a change in behaviour may have occurred due to numerous factors and thus difficulties exist in attributing the change to a single intervention. It is also important to acknowledge that policy interventions can have unintended consequences for behaviour (and thus the environment), with spill-over effects into other policy areas (Chapman, 2004; Ledbury et al., 2006). To overcome such challenges, Darnton (2008) suggests that policy development processes should use standard assessment tools (such as Impact Assessments), to determine potential side effects and feedback loops which could occur, thus allowing for solutions to be created. Hodge and Midmore (2008) provide another suggestion to overcome assessment challenges, arguing that evaluations of interventions should be conducted at a local level, as they are increasingly being designed and developed at this scale.

Despite these challenges, research has attempted to compare changes and analyse interventions. For example, Barnes et al., (2013) analysed the effect NVZs had on the voluntary adoption of water quality management techniques by comparing farmers within a designated NVZ with those outside the zones in Scotland. They found that restricting choices through NVZ mandatory rules did not lead to further voluntary adoption of measures, leading the authors to advocate the use of social norm approaches to interventions rather than a regulatory approach. Another example of evaluating mechanisms comes from the CSF surveys which collect ample data on the number of visits, recommendations made and uptake of mitigation measures. Such quantitative data is complemented with qualitative data collected via an annual telephone survey. Using a qualitative appraisal technique is believed to benefit the analysis of interventions, with Dwyer et al. (2007) highlighting the importance of triangulating quantitative data with qualitative.

2.3.2 Advantages and disadvantages of mechanisms for behaviour change

Policy makers face a difficult challenge in knowing what combinations of mechanisms should be implemented to achieve policy objectives. This section explores the literature which discusses the advantages and disadvantages of each type of mechanism and is summarised in Table 2.4.

Table.2.4 Summary of the advantages and disadvantages of the four categories of policy mechanisms.

	Advantages	Disadvantages
Regulation	• Low costs for building upon existing framework • Potentially effective at reducing pollution	• Difficult to enforce effectively • Higher costs for new systems • High administrative costs
Financial incentive	• Lower administrative costs if taxes/levies applied to traded inputs • Effective at causing substitution • Raise revenue through taxes	• High administrative costs for taxes and levies • Costs to exchequer for subsidies/grants
Advice	• Enhance the acceptability and effectiveness of other interventions • Long-term benefit as new policies may be more accepted • Improves effectiveness of other mechanisms • Small exchequer costs	• Benefits a smaller number of farmers • Effectiveness uncertain • Very dependent on message, messenger, capability etc.
Voluntary	• Can take forms difficult to establish through legislation. • Low absolute cost and administrative cost • No cost to the exchequer	• Efficiency uncertain, possibly poor at delivering targets • May be difficult to enforce • Could be costly to the farmer

The main advantage of regulation is thought to be the effectiveness of ensuring behaviour change. However, regulators must act to ensure rules are being followed (OECD, 2012b). This unfortunately results in high administrative costs. Improving implementation of existing legislation is thought to have lower costs and bring numerous benefits (European Comission, 2014; OXERA, 2003). Barnes et al.'s (2013) review of the literature examining farmers' response to compulsory regulations found:

- Aversion to responsibility,
- Lack of knowledge about the purpose of the regulations,
- High levels of resistance when regulation is imposed.

Negativity towards regulations can result in the minimal requirements implemented or people simply doing the opposite of what is required because policy demands it (Hall and Pretty, 2008). Information needs to be provided as to *why* regulations exist, as understanding often decreases resistance and increases acceptance (OECD, 2000).

Financial incentives such as those provided by AES are recognised to have beneficial impacts. Incentives are thought to generate interest and introduce farmers to the possibility of engaging in agri-environment programmes for the first time, signing whole farms up to a basic level of environmental management (Dolan et al., 2010; Hodge and Reader, 2007; Trout et al., 2005). Grants also help provide one-off funding contributions enabling farmers to accomplish a particular activity such as roofing over a farm yard, which their financial situation might have otherwise restricted. While such mechanisms can act as a catalyst for engagement and enablement of behaviour change, disadvantages have also been identified.

The drawbacks of using financial incentives exist in several forms. Costs incurred by the Government through making subsidy, AES and grant payments are a key disadvantage. However, financial disincentives in the form of taxes and levies can actually provide additional revenue. Discounting the economic costs, there is concern that if a measure has been adopted without convincing the individual of its need or of the benefits, the long-term effectiveness and sustainability is questionable (Prager and Posthumus, 2010; Ryan et al., 2003). Additionally, negative experiences from participation can alter attitudes, thus jeopardising future implementation (Cooper, 2014). Financial incentives can also result in feelings that once an activity is associated with external reward, individuals are less inclined to participate without further incentives in the future (de Snoo et al., 2013; Dolan et al., 2010).

Regulations and financial incentives risk not changing attitudes, thus hindering the longevity of the behaviour change (Burton and Paragahawewa, 2011; Stobbelaar et al., 2009). As a result, voluntary adoption of farm practices is thought to be key to the sustainability of changing behaviour, with the hope that it becomes embedded in social norms (Ayer, 1997). Efforts have therefore been directed at understanding the effectiveness of approaches which encourage voluntary adoption (House of Lords, 2011).

Advice provision and voluntary schemes are believed to be highly cost-effective (OXERA, 2003) with evidence provided by the example of the water industry's costs to remove pesticides from drinking water. Costs are estimated to be around £100 million/yr, whereas a voluntary scheme such as the UK's Voluntary Initiative on pesticides (which provides best practice advice to pesticide users) is estimated to cost the crop protection industry £2.1 million/yr, and the cost to farmers to implement the recommendations £11 million/yr (House of Commons, 2005). The Voluntary Initiative is therefore a cost-effective scheme if the willingness of farmers to use the information is high. Without any method to force participation in such schemes, increasing farmers' willingness can be difficult to achieve (Gachango et al., 2015). Garrod et al.'s (2007) assessment of the Voluntary Initiative explains farmers thought the Government would eventually introduce some form of pesticide tax or ban regardless of the campaign's success. There was a strong belief that they have to use current levels of pesticides – due to supermarket and customer demands and therefore have been reluctant to reduce their use of chemicals (Garrod et al., 2007). Heberlein (2012) suggests that voluntary action can be effective if the audience does not have pre-existing strong, negative attitudes toward the proposed action and if advice can be strongly linked to existing positive beliefs and attitudes. On the contrary, an understanding of the benefits for a farming practice does not guarantee adoption, as the perceived costs may be too high, especially if the practice or technology is new (Daberkow and McBride, 2003; Fountas and Blackmore, 2005). Changes take time and a one shot injection of information or generic advice will rarely lead to instant decisions and changes in land managers behaviour (Garforth et al., 2003).

Overall, despite the disadvantages of advice provision, using such a mechanism (sometimes in combination with others) has many benefits. Advice provision can reduce exchequer costs (OXERA, 2003; CAS, 2012), aid with persuasion to act (Blackstock et al., 2010), build trust (Dwyer et al., 2007), increase the credibility of actions and objectives (CSF Evidence Team, 2014), and allows adaptive, local responses to be achieved (Defra, 2013b).

Despite evidence of regulations, taxes and subsidies requiring substantial financial resources and administrative support (Andrews and Zabel, 2003; Heinz et al., 2002; McGonigle et al., 2012; OXERA, 2003), some countries largely rely upon such mechanisms e.g. Germany and Denmark (Johnson et al., 2011), whereas others predominantly use alternative, cost-effective mechanisms such as advice provision (OXERA, 2003) e.g. Austria (Opancar, 2014). It is clear from the literature that a toolkit of different mechanisms is essential (Aue and Klassen, 2005; Brouwer et al., 2003; Collins et al., 2016; Cook and Smith, 2005; Gachango et al., 2015; Mills et al., 2013; Moon and Cocklin, 2011; Prager et al., 2011; Smith et al., 2015), with recommendations in the most recent EU Environment Action Programmes for broadening the range of instruments used to control pollution (European Comission, 2014). Regardless of the approaches taken, Collins et al. (2016) state that it will be important to continue to gather new data on farmer attitudes to water pollution control options in order to inform intervention designs.

2.3.3 Private and third sector utilisation of mechanisms

Although Section 2.3 focuses on government interventions there are a number of other actors that influence farmer decision making with the use of particular mechanisms. At one end of the supply chain, consumers have an influence on farmers with their expectations and concerns over quality standards (Dwyer et al., 2007), encouraging participation in various farm assurance schemes, including business-to-business schemes such as GlobalGAP, and consumer-facing schemes such as LEAF, Rainforest Alliance, Soil Association (Tallontire et al., 2012) and Red Tractor. Farmers can voluntarily participate in such schemes to gain a premium price for products, whereas other schemes further along the supply chain, such as those created by supermarkets e.g. Tesco's NURTURE for fresh fruit and vegetable producers, require compliance in order to supply produce. Since the CaBA has gained momentum, as discussed in Section 1.2.1, different local interest groups and stakeholders have increasingly become involved in land management, taking on roles as influencing actors. The diversity of such actors is illustrated by the following examples:

1) Tenant farmers can be influenced by the demands from their land owners, who can dictate what farming practices are to be carried out. The Duchy Estate is a prime example, setting out specific environmental and good practice standards required by all tenants producing for the Duchy Originals[9].
2) Water companies have increasingly become involved with land management through a variety of techniques. For example by setting standards with tenants on their land in a similar way to The Duchy Estate, by forming voluntary agreements with farmers in their river catchments from which they extract water, through the use of financial incentives (Upstream Thinking, Slug it out and STEPS) and advice provision by: recruiting agronomists (Anglian Water); partnering with CSF (Essex Water) and creating a team of catchment farm advisors (United Utilities).
3) Environmental organisations such as the RT, Royal Society for the Protection of Birds (RSPB) and WT have also increasingly become involved and offer grants and advice to farmers to change their practices.

It is important to highlight that such influences exist as policy makers need to consider such actors when designing interventions, since many could be utilised as channels for delivering policy goals.

With the growing trend for governments to use non-regulatory mechanisms (UKWRIP, 2011), local scale and tailored approaches for specific targets (Defra, 2013a), the question of how best to deliver improved voluntary uptake of measures is important (Collins et al., 2016). Therefore, a more specific review of the literature surrounding farm advice provision is relevant.

[9] http://www.waitrose.com/home/inspiration/about_waitrose/about_our_food/our_brands/duchy_originals.html.

2.4 Advice provision

2.4.1 The changing role and provision of farm advisory services

The role of farm advice is to enhance farmer skills and access to knowledge and information (Labarthe et al., 2013), acting as a trigger for change (Dwyer et al., 2007). Through advice, improvements to existing practices and adoption of new ones can be achieved to increase the performance of farm activities (Proctor et al., 2011). Farm advisors act as crucial knowledge brokers for science to be implemented on the ground (Phillipson, 2007), with farmers expecting their advisors to absorb complex, ambivalent messages from diverse sources, and to translate and repackage them into terms they can understand and act upon (Proctor et al., 2011). Nevertheless, over time, the role and focus of advisors has changed.

Following WWII, the UK Government provided farm advice services focused on improving production. However, since the mid 1980's, governments have taken the view that production and farm management advice are essentially private, rather than public, goods and should therefore be provided by the market on a commercial and competitive basis (Garforth et al., 2003). In 2001, government departments reorganised to concentrate on environmental sustainability objectives rather than food production (Angell, 2007; Prager and Thomson, 2013; Winter et al., 2001) and a diverse advisory community emerged to fill the gap left by the repositioning of previously public advisory organisations such as the Agricultural Development Advisory Service (ADAS) (Prager and Thomson, 2013). This community of advisors has had to adapt over time with evolving policy[10] and the changing demands of those receiving advice. Advisors now not only have to help farmers improve competitiveness and resource efficiency, but they must also ensure farmers follow regulations (Cowap and Reed, 2013), deliver environmental objectives and contribute to the wider sustainable intensification agenda (AIC, 2013).

2.4.2 Assessment of advice provision in England

A recent study in Europe known as PROAKIS (Knierim and Prager, 2015) categorised EU countries' Agricultural Knowledge Information Systems (AKIS) on a continuum from weak to strong and fragmented to integrated. Figure 2.10 enables comparisons between the UK and other countries' AKIS, showing some governments to have weak fragmented AKIS, with minimal investments (e.g. Greece, Portugal and Romania), whereas examples of widespread public support, for example through training schemes, in-kind and networking support, are

[10] For example, since the 1986 Agricultural Act, advisors have been required to take account of the environmental impact of their advice.

found in Austria and Ireland. The UK is considered by Knierim and Prager (2015) to have a strong but fragmented system, implying that actors have resources available and farmers can access relevant knowledge but the fragmentation may reduce the ability of the system to meet the knowledge needs of farmers. Knierim and Prager (2015) acknowledge that due to diversity, the UK would be better represented split into England, Wales, Northern Ireland and Scotland.

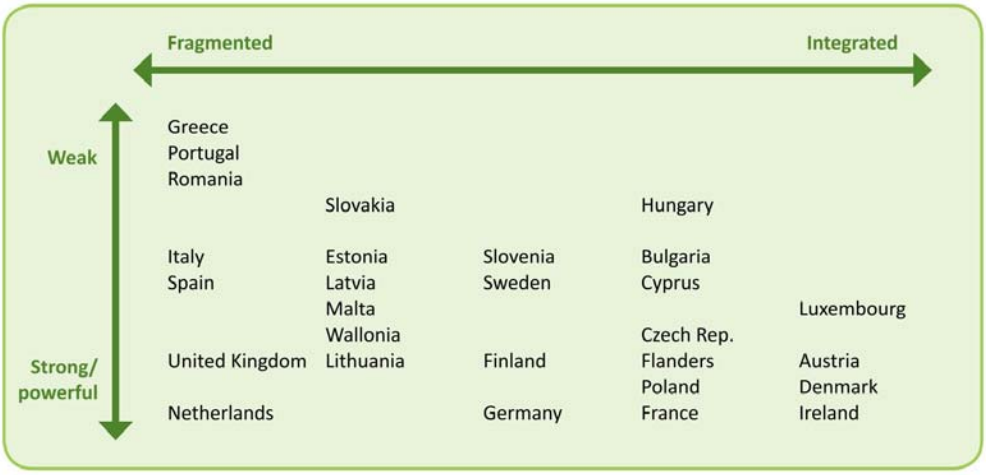


Figure 2.10 An overview of European AKIS distinguishing along a continuum from weak -strong and fragmented- integrated (as of 2014), Source: Knierim and Prager, 2015.

The diversity in the UK regarding the way advisory services are delivered and to what extent the state is involved is considerable. In England the approach is predominantly privately driven and decentralised, creating a diverse sector. In Wales, there is a strong publicly-driven approach by the Welsh Government and extension is provided by various private advisory networks such as, Menter a Busnes[11]. In Scotland and Northern Ireland extension is managed publically and creates more centralised systems, however some services are outsourced to accredited advisors (Kania et al., 2014).

The diverse, decentralised farm advice sector which has evolved in England is considered to have both advantages and drawbacks. Garforth et al. (2003) believes the sector benefits from efficiency, competition, flexibility, choice and reductions in public funding, and is in agreement with Rivera (2000) in that given the individuality of farmers and their practices, the pluralistic array of providers is exactly what is needed. However others are concerned that a lack of coherence, co-ordination and integration due to fragmentation has occurred, leading to: inconsistent, conflicting or duplication of messages (AIC, 2013), wasteful competition among providers and gaps in provision (Dwyer et al., 2007). Such fragmentation is also believed to create difficulties for farmers in deciphering which advice to follow (Angell, 2007;

[11] See http://www.menterabusnes.co.uk/

Winter et al., 2001), and may result in message fatigue, information overload, confusion, contradiction, misinformation and advice being ignored (AIC, 2013; Dwyer et al., 2007; Kahan et al., 2012). Government reports spanning more than the past decade consider the sector to be inadequate for meeting farmer requirements and have called for a streamlining of advice (Curry, 1997; Defra, 2013b; Farming Regulation Task Force, 2011; Foresight, 2011; HM Government, 2011). On the contrary, Klerkx and Proctor (2013) claim assumptions of a collapse of interaction within the advisor sector are not supported by evidence. Such debate in the literature highlights the need to investigate whether problems such as conflict, duplication or inconsistency exist in this pluralistic farm advisor sector.

Financial cutbacks further complicate the issue, creating additional pressure to reduce government spending, with England hoping to reduce its spend of £20 million/yr on administering and delivering government advisory schemes and initiatives to farmers by 25% (Defra, 2013b). To achieve such a goal *The Review of Environmental Advice, Incentives and Partnership Approaches for the Farming Sector in England* published in March 2013 highlighted that government advice needed to be clearly targeted and linked to that provided by other advisors, rather than duplicating or creating confusion (Defra, 2013b). Nevertheless, without a better understanding of the advisory landscape, it is not possible to know who does what and where to increase efficiency and effectiveness.

Several studies have attempted to summarise different aspects of the UK farm advisory landscape. Defra (2013b:4) provides an illustration of the different sources of environmental advice in England (Figure 2.11), but only includes the public sector and professional bodies providing advice on behalf of the Government. Another review was undertaken through the Value of Advice project, but focused solely on how the commercial sector delivers professional advice to farmers (AIC, 2013). The most relevant report to date which formed part of the European PROAKIS study, lists all actors in the UK's AKIS (Prager and Thomson, 2013). Despite such recent assessments, none focus specifically on the provision of WPA advice. Such knowledge is required to inform policy for designing effective schemes to meet WFD targets.

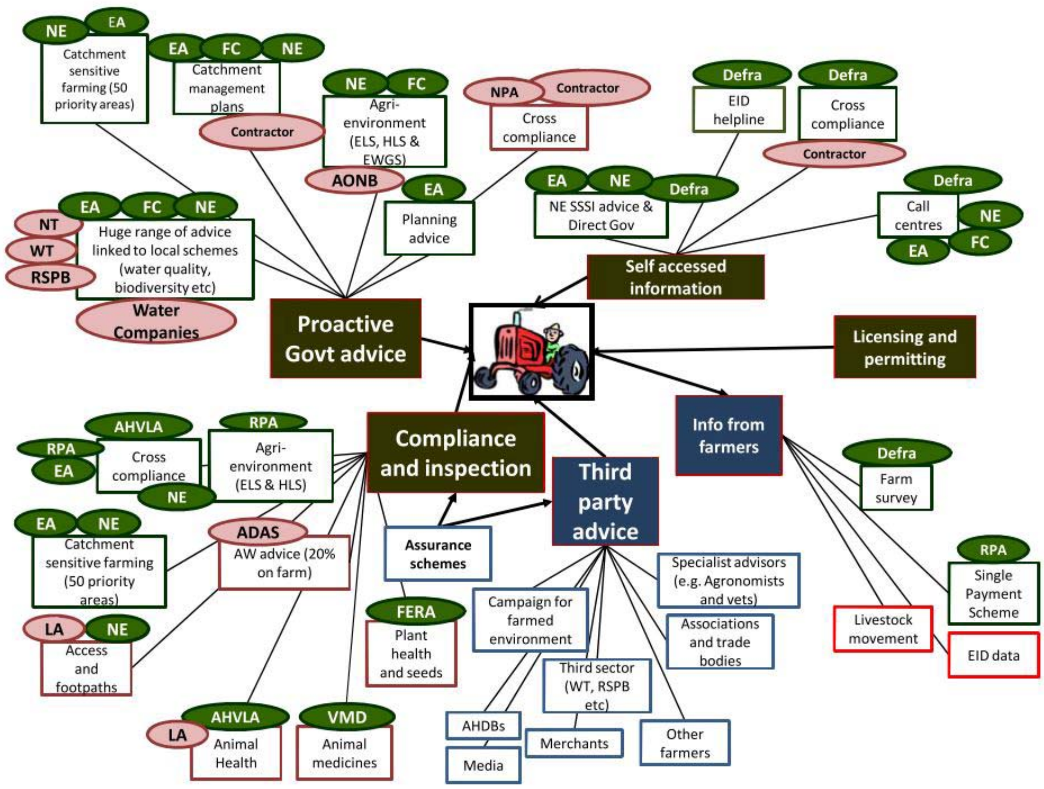


Figure 2.11 Illustration of the sources of environmental advice for farmers in England. Source: Defra, 2013b:4.

2.4.3 Factors influencing the success of advice

A wealth of literature exists on the importance of advice, with some key papers focusing on farm advice and water pollution. Important findings show that the advisor's expertise, trustworthiness and farming background are likely to improve message uptake (Blackstock et al., 2010; Dolan et al., 2010), with trust developing from repeated interaction (Bostrom and Klintman, 2011). Similarities in demographic and behaviour between the expert and the recipient have also been found to help message uptake (Dolan et al., 2010). Farmers in the community and family members are also considered as valued sources of advice (AIC, 2013). Research shows such sources are more valued than information from commercial, government or other organisations considered to have vested interests (Elliott et al., 2011; Garforth et al., 2006). Research which has focussed on advice effectiveness for influencing behaviour has discovered:

- Messages should be tailored appropriately to the different types of farmers (Dwyer et al., 2007).
- Messages need to be consistent and salient so that farmers feel able and willing to respond (Blackstock et al., 2010).
- The medium matters as well as the context of advice e.g. farm visit, farming press or group discussions (Pike, 2008).
- Messages should be simple and memorable (Ratner and Ris, 2014) such as the examples of 'the 4 Point Plan' by the Scottish Government (2002), and the '8 Steps' by The Campaign for the Farmed Environment (Clothier and Pike, 2013).
- Messages presenting both sides of an argument should ensure that opposing arguments are adequately refuted to be persuasive (O'Keefe, 2002).
- Messages should address multiple issues such as flooding, stream bank erosion, degraded fish habitats across the landscape, alongside those of water pollution (Curatolo and Zhu, 2005).

All of the findings listed above are of great use and widely applicable to the topic of advisory interventions for WPA mitigation. However, if policy makers want to engage and influence farmer uptake of measures, it is important to better understand how different sources of advice on pollution are evaluated by farmers (Blackstock et al., 2010). It is also necessary to identify who farmers trust and listen to for advice on such a topic (Pike, 2008) and who the key players are to disseminate advice through in each catchment (Barnes et al., 2013). Such information is critical for understanding determinants of behaviour, as well as the role of the Government as providers of advice (Pike, 2008). Dwyer et al. (2007) recommended that the Government should seek to work with established farmer-farmer and farmer-adviser networks and groups when developing advisory initiatives to improve policy efficiency. This would also avoid duplication, possible farmer confusion and to help identify possible groups of farmers which existing advice services do not reach, therefore requiring further attention from the policy initiative. Additionally, in a recent report outlining policy recommendations, it was stated that policy makers would benefit from identifying and describing the relevant actors for a certain agricultural topic/sector (Knierim et al., 2015). This would allow them to recognise strengths and weaknesses, and to identify gaps and missing interactions among actors (Knierim et al., 2015).

2.5 Summary and research objectives

In view of the literature cited in this chapter, and the context provided in Chapter 1, a number of key knowledge gaps and issues require examination.

It is clear that in order to design successful behaviour change interventions it is important to devote time and effort to fully understand the target behaviours (Michie, Atkins and West, 2014). In the context of behaviours to reduce WPA there is consequently a need to collect baseline information regarding current farmer uptake of such practices and to gather data on farmer intentions regarding future adoption of measures. This would help improve the reliability of information included in decision support tools and inform policy makers of the potential future rates of implementation.

One of the largest knowledge gaps concerning policy interventions involves advice mechanisms. Information is available on regulatory requirements, targeted incentives such as existing AES agreements (Natural England, 2009) and on grants successfully provided to farmers (CSF Evidence Team, 2014). However, there is a lack of information on who formally provides advice on WPA mitigation measures or what they recommend. There is a need to develop better knowledge of the relevant actors providing WPA advice to understand who does what and where. This is required for the Government to make effective and efficient use of existing networks for advice dissemination. In addition, such research should ascertain whether issues such as conflict, duplication, gaps, missing interactions between actors or other inconsistencies exist in England's pluralistic farm advisor sector. Studying what farmers are actually being recommended to do rather than simply considering what official guidelines state should be done, provides realistic insight into the advisory landscape.

Whilst considerable research discusses factors which motivate or act as barriers on the broad topic of farmer pro-environmental behaviours, it is also apparent that further detailed investigation is required into *specific* practices. Research needs to be conducted to understand what barriers need to be overcome and what factors motivate and positively influence uptake of individual WPA mitigating practices. Such information is essential to inform policy developments about what needs to change to influence greater uptake.

Another issue is what farmers actually want in the way of advice and who they trust and listen to regarding WPA mitigation. The literature highlighted an assessment of the advisory landscape is required, but in order to understand how to increase the credibility of advice to improve uptake, it is important to ascertain who is best placed to deliver such advice.

The research in this thesis aims to address all of these issues in order to discover what needs to change to increase farmer uptake of mitigation measures. The objectives are to examine:

- The current uptake of farm practices which mitigate water pollution. (Chapter 4)
- Farmers' attitudes towards future uptake of mitigation measures. (Chapter 4)
- What measures are being recommended by advisors. (Chapter 5)
- How the roles of farm advisors differ in the provision of mitigation measure advice. (Chapter 5)
- Which factors influence the uptake of specific water pollution mitigation measures. (Chapter 6)
- What advice farmers want and what their attitudes are towards farm advisors delivering mitigation measure advice. (Chapter 7)
- What needs to change to increase the uptake of water pollution mitigation measures. (Chapter 8)

This research continues the line of enquiry which has been ongoing for several decades regarding farmer behaviour change and the factors which motivate and create barriers to the uptake of environmental farm practices (summarised in Dwyer et al., 2007; Mills et al., 2013). To build upon previous literature, this thesis focuses on specific WPA mitigation measures in the current institutional, economic and social context. Whilst examining policy mechanisms this research places less emphasis on the regulatory and economic approaches - in a similar manner to Blackstock et al. (2010) - to allow for voluntary and advisory instruments to be explored in greater depth.

As socio-economic and cultural contexts vary markedly between areas, the factors which influence decisions differ between the various farming types (Knowler and Bradshaw, 2007). Therefore to provide policy makers with greater representative results, this research chose to study several contrasting catchments/regions. The next chapter describes the characteristics of the catchments and the context of the government funded programme in which this research was conducted.

Chapter 3

Chapter 3 The Demonstration Test Catchments programme

The research presented within this thesis was conducted as part of a national programme funded by Defra, the Demonstration Test Catchments (DTCs). This chapter outlines the key objectives and design of the programme, and describes the river catchments studied by the DTCs and this PhD, highlighting essential background information.

3.1 Overall objectives of the DTCs

The DTCs were set up in 2009. The overarching aim of the programme was to test the hypothesis that it is possible to cost-effectively reduce the impact of WPA on ecological status, whilst maintaining sustainable food production through the implementation of on-farm mitigation measures. The programme was established to address the gap in empirical evidence on the cost-effectiveness of combinations of on-farm mitigation measures at catchment scales. It also explores ways to bring science into stakeholder-led catchment management, demonstrating the use of local expertise to solve local problems (DTC, 2015a).

3.2 Design of the DTCs

The DTCs were designed to bring together teams of researchers, practitioners, policy makers, non-governmental organisations (NGOs), industry groups and farmers, to determine how catchments respond to on-farm mitigation measures. The programme focuses on four river catchments, chosen to maximise national coverage and representation of different physical and socio-economic factors influencing WPA. The four catchments consist of:

- The Eden, Cumbria (North West England)
- The Wensum, Norfolk (East Anglia)
- The Hampshire Avon, Hampshire (South West England)
- The Tamar, Devon and Cornwall border (South West England)

Over forty organisations across the country collaborate within the DTCs, creating a robust evidence base using novel scientific and state of the art techniques. Water quality monitoring programmes in experimentally manipulated and control sub-catchments are combined with local knowledge, expertise and socio-economic research on farming practices. The research communities, monitoring infrastructure and data generated by the DTCs also support a number of satellite projects to test mitigation measures and further understand the physical, ecological and social functioning of river catchments, but such projects will not be discussed further in this thesis. For further information see
http://www.demonstratingcatchmentmanagement.net/.

The four DTCs operate in very different environments in terms of physical characteristics, farm businesses, policy influences and presence of other organisations (DTC, 2015a). A brief description of each catchment is provided below, predominantly sourced from the DTCs evidence report (DTC, 2015a:15-18), with a summary of catchment landscape features, farm characteristics and the mitigation measure implemented by the DTCs shown in Figure 3.1.

3.3 DTC study catchments

3.3.1 The Eden Catchment – North West

The River Eden in Cumbria rises in Mallerstang and flows north to the Solway Firth and into the Irish Sea. The catchment has a considerable elevation range of 18m above sea level to a maximum of 394m, and drains part of the Lake District to the east, and the North Pennines to the west. Slopes within the catchment range from 0-30°, with the steepest associated with the surrounding fells, whilst the valley floor is characterised by gentle undulating slopes. The geology in the Eden varies greatly, with Permo-Triassic sandstones, mudstones and shales covered by a thick layer of glacial till. Soil texture is mainly clay loam with large areas of sandy loam soils adjacent to the river. The Eden is a largely rural catchment, dominated by farming with common grazing land found in the uplands of the catchment, and areas of intensive farming in the lowlands of the valley. Across the Eden valley there is a mixture of owner occupied farms, institutional estates such as the National Trust and private estates both large and small all with a mixture of tenants and tenancy agreements, thus causing complexity in land occupation and the economic structure of agriculture in the Eden.

Substantial water abstraction from Eden sources supports public, industrial and small farm water supply. Around 11% of the catchment is located within an NVZ, and a very small portion of land is designated a groundwater safeguard zone. The Eden is designated a Special Area of Conservation (SAC) under the EU Habitats Directive, and of the 39 units in SAC, only 23% are in favourable condition. Overall, only 41% of the 98 water bodies in the Eden currently achieve good status under the WFD. The Eden is a CSF catchment with 15-20% being a priority area providing funding to farmers, along with initiatives from the well-established Eden Rivers Trust (RT).

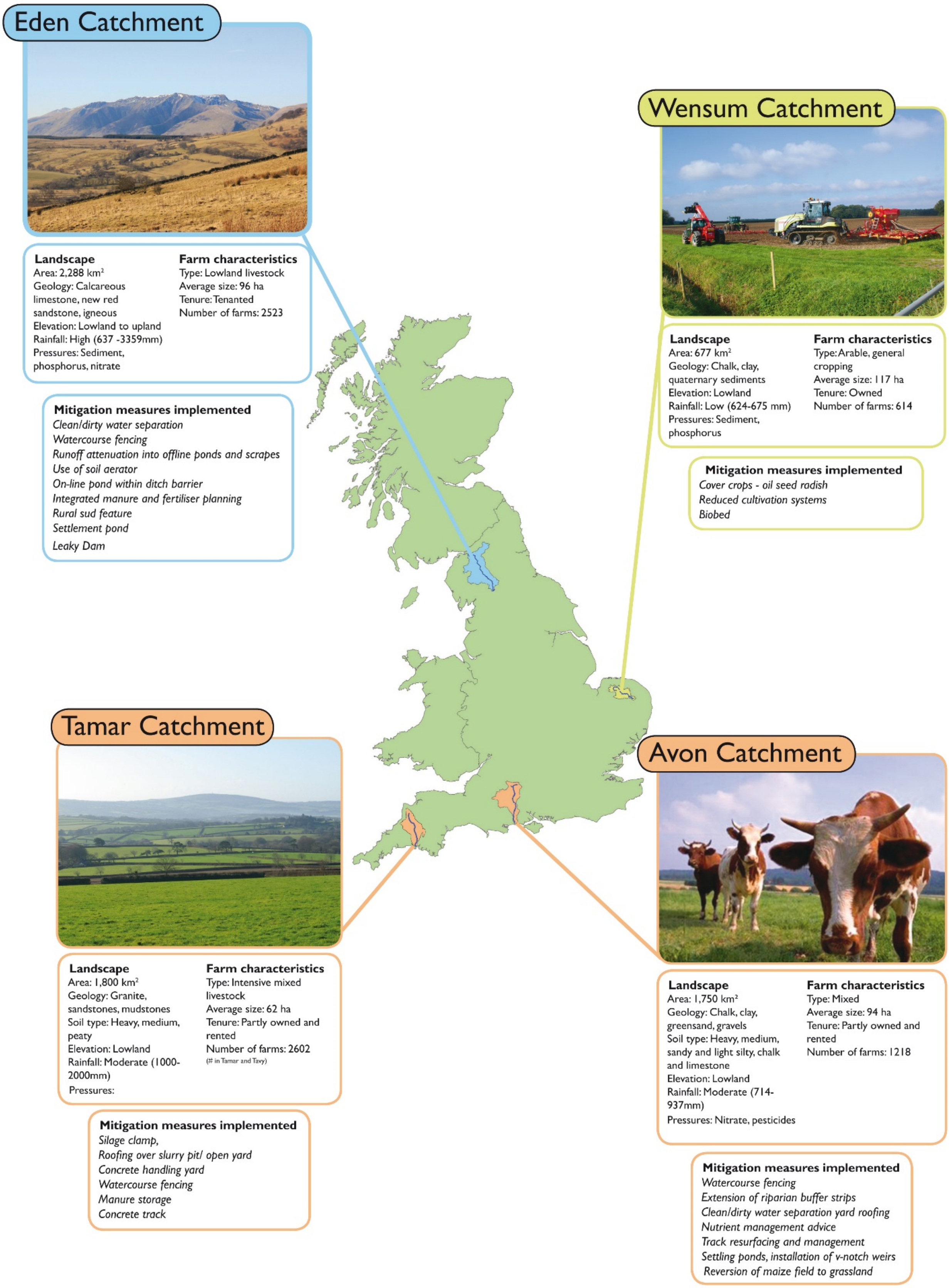


Figure 3.1 Overview of the four Demonstration Test Catchments, showing their location in England, general catchment information (landscape and farm characteristics), and the on-farm mitigation measures being implemented by the DTCs.

3.3.2 The Wensum Catchment – East Anglia

The River Wensum in East Anglia flows from its source between the villages of Colkirk and Whissonsett to Norwich via Taverham, and on to its confluence with the River Yare at Whitlingham, before joining the sea at Great Yarmouth. The juxtaposition of glacial deposits is a significant control on hydrological processes in East Anglia and the underlying Chalk aquifer supports river flow in the Wensum. Soils vary across the catchment, reflecting the complex geological history of the area, and are characterised by rich loams, silts and sandy peats. The clay loam and sandy loam soils have a high potential for arable agriculture, with soils further improved by field drainage and widening, straightening and deepening of tributaries and main river channels. The main arable crops grown are barley, sugar beet, beans, potatoes, oil seed rape and wheat. The majority of farms are owner occupied and the average farm size in the Wensum is the largest of the DTC catchments (at 117ha, see Figure 3.1).

The River Wensum is an important chalk river habitats and is designated a SSSI and SAC. Of the 'River and Stream' habitats included in the SSSI, 99% are considered to be in an 'unfavourable and declining' state under the WFD, primarily due to excessive sediment and nutrient loadings (Sear et al., 2006). The main river channel currently has 'poor' ecological status and 40% of water bodies in the catchment are at risk of failing drinking water quality standards for nitrate. The Wensum is a CSF priority catchment and 85% is in a NVZ, however high staff turnover within the initiative has resulted in a lack of continuity in officers providing advice. The RT in the area is a newly established group (2011) and has a number of projects working on conservation and restoration of Norfolk Rivers, none of which focus on the Wensum. However, the new Broadland Catchment Partnership (2014) includes the Wensum, and acts as a framework to bring interest groups together. The partnership was set up by the Broads Authority and has received funding through Defra's Catchment Based Approach, creating an exemplar catchment strategy and plan (see Broadland Catchment Partnership, 2014).

3.3.3 The Hampshire Avon Catchment – South West

The Hampshire Avon rises in Wiltshire as two separate rivers: the West Avon and East Avon just east of Pewsey, both of which drain the Vale of Pewsey. The two tributaries converge at Upavon, then flow south across Salisbury Plain and into the English Channel at Mudeford, Christchurch, in Dorset. The Hampshire Avon is a groundwater-dominated river catchment, with around 85% of main river flow supplied by the Cretaceous Chalk and Upper Greensand aquifers. Topographical features such as open chalk downlands with steep scarp slopes, sheltered valleys, chalk hills, ridges and limestone plateaux are typical of the catchment.

Principal farm types are cereals (51%) and mixed (20%), with farms being a mixture of owner and tenanted occupancy.

Enhanced phosphorus, nitrate and sediment pressures from agricultural land are believed to have contributed to nutrient enrichment, siltation issues and the occurrence of so-called ‘chalk stream malaise’. Only 24% of river length and 37% of local freshwater bodies currently achieve good ecological status under the WFD. The Hampshire Avon is designated as a SSSI, a CSF priority catchment and has approximately 85% designated as NVZ. The Wessex Chalk Stream and RT was formed in 2010 combining several organisations interested in protecting the chalk based ecosystem. Their projects focus predominantly on habitat improvement and fisheries.

3.3.4 The Tamar Catchment – South West

The River Tamar flows through the counties of Cornwall and Devon, originating near Bude on the north Cornwall coast, running south entering the sea at Plymouth Sound in south-west Devon. The upper catchment is predominantly low porosity clay soils and granite bedrock with the lower areas comprising of sandstones and mudstones overlain with alluvial silts and clays. The catchment includes the upland areas of west Dartmoor and east Bodmin Moor, and is characterised by rolling farmland, valleys and heaths. The dominating agricultural land use is permanent pasture for beef, sheep and dairy, most prevalent in the northern part of the catchment, with farms being a mixture of owned and tenanted.

The Tamar is a CSF priority catchment, a designated Area of Outstanding Natural Beauty, and the Tamar-Tavy estuary is a SSSI. Multiple funding sources have been available in the Tamar over the past decade or so, with various organisations providing grants to farmers e.g. Tamar 2000 fencing project and Upstream Thinking (Stollard and Rickard, 2005; Westcountry Rivers Trust, 2013.). The Tamar was adopted as a DTC focus catchment in autumn 2011, providing an opportunity to assess the water quality and freshwater responses to mitigation strategies funded by South West Water via the Payment for Ecosystem Services schemes being implemented by the Westcountry RT.

3.4 Experimental design

The experimental design used by the DTCs is the ‘Before-After Control-Impact’ (BACI) approach to monitor water quality. Two variations of the BACI approach have been used: comparing a manipulated sub-catchment with a non-manipulated sub-catchment before and after implementation of a mitigation measure (Figure 3.2a); and monitoring points upstream and downstream of the mitigation area (Figure 3.2b).

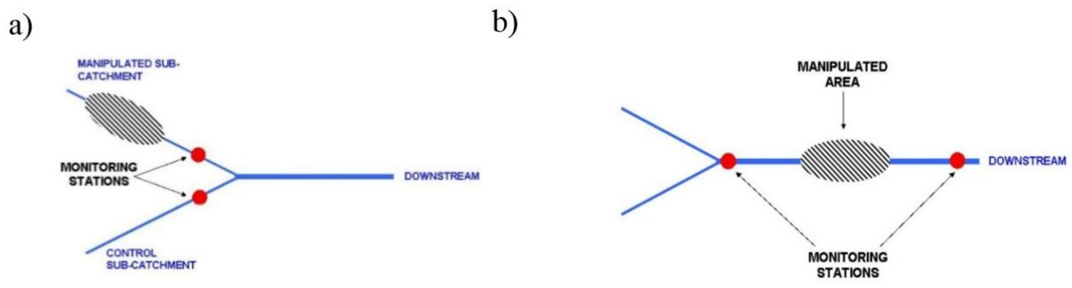


Figure 3.2 DTCs experimental designs for establishing controlled and manipulated sub-catchments.

Various meteorological, hydrological and hydro-chemical parameters are being monitored to assess the effectiveness of the mitigation measures on water quality. Each DTC's monitoring network uses slightly different equipment to collect data at either 15 or 30 minute resolution (Outram et al., 2014). Parameters being measured include: turbidity, suspended sediment, conductivity, temperature, pH, dissolved oxygen, chlorophyll-a, ammonium, total nitrogen (N), total dissolved N, nitrate, total phosphorous (P), total dissolved P and soluble reactive P (see the DTCs websites for a comprehensive explanation of the water quality monitoring equipment specifications[12]). The ecological monitoring of invertebrates, fish, diatoms and macrophytes occurs annually in each sub-catchment and WFD tools are used to establish the status of these Biological Quality Elements (BQE). The biological monitoring sites are closely matched to the hydrological and water quality monitoring stations, allowing observed change in the BQEs to be linked to reductions in pollution and on-farm pollution mitigation measures. Further details on the approach and the methodology are provided in the appendix of the DTCs summary report (DTC, 2015a).

Within each study catchment, different combinations of mitigation measures have been chosen for assessment by the DTCs consortium, following in-depth consultation between multiple stakeholders and national policy makers (see Figure 3.1). The subset of measures chosen had a lack of evidence for WPA mitigation at the catchment scale and were applicable to the remainder of the catchment and many other catchments across England. Measures were known to have the capacity to be delivered through existing or new policy funding mechanisms and could be readily incorporated into guidance for improved delivery of pollution mitigation at the catchment scale (DTC, 2015a:91). As research often struggles to compare farming practices across areas due to the different farming systems which occur (SoCo, 2009), an aim of this PhD research was to ensure that some of the measures investigated occurred in all regions studied to allow for comparisons. By studying several catchments, this research also aims to contribute to tackling the policy challenge of scaling up knowledge (Section 1.4).

[12] e.g. http://www.edendtc.org.uk/2011/10/water-quality-monitoring-equipment-specs/.

3.5 Mutual benefits - Bringing scientists, policy makers and farmers together

One of the main achievements of the DTCs has been the establishment of a foundation for collaborative research which can be built upon and form long-term communities of researchers and stakeholders. Through communication and knowledge exchange, the DTCs interdisciplinary approach and community of stakeholders and researchers, has strengthened the programmes ability to tackle short and long-term policy relevant research questions and to translate science into practice (McGonigle et al., 2014, 2012)**.** The research conducted by this PhD significantly contributes to this crucial element of linking science, policy, farmers, organisations and businesses, and has been conducted in the context of attending national DTC meetings, Defra policy meetings and having access to the DTCs infrastructure and farmer communities.

In order for research to inform policy, there are opportune moments when the greatest impact can be achieved. Directives and legislation are often implemented in a cyclical fashion and reviewed on a regular basis. Preceding a review period provides key opportunities for researchers and policy-makers to draw together new evidence and approaches to modify policy (McGonigle et al., 2012). The research presented within this thesis fell within the window of opportunity to influence policy during the CAP review of 2014, and has aided decision making for future adjustments of policy. A Defra research programme manager provided excellent opportunities throughout the PhD for results to be presented at Defra's offices in London. Results from pilot studies and the final data collection were presented to key members of the Nitrate Directive, Soils Directive, New Agri-Environmental Scheme and Water Quality teams designing policies in light of new budgets from the EU and the CAP reform (the contributions to policy achieved by this research are reflected upon in detail within Appendix D).

It is important to highlight that this research was influential to, but also heavily influenced by the British Government. Discussions from Defra meetings helped identify key interests of the policy makers, steering the direction of this research, as well as providing reassurance that survey designs were appropriate and relevant. The subsequent chapters (4, 5, 6 and 7) present this PhD's empirical research conducted within the DTCs.

Chapter 4

Chapter 4 Farmer baseline survey: Current adoption and attitudes of mitigation measures

Extensive research has been carried out to determine the best agricultural practices for pollution control (e.g. Deasy et al., 2010), however the implementation of such measures will only be effective with the cooperation of land owners and managers. Whilst the issue of water pollution persists and many agricultural management options remain voluntary, stakeholder knowledge and engagement is increasingly seen as a necessary component of catchment management. Before attempting to influence behaviour change and increase the uptake of mitigation measures, it is vital to understand what the baseline is regarding current uptake.

Detailed and accurate national data sets exist for the current uptake of measures within AES, however, such data does not reveal what farmers are doing voluntarily or provide an indication of uptake for measures not yet incorporated in AES. Chapter 2 identified the need to ascertain a baseline of current uptake of measures amongst farmers, as well as the likelihood of uptake in the future. Therefore this chapter sets out the research from a farmer survey conducted in three of the DTC catchments. This survey was carried out to assess current behaviours and the likelihood of future uptake of WPA mitigation measures. By doing so, the research expected to: 1) help decrease the data uncertainties within policy decision support tools, 2) provide a clearer understanding of the land management within the catchments being monitored by the DTC programme, 3) help identify mechanisms that may be required to influence uptake of particular measures by assessing attitudes towards future adoption, and 4) further develop an integrated and collaborative research community through the process of data collection and interpretation. A step towards the shared understanding necessary for successful catchment management (McGonigle et al., 2014). The main objectives of the survey were to:

- Determine the nature of the farm businesses in the three catchments.
- Ascertain the current uptake of mitigation measures by farmers.
- Evaluate farm characteristics which may influence the uptake of measures.
- Investigate the attitudes of farmers towards future uptake of measures.
- Evaluate farm characteristics which may influence attitudes to future uptake.
- Discover which measures farmers prioritise for implementation.

This chapter outlines the methodology used to conduct the survey in Section 4.1, presenting key findings from the data in Section 4.2, with aspects of the results separated into the four dominant farming systems found within the catchments. An overall discussion and conclusion in Section 4.3 considers the implications of the results for policy makers.

4.1 Survey methodology

4.1.1 Study design

The initial farmer survey comprised of a structured questionnaire covering such issues as AES participation, business structure and general farm attributes, and was based on a standard form ADAS (an agricultural and environmental consultancy) use during farm visits. Questions were added regarding the current uptake of WPA mitigation measures and attitudes to their future adoption (the term 'attitude' is used throughout this chapter to refer to the farmer's assessment of the likelihood of action). Many of the questions were in a closed response format, designed to aid comparability across farms and timely completion of the survey.

Choosing which WPA mitigation measures to include in the survey was challenging as innovative mitigation measures are continually being developed, trialled and tested. Numerous manuals and reports exist from various countries which list a multitude of potential measures - many being crop or region specific (e.g. Schoumans et al., 2011; Holsten et al., 2012). To design a methodology which would stay in date with the ever advancing literature, it was concluded the most appropriate list of mitigation measures to include was the Defra User Guide (Newell-Price et al*.,* 2011). This was the most comprehensive list, relevant across UK farming, of measures relating to WPA, thus allowing the research to investigate a wider range of practices than previous research. The complete list of 86 mitigation measures surveyed can be found in Appendix A.1, and a full description and assessment of the potential environmental and economic impacts of each measure is given in Newell-Price et al. (2011).

During the survey, farmers were asked *'Do you do 'x' mitigation measure? If not, would you be very likely, likely, unlikely or never consider doing it in the future?*' An example of the question format is shown in Table 4.1. After asking about each relevant measure, a follow-up question asked farmers to state which three measures they would consider a priority to implement on their farm.

Table 4.1 Example of the question format regarding infrastructure change on arable farms.

Mitigation measure examples	Present use		If not, would you consider doing this in the future? – very likely, likely, unlikely, never
	Yes	No	
Re-site gateways away from high-risk areas			
Farm track management			
Establish new hedges			

The majority of questions originated from a survey ADAS frequently use, therefore it was deemed unnecessary to carry out an extensive pilot survey. The survey questions were circulated to the DTC teams in each catchment and structured into an acceptable format for interviews and postal surveys, as the need to gather information had to be balanced with the time-to-complete tolerance of survey participants. In the Wensum catchment, the survey was pre-tested on two Suffolk farmers to assess suitability of wording and timing.

4.1.2 Farmer sample

As the survey was conducted as part of the DTC programme, the farmer sample was drawn from within three DTC catchments (originally selected due to their differences in agricultural and environmental characteristics – see Chapter 3). Assessment of the representativeness of the farmer sample is provided in Section 4.2.1. Where the business address of a farm fell within the catchment boundary, they were considered as a potential respondent for the survey, irrespective of whether some land was outside of the catchment itself. Farm businesses rather than holdings, were considered the most appropriate unit of study for this survey, as clusters of holdings in a business are likely to be managed in a relatively uniform manner. However, during the survey the respondent was requested to only consider the land farmed within the DTC study area.

Various strategies were used to recruit a cross-section of farmers within each catchment. Eighty-eight surveys in total were carried out in the three catchments between February 2012 and February 2013. In the Eden catchment, participants were targeted from within the Morland study sub-catchment where the majority of mitigation measures were implemented as part of the DTC research. A handful of representative farming types within the three other focus sub-catchments were also selected for participation. Farmers who had previously engaged with the Eden RT were phoned by the Trust's employees to arrange a convenient time to conduct a face-to-face interview for the entire questionnaire. Frontier Agriculture and the CSFO aided the Wensum researchers by suggesting possible farm contacts, whilst several participants were identified from previous DTC activities e.g. attendees at meetings. Farmers were initially contacted by telephone to arrange meetings, and recommendations from the initial group of participants provided further contacts to approach. In the Avon catchment, a questionnaire including the mitigation measures section of the survey was posted to all 86 farmers in the focus sub-catchments, along with a letter requesting a face-to-face interview to conduct the remaining farm business structure questions. The option of opting out of being contacted was provided. Farmers who responded were then phoned to arrange an interview.

4.1.3 Data collection

The surveys were conducted using face-to-face interviews and self-completion postal questionnaires, with methods varying between catchments for different sections of the survey. This was a pragmatic response to the survey resources available in each catchment and the amount of information being collected. Ideally an identical approach would have been used in all three catchments, but the differences are not considered to substantially impact on or bias the information obtained, as all participants were asked the same core set of questions.

Not all questions were relevant to all farmers (e.g. crop management mitigation measures for those only with livestock). During interviews, irrelevant sections were omitted once the farm type had been determined at the start of questioning. In self-completion cases, the farmers were provided with a list of all measures and asked to leave out inapplicable questions.

The duration of face-to-face interviews lasted on average one hour and each was conducted by local DTC staff with track records in engaging and working with farmers. The use of experienced people with farming knowledge is considered a key factor by Blackstock et al. (2010), who report that such qualities convince farmers of the credibility of the survey and encourage an exchange of information.

The self-completed questionnaires were either handed to farmers at the end of an interview (in the Wensum and Eden) or posted to them separately (Avon). If any of the responses from the returned postal surveys were ambiguous they were coded as missing data.

4.1.4 Survey data

Information collected from the sections of the survey are listed below. The key farm attributes and involvement in environmental schemes were included to allow assessment of the effect these variables might have on behaviours and attitudes to mitigation measures. The farm business and operational data collected during the survey is not considered further by this PhD, but is being used as part of ongoing DTC research to help interpret water quality monitoring data and assess the cost implications of adopting different measures.

1) **Key farm attributes** - Farm type, farm size and land tenure details.

2) **Environmental schemes** - Involvement in environmental schemes and farming on land in designated areas, as well as farmer awareness of and involvement with the CSF initiative.

3) **Mitigation measures** - Measures investigated during the survey were grouped using six categories from the Defra User Guide (Newell-Price et al., 2011:4)[13]:

- Land use change
- Soil management
- Livestock management
- Fertiliser management
- Manure management
- Farm infrastructure

The measures studied were also categorised by how they mitigate pollution, their location on farm and whether they were part of regulations or schemes. Although categorisation of measures into: mitigating pollution at source; slowing the pathway or protecting the receptor has a degree of fuzziness, experts such as local agronomists and authors of the Defra User Guide were consulted to provide validation of appropriate classifications. Similarly, measures were categorised according to the location on farm in which they would be implemented. A number of measures that do not occur in a particular location were described as ‘all farm’. The list of the 86 measures presented in Appendix A.1, identifies the categories each measure was assigned to.

The key topics covered in the survey are shown in Table 4.2, along with the number of responses received in each catchment and the modes through which data were obtained.

[13] The Defra User Guide and the original DTCs proposal excluded analysis of pesticides due to the variety used within agriculture and the costs of sample analysis. Therefore pesticide management measures were not considered in the survey. Other research has examined pesticide management issues e.g. as part of the Voluntary Initiative, http://www.voluntaryinitiative.org.uk/en/home.

Table 4.2 Topics in the farm survey and the numbers of responses obtained through the use of face-to-face interviews and self-completed surveys.

	Eden		Wensum		Avon	
	Face to Face	Self-comp.	Face to Face	Self-comp.	Face to Face	Self-comp.
Farm Type	18		32		28	2
Farm size	18		13 [a]	19	38 [b]	
Soils, drainage and waterways	18		32		28	
Land tenure	18			19	27	
Environmental schemes	18		32		28	
Mitigation measures	18		32			23
Farm business and operational data	18			19	28	

[a] obtained from follow up telephone calls.
[b] 10 of which were obtained through Rural Land Register datasets

With respect to the mitigation measures, it was not possible to know the reasons as to why the activities had been undertaken or were likely/unlikely to be considered in the future. Nor was it possible to ascertain if an action was taken with or without external funding, or if an action considered in the future would depend upon funding. A more detailed investigation of the motivations and barriers for particular mitigation measures is presented in Chapter 6. The following section presents the results and describes the key findings of the farmer survey.

4.2 Farm survey results

4.2.1 Characteristics of surveyed farms and current uptake of measures

Eighty farms provided details regarding their farm type. Defra's Robust Farm classification system was used, but 'cereal' and 'general cropping' were grouped together as 'arable', as many of the arable farmers surveyed did not distinguish which of the two provided the greater income. June Census data (Defra, 2010a) for the main counties and unitary authorities encompassing each catchment (Defra, 2010a) were used to ascertain how representative the sample farms were in terms of farm type and size. The percentages of the survey sample and June census data in each of the four main farm type categories are shown in Table 4.3 along with the range and average farm size for each catchment's sample. In terms of farm size, for context, Table 4.3 provides detail of the proportion of land covered by the respondents within each catchment.

Table 4.3 Survey participants compared to annual June census data and farm size characteristics and the area of land managed by survey participants in each catchment.

	Farm Type				Area of land managed by survey participants (ha)	Total area of catchment (ha)	% of total catchment area covered by survey	Average farm size of participants (ha)	Average farm size in June census data 2012 (ha)	Farm size range of participants (ha)
	Arable	Dairy	Lowland Livestock	Mixed						
Eden	0%	28%	39%	33%	2,111	228,000	0.93	117	96	54 – 247
June census data [c]	8%	14%	23%	4%						
Wensum	59%	3%	13%	19%	13,091	65,000	20.14	410	117	14 – 2000
June census data [a]	56%	1%	16%	8%						
Avon	3%	21%	16%	37%	6,607	175,000	3.71	174	94	2 – 1400
June census data [b]	35%	4%	45%	7%						

[a] Norfolk
[b] Portsmouth, Southampton, Hampshire CC
[c] East Cumbria

The data highlights that mixed farms were proportionally more common in the survey samples than the census data. Nevertheless, the general differences in farming types between the larger areas covered by census data are reflected by the survey. In the Eden, lowland grazing livestock, mixed and dairy farms were well represented, in the Wensum the dominant farming system was arable, and amongst the Avon respondents, mixed and dairy were most common.

With respect to farm size the sample average for each catchment was greater than the corresponding value for the larger census area. This was a reflection of the way in which the survey focussed on recruiting full time professional farmers, though the details in Table 4.3 also indicate that there was a considerable size variation. Such variation provides greater insight into different farming businesses and highlights that considering average size alone does not describe the sample sufficiently.

Tenure data were collected from 61 farmers within the three catchments. The surveyed Wensum farms were predominantly owned, whilst the majority in the Eden were tenanted. In the Avon it was quite common for respondents to own land but also rent additional land. In order to simplify analysis, farms were categorised according to the dominant type of ownership, resulting in most Avon farms being classed as owned.

Questions regarding participation in AES and farming in designated areas were answered by a total of 78 respondents. It is important to highlight that a higher proportion of surveyed farms participated in AES compared to all farms in the administrative areas within which the catchments are located[1]. Of the three catchments, the Eden had the greatest percentage of farmers participating only in the Entry Level Stewardship scheme, but also the lowest share with Higher Level Stewardship agreements. In the Avon a third of the respondents had a SSSI on their farm, reflecting the focus on chalk stream catchments. These statistics suggest that the survey respondents were more engaged with environmental schemes than the wider farming community, potentially influencing their responses. Seventy-seven farmers were asked whether they had engaged with their local CSFO as this was anticipated to potentially influence on their responses (due to the advice CSFOs provide on WPA measures). Forty-five participants responded in the affirmative (89% in Eden, 44% in Wensum and 56% in Avon).

The various methods for survey recruitment (Section 4.1.2) caused the sample to be unrepresentative of the population but any resulting bias in the profile of the sample does not jeopardise the aims of the study because it is still revealing of farmers' responses. Engaging with disengaged farmers has been a difficulty for researchers and advisors (CSF Evidence Team, 2014). However, if the results show that the more environmentally-minded farmers who make up the sample are reluctant to adopt certain measures, this suggests that there would be even greater challenges to increasing uptake in the wider farming population.

Current uptake of mitigation measures by farmers

Questions regarding mitigation measures were completed by 73 farmers. For each relevant measure, the participant indicated 'yes' or 'no' as to whether they currently do it. The number of farmers adopting each of the 86 measures from the Defra User Guide are displayed in Figure 4.1 in descending order of frequency of uptake. Not all measures were applicable to all farmers surveyed, resulting in fewer responses for such measures. Overall, current uptake greatly varied across the 86 measures.

Measures which were compulsory for farmers to implement as part of CAP Cross Compliance for the SFP are highlighted in Figure 4.1 along with measures which, according to the Defra User Guide, have no substantial benefit to water quality, rather they mitigate GHG emissions. It is clear that these two sets of measures cluster at opposite ends of Figure 4.1 with compulsory measures related to manure and fertiliser management, not surprisingly, having the highest uptake. One other widely adopted measure - *fertiliser spreader calibration* - stands out by not being highlighted. Consultation with agronomists confirmed that although this measure was not part of Cross Compliance, there has been a significant drive for farmers to practice fertiliser calibration in NVZs.

[1] Of the Eden farmers surveyed, 100% participated in AES compared to 68% of Cumbrian farmers, 88% of Wensum farmers surveyed compared to the 59% in Norfolk, and 78% of surveyed farmers in the Avon compared to 44% in Hampshire. Details available at: http://publications.naturalengland.org.uk/category/3555892.

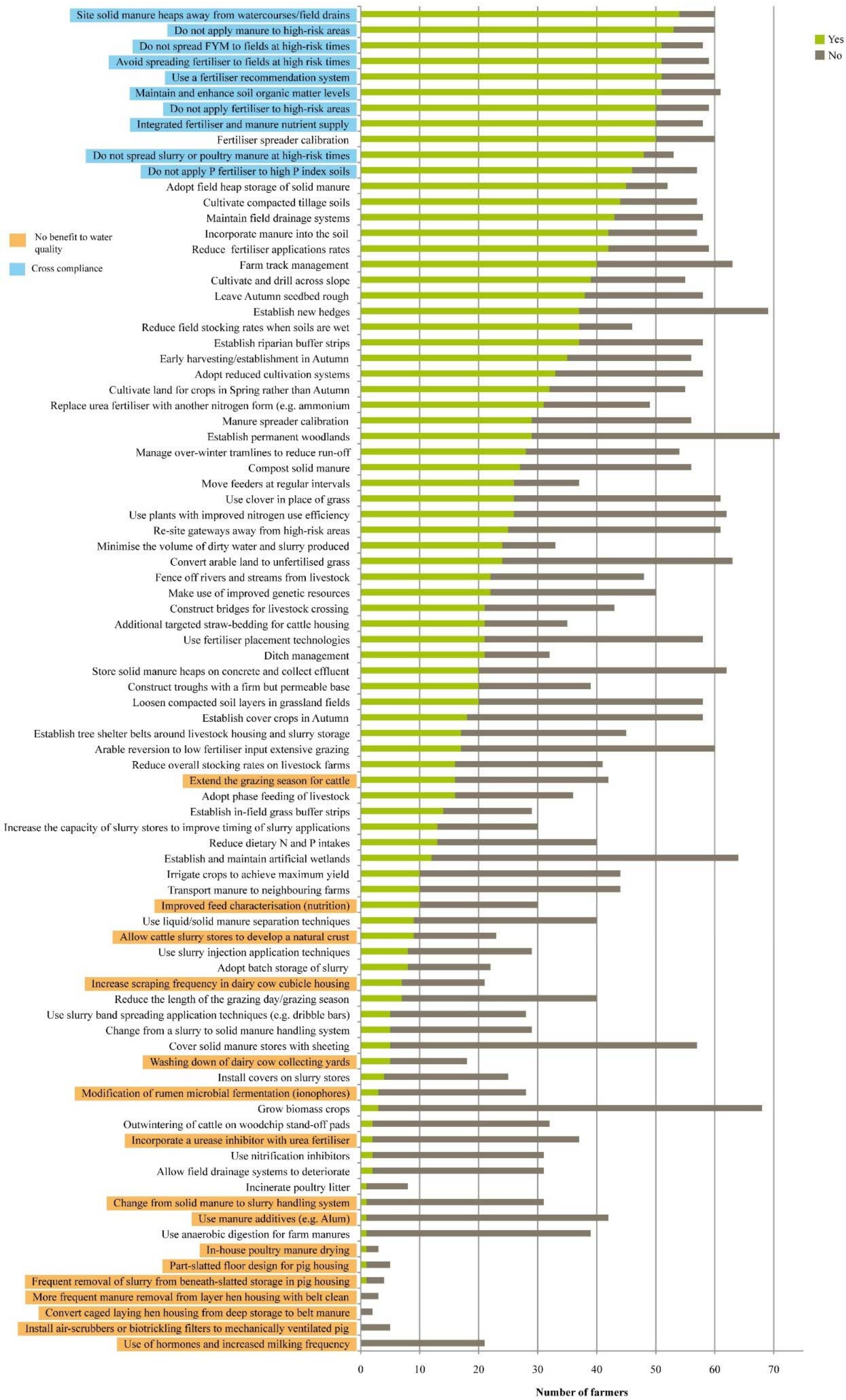


Figure 4.1 Current uptake of mitigation measures from the Defra User Guide.

Uptake of highly applicable measures

The measures of greatest interest to this research were those related to WPA mitigation which farmers had a *choice* to adopt (predominantly found in the mid-section of Figure 4.1). To assess the measures of interest in more detail, the measures which were applicable to 75% or more of the farmers surveyed were defined as 'high applicability' and their current adoption and future attitudes are summarised in Figure 4.2.

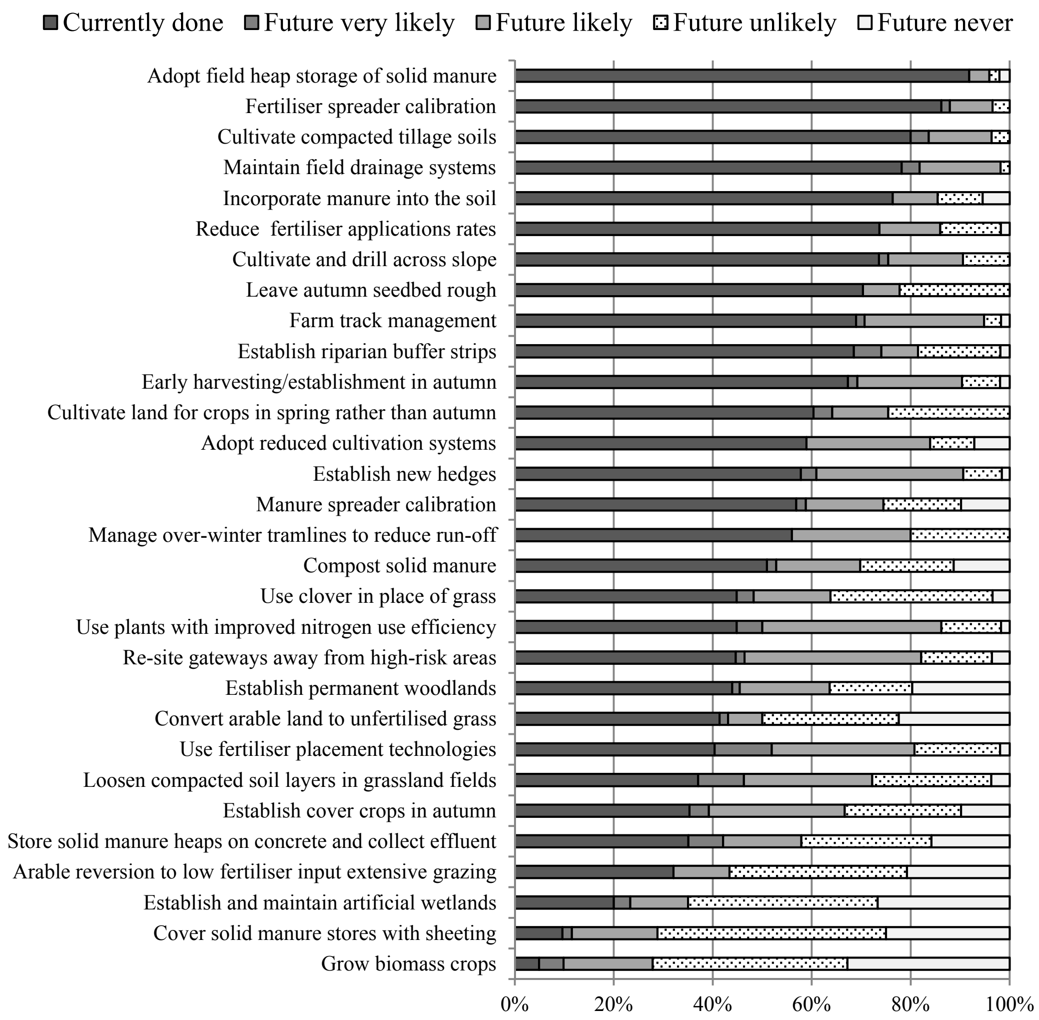


Figure 4.2 Adoption and attitudes to uptake of discretionary WPA mitigation measures applicable to ≥75% of surveyed farmers.

Some of the 30 measures in Figure 4.2 are supported by AES or other incentives, but a number of those towards the top of the list also provide an insight into what is considered as general good farming practice. Examples include *cultivating compacted tillage soils* and *maintaining field drainage systems*. It is also important to recognise that what is regarded as the 'norm' is likely to vary between catchments. For instance, reduced tillage methods were relatively common amongst arable farmers in the Wensum, but not in the other two catchments.

Influences on measure uptake

As Chapter 2 highlighted many factors can influence behaviours, it was acknowledged that certain characteristics of the survey participants will be linked to the uptake of measures. Chi-square tests were performed to examine associations between uptake of particular measures and variables such as participation in AES, CSF engagement, farm size, tenure, catchment and farm type. The results are discussed in subsequent sections of this chapter, but it is worth noting here that the sample size did not permit more complex statistical analysis of multiple influences on uptake.

Farmer AES participation was examined to assess whether this influenced uptake. As the great majority (87%) of surveyed farmers participated in Entry Level Stewardship, only Higher Level Stewardship participation (40%) was assessed and found to be significantly positively associated with four measures (Table 4.4).

Table 4.4 Mitigation measures Higher Level Stewardship participants were more likely to adopt than non-participants.

Mitigation measure	x^2	p≤
Establish permanent woodland	4.58	0.05
Riparian buffer strips	3.22	0.07
Establish new hedges	7.00	0.01
Compost solid manure	2.86	0.1

Engagement with a CSFO was hypothesised to strongly correlate with measures encouraged through the CSF Capital Grant Scheme (predominantly farm infrastructure or manure management focussed). Of the measures included in the grant scheme and featured in the survey, *re-siting gateways* and *farm track management* experienced the highest level of adoption. A weak positive association was found between CSFO engagement and adoption of *storing solid manure heaps on concrete* ($x^2 = 2.75$, d.f. = 1, $p \leq 0.1$).

Comparing farm size, the larger surveyed farms (>200ha) were more likely to have *established permanent woodland, riparian buffer strips, farm track management,* and the most significant at $p < 0.01$ was to *establish new hedges*. Many of the larger farms were arable and from the Wensum, both variables which could have also influenced responses.

Another characteristic assessed was farm tenure which can heavily influence: 1) the willingness to invest time or finances into adopting measures and 2) the number of people involved in making decisions (Mills et al., 2013). Farm infrastructure measures were more likely to have been implemented by farmers who owned their farm, but the difference was not statistically significant.

Comparison between catchments also revealed variation in current uptake, especially amongst mixed farmers. A higher uptake of *fencing rivers, re-siting gateways*, and *using clover in place of grass* was found in the Avon as opposed to mixed farms in the other two catchments, whilst no mixed farms in the Eden had adopted *reduced cultivation systems* compared with the high uptake found in the Wensum.

Variations in uptake by farm type

Responses from farmers within each of the four farming systems are considered in the following subsections. Measures found at the extremities of current uptake (high and low) are highlighted, whilst those found in the middle (with 25% to 75% current uptake) being discussed in Section 4.2.3 concerned with future uptake.

Arable Farms

Almost all of the 20 arable farmers who participated in the survey came from the Wensum catchment, with the exception of one from the Avon. The most popular measures with 100% current implementation amongst arable farmers could be considered as 'good farm practice' such as *fertiliser spreader calibration*. Other measures which were carried out by 100% of arable farmers, but by a much smaller percentage of mixed farmers growing crops, included *incorporating manure into the soil* and *reducing fertiliser application rates*.

Lowland Livestock Farms

The distribution of livestock farmers was more evenly spread between catchments compared to the arable category (four in the Wensum, four in the Avon and six in the Eden). Measures with high uptake included *reducing stocking rates when fields are wet*, as well as *farm track management* which 70% stated they had carried out. *Moving feeders at regular intervals* was implemented by 64%, whilst measures with low uptake included *covering manure with sheeting* and only 14% had *established new hedges* (compared with 54% of all surveyed farms).

Dairy Farms

Several measures in the Defra User Guide are targeted at dairy farms but are not considered in this report as they focus on reducing air pollution and GHG emissions. Ten dairy farmers in total were surveyed, with only one located in the Wensum. With such a small sample, interpretation of results must be treated with caution.

Many dairy farmers claimed to currently *minimise the volume of dirty water and slurry produced*, but few responded 'yes' to other measures which would help to do this. The one exception was *extension of the grazing season* which nearly three-quarters of those who claimed to minimise volume of dirty water also adopted. Other measures which can help reduce volume - such as *covering slurry stores* and *using liquid/solid separation techniques* - had very low rates of uptake. Another uncommon measure was use of an *anaerobic digester,* with none of the dairy farmers currently operating one.

Mixed farms

The 19 mixed farms surveyed came from all three catchments. As there were at least five in each catchment some comparisons can be made between the three areas.

A higher uptake of *fencing rivers and streams* was found in the Avon compared to the Wensum. *Re-siting gateways* was much less common in the Wensum than the other two catchments with only one of six farmers stating they had made such a change. *Reducing overall stocking rates* and *using clover in place of grass* was far more common in the Avon than in the other two catchments. No mixed famers in the Eden had adopted *reduced cultivation systems* compared with the high uptake in the Wensum.

Current uptake summary

The current uptake of individual mitigation measures was found to be varied. The limited sample size restricts the scope for statistical analysis, but some particular differences in practice by farm type and catchment were apparent. Wensum arable farmers acted relatively uniformly compared to mixed farmers growing crops in the other two catchments. Similarly, uptake of infrastructure measures for livestock farming differed amongst catchments. Assumptions regarding farmer behaviour cannot be made solely on the basis of farm type, but some consistency was evident within catchments.

4.2.2 Attitudes to future uptake of measures

Attitudes to measures which were applicable to ≥75% of farmers surveyed can be found in Figure 4.2. The measures of most interest are those with a mid to low current uptake. Knowledge of whether attitudes are more inclined towards positive or negative future adoption can help inform the use of appropriate policy mechanisms and the effort that may be required to encourage uptake. Results for measures which are applicable to all farmers are discussed first, followed by subsections presenting the results for measures relevant to each of the four farming types.

Attitudes to land use change and farm infrastructure measures

Many of the land use change and farm infrastructure measures are applicable to all farm types. When considering land use change the measure most likely to be adopted in the future by the farmers surveyed was the *establishment of woodland*. However, overall, land use change measures appeared to be among the least popular for future adoption. Changes to land use may be perceived as too 'radical' for a farming business, thus resulting in negative attitudes. Similar to land use change, farm infrastructure options may involve large commitments on the part of the farmer. Despite this, several measures such as *farm track management*, *establishing new hedges* and *re-siting gateways* all generally gained positive responses from farmers who had not already adopted them.

As with current uptake, attitudes varied between the different farm types. Tables 4.5 and 4.6 summarise the current uptake and attitudes towards future adoption for measures which were applicable to over 70% of the farmers within each farming type. The measures are divided into four groups, separating measures with current high uptake and little scope for future uptake from those with medium to low uptake. The latter have been divided into three categories according to attitudes regarding future adoption: generally positive; mixed opinions and those which farmers commonly would be unlikely to consider implementing. The key points from Tables 4.5 and 4.6 are described within the following subsections.

Table 4.5 Summary of surveyed arable and livestock farmers' current uptake and attitudes towards future adoption of WPA mitigation measures.

	High current uptake (≥ 75%)	Medium to low uptake, positive future attitudes	Medium to low uptake, mixed future attitudes	Medium to low uptake, negative future attitudes
Arable	• Cultivate and drill cross slope • Establish riparian buffer strips • Early harvesting/establishment in autumn • Cultivate compacted tillage soils • Reduce fertiliser applications rates • Fertiliser spreader calibration • Adopt field heap storage of solid manure • Incorporate manure into the soil • Adopt reduced cultivation systems • Maintain field drainage systems • Farm track management • Establish new hedges • Leave autumn seedbed rough	• Use fertiliser placement technologies • Re-site gateways • Manage over-winter tramlines	• Establish permanent woodlands • Use plants with improved nitrogen use efficiency	• Establish cover crops in Autumn • Loosen compacted soil layers in grassland fields • Grow biomass crops • Store solid manure heaps on concrete and collect effluent • Cultivate land for crops in Spring rather than Autumn • Use clover in place of grass • Irrigate crops to achieve maximum yield • Replace urea fertiliser with another nitrogen form (e.g. ammonium • Convert arable land to unfertilised grass • Cover solid manure stores with sheeting • Arable reversion to low fertiliser input extensive grazing • Establish and maintain artificial wetlands
Lowland livestock	• Reduce field stocking rates if soils are wet • Adopt field heap storage of solid manure	• Re-site gateways • Move feeders at regular intervals • Farm track management	• Establish new hedges • Establish permanent woodlands • Construct troughs with a firm but permeable base • Fence off rivers and streams • Compost solid manure	• Manure spreader calibration • Cover solid manure stores with sheeting • Establish and maintain artificial wetlands • Grow biomass crops • Reduce overall stocking rates • Store solid manure heaps on concrete and collect effluent • Construct bridges for livestock • Establish tree shelter belts around livestock housing and slurry storage

Table 4.6 Summary of surveyed Dairy and mixed farmers' current uptake and attitudes to future adoption of WPA mitigation measures.

	High current uptake (≥ 75%)	Medium to low uptake, positive future attitudes	Medium to low uptake, mixed future attitudes	Medium to low uptake, negative future attitudes
Dairy	• Reduce field stocking rates if soils are wet • Maintain field drainage systems • Fertiliser spreader calibration	• Use anaerobic digestion for farm manures • Reduce fertiliser applications rates • Minimise volume of dirty water and slurry produced • Construct bridges for livestock • Use fertiliser placement technologies • Install covers on slurry stores • Use slurry injection application techniques • Additional targeted straw-bedding for cattle housing • Fence off rivers and streams • Adopt reduced cultivation systems • Store solid manure heaps on concrete & collect effluent • Re-site gateways • Use clover in place of grass • Increase the capacity of slurry stores • Use nitrification inhibitors • Reduce dietary N and P intakes • Establish new hedges • Farm track management • Loosen compacted soil layers in grassland fields • Cultivate compacted tillage soils • Make use of improved genetic resources • Use plants with improved nitrogen use efficiency • Ditch management • Incorporate manure into the soil	• Cover solid manure stores with sheeting • Establish tree shelter belts around livestock housing and slurry storage • Transport manure to neighbouring farms • Establish and maintain artificial wetlands • Manure Spreader Calibration • Establish riparian buffer strips • Compost solid manure	• Allow field drainage systems to deteriorate • Grow biomass crops • Establish permanent woodlands • Out-wintering of cattle on woodchip stand-off pads • Reduce length of grazing day/grazing season • Reduce overall stocking rates • Construct troughs with a firm but permeable base
Mixed	• Cultivate land for crops in Spring rather than Autumn • Cultivate and drill across slope • Incorporate manure into the soil • Farm track management • Fertiliser spreader calibration • Reduce field stocking rates if soils are wet • Cultivate compacted tillage soils • Adopt field heap storage of solid manure	• Adopt reduced cultivation systems • Use plants with improved nitrogen use efficiency • Make use of improved genetic resources • Establish new hedges • Maintain field drainage systems • Establish cover crops in Autumn • Use fertiliser placement technologies	• Move feeders at regular intervals • Manage over-winter tramlines • Reduce fertiliser applications rates • Establish tree shelter belts around livestock housing and slurry storage • Establish permanent woodlands • Fence off rivers and streams • Manure Spreader Calibration • Establish riparian buffer strips • Loosen compacted soil layers in grassland fields • Re-site gateways • Compost solid manure • Early harvesting/establishment in Autumn	• Grow biomass crops • Arable reversion to low fertiliser input extensive grazing • Establish and maintain artificial wetlands • Reduce length of grazing day/grazing season • Convert arable land to unfertilised grass • Store solid manure heaps on concrete and collect effluent • Use clover in place of grass • Cover solid manure stores with sheeting • Reduce overall stocking rates

Attitudes of arable farmers

Several of the soil management options relevant to arable farmers are very reliant on being suitable for particular soil types e.g. *leaving autumn seedbeds rough*. Others are dependent upon field size, crop rotation or topography. Many in-field measures which would require a change in the crop rotation or overall farm management received negative responses for future adoption. For example, the results suggest that altering the timing of cultivation or crop type for the *establishment of cover crops* would be unlikely to occur on arable farms. However, *managing overwinter tramlines* is an in-field measure which received positive responses for future uptake.

Many of the fertiliser management measures received highly positive attitudes to future adoption. In recent years the cost of fuel and fertiliser along with unpredictable weather has resulted in a more cautious approach to usage. Many farmers surveyed did not want to waste fertiliser and stated they are likely to *reduce application rates*. New technologies such as *variable rate fertiliser placement* and *improved genetics of N efficiency in crops* received positive attitudes for future adoption across the board; however several comments were made during interviews regarding the difficulty of justifying the expense of machinery when it was believed the strength of evidence regarding effectiveness was weak.

Attitudes of lowland livestock farmers

Overall, there were more negative responses regarding the future uptake of livestock related measures compared to arable measures. Changes to farm practices may not be as popular for the livestock farmers surveyed as the majority were tenant farmers making it more difficult to implement change. The uncertainty of the economic environment for stock prices at the time (Figure 1.2d) also possibly contributed to caution regarding measure uptake.

Farm infrastructure measures relating to keeping livestock out of rivers e.g. through fencing, received polarised responses for future uptake along with the measure *having troughs with a firm but permeable base*. Measures which could provide substantial improvements to reduce soil erosion received positive attitudes, such as *moving feeders at regular intervals*, *farm track management* and *re-siting gateways*.

Reducing overall stocking rates is very effective in reducing many target pollutants if the land is too intensively farmed (Newell-Price et al., 2011). The issue of food security was raised by farmers during face-to-face interviews as increasing demand for local British meat existed. Nearly 40% of farmers had already reduced their stock, however all but two responded negatively regarding future reductions.

Attitudes of dairy farmers

The results indicated that the dairy farmers surveyed wanted to improve their current manure management as many of the measures in this category gained positive attitudes for future uptake. *Covering slurry stores* and *increasing storage capacity* were considered likely actions in the future and the majority were considering the use of *anaerobic digesters*.

Establishing woodland received the most negative responses from dairy farms compared to any other farming type, but they gave more positive responses for other measures such as *fencing off watercourses* and *using clover in place of grass*.

Attitudes of mixed farmers

The responses from the mixed farmers were relatively mixed in themselves, as illustrated in Table 4.6. Some measures which arable farmers rated negatively received positive answers from mixed farmers e.g. *cover crops in autumn*, and some measures received similar positive results to arable farmers, such as the *use of fertiliser placement technology*. An example of a measure which predominantly gained negative responses from a third of farmers was *using clover in place of grass*. Unlike dairy farmers, the mixed farmers predominantly provided negative responses regarding future uptake of manure management measures. One example was the use of *anaerobic digestion* for farm manures.

Comparing mixed farms between catchments, Avon farmers practiced more measures overall than the other two catchments and provided more positive responses for future uptake. All mixed farmers in the Wensum were unlikely to adopt *manure spreader calibration* in the future, but all those in the Eden stated they would be likely to do so. Such differences emphasises the importance of not categorising farmers merely by farm type when conducting research.

The attitudes to future uptake of mitigation measures amongst farmers showed consistencies amongst farm types when considering each catchment individually and identified a number of measures with considerable potential for policy mechanisms to encourage future uptake. Nevertheless, the limited sizes of sub-samples means that some caution is needed when interpreting the findings. To complement these results, findings regarding the farmers' priorities are presented in Section 4.2.3.

4.2.3 Farmer mitigation measure priorities

To gain further insight into farmer attitudes towards WPA mitigation measures, participants were asked to prioritise three measures they would like to implement on their farm. Sixty-five farmers provided responses, with a fifth being content with their current farming practices and providing no priorities. The majority of farmers with no priorities came from the Wensum catchment, had engaged with a CSFO and were in Entry Level Stewardship. In livestock areas it was interesting to discover that even some of those who believed they had nothing further to change on their farm did not do some important measures such as *cover their manure*.

Priorities stated have been categorised by a) management type and b) location on farm and displayed in Figure 4.3. Over half the priorities involved changing part of the farm infrastructure, with measures predominantly being within the farmyard.

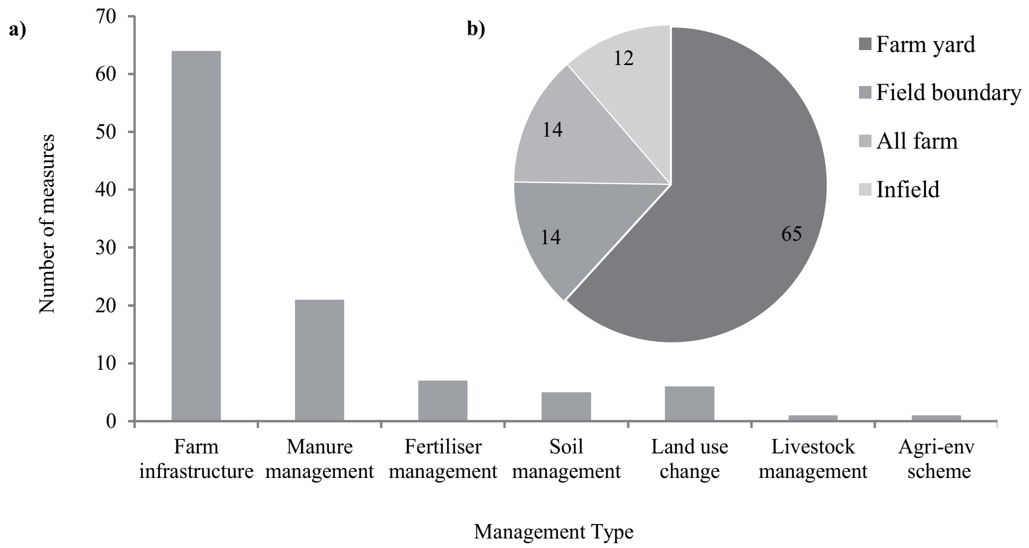


Figure 4.3 The frequency of priority measures mentioned by surveyed farmers.

Considering the measures prioritised, Table 4.7 lists the 10 most commonly cited priorities. Responses focussed on additional concreting, with a variety of uses raised. For example, concrete for manure heaps, diverting dirty water and track repair. Improved fertiliser and manure management ranked second, encompassing options related to correct timing and application efficiency. Covers and storage capacity for manure and slurry was also of high priority for farmers surveyed.

Table 4.7 The most commonly cited priority mitigation measures.

Mitigation measure	Overall Frequency
Concreting	17
Fertiliser and manure management	14
Increase manure/slurry storage	11
Manure/ slurry storage cover	11
Roofing in farm yard	9
Biobed	8
New Machinery or buildings	8
Fencing/repair walls	6
Collect rainwater	4
Plant trees/hedges/grass strips	4

Responses from farmers within the three catchments varied. There was interest, predominantly in the Wensum, for the establishment of a biobed to collect waste water from farmyard wash-down areas (an option not included in the Defra User Guide). In the Avon, application of fertiliser and manure, along with covering manure were seen as a priority, compared to the overarching importance for farmyard roofing and increased storage facilities for manure and slurry in the Eden.

4.3 Discussion

The results from the baseline farmer survey provided an insight into: the existing uptake of WPA mitigation measures amongst farmers in the three DTC catchments; their attitudes towards future adoption of measures, whether positive or negative and what they prioritise implementing on their farms. In the following section, the findings are placed into a wider context through comparisons with other surveys and suggestions are made regarding the implications of the results for AES design and policy.

4.3.1 Comparison of results with other surveys

As one of the ultimate objectives of the survey was to inform national policy and therefore have the ability to scale up research findings, it was deemed important to compare the results from the baseline survey with those from the wider literature. Focusing on national and regional farm surveys allowed assessment of similarities and the nature of any contrasts. Caution must be taken when making such comparisons, given possible variations in survey timing, sample composition and terminology used. Key WPA mitigation measures from Section 4.2 with the potential for wider adoption have been selected for particular attention, with similarities and differences between surveys discussed below.

National survey results

Two annual national farmer surveys can be compared to Chapter 4's baseline survey. These are the Farm Business Survey which provides information on the financial, physical and environmental performance of farm businesses in England[15], and the Farm Practice Survey which looks at how English farming practices are affected by current agricultural and environmental issues[16]. Neither of these surveys assesses a list of WPA mitigation measures which is as comprehensive as the one included in this study, however they do offer an insight into behaviour and attitudes regarding particular measures. Both the Farm Business Survey and Farm Practice Survey for the years 2009 - 2012 corroborate the message highlighted within this report that a great variation in measure uptake exists.

The 2010 Farm Practice Survey (Defra, 2011) surveyed over 10,000 farms with the results consistent with those of the DTCs survey regarding high uptake of fertiliser management measures (for example, fertiliser calibration), and low uptake of manure storage measures (for

[15] https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs/series/farm-business-survey

[16] https://www.gov.uk/government/organisations/department-for-environment-food-rural-affairs/series/farm-practices-survey

example, storage cover or plans to enlarge, upgrade or reconstruct storage facilities). The low popularity of manure storage measures also reflects similar results in a Scottish farmer survey (Barnes et al., 2009).

In a similar manner to the DTC survey, the Farm Practice Survey and Farm Business Survey results indicate that measures which are compatible with current farm practices are more widely adopted compared to those which are perceived as more radical changes. This is illustrated by livestock farmers having a high uptake rate for *reducing stocking rates when soils are wet* (Defra, 2010b) and a very low uptake rate for the measure of *using an anaerobic digester* (Defra, 2011). It is also apparent that the perception of what constitutes as 'normal farm practice' or an 'environmental measure' may influence farmers' behaviour and attitudes. For instance, a survey investigating East Anglian arable farmer's attitudes to environmental management found that participants believed environmental activities should take place at field boundaries (Mills et al., 2013). However, many of the measures in the DTC survey that arable farmers were found to be currently adopting involved in-field management. These encompassed several that could be classed as 'normal practice' and included *cultivating compacted tillage soils* or *across slope*. This difference implies that if environmental management is perceived as somehow separate from farming then measures involving field boundaries are more likely to be favoured, whereas if something is considered 'normal practice' then it would be more likely to be adopted.

In terms of surveys investigating the likelihood of future measure uptake and farmer priorities, a limited amount of research exists for measures studied in this research. However, two examples are worth highlighting. Firstly, results from a CSF survey in 2012 supported the DTCs finding that improving farm infrastructure is a key priority amongst farmers (Environment Agency, 2013). The second example illustrates changes over time with the 2011 Farm Practice Survey reporting only 3% of farmers planned to have an anaerobic digestion in the future (Defra, 2011), whereas the DTC survey found nearly a third stating they would be likely to - with the greatest interest from dairy farmers. This change may well reflect differences in sample composition, but is undoubtedly also influenced by rapid changes in policy regarding renewable energy incentives (Biogas Info, 2014).

Regional comparisons of surveys results

In terms of overall measure uptake, the DTC survey found farmers in the Eden (North West) to have the lowest rate, whilst those in the Wensum (East Anglia) had the highest. These differences are in line with regional variations in the CSF survey on recommendation uptake (CSF Evidence Team, 2014). Not surprisingly, certain types of measure vary in adoption across the country, with some appearing to be normal farm practice only in specific regions. The DTC survey and the Farm Practice Survey 2012 (Defra, 2012b) both identified East Anglian arable farmers as having a far higher rate of uptake, and more positive attitudes, towards technological measures than the corresponding national averages. Examples of such measures include computer controlled, variable-rate, fertiliser spreaders and reduced cultivation methods (Defra, 2012c). Such common practices in East Anglia reflect the nature of the farming businesses and the favourable financial circumstances at the time, for many farmers compared to elsewhere (Defra, 2012d).

In terms of specific measures, surveys identified variation in uptake across the country. One example was the adoption of clover mixes. The 2012 Farm Practice Survey (Defra, 2012b) and DTC survey identified the South West as a region with the greatest proportion of farmers sowing 100% clover mixes. However, DTC results also suggest potential to increase uptake elsewhere, with dairy farmers in the Eden having positive attitudes towards sowing clover in the future.

4.3.2 Implications for agri-environmental policy

Policy makers face the challenge of re-designing mechanisms to effectively reduce WPA whilst ensuring policies deliver consistently across a range of other desired outcomes or societal needs (e.g. ecosystem services and national food security) (McGonigle et al., 2014). The findings of this study improve the evidence base regarding current farmer behaviours and attitudes towards possible future changes that mitigate WPA. Interpretation of the survey results also provides insights relevant for ongoing discussions occurring within government regarding the reformulation of agri-environmental policy. To assist in this process the mitigation measures investigated have been categorised into the following four groups:

i. High current uptake with little scope for future uptake
ii. Mid to low current uptake with positive attitudes for future uptake
iii. Mid to low current uptake with mixed attitudes regarding future uptake
iv. Mid to low current uptake with negative attitudes for future uptake

These categories can be linked to the policy mechanisms of the 4Es, a model which forms part of the Pike (2008) framework used to guide this research and described in Section 2.1. Figure 4.4 shows the four categories mapped on to the 4Es. Making such associations helps to inform policy decisions as to which mechanisms may be most appropriate to address internal and external barriers which prevent greater uptake of particular mitigation measures. Pike (2008) describes how regulatory and market-based instruments should focus on external factors making desirable behaviours easier/cheaper. He then discusses how internal barriers can be addressed through communication, advice and other engagement options to influence attitudes and social norms. To increase adoption of individual mitigation measures it is likely that varying proportions of the four mechanisms will be needed and deciding upon an effective balance of emphasis is considered to be crucial for policy success.

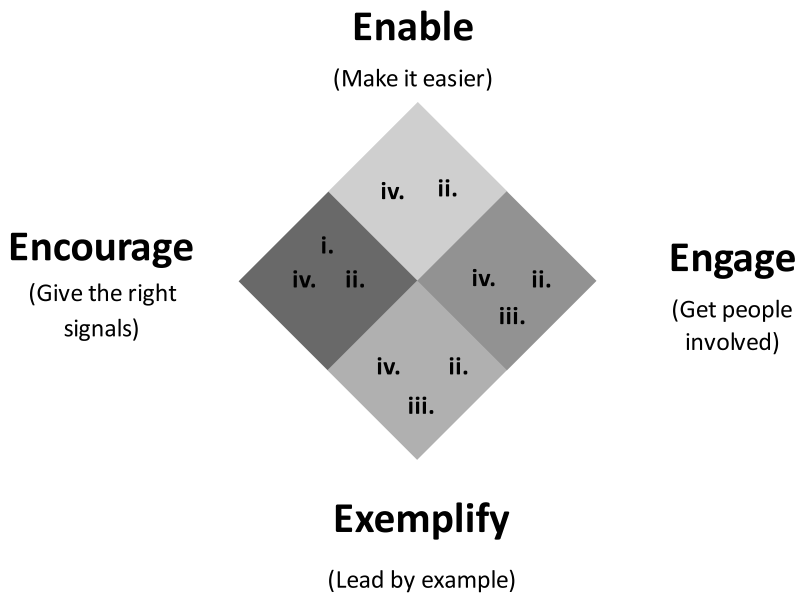


Figure 4.4 Mechanisms to increase the adoption of mitigation measures from the four categories of varying farmer uptake and attitudes to future uptake (i, ii, iii and iv). Adapted from Figure 2.5.

Measures in category (i) which already have a high uptake rate, such as *riparian buffer strips*, may have reached an upper limit in terms of adoption. For instance, many of the Wensum arable farmers who did not have them did not intend to introduce them. This potential saturation implies that the most effective policy options are probably those which lead to the measure becoming a 'social norm'. Consequently it is questionable as to whether efforts through incentives (enable) or advice delivery (engage) should be pursued to change the behaviours of the relatively small percentage of farmers remaining. Measures in this category would probably benefit most from a high proportional use of 'encouragement', for example through inclusion in the new greening options required under the CAP (see Section 9.2.1). Adequate evidence would need to be provided to justify the change of policy, as resistance or dissatisfaction can occur when using a regulatory approach (Barnes et al., 2009).

Certain mitigation measures had positive attitudes regarding future adoption (category ii) and were also named as priorities by survey participants. These are considered as measures where the Government could increase uptake through relatively simple mechanisms. Leading by example through providing good demonstrations (exemplify), raising awareness of benefits through initiatives such as CSF (engage), and small incentives (enable) would be anticipated to improve adoption. Measures in this category with positive attitudes included *using plants with improved nitrogen efficiency, reduced cultivation systems* and *re-siting gateways*, whilst those which farmers prioritised encompassed many forms of other infrastructure improvements. If offered as part of an AES, it could be anticipated that many farmers would choose to adopt such measures. However, it is likely that there would still be variations in uptake by farm type and location, in addition to varying factors such as suitability of soil type, weather conditions or availability of financial resources. This raises the question 'is AES the most effective mechanism to increase uptake?' and shows how important it is to consider each measure individually and the differing balance of the 4Es needed to increase uptake.

Measures with mixed and polarised views regarding future uptake (category iii) represent an opportunity for wider adoption but imply that higher levels of effort may be required to achieve the desired outcomes. A greater use and emphasis on *engage* and *exemplify* mechanisms could be of benefit for such measures. One example is the use of cover crops which were included in AES options from 2010, but have featured in relatively few agreements. However, providing advice about the wide variety of mixtures now available (e.g. Kings, 2014) and the long-term benefits of such crops for soil and nutrient management would be beneficial.

The measures in category (iv) with negative attitudes towards future uptake e.g. land use changes, are those where adoption seems unlikely to increase much within the current policy environment. As the evidence suggests there will not be a sudden uptake of such measures, substantial efforts through focused policy will be needed if there is a real desire for wider adoption. Even if a measure has received attention in the scientific community, such as *establishing and maintaining artificial wetlands* (Ockenden et al., 2012) and evidence from research suggests great environmental benefits, a combination of all four mechanisms is likely to be required. A chance to see a demonstration facility, speak to someone knowledgeable about implementation, and a grant incentive could all help to increase uptake. Simply including such measures within an AES may not have much effect on uptake, past experience suggesting most farmers would not select them within their agreements.

4.4 Conclusion

With many factors that influence farmer attitudes and behaviours continuously changing – CAP requirements, NVZ boundaries and rules, AES options, input costs, crop and livestock prices, the weather and the economy generally – it must be recognised that the survey presented in this chapter represents a snap shot of circumstances. Nevertheless, a particular merit of this survey is the investigation of 70 different WPA mitigation measures, offering the opportunity to assess farmer behaviours and attitudes to different options. The key points from the results include the great variability in current uptake of mitigation measures and the contrasts in behaviours and attitudes across farm types and the different catchments. These findings suggest that the growing momentum of CaBA (CaBA, 2015) and an associated shift towards allowing decisions to be made at local scales are steps in the right direction. This emphasis also needs to be reflected in the refinement of policy by facilitating more flexibility and increasing both spatial targeting and the use of different balances of mechanisms to support greater uptake of individual mitigation measures.

Insights from the survey have already been discussed with staff involved in the CSF initiative and Defra policy teams to help support their work, particularly through applying results to the model FARMSCOPER. Consequently this has informed Defra of realistic and potential future uptake of measures and guided their decisions during the CAP reform and re-design of AES (Defra, 2015e).

The baseline survey provides evidence of existing farmer behaviour and attitudes towards future adoption of a wide range of mitigation measures. However, the scoping nature of the baseline survey meant that there was limited opportunity to investigate why certain measures had been adopted or particular attitudes existed. Research focusing on the reasons behind adoption or non-adoption of mitigation measures was therefore carried out by this PhD and is presented in Chapter 6. Studying the role of different mechanisms, such as various sources of advice delivery, was also believed to help inform decisions as to where policy initiatives should be focused.

Chapter 5

Chapter 5 Farm advisor interviews: The roles of farm advisors in the uptake of measures

Chapter 4 illustrated a wide variety of mitigation measures exist which farmers can implement to reduce agriculture's impact on water pollution. The baseline survey within Chapter 4 discovered that some measures are already accepted as standard farm practice and widely adopted (e.g. not spreading manure or slurry to fields at high risk times) whilst others are implemented less widely (e.g. cover crops or biobeds). Pressure therefore exists for the Government to encourage the uptake of additional mitigation measures by engaging with and influencing farmers' behaviours to achieve public policy goals. The farmer behaviour and attitudes discovered in Chapter 4 could, in part, be due to interactions with advisors and their recommendations. Section 2.4 highlighted policies emphasis on advice as a means of increasing voluntary uptake of mitigation measures, the diversity of current advice provision and the limited existing data. The study presented within this chapter therefore sought to undertake a detailed assessment of the recommendations delivered by different advisors and the mechanisms they employed to increase the uptake of their advice. Through interviews with a diverse, fully representative sample of farm advisors across three contrasting regions in England, the main objectives were to discover:

- Which WPA mitigation measures are being recommended by advisors;
- How recommendations differ between sources of advice and whether they conflict;
- Which mechanisms (guidance on regulatory requirements, financial incentives, signposting or voluntary approach) are being used to influence uptake of mitigation measures.

This chapter firstly examines the available knowledge of WPA advice provision in Section 5.1, illustrating the need for greater research. Section 5.2 describes the methodology used for interviewing farm advisors, whilst Section 5.3 provides key findings and discussions. An overall conclusion in Section 5.4 considers the implications of the findings for policy makers regarding the provision of WPA advice and improving efficiencies and effectiveness of the advisory sector as a whole.

5.1 Current WPA advice provision

As WPA has risen up the policy agenda and various mitigation measures impact other aspects of a farming business, many areas of the industry have become involved in WPA advice dissemination. Government agencies, land agents, large agri-consultancies and independent specialists (for example in the fields of agronomy, veterinary care, feed supplies, and agri-chemicals) all offer advice regarding elements of WPA mitigation. Furthermore, even organisations and businesses not directly related to agriculture, such as environmental NGOs and water companies have realised the potential for influencing farming practice through delivering advice to farmers (Devon Wildlife Trust, 2012; Eden Rivers Trust, 2014; Inman, 2005; RSPB, 2014; Wessex Water, 2011).

Underlying this focus is the normative perspective that effective advice provision is that which results in changes of farm practice and adoption of additional mitigation measures. As one-to-one delivery is generally considered to be the most effective (AIC, 2013; Blackstock et al., 2010; CSF Evidence Team, 2014; Dwyer et al., 2007), it is therefore the focus of this research. Table 5.1 summarises the main providers of one-to-one advice to farmers from the government sector; not for profit environmental sector and the agricultural business sector.

Table 5.1 Farm advisors providing one-to-one advice in England.

	Source of WPA advice	**Main types of advice provision**
Government departments and agencies	Environment Agency (EA)	Regulatory advice on farm practices.
	Natural England (NE)	Agri-environment scheme options.
	Catchment Sensitive Farming Initiative (CSF)	Targeted WPA advice and capital grants.
	Forestry Commission (FC)	Tree planting and forestry legislation
Environmental organisations	The Farming and Wildlife Advisory Group[17]	Whole farm conservation
	Game and Wildlife Conservancy Trust	Game and wildlife conservation and shoot management
	RSPB	Farmland bird conservation and habitat management
	The Wildlife Trust (WT)	Species and habitat management advice/grants.
	The Woodland Trust	Tree planting and woodland maintenance advice/grants
	The Rivers Trust (RT)	Catchment scale projects delivering WPA advice/grants
Business sector	Large agricultural consultancies	Whole farm business advice
	Agronomists	Crop improvements e.g. through soil and pest management
	Veterinarians	Animal health and welfare
	Feed/seed/ chemical/machinery salesmen	Farm practices for best use of product
	Water companies	Each company has implemented a different strategy
	Auction houses	Whole farm business advice for livestock farmers
	Land agencies	Whole farm business advice

[17]FWAG is a not for profit organisation set up to provide independent environmental advice to farmers but went into administration in 2011 due to limited funds (http://www.fwagadvice..co.uk/). Former employees in different regions (e.g. the South West) were collaborating efforts to continue providing advice to farmers as a not for profit, whilst others established new advisory businesses, some of whom were applying for charitable status.

A key development in this area has been the role of the CSF initiative established in 2006. CSFOs targeting eighty priority catchments in England, provide free advice to farmers on mitigation measures and offer capital grant incentives to help encourage behaviour change (Natural England, 2014). CSF also collects evidence on scheme effectiveness. CSFOs record each recommendation made (approx. 112,000 over six years) into a central database and a survey contacts a sample of farmers to assess whether the advice was acted upon. Table 5.2 provides an example of the five most commonly recommended measures by CSFOs in three regions of England with contrasting farming systems.

Table 5.2 The five most commonly recommended WPA mitigation measures by CSFOs in the North West, South West and East Anglian regions of England over six years 2007-2013. Calculated from data supplied by John Douglas, CSF Evidence Team.

	Top 5 recommendations in each region	Frequency recommended	% of all regional recommendations
North West	Separate clean and dirty water from farm yards and roofs	1086	7
	Adopt and follow a nutrient management plan	1004	7
	Analyse soils regularly	930	6
	Do not apply P fertilisers to high P index soils	541	4
	Minimise the volume of dirty water produced and contain	523	4
	14,498 recommendations made in total		Total = 28%
East Anglia	Adopt recognised soil management plan	1587	4
	Adopt and follow a nutrient management plan	1462	4
	Analyse soils regularly	1372	4
	Analyse slurry and manure for nutrient content	1154	3
	Keep records of applications	1148	3
	38,171 recommendations made in total		Total = 18%
South West	Separate clean and dirty water from farm yards and roofs	2137	5
	Analyse soils regularly	1696	4
	Minimise the volume of dirty water produced and contain	1548	4
	Adopt and follow a nutrient management plan	1406	3
	Collect dirty water effluent from yard and return nutrients to fields	1235	3
	40,642 recommendations made in total		Total = 20%

Table 5.2 demonstrates obvious similarities and differences in recommendations being made in the different regions. *Analyse soils regularly* is a highly recommended measure in all three regions, along with measures which concentrate on fertiliser and nutrient management, and the reduction of dirty water production. The number and variety of recommendations varies between regions, partly reflecting the distribution of farm types and CSF priority catchments (14,498 recommendations in the North West to 40,642 in the South West).

To compare CSFO recommendations with other sources of advice, personal communications with three environmental organisations provided datasets. These datasets were of WPA mitigation measures which the organisations had implemented or recommended to farmers through advice, coupled with other mechanisms (e.g. grants, lending machinery, and AES agreements).The three organisations were: Eden RT; Westcountry RT and Devon WT. The Eden RT and Westcountry RT focussed on a broad range of mitigation measures, including farm yard infrastructure, nutrient management plans and tree planting. Whereas Devon WT concentrated on specific practices, such as low input grassland management to help obtain AES agreements for the farmer or to improve particular habitats designated by projects.

The CSF, RTs and WT data demonstrates the differences in organisations' recommendations, however, only a limited number of organisations record such details and it is recognised that there are some limitations in the completeness and consistency of the data. Consequently more systematic analysis was not feasible, and therefore provided further justification for the need to collect data on farm advisor recommendations.

5.2 Interview methodology

5.2.1 Study design

To gather data which would be comparable between different advisors, semi-structured interviews were conducted with set objectives and open questions. Open questions were used to allow greater context to be obtained. A technique suited for research seeking to identify peoples' experiences and discover thoughts, feelings, intentions and attitudes (Gillham, 2008), thus gaining a deeper understanding of their role for providing WPA advice to farmers and their techniques.

Exploratory in-depth interviews with various experts in the field of farm advice and farmer attitudes/ behaviours were conducted to support development of the study design. Independent agri consultants, RT staff, the CSF evidence team, academics and experts from within government were consulted to clarify research objectives and question structure. Pilot interviews were then conducted with four CSFOs based in catchments outside of the study areas.

Interviews were structured around the question topics listed in Table 5.3, with greater detail of the interview questions and layout found in Appendix B.1. In the first section, the interview focused on gaining an understanding of the advisor's employment and background. The second section investigated the methods used by the advisor to deliver advice and target farmers. In the third, the focus was on the advice delivered, asking which WPA mitigation measures are recommended, whether any conflicting suggestions had been encountered and whether uptake was monitored. The final section sought personal opinions on what individuals believed influenced farmer uptake of their advice and what their niche was in the advice sector.

Table 5.3 Question topics for the semi-structured interviews with farm advisors.

1	Employment and background
2	Farm types advice is delivered to Method of advice delivery and targeting of advice
3	WPA mitigation measures recommendations Other advice provided Examples of conflicting advice with other advisors Monitoring uptake of advice
4	Mechanisms to influences advice uptake Niche of the advisor in the sector

5.2.2 Advisor sample

To select advisors for interviews, the UK AKIS report (Prager and Thomson, 2013) was first consulted, leading to a web based search to identify whether the listed bodies deliver one-to-one advice. Furthermore, existing knowledge and consultation with CSFOs in various catchments helped identify suitable individuals and organisations to interview. To provide a complete picture of the sector, the research aimed to include advisors from as many different organisations as possible, as well as capturing the diversity of advice within them. Therefore, interviews with more staff from particular organisations were sought when multiple perspectives existed.

To enable generalisations to be made from the interview findings, a comparative framework was designed. Advisors were categorised dependent upon their geographical location and employer: the public sector (government); not for profit environmental organisations (environment); or private agriculture sector (business). Selecting advisors from similar localities was fundamental as the farming landscape varies greatly and with it advice. Interviews were carried out with advisors in three regions of England (Figure 5.1). These three regions were selected to cover the four main farming types, DTC catchments and reflect the different physical and socio-economic factors which influence agricultural activities. The farming systems were: arable in East Anglia; lowland livestock in the North West; and dairy and mixed farms in the South West. Within each region, only advisors who predominantly deliver advice to the relevant main farm type were contacted. Such purposive sampling meant that advisors who advise farmers in the pig and poultry industry were excluded from the study, as were advisors in each region who targeted the less dominant farming systems (e.g. livestock in East Anglia). Although a limitation, this sampling strategy was necessary for the pragmatic reason that it would produce findings of most use to the majority of advisors and policy makers.

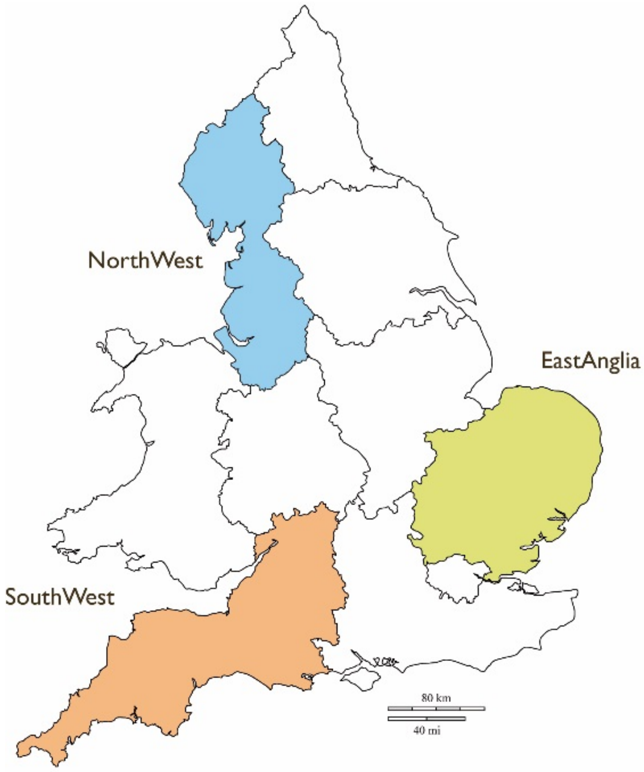


Figure 5.1 The regions of England where farm advisors were interviewed.

5.2.3 Data collection

Advisors were selected and initial contact was made through email to introduce the research project. Of those contacted, 83% agreed to participate and interviews were then arranged to be conducted over the phone or face-to-face. The semi-structured format of the interviews and the manner in which discussions took place, justified the use of both face-to-face and telephone data collection (Roberts, 2007; Sturges, 2004). A single interviewer conducted all interviews to ensure consistency in the procedure. Interviews occurred between August and October 2013, when advisors generally experienced a lower demand of work load from farm visits. Interviews lasted 40-60 minutes and occurred in privacy to avoid any external influences biasing responses.

Dictaphone recordings and hand written notes were taken during both face-to-face and telephone interviews when possible. Transcripts were typed the same day, ensuring any extra thoughts from the discussion could be added to the transcripts.

5.2.4 Data analysis

To analyse the results obtained, transcripts were coded and imported into the statistical analysis software SPSS® version 22 (IBM Corp, 2013). Responses regarding recommended measures were allocated to one of thirty-five categories. Numerous responses were similar in vocabulary and thus simple to categorise e.g. soil analysis, however, on occasion, novel recommendations were mentioned which did not fall into the common categories and thus placed in their own. Summary tabulations were created to identify what advice was recommended most frequently and by whom. To enable comparisons between the various organisations, a Multidimensional Scaling tool PROXSCAL (PROXimity SCAling) was used, as this can be very useful in highlighting relationships within data (Young, 1987; Garson, 2012) and is more flexible for visualising and data analysing than other methods such as ALSCAL (Jung and Takane, 2015). PROXSCAL is often used in fields such as ecology and psychology (Borg and Groenen, 2005; Gatrell 1983), and has been previously used to visualise correlations in survey responses (e.g. Grunert et al., 2012). In this study PROXSCAL was used to compare individual advisors in terms of the measures they recommended and then derive an overall proximity matrix indicating the degrees of difference between them. The same data were also used to assess the similarities between measures in terms of which advisors recommended them.

PROXSCAL processes the proximity matrix to generate a variety of outputs, including x,y coordinates for each input entity (e.g. individual advisor) which position them in a two dimensional conceptual space so that, for example, advisors who made similar types of recommendations were located close together and those with little or no overlap were spaced much further apart. To compare the similarities in recommendations between groups of advisors (e.g. all CSFOs), one standard deviation ellipses were created in ArcGIS using the advisor co-ordinate positions derived from the PROXSCAL output. The sizes of ellipses indicated the variability in the recommendations made by a group of advisors, with compact shapes where they were all similar and much larger where they were diverse. Since the ellipses were based on only one standard deviation around the mean co-ordinate position for each group they essentially defined the core area of interest (e.g. in terms of common recommendations), but with some individual advisors likely to be situated outside their boundaries. Comparing the shapes, size, overlap and location of the various ellipses helped to visualise differences between groups of advisors and to inform interpretations of results.

5.3 Results and discussion

5.3.1 Advisor characteristics

Across the three regions, 81 advisors were interviewed, of which 29 were CSFOs (Table 5.4). When asked about their previous jobs, the majority came from a job either in the environmental or agricultural sector, and only 7% had education in both.

Table 5.4 The number of farm advisors interviewed from each group in the three regions.

		Catchments		
		East Anglia (Arable)	North West (Livestock)	South West (Dairy/mixed)
Government	Environment Agency (EA) Natural England (NE) CSFO Forestry Commission (FC)	14	12	14
Environment	FWAG [a] RSPB Wildlife Trust (WT) The Woodland Trust Rivers Trust (RT)	5	9	11
Business	Large agricultural consultancies Agronomist Veterinarians Seed salesmen Auction houses Land agencies Feed nutritionist FWAG [b]	6	4	6
	Total	25	25	31

[a] in the South West
[b] in the North West and East Anglia

5.3.2 Methods to target advice

Many differences were found in the way advisors were operating to target farmers for advice. For instance, Natural England proactively target farms suitable for Higher Level Stewardship agreements but are reactive when farmers request consent for particular farm practices within AES agreements. Many advisors in the business category claimed they were reactive when undertaking a public sector contract but proactive for private clients, especially true for sales representatives who target large farms for the opportunity to sell more. Two of the RTs explained they first target larger dairy farms near rivers by driving around their catchments and looking for issues, whereas a WT in the North West used aerial photographs to identify potential farmers to target. Overall, 65% of advisors were both reactive and proactive for providing advice, but only 9% stated they were solely proactive. Many advisors highlighted that as a good reputation was gained, less proactive work was required.

5.3.3 Methods of delivery and other topics of advice

Advisors were interviewed because they provided one-to-one WPA advice, but questions were also asked about other methods of delivery used and what, if any, other types of environmental advice were provided. Results indicated that events are the most common secondary method, and in terms of other advice, AES options were advised to help secure agreements, followed by signposting to other organisations.

5.3.4 Monitoring of advice provision

Advisors were asked whether or not they collected details of recommendations made or of advice uptake. Several independent specialists stated they informally monitor their private clients as they have a good relationship, revisiting and setting targets. However, specialists carrying out events, or one-to-one advice through a government scheme contract, stated that they often never see the farmers again, receive no feedback and had no opportunity to build a relationship. On the other hand, some advisors from agricultural businesses conducted no monitoring, one explaining *'the farmer has paid for my advice, it is up to them if they choose to take it'*. This illustrates that although an effective advisor would be most commonly regarded as one whose recommendations are implemented, there are situations where their goal may extend no further than delivery.

For newly established environmental organisations, limited funding resulted in data collection only to meet the requirements of funders, often not including details of actual recommendations made or which mechanisms were used to encourage the uptake of advice provided.

5.3.5 WPA recommendations

Each interviewee was asked *'What are the top five WPA mitigation measures you currently recommend to farmers?'* The responses provided were categorised under 35 different headings. Amongst the most common were: *soil analysis, separating clean and dirty water, buffer strips* and *reducing fertiliser applications* (see Table 5.5).

Table 5.5 The top ten most frequently recommended mitigation measures from advisors interviewed.

Recommendation	Number of advisors recommending (n=81)
Soil analysis	28
Clean and dirty water separation	26
Roofing	21
Buffer strips	18
Reduced fertiliser application	17
Increase manure/slurry storage	16
Track management	16
Fencing	15
Soil compaction/pits	15
Pesticide handling	15

It is important to note that in some cases the organisational affiliation constrained the recommendations made, whereas other advisors had more discretion and tended to make suggestions based on their own knowledge and regarding measures they were more comfortable with. Recommendations regarding measures such as cover crops and biobeds were rarely made, as advisors stated they did not feel confident providing advice with limited information. Overall, there was no simple tendency for either organisational affiliation or personal background to be the dominant influence on the recommendations made.

Analysis using PROXSCAL assigned each of the 35 recommendations to a location in a conceptual two dimensional space dependent upon the advisors who recommended it. In the results plotted in Figure 5.2, recommendations located nearer each other were more likely to be put forward by the same person.

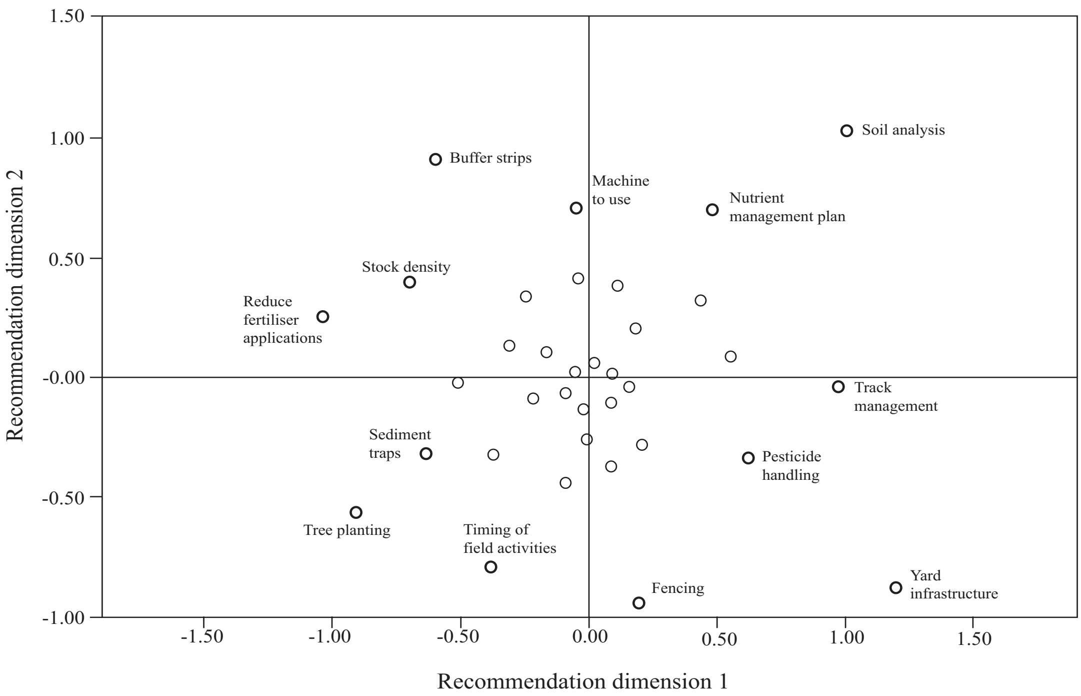


Figure 5.2 WPA mitigation measures plotted on a 2D similarity scale using PROXSCAL based upon advisors recommending them. Peripheral measures are labelled.

Many of the recommendations cluster near the central origin of the two dimensions. These include *arable reversion* (taking land out of crop production) and *re-siting gateways*. This suggests no particular pattern exists in terms of who recommends such measures. The peripheral measures (labelled on Figure 5.2) are more distinctive in terms of who recommends them. Groupings occur between measures in the different quadrants, for example, *soil analysis* and *nutrient management plans* (top right) were less likely to be recommended by an advisor who also recommended *tree planting* (bottom left). Additionally, advisors recommending in-field and field boundary mitigation measures were unlikely to be recommending farm yard measures. These results do not imply advisors never made such combinations of recommendations, only that the likelihood was less.

Comparison of recommendations made by sets of advisors

PROXSCAL was also used to assign each advisor to a specific location in a conceptual two dimensional space dependent upon the recommendations they most commonly made. To compare the similarities in recommendations one standard deviation ellipses were created.

In Figure 5.3, each of the 81 advisors are plotted on the two dimensions as a point. Advisors located near each other were more likely to have recommended similar measures. One standard deviation ellipses were created for: CSFOs; NE; EA; independent specialists and organisations with an environmental agenda (RT; WT; RSPB; Woodland Trust and FWAG in the South West).

Not surprisingly, overlap exists between organisations in terms of recommendations, with certain measures being proposed by many different advisors (e.g. *timing of field activities* and *buffer strips*). However contrasts also exist, suggesting distinct niches for particular groups of advisors.

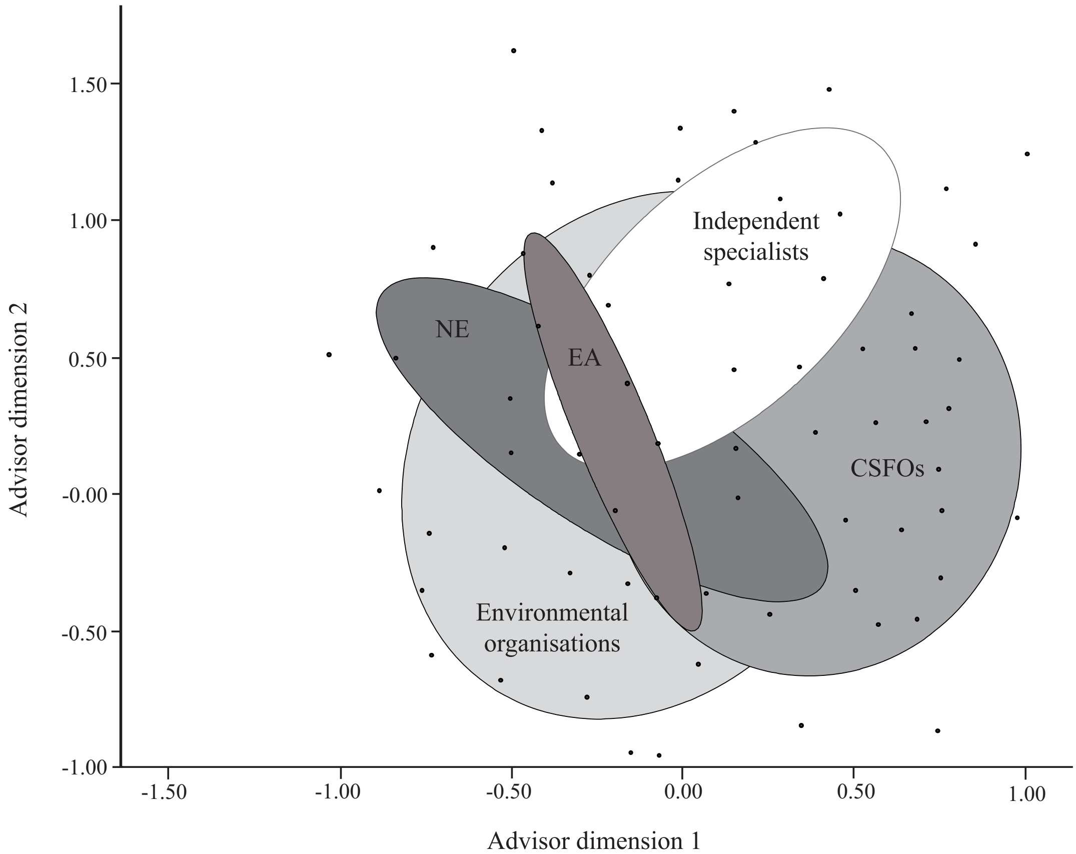


Figure 5.3 Eighty-one advisors plotted on a two dimensional similarity scale using PROXSCAL based upon measures they recommend, with one standard deviation ellipses for CSFOs, NE, EA, independent specialists and environmental organisations.

The EA is represented by a narrow ellipse reflecting the particular focus in their advice on regulatory requirements. Substantial overlap occurs between NE and environmental organisations, as many of the latter focused on recommending AES options (similar to NE) as an incentive to engage with farmers. Grouping environmental organisations resulted in a large ellipse corresponding to a broad set of recommendations. Nevertheless, different organisations in this group tended to focus on their own area of expertise such as habitats or species. Independent business specialists had the least overlap with government staff, primarily as they provided particular advice on topics such as animal nutrition, crop rotation and nutrient requirements which are not part of the public sector advice remit.

Comparison of regions

As this research was conducted across different regions and therefore farming systems, Figure 5.4 demonstrates differences in recommendations in the three regions considered. The EA ellipse in all three regions is the same and represents the results at the national level (from Figure 5.3) to provide context. This was deemed appropriate as the role of EA staff is to provide regulatory measure advice and does not differ regionally. The CSFO and environmental organisation's ellipses (calculated separately using data from advisors in each region) highlight that recommendations from such advisors focussed on different sets of WPA measures. Regional results could not be plotted for independent business specialists and NE staff due to insufficient data for the calculation of standard deviation ellipses.

The differences shown in Figure 5.4 indicate that CSFOs were adapting their approach within their catchments/region depending upon farmer needs. In East Anglia, many of the CSFOs interviewed recommended a smaller number of measures that they specialised in depending upon farmer requirements in their catchment e.g. *pesticide management*. The larger sized ellipse implies that advisors within CSF were making different recommendations to one another, covering a broader remit. CSFOs in the North and South West recommended similar measures to each other, such as *yard infrastructure, track management* and *fencing*, resulting in more compact ellipses.

Environmental organisations were also found to fulfil different roles in the three regions. In East Anglia, they tended not to make recommendations for farm yard infrastructure, contrary to the findings for the North and South West, providing a much narrower set of recommendations. Whereas in the South West, recommendations made by environmental organisations were more similar to the CSFOs but covered a broader remit.

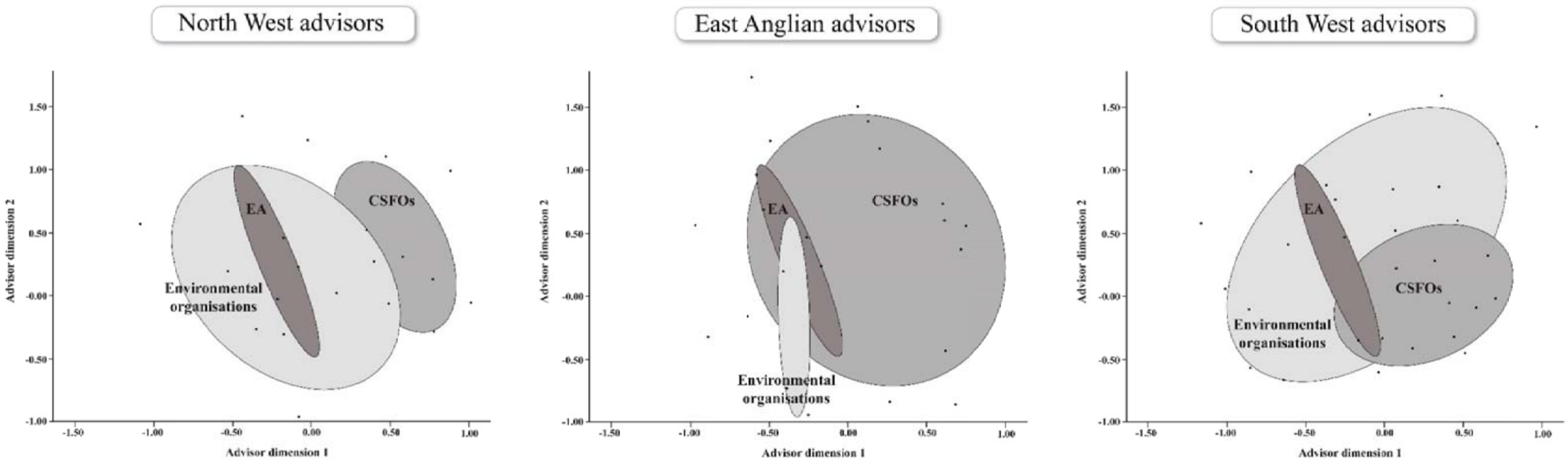


Figure 5.4 Advisors from each region plotted on a two dimensional similarity scale using PROXSCAL based upon the water pollution mitigation measures they recommend, with one standard deviation ellipses for CSFOs, EA and environmental organisations.

5.3.6 Issues of consistency in advice provision

Interviewees were asked '*Can you think of examples when you have provided advice which has conflicted with other advice the farmer has received?*' Of the advisors, 64% reported that during a one-to-one visit, a farmer stated they had received different advice from another source. Conflicts predominantly existed between advisors with differing focuses (government, environment or business). For example, regarding the amount of fertiliser to spread or silage cutting times. However, conflicts also occurred between advisors with the same broad focus, e.g. species and habitat priorities varying amongst environmental organisations. One example was tree planting to create shading for fish versus open spaces for wading birds. Conflicts also occurred within and between government organisations. The most common disagreements involved AES options and whether they were effectively targeted, such as, AES grassland management options resulting in over or under grazing of grasslands.

Frequently changing regulations were identified by many non-governmental advisors as causing confusion and creating difficulties with keeping up-to-date and delivering consistent advice. Advice regarding dates for closed periods in NVZs differed greatly and was the primary concern amongst advisors.

Not only did conflicts of recommendations occur but there were also reports of a lack of communication and knowledge exchange between advisors, thus creating some unnecessary duplication of recommendations and barriers in locating and signposting expertise to meet particular needs. Communication and interactions did exist in particular circumstances. An excellent example of coordination between advisors was apparent in the North West's Eden catchment, where the 'close knit' nature of the whole farming community brought various advisors from different organisations together. Signposting farmers to the relevant advisor was second nature, and collaborative projects occurred between NE, EA, CSF, RT, Woodland Trust and independent contractors.

5.3.7 Mechanisms used by advisors: Toolkit for engagement

The interviews revealed that advisors utilised a range of mechanisms to increase farmer adoption of their advice (grants, AES, guidance on regulatory requirements, voluntary approach or signposting to other advisors). Differences were found between advisors regarding the approaches they used. Many organisations focused upon one form of mechanism (e.g. RSPB encouraging AES options), whilst a select few used a variety of mechanisms (e.g. RTs used funding incentives, voluntary approach, regulatory advice and signposting). The majority of advisors favoured specific mechanisms for particular measures (e.g. grants and

AES for tree planting) but employed a combination of mechanisms in other instances (e.g. *timing of field activities*). Two measures illustrating the greatest differences in results (*tree planting* and *timing of field activities*) are shown in Figure 5.5 displaying only the advisors which recommended either or both of the measures. Appendix B.2 provides figures with all the organisations recommendations and the mechanisms used in each of the three regions.

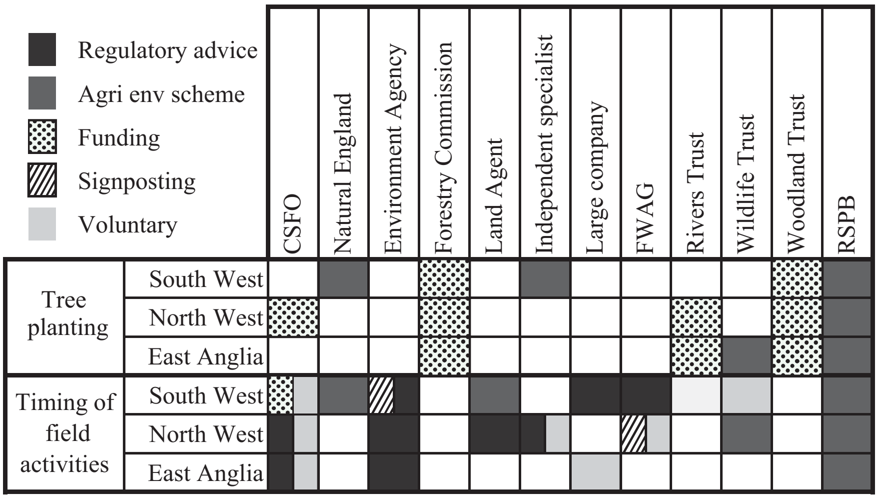


Figure 5.5 Mechanisms used by different organisations in the three regions, to increase the uptake of tree planting and timing of field activities.

Government agencies such as EA, NE and FC were consistent in their use of mechanisms, however, CSFOs used a variety of mechanisms for each measure, differing between catchments.

Environmental organisations varied more in the mechanisms used, predominantly caused by varying access to funds. If an organisation did not have a funded project or were unable to offer farmers a grant, they often provided advice on AES options (fulfilling a similar role to NE staff) but targeting specific options for the benefit of a particular species or habitat. Organisations with grants often fulfilled gaps in government schemes by providing grants for mitigation measures not covered by AES. Additionally, some environmental organisations used more unusual mechanisms to encourage advice uptake such as volunteer power (Cornwall WT), machinery sharing and the lending of livestock for grassland management (Devon WT). Advisors with a farm business focus predominantly used the voluntary approach and signposting with advice provision. Recommendations using the voluntary approach would often be to save the farmer resources e.g. *reducing fertiliser application rates* and if a recommendation required resources, signposting would be used, e.g. to CSF capital grants for infrastructure.

5.4 Implications for agri-environmental policy

From the survey results it is apparent that the advice delivered by different advisors is not homogeneous and particular niches exist within the farm advice sector. However, gaps were discovered and concerns were raised by some advisors about a lack of knowledge regarding activities by representatives from other organisations. These results provide evidence which supports Proctor et al.'s (2011) claims that advisors need to be better informed of the networks and local contexts in which they are operating and their role within them. To address such issues, two key recommendations are made below.

5.4.1 Assessing advisory services

The diversity highlighted in this study suggests there would be merit in conducting further assessments of advisory services in other regions. This would help policy makers, advisors and farmers to better navigate the existing advisory landscapes and identify potential sources and pathways for the dissemination of information on particular issues. Catchment Management Plans (CMP) would significantly benefit from such work and organisations involved in creating CMPs should consider conducting similar advisory system assessments for their catchment. In England, many CMPs currently fail to consider the importance of advice provision to farmers (e.g. Norfolk Rivers Trust, 2014) and only a few summarise the current advisory landscape (e.g. Broadland Catchment Partnership, 2014) or include advice provision in their strategy (e.g. Tamar Catchment Plan, 2012). The Eden Rivers Trust CMP (2014:12) acknowledges the need for developing a joined up advice programme and better co-ordinate existing initiatives, thus supporting the need for further assessments.

5.4.2 Non-government advisors

There is also scope for government policy implementation to make better use of non-government advisors. Although regional briefing sessions and training are provided for such advisors, this has not always avoided conflict or confusion regarding what should be advised. Through greater cooperation and better communication, advice dissemination schemes could achieve more effective implementation of agri-environmental policies to support catchment management (as evidenced in many of the case studies discussed by Smith et al., 2015). It is recommended that more funds are targeted towards organisations providing advice which have well-established relationships with farmers, acting as an intermediary for the Government. The ability to offer trusted, tailored advice reduces a farmer's perception of risk, and with the use of mechanisms such as grant incentives or other innovative methods (e.g. the WT's machinery ring) allows flexibility and improves effectiveness of engagement.

5.5 Conclusion

The aim of this study was to enhance understanding of advice provision ultimately improving such dissemination for reducing WPA. Interviews with a diverse range of advisors in different farming systems provided information on who advises which WPA mitigation measures and how they seek to influence advice uptake.

Through the use of PROXSCAL and standard deviation ellipses, the research demonstrates how an analytical method more commonly used in other research fields, is an effective technique to visualise survey data and in this case, show how various sets of advisors fulfil different or similar roles in terms of recommending WPA mitigation measures.

Results from the advisor interviews made noteworthy contributions to policy development, with findings on the role of advisors used to update the CSF evidence base and forming part of their report '*Catchment Sensitive Farming: Evaluation Report - Phase 1 to 3'* (CSF Evidence Team, 2014:42-44). Results will also feature within the CSFO's training scheme in 2016.

The study provides evidence of the different mechanisms used to positively influence farmer behaviours towards adoption of WPA mitigation measures. Building upon the work presented in Chapters 4 and 5, research focusing on the motivations and barriers behind adoption and non-adoption of mitigation measures was carried out to discover what other factors influence farmer decision processes and is presented in Chapter 6.

Chapter 6

Chapter 6 In-depth farmer interviews: Farmer motivations and barriers to mitigation measure adoption

In order to tackle the issue of WPA, farming practices need to change. Designing successful behaviour change interventions requires time and effort being devoted to fully understand the target behaviours (Michie, Atkins and West, 2014). Chapter 4 initiated such an investigation through a farmer survey examining the current uptake and likely future uptake of 70 WPA mitigation measures, thus providing a baseline of behaviours and attitudes. It was beyond the scope of the survey to explore in detail why the measures had been adopted or particular attitudes existed. Therefore the research presented in this chapter focuses on the reasons behind adoption or non-adoption of a smaller subset of mitigation measures. Whilst it has been common for research to concentrate on the broad motivations, barriers and willingness to adopt pro-environmental practices (e.g. Mills et al., 2013), it was identified that there is a need to investigate specific farm practices to fully understand the key determining factors which influence farmer decisions.

The research presented within this chapter carried out in-depth interviews with farmers from three of the DTC catchments (the Eden, Wensum and Tamar), to discover precisely what influences farmers' decision making processes. Interviews investigated what barriers need to be overcome and which factors motivate and positively impact measure uptake. A set of eleven mitigation measures were chosen to be discussed in great detail with farmers who had either already adopted or not adopted the measures. The main objectives were to discover:

- What motivates uptake of specific mitigation measures?
- What creates barriers for uptake of specific mitigation measures?

This chapter sets out the methodology used to conduct the farmer interviews in Section 6.1, presenting the surveyed farmers' characteristics in Section 6.2. Explanations of the qualitative data analysis techniques used are provided in Section 6.3, along with the key findings from the in-depth discussions for each of the eleven mitigation measures. Having discussed each measure separately, a synthesis of all the results in Section 6.4 highlights the policy implications, with a final conclusion presented in Section 6.5.

6.1 Survey methodology

6.1.1 Study design

In-depth farmer interviews were conducted to gain an understanding of attitudes, beliefs, decision processes and experiences of adopting or not adopting specific WPA mitigation measures. As the purpose of the interviews were to develop ideas and explore theories rather than collect data for statistical analysis, a semi-structured format and predominantly open-ended questions were believed to be the most appropriate methodology (Michie, Atkins and West, 2014) with recommendations made by Sapsford (2007) influencing the design.

The interview was divided into four sections (see Appendix C.1 for a copy of the survey). Section A gathered general information about the farm, its management and AES participation.

Section B focussed on mitigation measures to reduce WPA and gauged the level of knowledge the participant had of the issue. At the beginning of this section the farmer was asked to study an image of a farm portraying poor farm practice and to identify such practices (Figure 6.1), stating hypothetically what advice they would provide to the farm in the picture. Other questions sought opinions regarding soil and water management issues which occurred on the participant's farm and what techniques or practice tools they had used to address such issues.

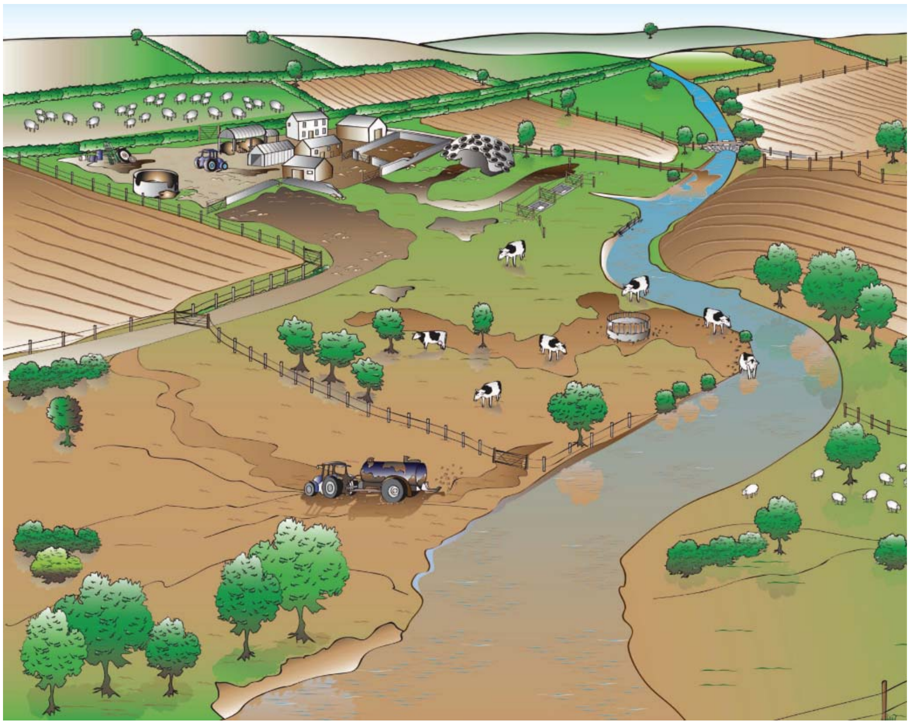


Figure 6.1 Image shown to farmers during interview as part of Section B.

The latter part of Section B is the main focus of this chapter. Information was gathered on whether or not specific farm practices had been implemented. Once current uptake was revealed, the interviewer selected two measures which the participant had implemented, having an in-depth discussion about the measures to discover what influenced adoption. A further two measures were selected which the participant had not implemented. Questions and discussions examined the reasons for not adopting the measure and what it would have taken to encourage adoption. Discussions allowed exploration of the balance between ability and willingness of undertaking each specific mitigation measure.

The eleven measures investigated are listed in Table 6.1, identifying which measures were examined in each catchment, as not all were relevant to the farm types in each.

Table 6.1 WPA mitigation measures investigated in each catchment during farmer interviews.

		Eden	Wensum	Tamar
Land use change	Land out of agricultural production	✓	✓	✓
	Tree planting	✓	✓	✓
	Sediment trap	✓		✓
Management change	Subsoiling/ grass aeration	✓		✓
	Reduced cultivation system		✓	
	Tramline management		✓	
	Cover crops		✓	
Infrastructure change	Track re-surfacing	✓	✓	✓
	Roofing over yards	✓		✓
	Re-siting gateways	✓		✓
	Biobed		✓	

Land out of agricultural production, tree planting and *track re-surfacing* were investigated in all three catchments, allowing comparisons between responses from farmers. In addition, *sediment traps, subsoiling, re-siting gateways* and *roofing over yards* were investigated in the Eden and Tamar (farms with livestock) providing the ability to conduct further comparisons.

A brief description of what the measures are, how they benefit water quality and the use of mechanisms to influence uptake is provided in Appendix C.2, along with a detailed explanation of the mechanisms used (regulations, advice provision and financial incentives) to influence uptake at the time of research. Table 6.2 summarises the mechanisms used. Voluntary initiatives have been included within advice provision as they predominantly use advice to encourage uptake. Table 6.2 provides an understanding of the socio-political and economic landscape and therefore how farmer responses may have been influenced.

Table 6.2 Mechanisms used to influence uptake of each mitigation measure in 2014

		Regulation	Financial incentive	Advice provision
Land use change	Land out of agricultural production		AES options such as: arable reversion to unfertilised grassland, nectar flower mixtures, wild bird seed mixtures, or extending buffer strips.	Initiatives (e.g. Campaign for the Farmed Environment and LEAF) promoted the benefits and offered advice.
	Tree planting		AES options involved creating, restoring and maintaining woodland, wood pasture, scrub and orchards. Rural Development Programme funding installation of biomass boilers incentivised tree planting for biomass energy.	FC offered advice on establishment and management of woodland, as well as the English Woodland Grant scheme encompassed a number of grants to encourage planting trees.
	Sediment trap		The CSF Capital Grant supported the excavation and establishment of sediment ponds and traps. AES options included the establishment and maintenance of wetlands.	Research projects exploring the measures potential and feasibility with landowners provided demonstration sites and promoted use in the local area.
Management change	Subsoiling/ grass aeration			Organisations offered the opportunity for farmers to trial or rent soil aerator machinery along with advice on best use (e.g. WT and FWAG).
	Reduced cultivation systems			Agricultural industry promoted
	Tramline management			Agricultural industry promoted
	Cover crops	During interview period uncertainty surrounded the inclusion of cover crops within new regulatory requirements for farmers to claim Basic Farm Payments (CAP Pillar I).	AES option	Private and public sector experimental trials disseminated advice through events and press.
Infrastructure change	Track re-surfacing	Soil Protection Review required farmers to identify and take action to remediate damage caused to soil, such as poaching and soil erosion on tracks	CSF Capital Grant scheme supported the creation of new livestock and farm machinery tracks, but does not cover repair of potholes or upgrade existing tracks (unless they are degraded bark/wood chipping tracks for livestock movement). Other organisations offered similar grants through funding from e.g. Water companies or EU sources.	
	Roofing over yards	NVZ rules require manure and slurry storage facilities to be of a large enough capacity to store 6 months (pigs and poultry) and 5 months (other livestock).	CSF Capital Grant scheme supported construction and material costs of roofing over existing manure, slurry and silage storage and livestock gathering areas. Other organisations offered similar grants through funding from e.g. Water companies or EU sources.	Many advisors were found to recommend roofing (Chapter 5) with signposting to the CSF Capital Grant.
	Re-siting gateways	Soil Protection Review required farmers to identify and take action to remediate damage caused to soil, such as poaching in gateways	CSF Capital Grant scheme offered financial support to relocate gateways and gap up the original locations	
	Biobed	Statutory code of practice for using plant protection products outlines correct handling of pesticide disposal, as well as product labels which provide guidance.	CSF Capital Grant scheme offered financial support to establish a biobed.	The Voluntary Initiative promoted responsible pesticide use, offering a source of advice and practical guides for biobeds.

During 2014, when farmer surveys were being arranged, key decisions were being made regarding the CAP reform. It was therefore essential such political uncertainties were considered in the interview design and how it may affect farmer responses. Consultation with academics from the DTCs and members of Defra's Water Quality policy team for up-to-date information, ensured the collection of data on mitigation measures of most use to assist with policy decisions. The eleven measures were chosen to represent a wide range of practices, the majority of which were being implemented as part of the DTC monitoring research (Figure 3.1). As mentioned previously in Chapter 3, measures implemented by the DTC were selected where they were widely applicable, a lack of evidence for effectiveness existed and they had the capacity to be delivered through existing or new policy funded mechanisms. Additional measures investigated were chosen due to government interest and requests made during Defra meetings.

Section C of the survey investigated attitudes towards farm advisors. This involved the use of an interactive survey method, building rapport between the interviewer and participant. Printed cards displaying individual words were laid out on a table to act as prompts. The choice of words displayed originated from the words stated by farm advisors when asked '*What do you think most influences whether a farmer implements your advice?*' during their interviews (Chapter 5). After the farmer had been asked to study all the word cards, the interviewer held up a sheet presenting either an organisation's logo or description of a type of advisor e.g. independent consultant. Farmers were asked whether they would listen to this organisation/advisor for advice on the various farm practices discussed, if so, what were the reasons as to why they would listen? Such a method (shown in Figure 6.2) provoked rich conversation, with results analysed and discussed in Chapter 7. Section C's results complement findings from the farm advisor interviews in Chapter 5 providing farmers' perspectives on advice delivery.

The final section (D), was a separate sheet provided to the participant to complete while the interviewer tidied the word cards away. The sheet contained personal questions such as age and level of education. Self-completion was considered suitable as participants did not have to say aloud personal information and could easily choose to opt out of answering.

A pilot study with six farmers was conducted during January 2014 in the Derwent catchment adjacent to the Eden in Cumbria. The pilot confirmed that only four mitigation measures (two adopted and two not adopted) could be discussed in great detail if the survey was to be kept to an hour (a desired survey time from pilot participants). Survey length and phrasing of questions were altered as a result of feedback from the pilot and a final draft presented to Defra policy makers to ensure the most appropriate and informative results would be gained.

Figure 6.2 Section C of the farmer interviews. Word cards are laid out on the table whilst the interviewer displays an organisations logo.

6.1.2 Farmer sample

As the interviews were conducted as part of the DTC, the farmer sample was drawn from within three of the DTC catchments: the Eden, Wensum and Tamar. The Tamar catchment was chosen instead of the Hampshire Avon (used in Chapter 4), as data was desired from catchments which are more representative of specific farming systems. The Tamar is more illustrative of dairy and mixed farming, whilst the Hampshire Avon is highly diverse across the catchment (Chapter 3). The representativeness of participant characteristics are provided in Section 6.2.

The sampling framework for this survey consisted of: interviewing five farmers in each catchment who had implemented a farm practice, and five who had not (totalling ten in-depth discussions for each measure). Greater numbers for both adopters and non-adopters would ideally have been sought for the sample, however due to practicalities of time and funds, it was believed the above framework was sufficient to provide insight for the research objectives. In the Eden catchment, eight measures were investigated, therefore 80 different in-depth discussions were required). As time allowed, on average, four in-depth discussions with each participant, a target of 20 farmers was necessary in the Eden. Similar targets existed in the Wensum and Tamar. During each interviewing period, discussions were tallied for each measure to monitor the number of discussions achieved.

Several strategies were used to help recruit farmers. Various contacts established from previous survey work (Chapters 4 and 5) helped identify farmers in the area. To ensure that not only farmers who had environmental interests were surveyed, and to provide a broad range of views for the study, snowball sampling was used by asking participants for further contacts of neighbours who had less involvement or interest in the survey topics. This proved to be successful as participants understood why this was important and ensured a representative sample was achieved, thus minimising sample bias. Other methods of recruitment involved actively attending local events e.g. The Norfolk Show, as well as simply spending time in village pubs, community sports centres, and local shops, speaking to people and informing them of the research. Several challenges were encountered in fulfilling some of the measure quotas. One example included the difficulty in finding farmers in the Wensum who had established a biobed (resulting in only two farmers interviewed). Additional efforts were made to seek farmers with biobeds, sending requests to numerous contacts who had multiple farmer clients/customers in the catchment, however, no farmers could be found. This alone provides interesting insights, highlighting the limited implementation of biobeds.

6.1.3 Data collection

Interviews were conducted during 2014 at times when farmers were least busy with their day-to-day operations, enabling them to provide adequate time to participate. Interviews were conducted in the: Eden (lowland livestock farmers) during January and February; Wensum (arable farmers) during June and October; and Tamar (mixed and dairy farmers) during November and December.

Farmers were contacted directly by telephone, explaining the research, its benefits and to arrange a convenient day and time for the interviewer to visit their farm to conduct the interview. A success rate of 97% was achieved from initial contact to interview. Being friendly and keeping to the point helped build immediate rapport over the phone and resulted in farmers agreeing to participate. Often mentioning the name of someone in the community who had participated, as well as mentioning that the research project worked with Paul Hoveson (Farmers Weekly Farmer of the Year 2014 and estate manager of the Wensum DTC monitoring platform) helped get a ‘foot in the door’.

The duration of face-to-face interviews lasted on average one hour. The combination of interactive, discursive and ranking questions created a positive atmosphere and established a friendly relationship in a similar manner to Chiswell (2014). Furthermore, using a flexible survey structure allowed questions to be most relevant for each participant (Oppenheim, 2000) and for new routes and topics to be explored, accessing a wealth of knowledge which might otherwise not have been revealed. Participants were assured of the confidentiality of their responses, however, it is acknowledged that honesty of participant responses will vary depending on the level of trust gained by the interviewer - a well-established concern in all social science research (Sayer, 1992) – however, a crucial objective during interviews was to build a rapport to minimise such issues. During discussions it was vital the interviewer was responsive, flexible, adaptive, a good listener, as well as a listener with the 'third ear' noticing not only what was being said but what was being omitted, including gaps and hesitations, as discussed by (Oppenheim, 2000). Many field notes were made during interviews, and when permitted, dictaphone recordings taken. Transcripts were typed up during the same day, ensuring any further thoughts occurring to the interviewer could provide additional notes to the transcripts. To maintain consistency, all interviews with farmers; data management; and data interpretation were conducted by the same researcher.

6.1.4 Survey adjustments

Further insights were gained through data collection and analysis as the implementation of the survey progressed. It is acknowledged that unavoidably, experience from the Eden surveys and then the Wensum surveys, will have influenced some later aspects of the research. However, the slight adjustments to the survey needed, as certain challenges became apparent, were not considered substantial enough to invalidate comparisons between catchments.

Track re-surfacing discussions varied greatly, with farmers' interpretation of re-surfacing farm tracks altering with materials used and the frequency of re-surfacing. It became clear that each farm managed their tracks in a slightly different way depending on their circumstances. Therefore the requirements for in-depth discussions for *track re-surfacing* were not overly specific. If a farmer had actively invested time, effort and material (bought in or farm sourced) and within a suitably recent timeframe (within approximately five years) they were categorised as having adopted this measure. A further challenge involved the overlap which occurred between responses for *tree planting* and *sediment traps* with *land out of agricultural production*. Farmers who stated they had taken land out of production would then describe the land was taken out for trees or sediment traps. Interview discussions therefore needed to discover what the land had been used for once it had been taken out of production. If the land was set aside or being used for purposes other than tree planting or sediment traps, discussions were categorised in the quota for taking *land out of agricultural production.* Finally, certain elements of the survey were discontinued. During Wensum interviews, the prompt questions and attempts to discuss *re-siting gateways* proved challenging as farmers often did not have gateways. Gentle slopes and minimal field traffic during wetter periods meant re-siting field entrances (their equivalent to gateways) was less necessary compared with their livestock counterparts. It was deemed acceptable to discontinue investigating this measure in the Wensum, as it was felt credibility of the interviewer was lost when asking 'irrelevant' questions. Another element of the survey discontinued in all catchments was in Section C, with attitudes towards land agents/auction houses providing advice. Farmers did not see a connection with such sources of advice and WPA.

6.2 Results - Surveyed farmers' characteristics

In-depth interviews were successfully conducted with 58 farmers across the three catchments, namely 21 farmers in the Eden, 17 in the Wensum and 20 in the Tamar. To provide an overview of the farmers' characteristics, Table 6.3 shows the average and standard deviation for the number of years of farming experience in each catchment, the percentage of farmers in each age bracket, sex, level of education and whether they had identified a successor.

The sample was younger than the farming population as a whole, as the national average age was 59 in 2013 (Defra, 2015a:8). A higher percentage of females (25%) and younger farmers (70% ≤50) were interviewed in the Tamar, than in the other two catchments. A higher level of education was characteristic of farmers in the Wensum, with a third having obtained a university degree related to agriculture, and the lowest rate of university graduates was interviewed from the Eden. Half of the Wensum farmers provided a negative response to the question '*Have you identified a successor?*' stating they definitely had not, and a fifth did not want one. In comparison to the Eden and Tamar, none of whom stated they did not want a successor, the Eden had the highest rate of responses '*definitely identified a successor'* (57%) and the Tamar had the highest rate of responses stating *'possibly identified one'* (70%).

Table 6.3 Farmer characteristics from the survey sample.

		Eden	Wensum	Tamar
	Number of farmers	21	17	20
Farming experience	Average number of years farming	34	36	27
	Standard deviation of years	11.11	11.39	11.96
Age	< 25	0%	0%	0%
	25-50	52%	39%	70%
	51-75	43%	61%	30%
	>75	5%	0%	0%
Sex	Male	90%	100%	75%
	Female	10%	0%	25%
Education	Secondary	19%	11%	40%
	Further education non-related to agriculture	5%	17%	10%
	Further education related to agriculture	57%	33%	25%
	University non-related to agriculture	14%	6%	0%
	University related to agriculture	5%	33%	25%
Successor identified	Definitely	57%	17%	20%
	Possibly	29%	33%	70%
	Definitely not	14%	28%	10%
	Don't want a successor	0%	22%	0%

Such differences in farmer profile between the catchments can impact attitudes (e.g. long-term planning for the business if a successor is identified) and is worth bearing in mind when interpreting the results as successful strategies used to encourage measure uptake may work in one catchment but not another.

Information regarding participant's farm size and farm type is provided in Table 6.4 to gain a perspective on how representative the sample is of farms in each area compared with June census data. The average size of sampled farms was greater in each catchment than the overall administrative area's average, reflecting the way in which survey participants were recruited (focusing on recruiting full time professional farmers). As with the farmer sample in Chapter 4, the range of farm size is vast and thus distorts the average size.

Table 6.4 Farm size and farm type of the survey sample compared with June census data from 2013.

			Eden	Wensum	Tamar
Farm size		Area of land managed by participants (ha)	3,715	9,180	3,851
		% of catchment managed by participants	1.6%	14.1%	2.1%
		Average farm size of participants (ha)	177	540	193
		Average farm size in June census data (ha)	99	123	63
		Farm size range of participants (ha)	69 - 500	115 - 2050	22 – 645
Farm type	**Arable**	% of June Census data	9% [a]	57% [b]	18% [c]
		% of survey sample	0%	76%	0%
	Dairy	% of June Census data	12% [a]	1% [b]	11% [c]
		% of survey sample	33%	0%	30%
	Livestock (lowland)	% of June Census data	22% [a]	16% [b]	38% [c]
		% of survey sample	23%	0%	40%
	Mixed	% of June Census data	49% [a]	7% [b]	9% [c]
		% of survey sample	23%	24%	25%
	LFA livestock	% of survey sample	19%	0%	0%
	Other	% of survey sample	0%	0%	5%

June census data area: a) East Cumbria b) Norfolk c) Devon

6.2.1 Soil and water related issues on farm

At the start of Section B, an image of 'poor farming practice' (shown in Figure 6.1) was presented to some of the survey participants to act as an interactive ice breaking tool. In particular circumstances, this element of the survey was needed more than in others, however as such a tool was not to collect data for analysing, no further discussion is presented.

In the next part of Section B, farmers were asked how frequently six soil and water related issues occurred on their farm (1 being uncommon and 5 very common) to gain an understanding of how relevant particular issues were perceived to be. Farmers were asked to consider their entire farm over a typical year, as weather conditions ultimately alter the frequency of the issues. The average rating for each catchment and the standard deviation were calculated to show the variation in responses, helping to determining overall patterns of variation (Urdan, 2001). Figure 6.3 shows that participants in the Eden rated all issues higher than participants in the other two catchments (overall average rating scores: Eden = 2.97, Wensum = 1.86, Tamar = 2.34).

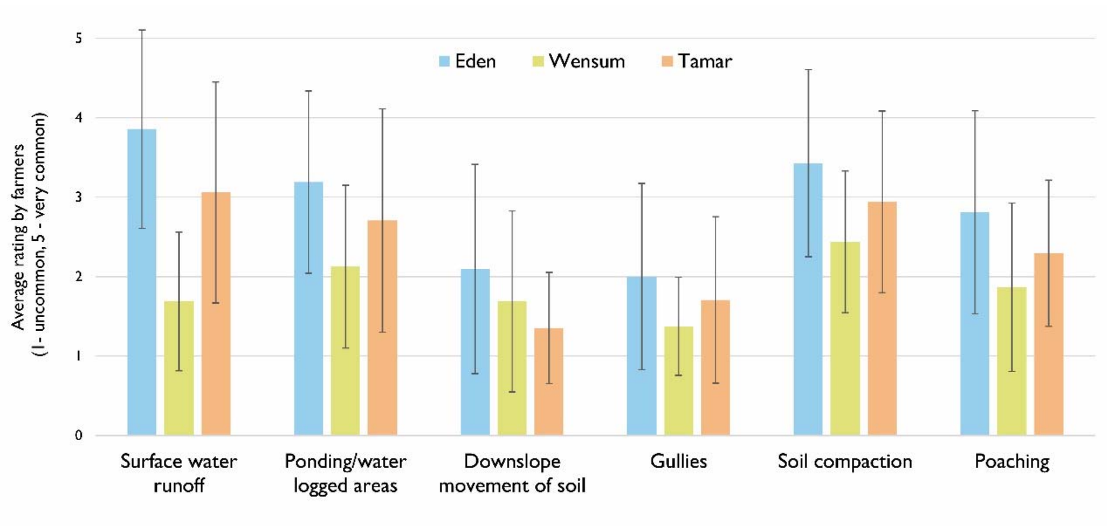


Figure 6.3 The average ratings by farmers in each catchment for soil and water issues on their farms (with standard deviation error bars).

For the six issues investigated, significant differences between the catchments existed for three. Significant differences were found, with Wensum responses being lower than the other two catchments for *surface water runoff* ($p < .05$), and the Wensum responses being lower than the Eden for *water logged areas* ($p > .05$) and *poaching* ($p < .01$). The most frequent issue in the Wensum was *soil compaction*, whilst in the Eden and Tamar it was *surface water runoff*, with one Tamar farmer stating,

> *'I never fully understood what people meant when they spoke of surface water runoff, only picturing flash floods on the news, but in the summer of 2012 a road drain blocked and caused a colossal amount of water to flood the road and run on to our field. It caused a huge gully, cutting straight through our field. Now that was runoff and erosion.'* Tamar farmer 20.

Despite the fresh memories of 2012's wet summer, *downslope movement of soil* and *gully formation* were thought to be the least frequent issues by farmers in all three catchments, with results not being significantly different.

6.2.2 Use of management tools

Having gained an understanding of the issues each farmer had on their farm, questions were asked regarding various management tools which aid decision making for farm practices to help address such issues. Chapter 5 revealed soil management plans and digging soil pits to check for compaction were two of the most frequently recommended practices by advisors. Therefore it was of interest to discover whether or not farmers currently use such management tools, amongst others. In-depth discussions were not sought regarding the management tools, as this research aimed to investigate other mitigation measures for reducing water pollution (justification for measure choice was provided in the study design - Section 6.1.1).

Figure 6.4 displays the percentage of farmers in each catchment who had a: *soil management plan; nutrient management plan; slurry and manure plan* or *infrastructure plan*, as well as the percentage who carried out *soil tests* or dug *soil compaction pits*. Once again, results show striking differences between the catchments. Overall, the various management tools were least adopted in the Tamar, and most adopted in the Wensum. Figure 6.4 highlights *infrastructure plans* as being highly uncommon, however from discussions, many farmers showed a positive interest towards having one created for their farm. Surprisingly, even though Eden farmers believed compaction was highly common (Figure 6.3), adoption of digging soil pits remained low compared to farmers in the Wensum (Figure 6.4).

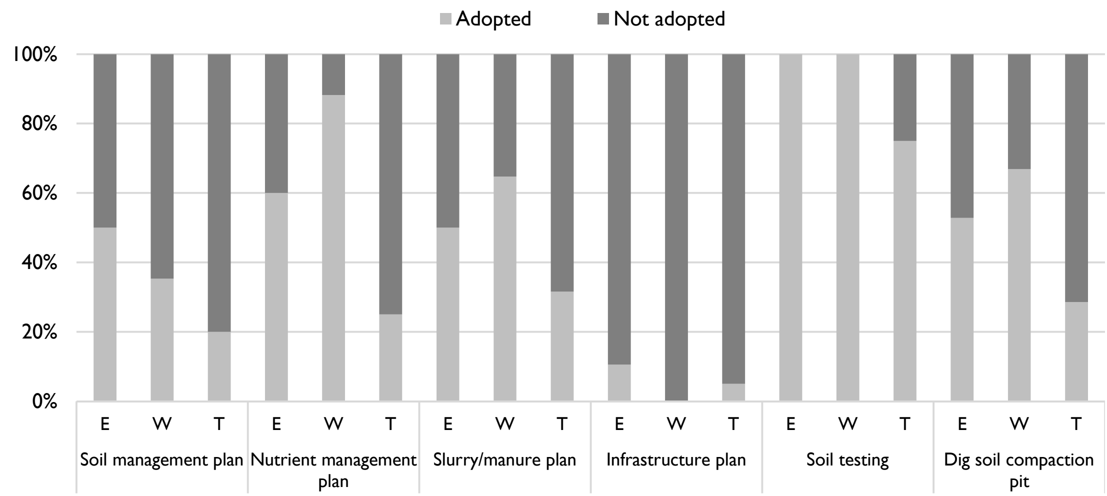


Figure 6.4 The percentage of farmers who had adopted or not adopted farm management tools in the Eden (E), Wensum (W) and Tamar (T) catchments.

At the time of interviews, farmers were required as part of CAP Cross Compliance to have a basic soil management plan known as the Soil Protection Review. This survey wanted to discover if they voluntarily had a more detailed soil management plan. The majority of farmers did not (Figure 6.4). During the interview period, the Government announced the Soil Protection Review would not be compulsory for farmers to receive the CAP Pillar I payments in 2015. Further research is needed to discover whether such changes negatively impacted upon the uptake of *soil management plans.*

Having discussed the characteristics of the farmer sample, Section 6.3 explains the data analysis process used to synthesise the vast amount of qualitative data collected from the latter part of the survey's Section B. Key findings are then presented regarding the motivational and barrier factors for each of the eleven mitigation measures.

6.3 Results - Mitigation measures discussions

6.3.1 Data analysis

Section B's discussions on mitigation measures were typed up, with responses to specific questions entered into Microsoft Excel 2010 in a coded or reduced format (see Table 6.5 for an example spreadsheet, illustrating farmers who had not taken land out of production). This stage in the analysis decreased data volume from the enormous amount collected and prioritised key points. Appendix C.3 lists the headings used for the different Excel spreadsheets. Data was then organised using the framework approach of ‘case and theme’ to allow for matrices to be created and to facilitate systematic analysis (Ritchie et al., 2013). Responses were grouped by catchment and mitigation measure. The two main types of analysis within this research included: thematic analysis and explanatory analysis.

Transparent and replicable methods were needed to synthesise the matrices created and to present findings on factors which motivate and create barriers to adoption in a clear, interpretable and comparable manner. Consulting the large behaviour change literature (some of which was discussed in Section 2.2), this research found no single available method or framework which could synthesise and account for all aspects of farmer behaviour discovered by this survey. It was decided that an adaptation of available frameworks was needed to fully represent survey findings, and that two different approaches would be needed. A description of the literature and methods to create the two frameworks used (one for motivational factors and one for barrier factors) is provided.

Table 6.5 The layout during initial data analysis in Microsoft Excel for farmers who had not taken land out of production

Haven't taken land out of production

Key = 5 would strongly influence decision and 1 would not.

Key = 1 - yes, 2 - no

			What would influence decision																				Received advice from	
Farmer ID	Reason not done	Disadvantages	Agri env scheme	Grant	Press	Regulatory	Advisor	Quality scheme	Peer pressure	Landowner	Neighbour	Farm report	Long term viability	Other	Decision maker	Payback time	Advisor	Press	Internet	Event	Neighbour	What information wanted?	Who for advice?	Further comments
13E	Not forced to, need all the land we can get.	Need to use more pesticides on it to get it back	1	5	1	5	1	5	1	1	2	1	1			Grant would have to cover costs of loss	2	2	2	2	2	Told if figures added up right.	Doesn't matter	Would only do it if costs forgone are covered
15E	Renting so want to make the most for the land we are paying for	Loss of production	1	1	1	1	1	1	1	1	1	1	1	Wouldn't do it	If landlord demanded then nterviewee would stop paying rent for that area. Landlord would need persuading		2	2	2	2	2		Wouldn't matter	
18E	Tenant	Food shortages and loss of land	1	1	1	1	1	1	1	1	1	1	1	Wouldn't do it	Landowner and Interviewee		2	2	2	2	2			
2W	Not cost effective	Doesn't make money	5	1	1	5	1	2	1	1	1	1	3	Only if there was a good opportunity			2	2	2	2	2	To learn that payments were good enough or if I could build on it	EA	
13W	Don't want to lose land	Lose out on profit	3	1	1	5	1	2	1	1	1	1	1	Only if they paid well	Interviewee		2	2	2	2	2	If there was money available	Doesn't matter	
16W	Prices of crops, we are farmers 'would you like to go to work for a month and not get paid?'	Lose land that is productive, we got to eat	5	5	1	1	1	1	1	1	1	1	1	If they told me it improved yields if kept out of production for a year and I was given some compensation then yes I would consider it but that's the only time	Interviewee		2	2	2	2	2	Which land and how much should be taken out	Agronomist and EA/NE	
2T	Shouldn't leave a field, still got to do something for its OM,	Not good for soil to just abandon field	5	5	3	5	3	1	1	1	1	1	1		Interviewee		2	2	2	2	2	Only would do it if paid enough		Not sustainable and could cause more damage than realise
3T	Would be a last resort, it's a shame for a farmer to do that	All good land	1	1	1	1	1	1	1	1	1	1	1	Never do it	Interviewee	N/a	2	2	2	2	2	Doesn't matter		
15T	Never do it voluntarily, it would have to be for a big enough payment	Cant farm it	5	5	1	1	1	1	1	1	1	1	1		Interviewee	N/a	2	2	2	2	2	Doesn't matter	No one	
14T	No real reason to. There would have to be a good reason to.	Waste of land	5	5	1	5	1	1	1	1	1	1			Interviewee	Would have to be worth it straight away, big enough incentive	2	2	2	2	2	Doesn't matter		
17T	Better to be grazed	Becomes overgrown and difficult to manage	5	1	1	1	1	1	1	1	1	1	1		Interviewee and family	Straight away	1	2	2	2	2	How much I'd get from HLS	Government HLS advisor	
18T	I need my land to farm	Loss of land	5	1	1	1	1	1	1	1	1	1	1			Wouldn't do it	2	2	2	2	2	Info on best flower/nectar mixes, where best	Government should provide it	

6.3.2 Analysis of factors motivating adoption of a measure

During examination of the qualitative data from discussions with farmers who had adopted a measure, it became clear that particular motivating factors contributed at different stages of the decision process leading to their adoption of a measure. Motivating factors reflect the reasons why a person follows their aims and desires and is the driving force for doing something (Mills et al., 2013). As this research aimed to discover such factors, each farmers' decision making process was drawn as a pathway, in a similar way to the staged models discussed in Section 2.1. The decision process diagrams were based upon the farmers' perspectives of key motivational drivers for change. Such work is in line with early empirical approaches which sought to discover patterns or predictive factors in the way decisions are made on the basis of farmer socio-economic factors and provision of information (Dwyer et al., 2007). Black (2000) argued such methods are still needed by governments to achieve policy objectives and therefore were chosen for use within this research to inform policy.

The decision processes discussed in this chapter begin with what the farmer believed was the initial catalyst for starting the process and travel through to the end accomplishment of changing their behaviour and adopting a measure. All the decision processes by farmers who had adopted a particular measure were then combined in a single diagram to represent responses for each measure. As each measure was carried out on a farm in a different context, to enable patterns and differences in decision processes to be analysed, the motivating factors were categorised into six groups and assigned a colour (shown in Figure 6.5).

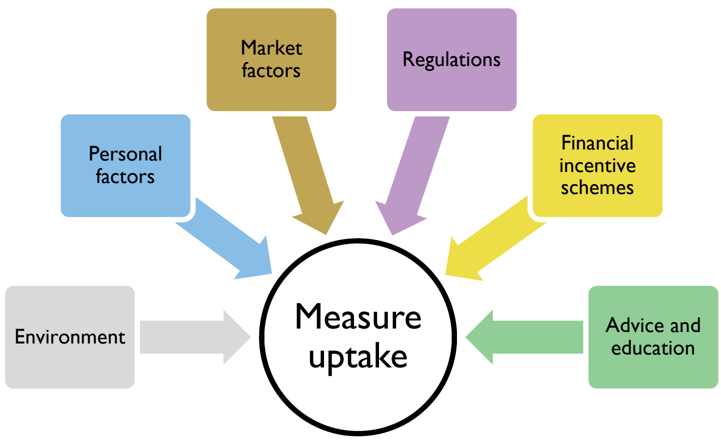


Figure 6.5 Categories of factors which influence adoption of farm practices.

The six categories in Figure 6.5 build upon the four used by Prager and Posthumus (2010) in their highly relevant paper entitled *Socio-economic factors influencing farmers adoption of soil conservation practices in Europe.* The four categories used by Prager and Posthumus consisted of: *environmental* representing the bio-physical context, *personal* representing the individual, *economic* comprising of the technical and financial aspects of the practices and *institutional* representing the institutions and governance structures. As this research wanted to identify motivational factors devised by government policy (regulations, financial incentives and advice provision) in order to understand elements of their effectiveness and inform future policy developments, the four categories from Prager and Posthumus (2010) needed elaborating. *Environment, economics* and *personal* remained the same, however the definition of *economics* was changed and labelled as *market factors*. Whilst *economics* can be considered as a compound of the other elements (Prager and Posthumus, 2010), this is arguably too broad of a term. The explanation of the *economics* category provided by Prager and Posthumus (2010), included: characteristics of technology, such as its affordability, cost savings, profit generated; production factors and farming system, such as labour availability and flexibility of the farming system to adopt new technology without major costs; and financial factors including market access, crop profitability and incentive schemes. In order to separate the government incentive schemes which fall under both *institutional* and *economics* in Prager and Posthumus (2010), this research added a category entitled *financial incentive schemes* and renamed *economics* to *market factors*. This was possible as the reasons stated by farmers during interviews related to economics were associated with market factors.

The final category from Prager and Posthumus (2010) was *institutional,* which encompassed policies, legislation, incentive schemes, tenure, property rights, networks, extension and training, social and cultural factors. Many of these examples were not mentioned, as farmers did not acknowledge or perceive such factors as having contributed towards their decision process. Peer pressure for example was not declared as a motivational factor but may be considered within comments such as '*advice from neighbour'* as this is how the farmer perceived it. Tenure is another example which could be considered as very influential to decision making but has been incorporated into the category p*ersonal* in this study, as tenancy is thought to impact a farmer's attitudes towards future sustainability of the business (Wilson and Hart, 2000). Of the *institutional* examples from Prager and Posthumus (2010) which were discussed during interviews, these have been subdivided into *regulations, financial incentive schemes* and *advice and education* (Figure 6.5). There will inevitably be some overlap amongst categories as feelings and attitudes (*personal*) are shaped by external influences e.g. regulations instigate fear of prosecution, and thus a negative internal personal factor. To ensure decision process diagrams remained simple, factors were categorised by their dominant characteristic and not by their indirect impact on internal motivations.

An example of how various motivations have been categorised is shown in Figure 6.6. Each motivation has been colour coded to represent which of the six groups it was assigned.

Looking at two examples, ‘poor soil quality’ has been classified as e*nvironment* as it is a farm feature, and ‘long term viability’ has been termed as a *personal factor* as it is an internal belief and attitude that the change in behaviour will benefit the long term viability of the business. Figure 6.6 displays an example of the decision processes leading to the adoption of subsoiling using survey results.

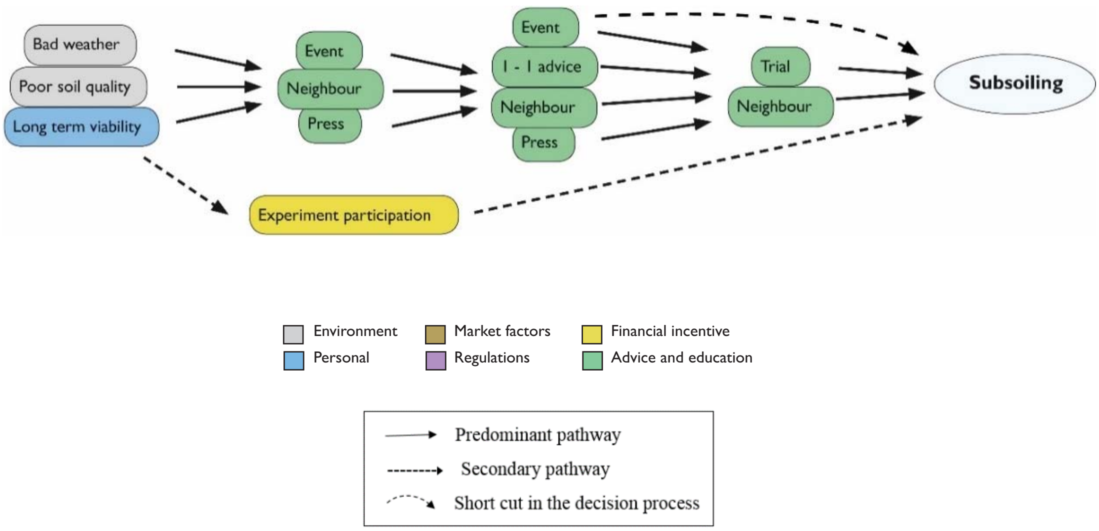


Figure 6.6 An example of the decision process pathways for farmers adopting subsoiling.

All the influencing factors in each stage are not necessarily required (e.g. bad weather, poor quality soil and long-term viability to initiate farmers’ decision processes for subsoiling), but such diagrams highlight what could be required, where factors commonly occurred in the process and the level of complexity involved.

The influencing factors and pathways of the decision processes presented within this chapter solely represent the farmers who participated in the survey and do not attempt to represent the necessary steps all farmers must travel through. It would not be possible to construct decision process diagrams which accurately represent all possible iterations of farmers’ decision making steps without becoming too vague or complex, due to the great variation in the farming community.

6.3.3 Analysis of barriers to adoption of a measure

Discussions with farmers who had not adopted a measure, highlighted the factors which act as barriers. Such factors were particularly identifiable as internally and externally instigated. This proved to be relatively different to the discussions with farmers about motivations and decision making who had adopted measures, as it was often external influences which they identified as leading to change. It was therefore decided a different framework would be needed to analyse the data collected on barriers.

Michie et al.'s (2011a) general behavioural framework – The Behaviour Change Wheel (BCW) discussed in Section 2.1 - identifies sources of behaviour under six categories (Figure 6.7). The definitions of each category can be found in Figure 2.6.

Figure 6.7 Sources of behaviour categorised by the COM-B model. Source: Michie, Atkins and West, 2014:63.

It was not possible to directly apply Michie et al.'s (2011a) framework to the issue of WPA mitigation measure adoption given the nature of the agricultural context. Many of the external influencing factors discovered by the farmer interviews would have been grouped as a negative to the p*hysical opportunity* category, thus over generalising and losing detail from the data. Furthermore, the category *physical capability* was less relevant for the behaviour changes considered in this thesis as many of the behaviours do not directly rely upon the individual being physically capable to perform them. Therefore, categories from Michie et al. (2011a) were modified, drawing upon Kollmuss and Agyeman (2002) (also discussed in Section 2.1).

Kollmuss and Agyeman (2002) reviewed behavioural literature and listed multiple categories of barriers to pro-environmental behaviour change: demographic; economic; institutional; social/cultural; motivation; knowledge; values; awareness; attitudes; emotion; locus of control; responsibility and priorities). Within their paper they clearly separated factors between internal and external, however their categories are divided into twelve headings, which this research believed was too defined and multifaceted, thus overcomplicating analysis and not aiding summarisation. A combination of the categories from Michie et al.'s (2011a) framework and Kollmuss and Agyeman (2002) was used to create eight relevant categories of factors which can act as barriers towards farmer behaviour change. Table 6.6 lists the eight categories used and, for clarification, provides examples of barriers discovered from both the survey results and the literature.

Table 6.6 Categories of external and internal barriers to measure adoption with examples of factors in each category.

Internal		**External**	
Capability	Experience Physical skills Mental skills Knowledge Awareness Cognitive skills Interpersonal skills	**Social/ cultural**	Peer pressure Land management ethics Traditions Society trust in government Presence of young farmers
Reflective motivation	Attitude Risk perception Goals Intentions Optimism Beliefs about outcomes Beliefs about capabilities Identity Attention	**Economic**	Technology Production factors Farming system Labour Financial factors Incentive schemes/fines Indirect costs – e.g. time
Automatic motivation	Emotion e.g. fear, Habit Routine	**Institutional**	Infrastructure provided Policies Legislation Incentive schemes Land tenure/property rights Extension services Enforcement mechanisms
Demographic	Gender Level of education Age	**Environmental**	Climate Soil type Proximity to water Degree of soil degradation Land availability

Factors acting as barriers to adoption could not be displayed as a pathway, in a similar way to the motivational factors, as it was not possible to temporally determine the order barriers contribute to the inaction of not adopting a measure. Instead, this research chose to display the eight barrier categories as wheel segments, the left-hand side displaying internal factors, the right-hand side external factors (Figure 6.8a). By showing the eight categories in a single wheel diagram and altering the size of each category segment, it was possible to display the extent each category was a barrier for each particular mitigation measure (Figure 6.8b).

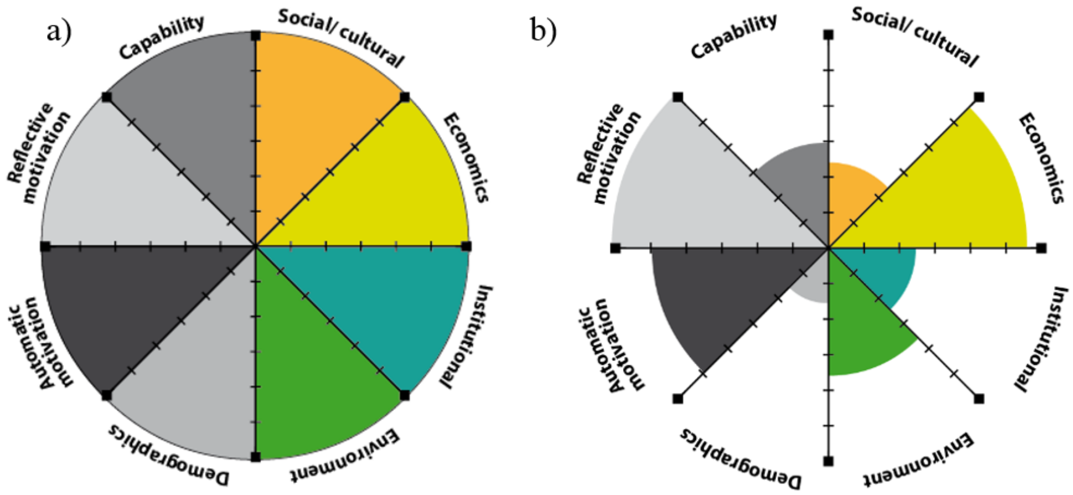


Figure 6.8 An example of the framework wheel (a) and barrier wheel (b).

To determine the size of each category segment, a consistent and transparent methodology was devised. Responses from farmers regarding reasons as to why they had not adopted a measure were categorised under the headings in Table 6.6. A comment made during an interview could be listed under multiple categories, for example *'I need all my land to farm'* as a reason for not taking land out of production was categorised under *economic* as the response indicates the farmer needs all their land to create an income, e*nvironment* as the farm size is limiting and *reflective motivation* as this signifies the farmers attitude and belief that they 'need' the land.

Once responses had been listed and tallied under each category, it was important to validate the categorisations. Five researchers who specialise in either behaviour psychology or environmental sciences were provided with: samples of raw data spreadsheets (similar to Table 6.5); a copy of Table 6.6 to provide examples of categorisation; and blank copies of Table 6.6 with only the category headings. After a short briefing about the survey and an explanation of the exercise, researchers were asked to categorise and tally the various barriers found in the raw data. Comparisons were made between category choices of the researchers and conclusions formed of the most appropriate categorisation. The tallied scores for each category were transferred to the scale on the barrier wheels (Figure 6.9).

External		Internal	
Social/cultural	III	**Demographic**	
Economic	𝍸 𝍸 III	**Automatic motivation**	
Institutional	𝍸 I	**Reflective motivation**	𝍸 𝍸 II
Environmental	𝍸	**Capability**	IIII

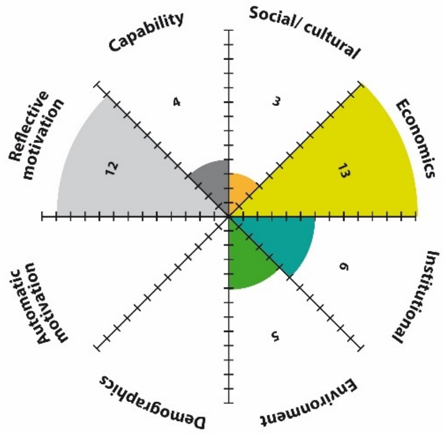


Figure 6.9 Example demonstrating the creation of a barrier wheel by tallying each category.

Limitations existed with such a method. Firstly, factors contributing to the size of the segments were treated of equal importance. In reality this may not be true, but to be pragmatic this research chose to surrogate frequency of mentions with importance. It is imperative to state this research does not attempt to claim that the largest segments are more influential, they are simply the factors most frequently mentioned by farmers. The second limitation was that the barrier wheels only represent what the farmers perceived as barriers and does not present barriers which are not acknowledged by the individuals. One obvious example would be age, which the farmer would not admit or appreciate as a barrier. The final limitation to note is the varying number of farmers interviewed for each measure, therefore barrier wheels for particular measures will be less robust. To remain transparent each barrier wheel indicates the number of farmer responses contributing to its formation.

In the initial phases of analysis, the default position was to keep each catchment's results separate, but it became apparent that discussions of barriers tended to be similar across catchments for particular measures, whereas a lot more variation occurred during the motivational discussions. Therefore in the presentation that follows, barriers are considered overall, and in some cases motivations are separated out when they were clearly different between certain catchments.

6.3.4 Individual measure results

The eleven mitigation measures investigated by this research are listed in Table 6.7 showing the number of in-depth discussions achieved. As discussions were farmer led, and challenges with fulfilling quotas occurred, some measures were investigated more than others. Although this resulted in an unevenly distributed fulfilment of the quota, it does identify which measures were of interest in the catchments at the time.

Table 6.7 Frequency of in-depth farmer discussions regarding the mitigation measures investigated in each catchment.

		Eden		Wensum		Tamar	
		Have adopted	Have not adopted	Have adopted	Have not adopted	Have adopted	Have not adopted
Land use change	Land out of production	5	3	5	3	5	6
	Tree planting	9	5	5	3	6	5
	Sediment trap	6	6			5	4
Management change	Subsoiling/ grass aeration	6	4			6	5
	Reduced cultivation system			5	3		
	Tramline management			5	5		
	Cover crops			5	5		
Infrastructure change	Track re-surfacing	7	2	5	4	5	5
	Roofing over yards	6	4			7	5
	Re-siting gateways	5	5			5	5
	Biobed			2	7		

Although in-depth interviews were not possible with every farmer for each relevant measure, all were asked '*Do you do 'x' mitigation measure? If not, would you be very likely, likely, unlikely or never do it in the future?'* A question from Chapter 4's survey. Figure 6.10 shows the farmers' responses, displaying current uptake and attitudes to future uptake of measures. This provides a benchmark and comparison between measures, as well as a means to compare results with the farmer sample from Chapter 4. Separate graphs displaying results for each catchment are provided in Appendix C.4 to illustrate the differences in uptake and attitudes.

The results show that *reduced cultivation* was highly adopted amongst Wensum farmers, whereas *biobeds* were rarely adopted. *Tree planting* was the most adopted out of the measures asked in all three catchments, with *land out of production* receiving the most negative responses for future uptake. Additional measures receiving a large percentage of negative responses comprised of *re-surfacing tracks, re-siting gateways* and *sediment traps. Cover crops and roofing over yards* received the most positive responses from farmers who had not yet adopted such measures.

Comparing the results in Figure 6.10 with those from Chapter 4, highlighted some differences. Such differences may be due to the changes in socio-economic context which occurred over the two year period, as well as differences in participants. Any substantial differences in uptake are noted in the relevant discussions regarding the particular measures.

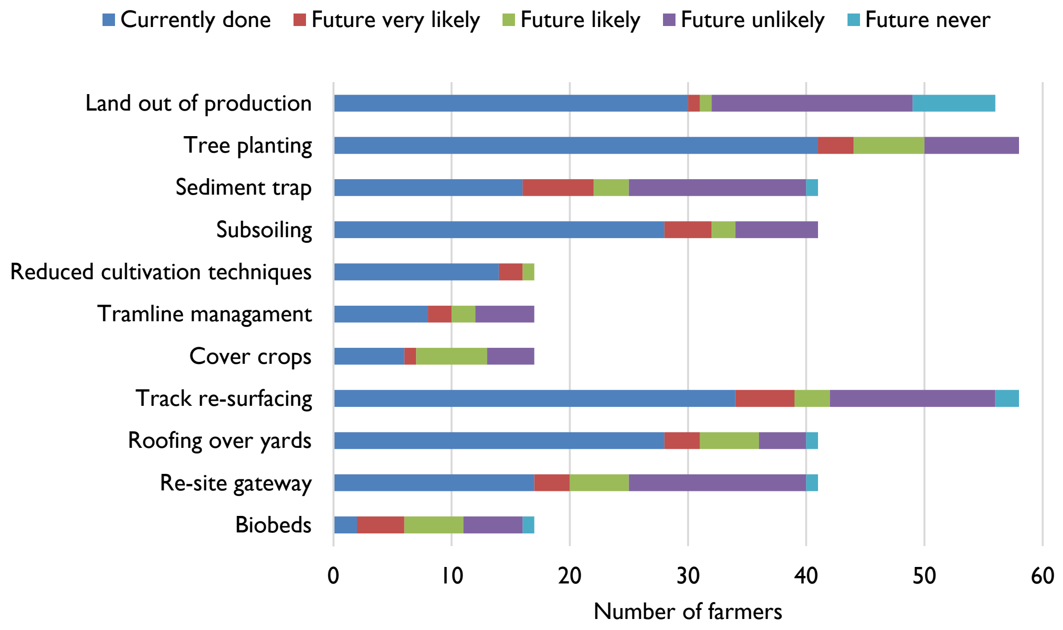


Figure 6.10 Current uptake and attitudes to future uptake of WPA mitigation measures.

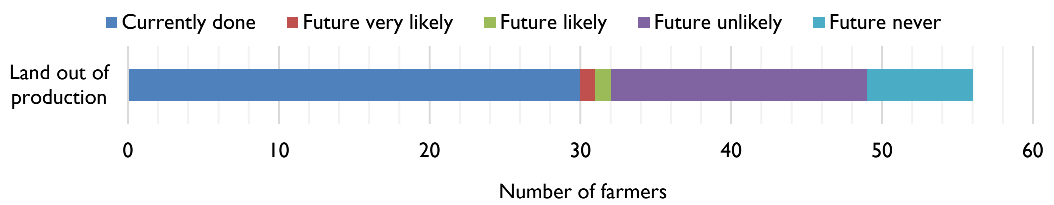
The next section of this chapter is divided into sub headings for each mitigation measure. Each subheading contains survey results presented in the form of a: bar chart of current uptake and future attitudes to uptake for context (taken from Figure 6.10); decision process diagram depicting the motivational factors which influenced famers to adopt the measure; and barrier wheel to show the most common barriers to adoption. Diagrams are presented alongside descriptions, accounts and quotes from the survey discussions to provide further insights.

Land use change measures

Land out of production

Current uptake and future adoption – Over half of the farmers interviewed had taken land out of production (Figure 6.11a). Attitudes to future uptake were similar to the results from Chapter 4, predominantly being negative, with 10% claiming they would never do it.

a)



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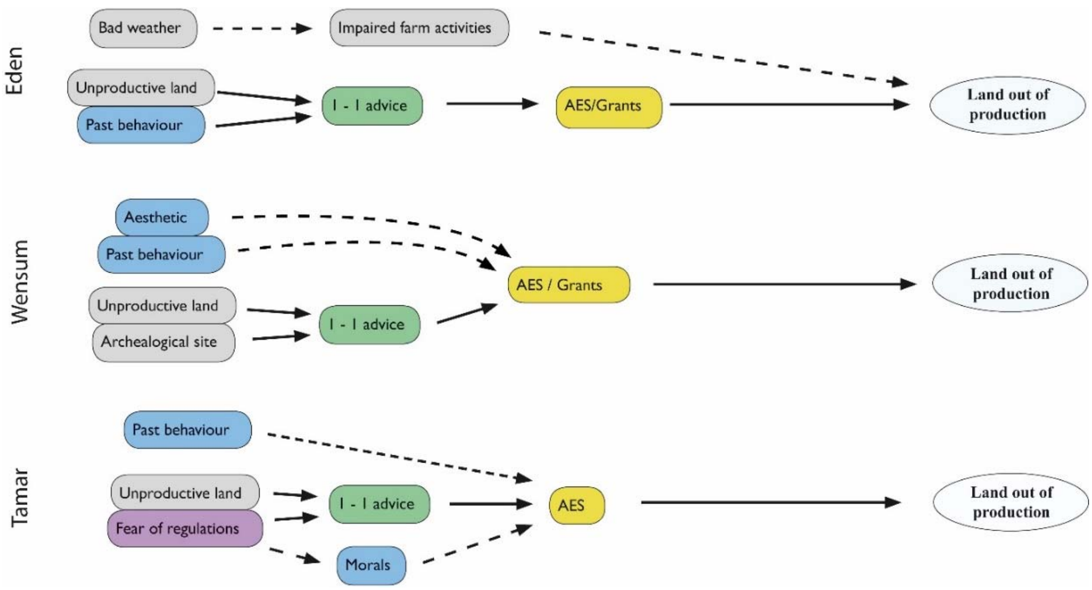


Figure 6.11 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of land out production (15 farmers).

Motivational factors – A variety of different factors were found to have contributed to the farmers' decision processes, with a particular order visible in the stages of influence. Initial factors predominantly consisted of farm characteristics and endogenous reasons, with responses from farmers similar in some respects to each other across the three catchments, however differences are worth noting. Unproductive land was key amongst the majority in all three catchments, whilst aesthetic reasons were highlighted by Wensum farmers (Figure 6.11b).

The next factor was often one-to-one advice from an advisor about grants or AES options. A striking element of the decision processes was that all, apart from one farmer in the Eden, had needed a financial incentive. The exception was reluctantly caused by bad weather which prevented seed drilling. Financial incentives came in several forms, from AES agreements, to solar energy or wind turbine grants/contracts. Discussions highlighted that even farmers who stated they took land out of production for moral reasons and their love of wildlife, claimed they would not be willing to do so without financial compensation. This implies 'crowding out' has occurred (a phenomenon when an activity becomes associated with an external reward, and individuals will be less inclined to participate without incentives in the future - Frey and Oberholzer-Gee, 1997). AES will need to continue to reward farmers, otherwise mandatory rules similar to the old set aside scheme (Figure 2.9) should be brought back if needs be for policy targets.

Further exploratory discussions revealed that negativity existed amongst some farmers who had taken land out of production. Attitudes of '*wasted land'* and '*creating a mess with brambles'* revealed regret, with several farmers remarking that continuation of such land agreements is doubtful and not worth it.

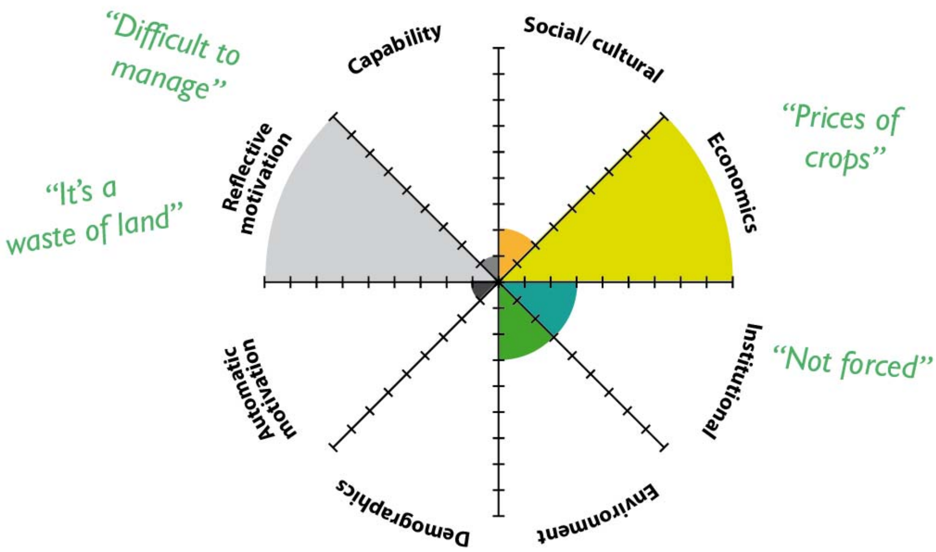


Figure 6.12 Factors contributing to the non-adoption of land out of production (12 farmers).

Barrier factors – Figure 6.12 shows the factors contributing to the non-adoption of land out of production. Of the twelve farmers who discussed barriers for land out of production, only one stated they would be likely to do so in the future as they believed regulations will eventually force everyone. The remaining farmers provided similar responses to each other as to why they wouldn't adopt, with reasons grouped into two categories - reflective motivation in the internal factors and economics in the external factors.

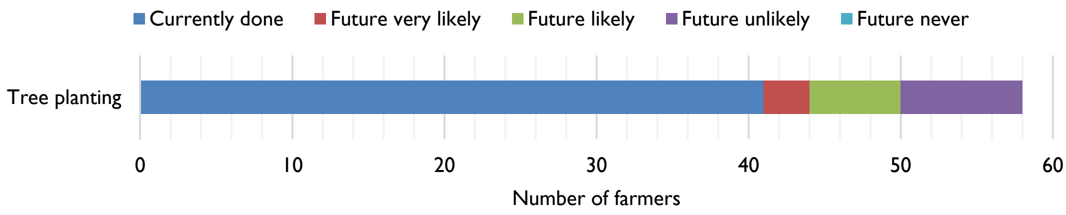
Firstly, the opinion of increasing food shortages in the future and therefore rising prices for commodity items meant that farm profits were expected to improve (despite the acceptance that input costs will increase). This discouraged farmers from wanting to be tied into agreements for periods of 5–10 years, especially AES or energy production contracts. Secondly, there was a view that compensation for the loss of land was not enough, particularly for those who believed they had no unproductive land. Finally, despite workload potentially decreasing with less land to cultivate, opinions were that workload would increase due to complex management required. One farmer made the comparison with a regular job and the work associated with land out of production, such as sowing flower mixes or for reintroducing land back into production after an agreement, proclaiming '*would you like to go to work for a month and not get paid for it?'* Wensum Farmer 16.

Comments made by the non-adopters focussed emphasis on what they stood to lose i.e. loss of income, land, management, flexibility and control. Further barriers included institutional concerns about the ever-changing policy landscape which discouraged investing in long-term agreements, as well as AES being too restrictive, especially with timings. Eden farmer 13 argued '*the weather is changing, and every year is different. How can they (Defra) possibly set a fixed date for activities without causing more damage if the weather isn't suitable?*'

Tree planting

Current uptake and future adoption - Tree planting was the most widely adopted land use change measure out of the three investigated, with the largest proportion of farmers who had not adopted stating they would in the future. However, mixed attitudes for future adoption did occur, with differences found between the catchments (Figure 6.13a).

a)



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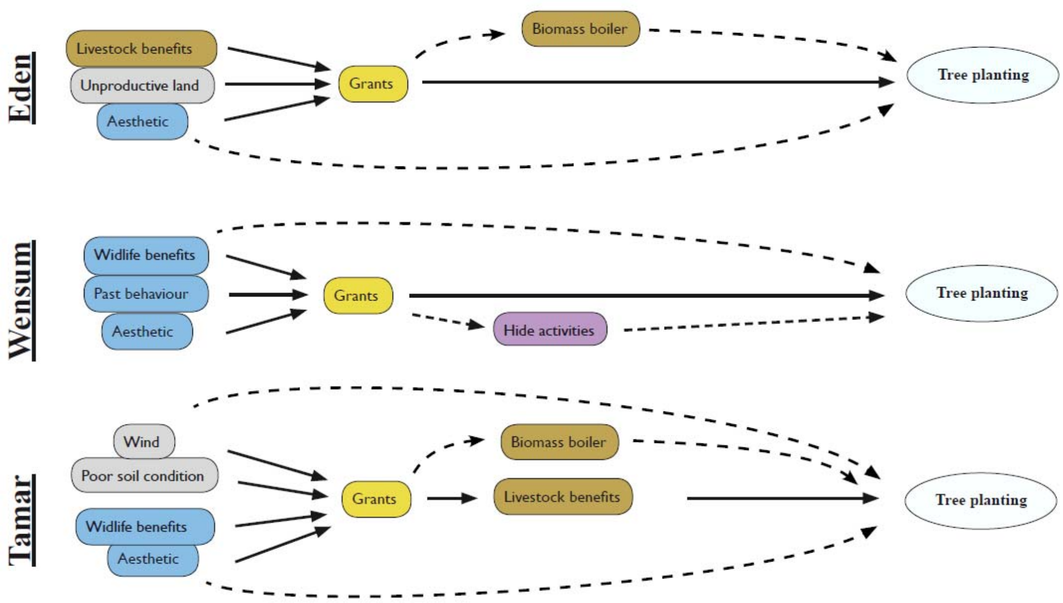


Figure 6.13 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of tree planting (20 farmers).

Motivational factors – Initial motivational factors were wide ranging, with differences occurring between farmers in the three catchments (Figure 6.13b). Farmer responses stating wildlife benefits and aesthetic reasons were more common in the Wensum whilst more practical reasons for planting trees came from the Tamar and Eden. Cultural differences were apparent between catchments and may go some way to explaining the different initial motivational factors. The most striking difference was that Wensum farmers claimed tree planting added value to the land, whereas Tamar farmers believed it devalued the land (such cultural differences in the Tamar are discussed in the barriers section). From discussions it can be assumed that the perceived value in the Wensum came from the desire of game cover for shooting, investing in long-term fuel sources and timber trade, handing on a legacy and the social benefit of adding aesthetic value to the 'flat, barren' landscape.

Despite whatever the initial factor was, the dominant pathway for decision making quickly became more linear in all catchments, with 'grants' being a crucial element. Unlike taking land out of production, grants were not always either necessary or the final push to encourage uptake. The latter was especially true in the Tamar, with extra benefits such as livestock benefits or biomass fuel sometimes being needed to attract some farmers, such as Tamar farmer 10 who stated *'Grants have always been available for trees but they're just not enough to sacrifice your land. When I heard of biomass I thought hang on a minute am I missing a trick'*.

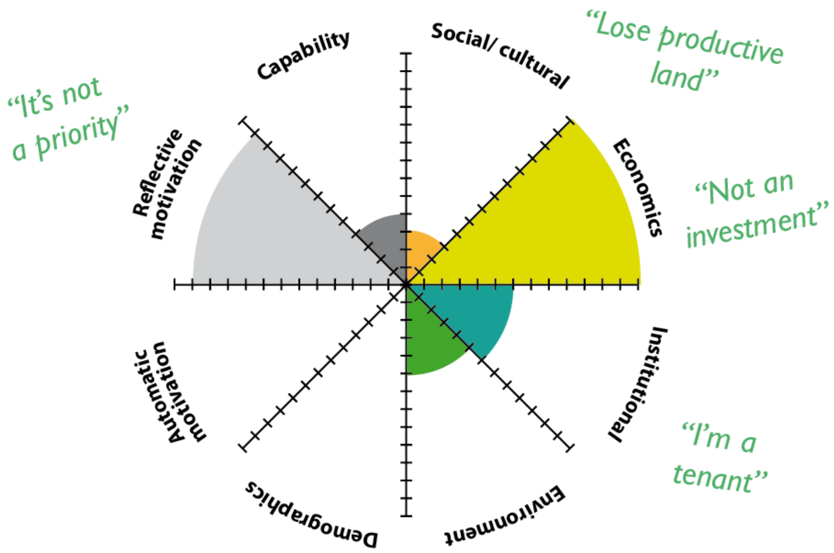


Figure 6.14 Factors contributing to the non-adoption of tree planting (13 farmers).

Barrier factors – The tree planting barrier wheel (Figure 6.14) displays *economics* and *reflective motivations* as being the dominating segments. Some responses were different between the catchments and are worth highlighting but still fall under the same two categories (largely Eden farmers claimed they were likely to plant in the future, Wensum farmers claimed they were unlikely to and Tamar farmers provided a mixed response).

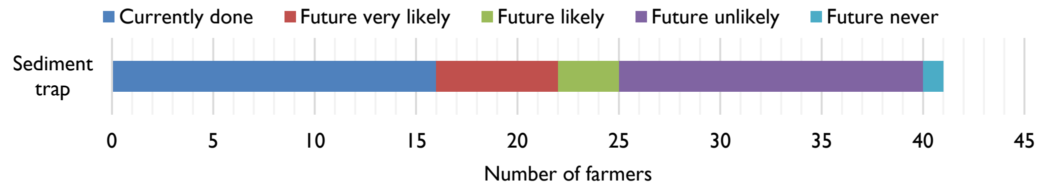
In the Eden, despite wanting to plant, tenancy agreements and small margins earned by livestock farmers were claimed to impact their ability to invest. On the other hand, in the Wensum, the arable land owners did not want to plant trees as they believed there was no unproductive land on their farm. In the Tamar, farmers who were likely to plant in the future believed they had unproductive land and wanted to make use of it. The other farmers in the Tamar who were unlikely to plant, perceived trees devalued the land. A number of perceived costs came out of the discussions, contributing to the farmers negative attitudes: the inter-generational costs of the land being locked up forever; the income expectation of trees being miniscule; the income foregone by taking land out of agricultural production or from cattle contracting mastitis caused by flies from the woods; the actual costs of tree management, deer control, replacing dead trees and the costs of time. As one farmer put it *'doesn't make me money, make my life easier or save me money so why do it?'* Tamar farmer 7. Additionally, the social costs could be that it is seen as forestry not farming or there is the risk of looking a 'plonker' to the rest of society if the trees died, which was the case for many in the 1970's, with the familiar rhyme as a reminder (pers. comms. Jilly Hall, Natural England, 30th March 2015) *"Plant a tree 73, plant some more 74, barely alive 75, bundle and sticks 76, gone to heaven 77, far too late 78."*[18]

[18] The drought of 1975 scorched away the efforts of a Government-sponsored national campaign in the UK coined 'Plant a tree in '73, plant some more 74'. (Cooke, I., 2008).

Sediment trap

Current uptake and future adoption - Sediment traps were found to be fairly uncommon in the two catchments surveyed (Eden and Tamar), with the majority of attitudes to future adoption being negative. There were however a small collection of farmers who were interested stating they would be very likely to implement a sediment trap in the future (Figure 6.15a).

a)



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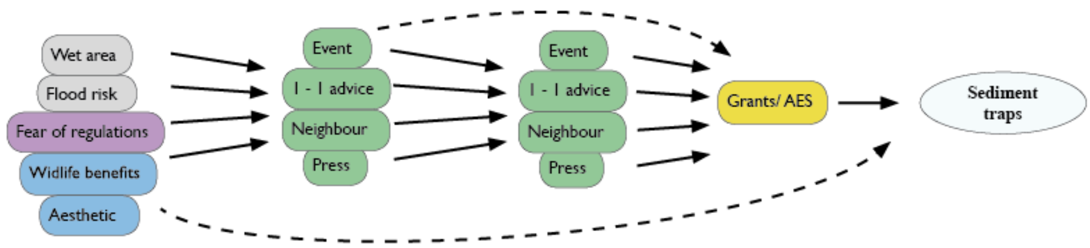


Figure 6.15 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of sediment traps (11 farmers).

Motivational factors – A large range of factors motivated adoption of sediment traps, with a greater number of stages required compared with most other mitigation measures (Figure 6.15b). Fear of regulations was an initial factor for the farmers who created sediment traps specifically for trapping sediment (e.g. one farmer had steep sloping fields leading directly into a reservoir, and another had land that continuously flooded, silting an A road). Those who had established a 'pond', often did so in an area which was always wet and often flooded in the winter, with reasons oriented around wildlife and aesthetics. Such farmers, side stepped a lot of stages in the decision process (represented by the dashed arrows).

The remainder of the farmers, whose initial reasons for sediment trap creation were flood and/or pollution risk, not only needed advice from multiple sources before deciding to finally establish a sediment trap but also a financial incentive. Seeing a demonstration at an event, speaking with an advisor or neighbour and reading about the topic were important for persuading farmers to establish a sediment trap, as well as an incentive.

Even once the barrier of adoption had been overcome, a barrier of correct management was also apparent too, as one farmer stated "*I probably will just leave them and not empty the sediment, can't be bothered to empty them.*" Eden farmer 14.

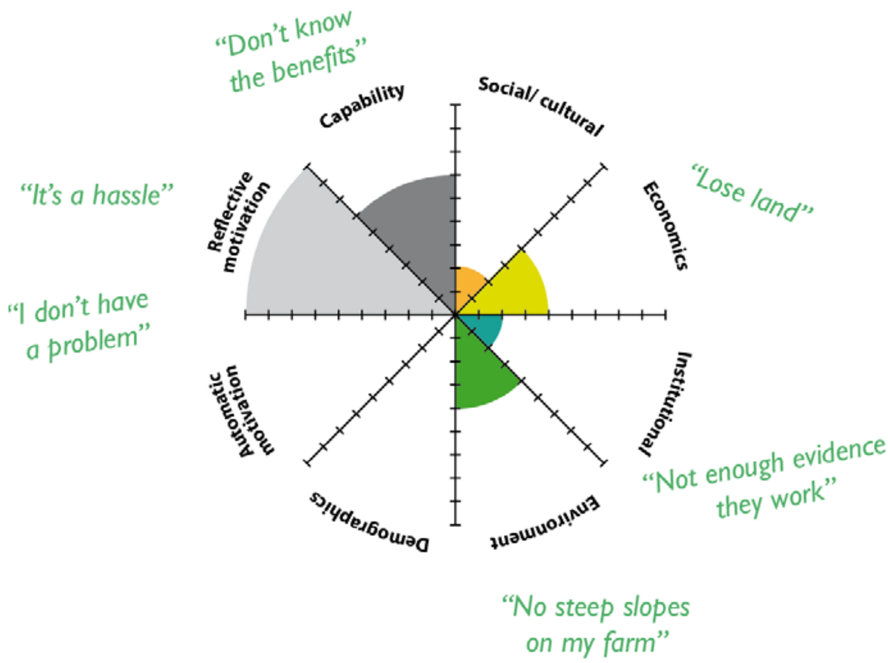


Figure 6.16 Factors contributing to the non-adoption of sediment traps (10 farmers).

Barrier factors – The factors which acted as barriers for the adoption of sediment traps were predominantly internal (Figure 6.16). In both catchments, farmers who claimed they would be likely to establish a sediment trap in the future, stated not knowing enough and the need for more research to convince them they worked were the dominant barriers. Differences between the catchments also occurred. Farmers in the Tamar claimed tenancy agreements and the loss of land for agricultural production were reasons for not currently having one, whilst farmers in the Eden, despite also being tenants, provided some different responses of not wanting the hassle of cleaning it out, thinking it looks bizarre on the land and that it could be dangerous for children drowning. A further barrier mentioned by one farmer was they were not into rural sports (shooting) and therefore felt they would not gain full use out of a 'pond'.

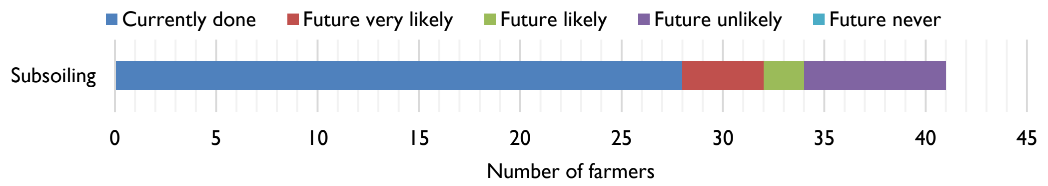
Farmers in both catchments who claimed they would be unlikely to establish a sediment trap in the future simply stated they (sediment traps) were not relevant or necessary on their farm.

Management change measures

Subsoiling

Current uptake and attitudes to future uptake - A higher percentage of farmers were found to subsoil compared with the farmers from the baseline survey[19]. Responses were similar across the Eden and Tamar, with non-adopters having mixed attitudes to future adoption (Figure 6.17a).

a)



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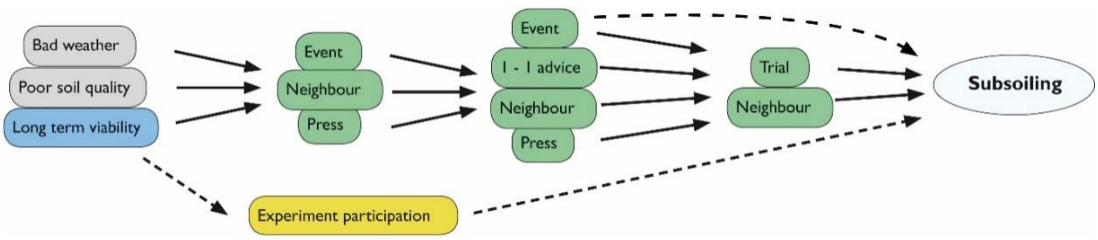


Figure 6.17 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of subsoiling (12 farmers).

Motivational factors – Analysing the decision process of motivational factors (Figure 6.17b), it is striking how dominant the advice category was for the adoption of subsoiling. For the vast majority of adopters, a very complex process with numerous sources of different advice, at multiple stages was required to encourage adoption. Not all received one-to-one advice, but having the desire to invest in the long-term viability of their farm and/or suffering from poor grass yields started their thought processes. Then attending events with demonstrations, reading farming press and/or speaking with fellow farmers helped contribute towards adoption. Having the ability to trial the machinery was required by some farmers as a final persuading factor to incorporate subsoiling into their farm practice.

Amongst the adopters, first-hand experience of benefits through visible changes and direct increase in profitability from yields resulted in highly positive comments and them advocating

[19] Farmers in the baseline survey (Chapter 4) were asked about their adoption of 'loosening compacted layer in grassland' with 34% having implemented it.

the measure. *"I did a strip in the middle of a field as an experiment and one farmer said, "Have you got the new electrical collar fencing, your cows are staying in a straight line!?" I laughed and explained what I had done, they were astounded. I have experienced a third more milk, which I think is from better quality grass! And it has even helped with reducing water logging."* Tamar Farmer 2.

One farmer represented in Figure 6.17b was involved in a project run by the Eden RT to examine cost-effective ways to reduce run-off. As the farmer also worked part-time for the Trust, he was frequently exposed to a wealth of knowledge, perhaps explaining why there was no mention of advice provision in the process of adoption (represented by the experimental participation box and arrows).

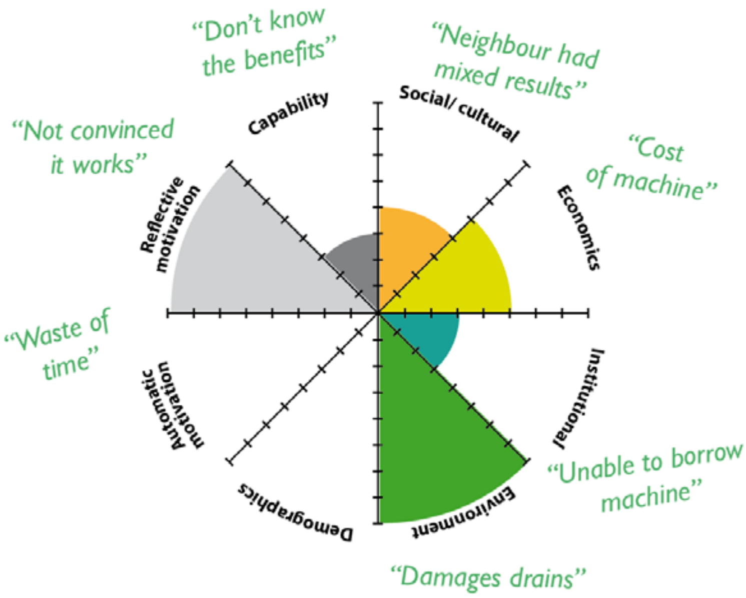


Figure 6.18 Factors contributing to the non-adoption of subsoiling (9 farmers).

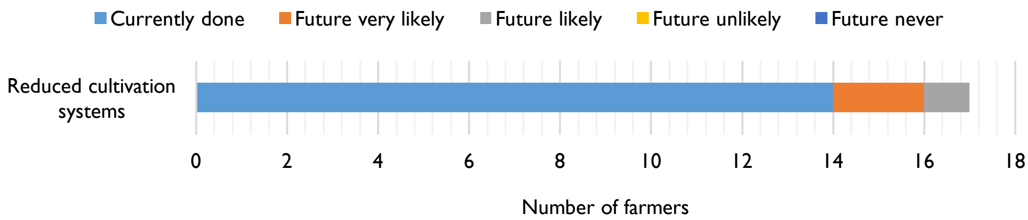
Barrier factors – Discussions with non-adopters highlighted that several different types of internal and external barriers existed (Figure 6.18). Farmers with negative attitudes to future adoption predominantly made comments which fell in the reflective motivation, environment and economic categories, as well as some social/cultural barriers. Comments included *'it doesn't work', 'it's a waste of time',* and *'the window of opportunity to do it is too small'* denoting the internal factors which influenced decisions, whilst the external factors heavily involved the environment, with wrong soil type or drains being the issue. Farmers who had positive attitudes to future adoption claimed lack of knowledge or ability to borrow and trial machinery (capability and institutional) prevented them from doing so. Whilst neighbours had mixed results, they wanted to try it for themselves before committing.

The following three measures were only investigated in the Wensum, just being applicable to arable farmers, therefore it must be acknowledged results are based upon fewer responses.

Reduced cultivation systems

Current uptake and attitudes to future adoption - Reduced cultivation systems were already widely adopted and appear popular amongst the three non-adopters from the survey sample (Figure 6.19a).

a)



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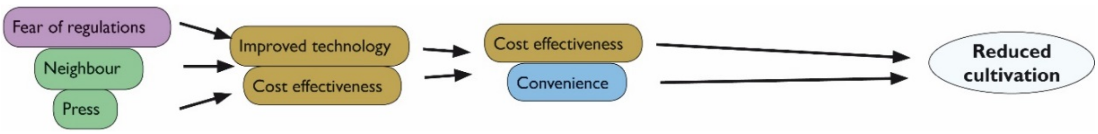


Figure 6.19 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of reduced cultivation systems (5 farmers).

Motivational factors – Of the adopters interviewed in-depth, a similar thought process occurred amongst many, thus creating a simpler process for adoption than other mitigation measures (Figure 6.19b). The risks associated with smearing and too much soil erosion from ploughing during inappropriate weather caused one farmer to be fearful of breaking rules and instigated their thought process to change farm practices. Advice from press and neighbours caught the attention of the remainder.

Industry and market factors heavily influenced their decision, with profit margins frequently mentioned during discussions. Cost-effectiveness was believed to be far greater than ploughing, and with improved machinery at cheaper costs farmers claimed they were able to get a good deal. Wensum Farmer 13 explained '*now that technology has been around for a few years, and it keeps improving you can get a good price on a second-hand beast that does a good job.'* Such cost advantages for reduced cultivation were believed to get better with fuel and fertiliser costs expected to rise.

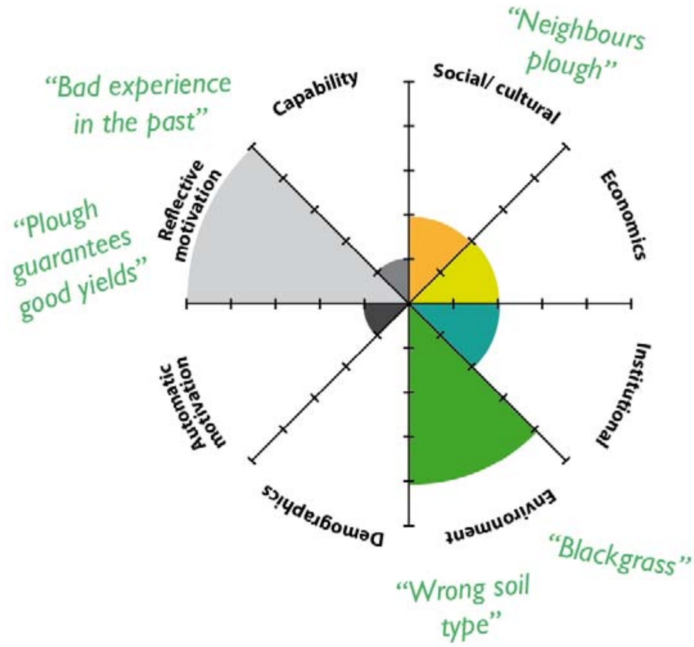


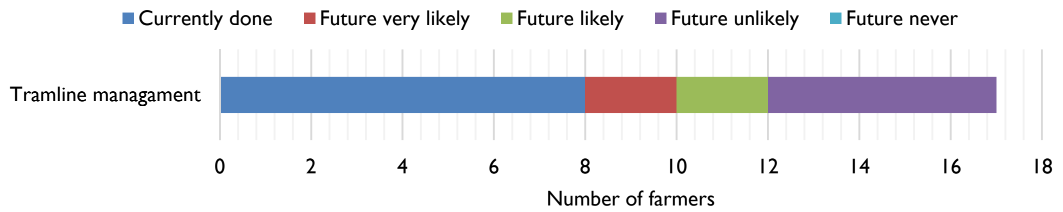
Figure 6.20 Factors contributing to the non-adoption of reduced cultivation systems (3 farmers).

Barrier factors – The three farmers interviewed who had not adopted reduced cultivation practices, were not opposed to adoption however stated a number of barriers (Figure 6.20). In a similar way to subsoiling, reflective motivation and environment dominated. Internal factors included negative past experiences from trials and believing ploughing is the safe option for ensuring good yields, *'if something works why change it?'* remarked Wensum Farmer 9. External factors were predominantly linked to the environment with wrong soil type and fear of blackgrass (weeds) being stated, with other barriers including cost of machinery.

Tramline management

Current uptake and attitudes to future adoption - Nearly half of the farmers interviewed had adopted tramline management, however mixed responses to future uptake occurred (Figure 6.21a).

a)



b)

Figure 6.21 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of tramline management (5 farmers).

Motivational factors – Of the five farmers interviewed about their adoption of tramline management, two were asked about their use of GPS tracking systems and one about GPS and control traffic farming, whist two were asked about their use of low ground pressure tyres.

The three farmers using GPS and/or control traffic farming were all large farm estates with highly educated managers. Striving for long-term sustainability of soils was mentioned frequently as the key reason for deciding to invest in the technology in the past three years (Figure 6.21b). Recent sale prices enticed one farmer to make the management change, whilst another had been waiting for the technology to improve. Being a large estate, one farmer felt neighbours were always watching their every move and it would be an embarrassment if their tramlines were not straight, *'it's a matter of pride.'* Wensum Farmer 4.

The two farmers using low ground pressure tyres had done so for over 10 years. Fuel efficiency with improved technology and common sense for doing the right thing for the soil were said to have persuaded uptake, with comments being made *'it's the done thing now, everyone uses them'* Wensum Farmer 3.

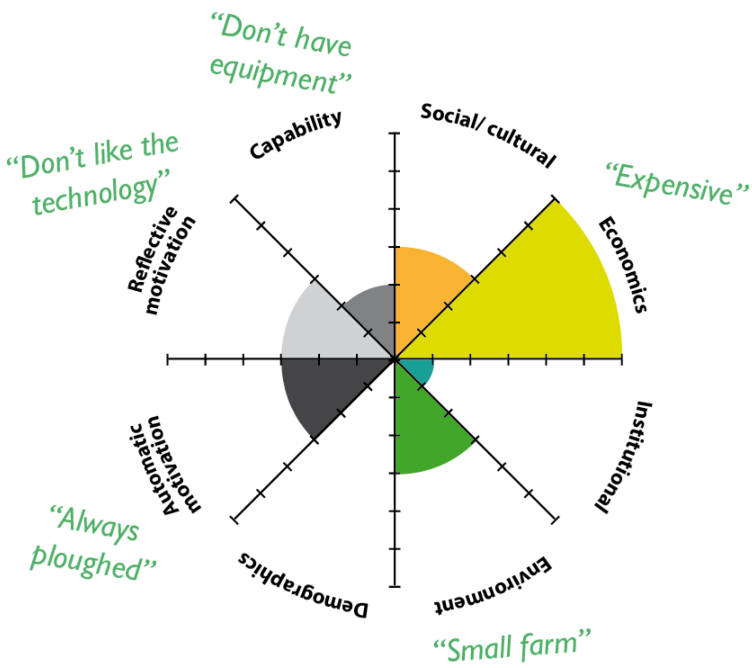


Figure 6.22 Factors contributing to the non-adoption of tramline management (5 farmers).

Barrier factors – The barrier wheel above (Figure 6.22) displays responses regarding GPS for the management of tramlines. A range of both internal and external factors appear to influence farmers to not adopt, with economics dominating the external factors.

Despite economics being stated most frequently as a reason for not adopting, it is clearly not the only factor. Many of the other factors do link to economics, for example, small farms (environment) and not having the equipment (capability) can be related to the lack of ability to invest in the cost of technology.

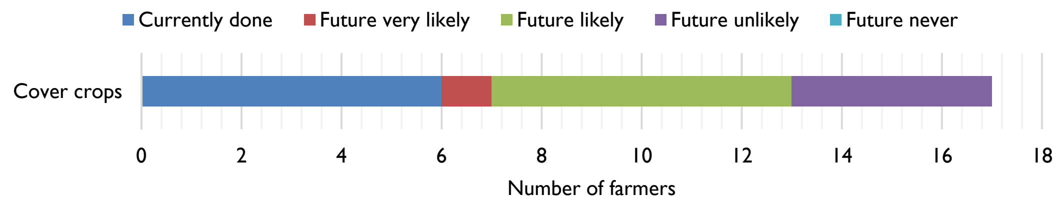
The barrier categories of automatic motivation and cultural are a result of personal habits and social norms, with two farmers saying they had always ploughed so there was no need to worry about compaction of tramlines, whilst another farmer explained how their contractors had always done it their way and ploughed.

Further discussions occurred regarding other tramline management options such as control traffic farming and low ground pressure tyres. Such measures are not discussed further as the main barrier was simply having to change machinery.

Cover crops

Current uptake and attitudes to future adoption - Although current adoption of cover crops was found to be low, positive responses were given for future adoption[20] (Figure 6.23a).

a)



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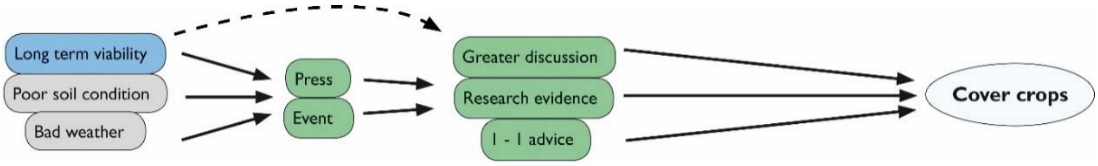


Figure 6.23 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of cover crops (5 farmers).

Motivational factors – Advice was the dominant category of factors in the decision process for the cover crop adopters (Figure 6.23b). Financial incentives, market factors or regulations did not feature in the decision processes. Farmers currently growing cover crops were educated at a high level and appeared to be innovative and willing to experiment, with one farmer explaining that *'it's going to be trial and error with cover crops. I wanted to start this year to start experimenting and finding out what works best on our farm.'* Wensum farmer 18. Adopters often mentioned long-term benefits to soil as being very important.

[20] The percentage of responses who stated they would be likely or very likely to consider adopting cover crops was higher amongst farmers in this sample (2014)(64%) compared with the sample from the baseline survey (2012)(48%).

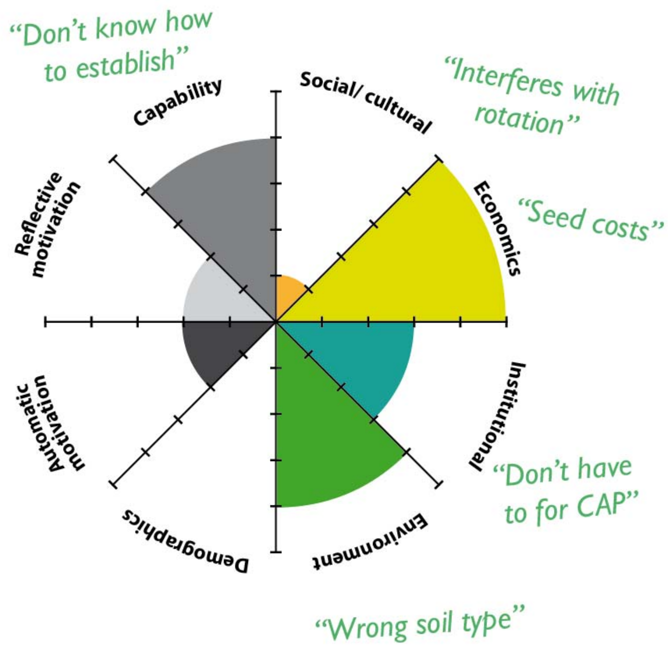


Figure 6.24 Factors contributing to the non-adoption of cover crops (5 farmers).

Barrier factors – Barriers to cover crops encompassed a variety of internal and external factors (Figure 6.24). Farmers who provided positive responses towards future adoption made comments which predominantly came under the capability category. Many felt they did not know enough, for example about the varieties, best establishment methods, seed costs or how they are effective. Even one farmer who had done them before on a different farm and had a good experience wasn't willing to try cover crops where he was now until he saw how well the neighbours did. Local evidence was missing.

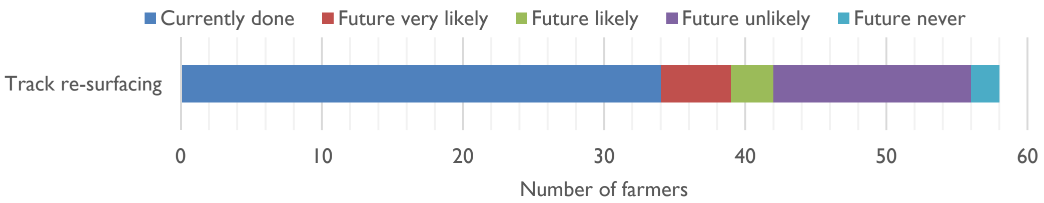
Of the farmers who stated they would be unlikely to adopt cover crops in the future, their main responses were linked to: 1) economic barriers, 2) environmental barriers, believing they either had the wrong soil type, wrong rotation e.g. all autumn crops, or that cover crops only helped with erosion issues and they did not have such issues, and 3) institutional barriers. The comment *'I don't have to'* arose on numerous occasions, but was rarely mentioned for any of the other mitigation measures investigated.

Infrastructure change measures

Track re-surfacing

Current uptake and attitudes to future adoption - Current uptake of re-surfacing tracks was high, however negative responses were provided by farmers about future adoption, stating they would be unlikely to do it in the future (Figure 6.25a).

a)



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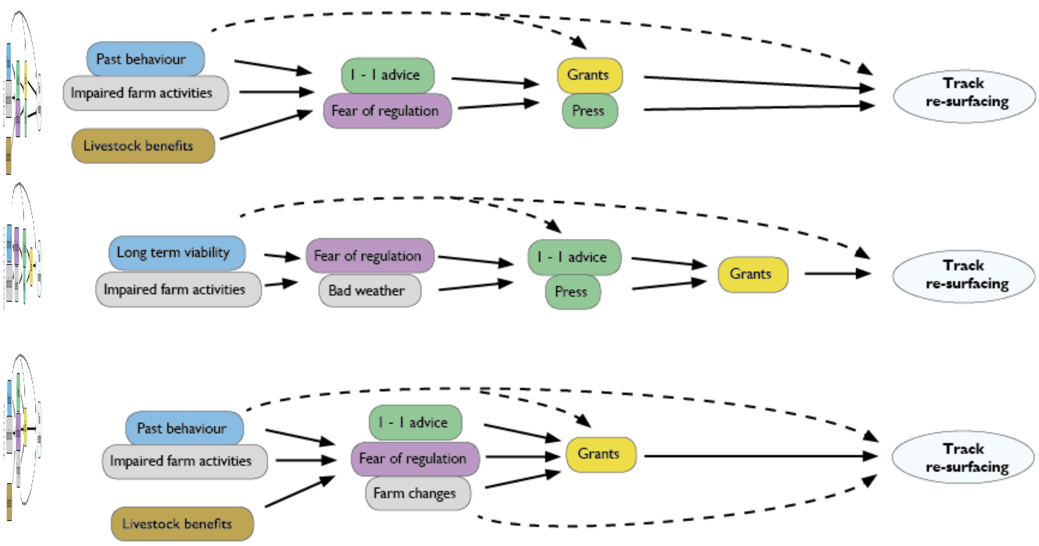


Figure 6.25 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of track re-surfacing (17 farmers).

Motivational factors – Of the infrastructure change measures, re-surfacing farm tracks was discussed with farmers in all three catchments, with responses differing between them (Figure 6.25b). Overall the decision processes were complex compared to other infrastructure measures with many different types of factors at play. Management of tracks greatly differed, as each farm had varying amounts of tracks, different lengths, uses and vulnerabilities, and could be re-surfaced using various resources. Considering responses from farmers who had resurfaced their tracks, a common stimulus was bad weather or farm activities being impaired before any action was taken. The mind-set for many was fighting fire rather than prevention, with ‘past behaviour’ representing all those who frequently re-surface and manage their farm tracks. The decision processes in the Tamar and Eden, often included livestock benefits as a key influencing factor, as re-surfacing tracks directly improves their daily work and livestock health.

Further along the decision process was fear of regulations for some but not all, as several farmers side-stepped this stage as they either believed their issue would not warrant threat of prosecution or they failed to mention regulations at all. Finally, if tracks were concreted or used greater capital investment than cheaper options such as farm sourced material, financial aid from grants was necessary as a last push to re-surface their tracks.

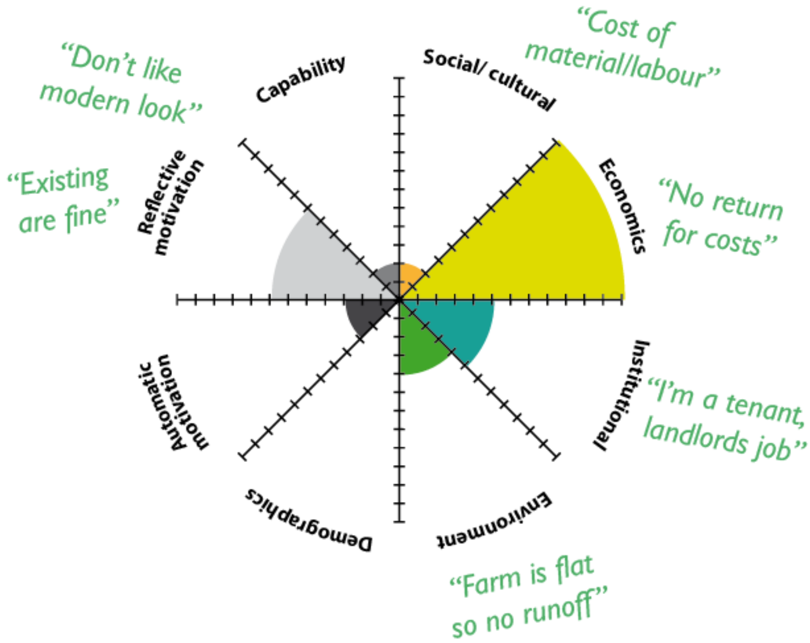


Figure 6.26 Factors contributing to the non-adoption of track re-surfacing (11 farmers).

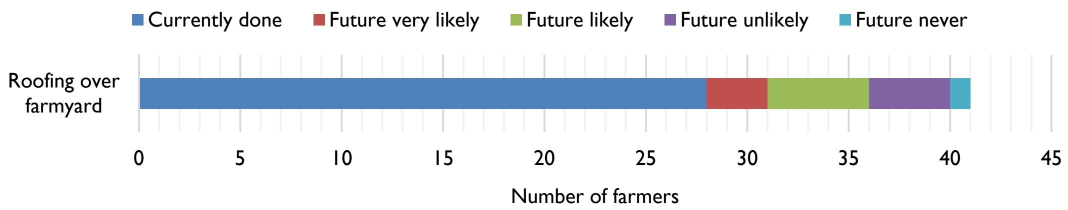
Barrier factors – Barriers to re-surfacing tracks were predominantly economical for farmers who were likely or unlikely to do them in the future (Figure 6.26). Although cost was a key barrier for many, various other factors were stated. Of the farmers who were unlikely to re-surface tracks, several didn't have tracks as their farm was accessed by roads. Other farmers felt they had no problems with their current tracks and therefore had no need to re-surface them. One farmer, despite knowing they had a problem, didn't want to lose the quintessential look of their farm by modernising it with proper tracks, whilst another with track problems blamed their landlord for not acting on the issue.

Of the farmers who claimed they would be likely to re-surface tracks in the future, costs were currently preventing them from doing so, however they all had the attitude that it was something that needed doing. One farmer from the Tamar acknowledged the importance of track improvements stating that *"mainly dairies need them and there hasn't been the spare capital so can't prioritise. Dairy industry is changing so definitely need better tracks as they try to be more intensive and more on grass"* Tamar Farmer 6.

Roofing over yards

Current uptake and attitudes to future adoption - Over 60% of famers interviewed had roofed over part of their yard, with a greater percentage of attitudes to future adoption being positive rather than negative (Figure 6.27a).

a)



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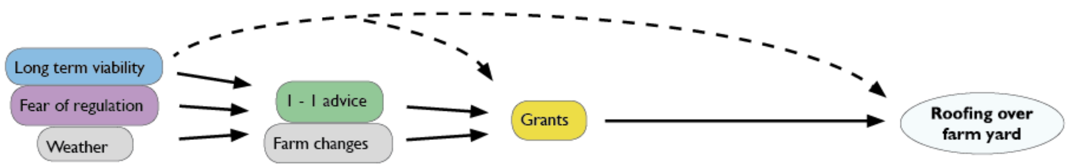


Figure 6.27 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of roofing over yards (13 farmers).

Motivational factors – Of the farmers interviewed who had roofed yards, 85% had received financial aid in the form of a grant (predominately from the Capital Grant scheme) and commented positively on the scheme. '*Wouldn't have been able to afford without help. So grateful. Helped us stop doing something we didn't want to do.'* Tamar farmer 4, *'Grants saved a decade where I haven't had to save, slowly making changes'* Tamar farmer 7.

Along the decision process (Figure 6.27b), very little side stepping of grants was found for roofing over yards compared to other infrastructure measures, with only two anomalies (15%). Changes in farm structure and personal desires to quickly upgrade and modernise dairy parlours resulted in one farmer not wanting the hassle of grant form filling, whilst the other farmer refused to accept advice or aid from anyone (apart from friends and family) as a matter of pride. He had never applied for grants or AES, and wouldn't usually accept unknown visitors on their farm. *'The farming system is unsustainable, got to prove it is possible to be successful without government intervention…We had three generations up on that roof banging nails in.*' Tamar farmer 6. Despite roofing yards not being the social norm several years ago, one farmer who didn't care about being different claimed *'Yes, everyone thought I was mad and it was a waste of a shed, putting muck in it, now everyone does it!'* Tamar farmer 7. Although not everyone is doing it, it is true there has been a shift in awareness and practice in recent years with adoption increasing.

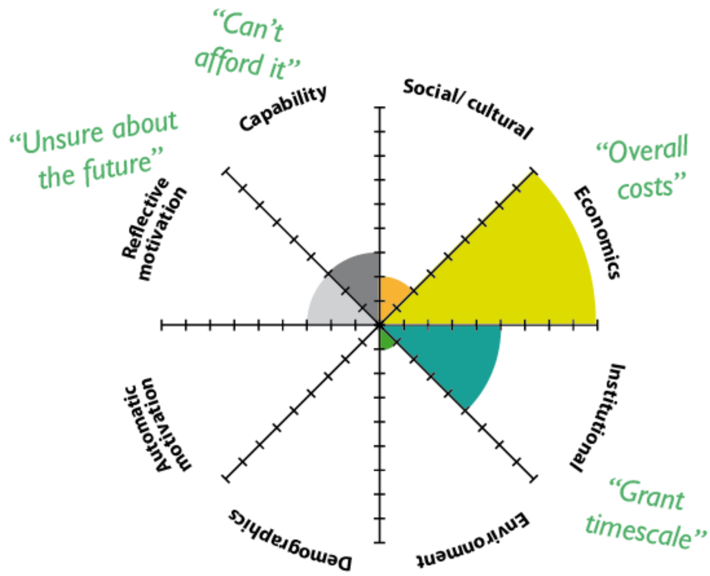


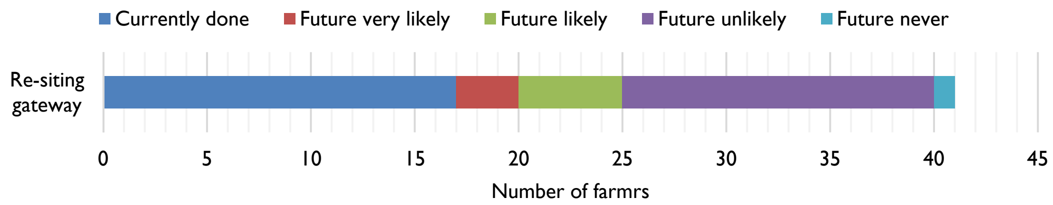
Figure 6.28 Factors contributing to the non-adoption of roofing over yards (9 farmers).

Barrier factors – Cost was the primary barrier for roofing over yards (Figure 6.28). All responses were related to some aspect of costs, '*can't afford it*', '*too expensive*' and '*not enough grant aid*'. As the survey did not investigate the farm business economics, it was not possible to determine whether statements such as '*I can't afford it*' were true. The long-term benefits of roofing over yards may not have been valued, so the upfront costs seemed too expensive. It is also possible that the response '*too expensive*' is an automatic easy response to offer as an explanation to a survey question. Whilst this was acknowledged and further questioning was used to try and discover more information, the discussion always finished with the fact they were not willing to spend money on a roof.

Re-siting gateways

Current uptake and attitudes to future adoption - Re-siting a gateway was found to be less common than other infrastructure measures, with just over a third of farmers having done it. The majority of attitudes towards future uptake were negative (Figure 6.29a).

a)



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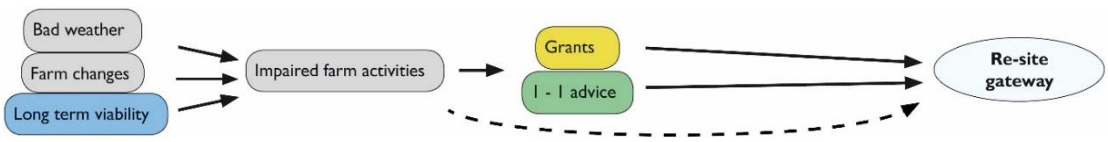


Figure 6.29 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of re-siting gateways (10 farmers).

Motivational factors – The decision processes leading to adoption of re-siting gateways appeared to be less complex than other measure's decision processes, with fewer factors involved (Figure 6.29b). Decisions were strongly motivated by factors which involved farm characteristics. It became clear that no farmer re-sited a gateway until it impaired farm activities. Even when they realised it was in a high risk location, and problems occurred after bad weather or intensification of grazing and gate use, it wasn't until the area became so muddy and practically impassable that they decided to re-site the gateway. The key difference between the two catchments was the final step before adoption. In the Eden farmers received advice, whereas in the Tamar grants were needed for the majority.

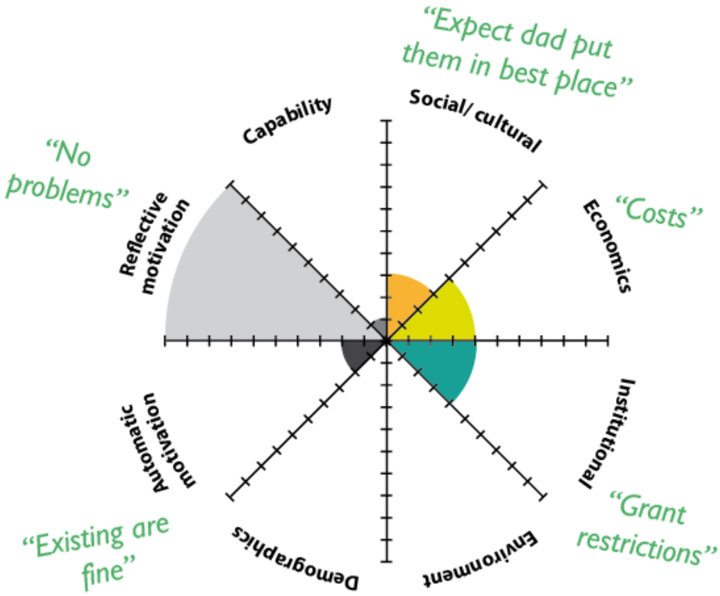


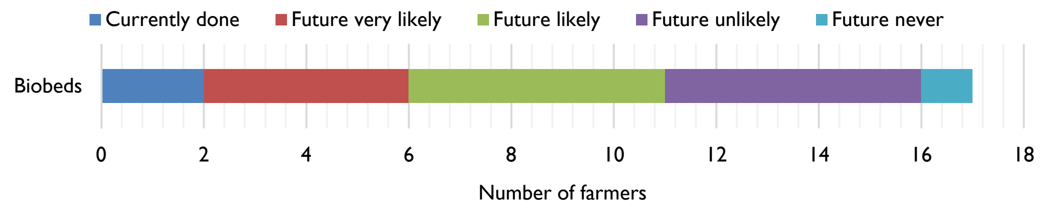
Figure 6.30 Factors contributing to the non-adoption of re-siting gateways (10 farmers).

Barrier factors – During discussions with farmers who had not re-sited gateways, internal factors were the dominant barriers discovered (Figure 6.30). Many believed they had no problems, that the problem was only for short amounts of time in the year and therefore not worth moving a gate, or that they must have been put in the best location in the first place. One farmer proclaimed *'been there hundreds of years, works well.'* Tamar farmer 1. It was interesting to observe Tamar farmer 1's opinion alter as the interview conversation progressed *'except come to think of it some fields do get wet and flooded in the winter now and it is difficult to get to… I'd never thought about it but there is opportunities on the farm. Some fields flood entirely so doesn't matter where gate is, but a field which floods at the gate and prevents access could be moved.'* Farmers did not appear to be averse to moving gateways, with the only disadvantages mentioned, being '*time to do it'* and *'hassle',* thus resulting in the response *'unlikely to do it in the future'*.

Biobeds

Current uptake and attitudes to future adoption - Current uptake of biobeds is very low with mixed attitudes towards future uptake (Figure 6.31a). Great difficulty was experienced finding people who had established one for interviewing, with only two farmers found.

a)



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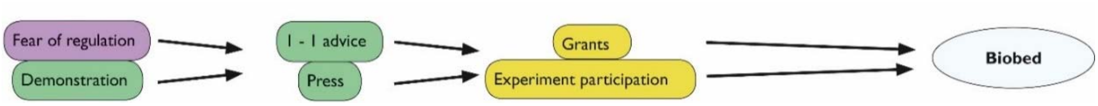


Figure 6.31 a) Current uptake and attitudes to future uptake and b) the decision processes of factors contributing to the adoption of a biobed (2 farmers).

Motivational factors – The two farmers who had established biobeds were forward thinking, innovative farm managers of large estates with the flexibility to invest in what one farmer described as '*luxury infrastructure'*. One characteristic which came across during interviews was their willingness to take risks (investing in biobeds was seen as a risk). The decision process for one farmer started with the fear of regulations, leading to advice and finally a financial incentive (Figure 6.31b),

'*In 1995 we had a diesel tank and spray filling area 100m from a SSSI. I asked the Environment Agency to come out and have a look. They did an infrastructure audit and advised to put some new concrete down which would slope away from the land drains. This was fine but with talk of tighter regulations, in 2008 when a CSFO came to visit they advised us about biobeds. An ADAS specialist came out to visit and next thing you know he's written a very detailed report with all the information we needed. It was incredible. We even got a grant from CSF to help out. We have topped it up once after 2 years, but will need to scoop it all out and refill it soon. We pump between different containers.'* Wensum Farmer 14.

For the other farmer, attending a demonstration event sparked interest as biobeds were not on their radar. This prompted the farmer to carry out his own research, reading the press and agreeing to partake in an experimental study (the DTCs).

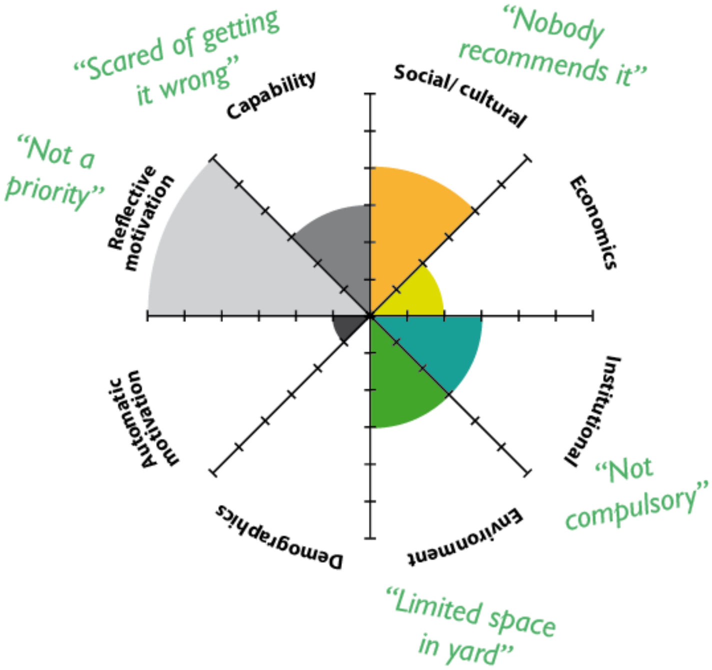


Figure 6.32 Factors contributing to the non-adoption of a biobed (7 farmers).

Barrier factors – The barriers to adoption of biobeds fall under multiple categories (Figure 6.32). There was scepticism amongst farmers as to whether biobeds are necessary on a farm for reducing water pollution, whether they are cost effective, and whether alternative practices such as improving chemical handling in the first place is a more efficient method of achieving similar outcomes. The fact they are not compulsory and farmers didn't think they needed one meant that they were not willing to invest. Not knowing enough decreased their capability to make an informed decision. Some farmers stated no one had recommended a biobed, whilst others had advisors recommending against them.

Having outlined the key factors which motivate or create barriers to adoption for each of the eleven mitigation measures investigated, a discussion and synthesis of the results' implications for agri-environmental policy follows.

6.4 Implications for agri-environment policy

Policy makers face a difficult challenge in designing policies which will effectively influence farmers to adopt farm practices which mitigate water pollution. Understanding motivations and barriers for undertaking specific practices is argued to be of considerable significance to policy makers (Section 2.1 and 2.2). The results presented in this chapter contribute towards improving such knowledge, with Section 6.3 displaying, in detail, the survey results for each mitigation measure investigated. A synthesis of the results is provided below, considering the motivational factors, the barrier factors, and finally combining the two to examine if any relationships exist and identifying implications for agri-environmental policy.

6.4.1 Motivational factors

Interviews with farmers who had adopted a particular farm practice revealed that no single influential factor caused them to adopt. It was found to be an evolving combination of influences. The decision processes for each measure are not directly comparable due to the differences in the farming contexts. However, they can be characterised by their complexity and more generally compared. 'Simple' decision processes are considered to comprise of fewer stages in the decision process and fewer types of influencing factors, whereas 'complex' decision processes involve more stages and influencing factors. Figure 6.33 summarises the eleven mitigation measures in a matrix to illustrate the extent of complexity in the decision processes. Each measure has been placed on a scale to display the number of stages, and the range of different categories of influencing factors involved, based on the qualitative assessment from the interviews. Where results revealed measures with a similar number of categories and stages, the labelled boxes on the matrix are shown to be touching and have been placed in a location which consolidates results. The assessment of biobeds is based on fewer data points and deserves to be treated more cautiously.

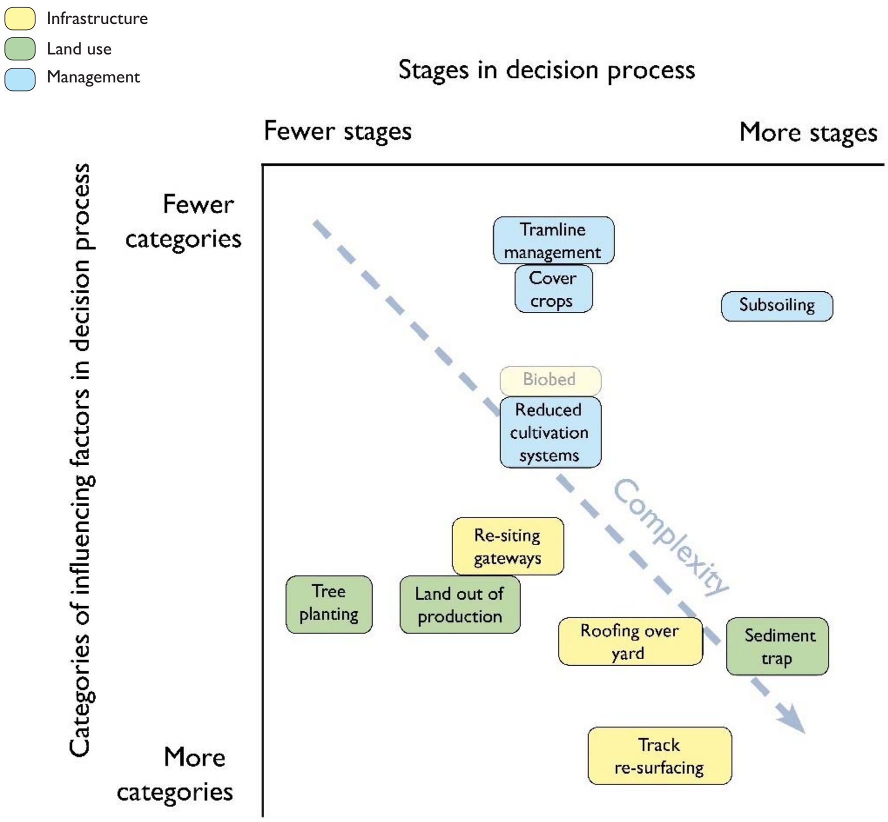


Figure 6.33 A matrix to synthesise the complexity of the decision making processes for the eleven mitigation measures based upon the number of stages and categories of influencing factors.

Figure 6.33 shows that regardless of whether a measure was land use, management or infrastructure change, the number of stages contributing to the farmer's thought process greatly varied. Some of the novel measures such as sediment traps and subsoiling, regularly required more stages with different sources of advice throughout the process. Whereas other familiar measures, such as land out of production and tree planting often merely required two or three stages i.e. having unproductive land or a love of wildlife and receiving a grant. For some farmers, additional stages in a decision process were needed to add to the tipping scales and provide the extra push, with such factors being either secondary benefits (e.g. biomass boiler fuel for tree planting) or knowledge to make a more informed decision (e.g. advice of crop varieties and benefits for cover crop planting).

Studying the number of different factors influencing a decision process, certain patterns can be noted from Figure 6.33. Decision processes for the management change measures commonly involved fewer categories of influencing factors, whereas land use change measures involved a greater number. Infrastructure change measures were generally the most linear with consistent influential factors, however such factors did come from the widest range of categories.

There were also trends in the order in which different influencing factors contributed to decisions. The general order of influential factors is shown in Figure 6.34. Such information identifies *what* might be required to influence other farmers to adopt the measure and at *what stage* in their decision process it might be needed.

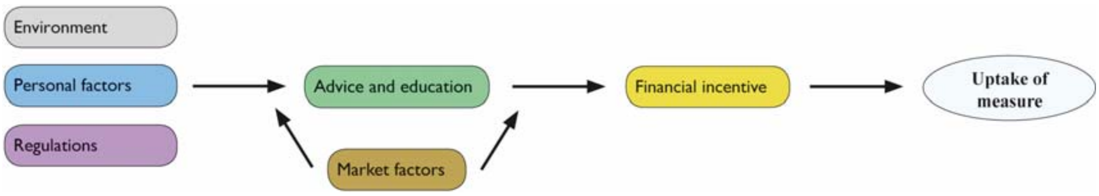


Figure 6.34 Schematic to represent a generalised order of influencing factors which contribute to the uptake of a measure.

There was no initial factor found which could predict or determine the remainder of the decision process, as each farmer's context was different. However, common factors at the start of decision processes often involved: fear of regulation; farm activities becoming impaired and wanting to improve the farm's long-term viability. From the initial factor which catalysed the thought process, a series of stages, varying in number, occurred.

The final stage for many farmers involved a financial incentive of a grant or AES payment, highlighting their importance for encouraging farmers to adopt measures. However, this was not always the case, even when incentives were available, indicating that other mechanisms are also effective, such as advice provision.

Designing efficient mechanisms and focusing government resources where they would be most cost-effective is a priority for policy makers, and highlighting the decision processes farmers go through before adopting a measure raises the important question of 'where should the Government concentrate efforts along the decision process to encourage uptake?' To answer such a question, an understanding of the barriers which need to be overcome is required, to identify relationships between stages in the decision process and barriers, informing the effective targeting of mechanisms.

6.4.2 Barrier factors

To determine which barriers needed to be overcome to influence uptake of particular mitigation measures, this research used a framework to categorise farmer responses. Barriers were presented in the form of 'barrier wheels'. Such analysis provided the ability to determine: 1) how many different types of factors acted as barriers and 2) whether internal or external factors were the most common barriers. The results of the eleven mitigation measures showed that a great diversity of barriers existed for measure uptake.

In Figure 6.35, each measure has been placed in a matrix to summarise both the number of dominant factors and whether barriers were primarily internal or external. In a similar way to Figure 6.33, results for measures with similar outcomes are shown with the labelled boxes touching and placed in a consolidated location (Figure 6.35). Reduced cultivation systems has been faded in Figure 6.35 in the same way as biobeds in Figure 6.33 as results are based upon fewer responses.

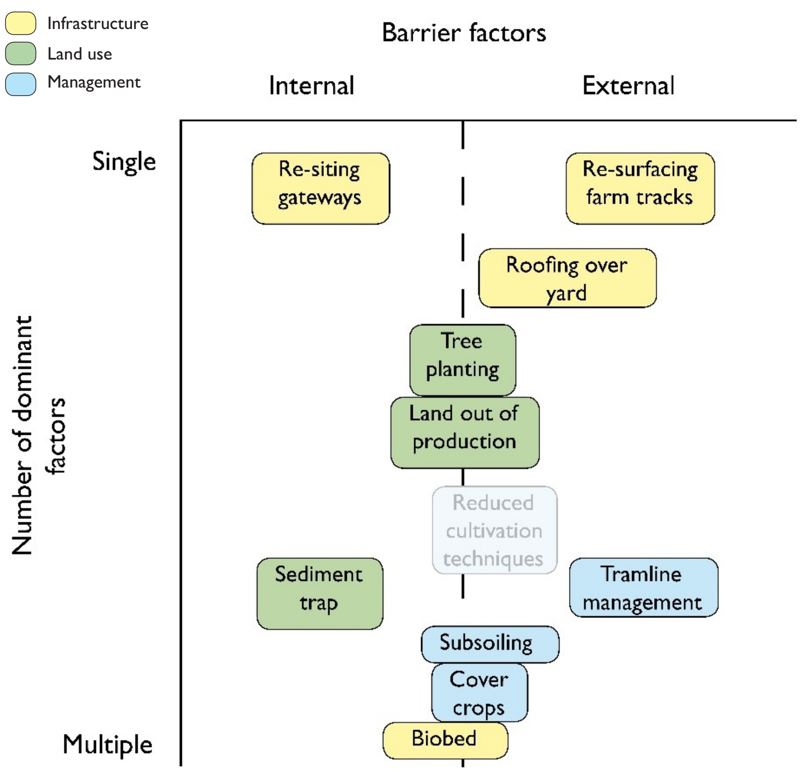


Figure 6.35 A matrix to synthesise the dominant barrier factors for the eleven mitigation measures.

The wheels indicated the categories of barriers most common amongst the farmers interviewed, with only two wheels appearing very similar to one another (land out of production and tree planting). Although subsoiling, cover crops and biobeds are seen to be touching in Figure 6.35, the multiple dominant factors and the balance between internal and external differed between the measures. Between the three groups of measures (land use, management and infrastructure) no commonalities were found for all measures within a group, however differences between the dominating barriers for each group can be noted.

With the land use change measures the internal barrier reflective motivation was the most common barrier to adoption. Amongst the management change measures, the external factor of the environment was a common barrier with the belief that the measure was not relevant e.g. for the farm size, soil type or location on farm. Not surprisingly, economics was a dominating factor for some infrastructure changes, however it did not always feature strongly (biobeds and re-siting gateways).

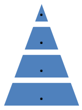
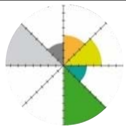
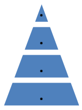
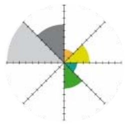
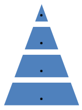
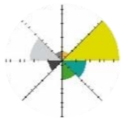
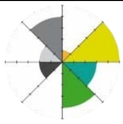
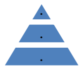
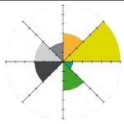
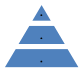
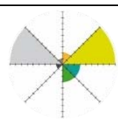
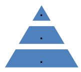
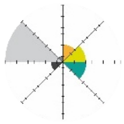
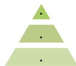
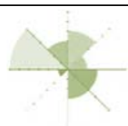
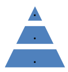
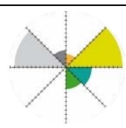
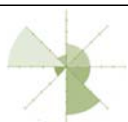
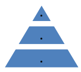
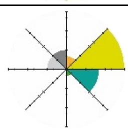
Some measures were found to have many different types of barriers, both internal and external - tree planting, subsoiling, cover crops, and biobeds, whereas others were identified as having only one or the other as the main type of barrier - sediment traps and re-siting gateways having more internal barriers and tramline management, re-surfacing tracks and roofing over yards having external barriers.

Identifying whether internal or external barrier factors dominated or whether numerous different factors act as barriers provides a greater understanding of what various mechanisms need to be tailored towards. Policy interventions for measures which have dominant internal barriers need to focus on changing social norms and attitudes and will often take a long time to successfully change behaviours. By contrast, measures with dominating external factors and positive attitudes should need less attention of changing attitudes and more focus placed on altering the external factors influencing farmers' behaviours.

6.4.3 Relationships between motivational and barrier factors

The combination of interviewing farmers who hadn't adopted a measure (studying the barriers) and those who had (examining what they went through to overcome such potential barriers), provided comprehensive knowledge which contributes to understanding what needs to change in order to influence more farmers to implement the mitigation measures. Drawing upon the results presented in Section 6.3, and the information displayed in the two matrices (Figures 6.33 and 6.35), a summary of the key findings for each mitigation measure is presented in Table 6.8. The order in which measures are listed loosely correlates to their descending ranking in terms of decision processes (many different factors and stages) and multiple barriers (both internal and external). The complexity of the decision process was considered first, followed by the barriers. Biobeds and reduced cultivation have been faded to remind that caution should be taken when interpreting the results.

Table 6.8 Summary of results ranked in order of overall complexity of factors impacting uptake of mitigation measures.

		Decision process		Barrier wheel	
Mitigation measure	**Attitudes to future uptake**	**# of factors**	**# of Stages**	**Wheel image**	**Key Barriers**
Subsoiling	Mixed	✓✓✓			Reflective motivations, environment
Sediment trap	Negative	✓✓✓			Reflective motivations, capability
Track re-surfacing	Negative	✓✓✓			Economics
Cover crops	Positive	✓✓			Capability, economics, environment.
Tramline management	Mixed	✓✓			Economics
Land out of production	Negative	✓			Reflective motivations, economics
Re-site gateways	Negative	✓			Reflective motivations
Biobed	Mixed	✓			Reflective motivations, social/cultural
Tree planting	Mixed	✓			Reflective motivations, economics
Reduced cultivation techniques	Positive	✓			Reflective motivations, environment
Roofing over yards	Positive	✓			Economics

The sheer diversity of results for the mitigation measures is clearly demonstrated in Table 6.8. No obvious trends or relationships were apparent between whether certain types of barriers caused complex or simple decision processes for adoption of measures, or whether a specific barrier hinders a precise stage in a decision process. It is also evident that attitudes to future uptake did not correlate to the decision process complexity or number of barriers of a measure, as Table 6.8 shows a mixture of attitudes along the entire range of measures.

It is however, possible to conclude that a multifaceted measure (those found towards the top of Table 6.8) is one that requires substantial effort (multiple channels of intervention) or drastic change (e.g. regulations), in order to increase adoption of the behaviour. Such measures included those considered as ‘novel’ measures i.e. sediment traps, cover crops and subsoiling. These measures could greatly benefit from advice provision, to tackle the internal barriers of capability and reflective motivations, along with more research to provide local evidence of the benefits. Demonstrations in different regions would provide local evidence to overcome several barriers (e.g. lack of knowledge or belief there is a lack of local evidence that it works). Such factors contributed to the decision processes of the adopters and therefore could be expected to help influence more to adopt.

It is surprising to find track re-surfacing towards the top end of Table 6.8, as the dominant barrier economics is something that could be regarded as easily overcome. However, bearing in mind that grants have been available in all three catchments, farmers who had not adopted such a measure still expressed negative attitudes to future adoption and claimed economics as a common barrier. Such results imply that either the grant does not provide enough of an incentive or that other factors are at work. By looking at the decision processes again (Figure 6.25b), it is possible to see that several different factors and stages were needed by many of the farmers who did re-surface tracks. ‘Long-term viability’ and ‘livestock benefits’ can be seen to have initiated the decision processes, therefore education of the benefits for soil and livestock (in the Eden and Tamar), as well as shifting the social norm as to what is acceptable as a ‘good’ track, could help catalyse non-adopters to move through the decision process.

It was initially anticipated that results could be generalised and measures grouped so as to inform policy makers that if they want measures to be more widely adopted, they would need to do ‘x’. However, the variations in characteristics of motivational and barrier factors highlighted in Table 6.8 suggest that it is difficult to create many meaningful categories. Such an outcome is a finding in itself, as the implications provide support to the literature in Section 2.2 which suggested that in order to influence behaviour change, a full understanding of the particular behaviour is required.

6.5 Conclusion

The results presented within this chapter provide a detailed assessment of the factors which influence the adoption of eleven different WPA mitigation measures.

Studying the decision process diagrams highlights how policies, financial incentives, advice and factors out of the Governments control contributed towards the adoption of a measure. They also show where motivational factors commonly occurred in the process and the level of complexity involved. Short cuts were also identified, creating more direct routes to adoption by some farmers. Lessons can therefore be learnt from past experiences, helping to improve future policies. Studying the barrier wheels created from the results of farmers who had not adopted a measure also highlights where efforts should be targeted to overcome hurdles and influence positive behaviour change.

Considering both the decision processes and barriers helps towards addressing the key questions as to what needs to change to influence certain behaviours, in other words where should the Government concentrate efforts and which interventions could aid such change. Measures with complex decision processes and multiple barriers (the top of Table 6.8) can be expected to require substantial input from the Government to increase uptake. Such measures were found to need greater levels of advice provision to overcome internal barriers. As Chapter 5 discovered that advisors have particular niches in the different regions of England, knowing which agents to channel policy interventions through to deliver on the ground advice is crucial to ensure effectiveness. The following chapter begins to address such issues by discussing the findings from Section C of the farmer survey which focussed on advice provision. Insights into what type of advice, if any, is needed to encourage uptake and who is best placed to deliver such advice are discussed, along with farmers' attitudes towards different farm advisors.

Chapter 7

Chapter 7 In-depth farmer interviews: Farmer perspectives on advice delivery

Results presented in Chapter 6 showed that advice was a key influence for decisions to adopt several mitigation measures, as well as a lack of knowledge and capacity were barriers to adoption. This chapter presents further results from both the farmer interviews (Chapter 6) and advisor interviews (Chapter 5) regarding attitudes towards advisors and advice provision. Previous research has often highlighted farmers trust advisors from the industry more than government and third sector organisations (e.g. AIC, 2013), however this research was unaware of any previous work having been carried out which examined both perspectives (farmers and advisors) of who farmers listen to for advice on WPA mitigation and the reasons why they listen.

The main objectives of the results presented in this chapter were to discover:

- What advice do farmers want about specific mitigation measures?
- Who do farmers want advice from for particular mitigation measures?
- Why do farmers listen or not to advice from particular advisors?
- Where do inefficiencies exist in the advice sector? (From the farmers' perspectives).

During the in-depth interviews conducted, farmers were asked whether they would want advice about a measure, and if so, what advice they would want and from whom. Participants were then asked more generally *'would you listen to advice from 'x advisor' about mitigation measures?*' and *'what are the reasons for your response?'* For a full description of survey methodology see Section 6.1.1.

Results and discussions are presented in Sections 7.1 to 7.4, whilst Section 7.5 summarises the implications for agri-environmental policy. Finally, Section 7.6 provides a conclusion.

7.1 What advice do farmers want?

In-depth discussions were conducted with farmers who had not adopted particular mitigation measures, with one question asking '*what advice would be of use?*' (For considering adoption). Responses have been summarised in Table 7.1 to demonstrate the variety of information farmers believe would be beneficial.

Table 7.1 Advice farmers from each catchment wanted about different mitigation measures.

	Mitigation measure	Eden	Wensum	Tamar
Land use change	**Land out of production**	Cost effectiveness	Funds available, suitable areas, size of area required	Funds available, suitable areas, financial gain
	Tree planting	Grants available, long/short-term costings, maps of best locations, species for biomass, benefits, planting method, nutrients/soil type required, business impacts	Costs, ash die back advice	Benefits, earnings, cost effectiveness, woodland management, suitable species, planting season, planting method
	Sediment traps	Value of soil, costings/ payback, local evidence, how they work, size, wildlife benefits, maintenance requirements		Benefits, location, financial gain
Management change	**Subsoiling**	Tyre varieties to reduce compaction, soil science, available machinery		Demonstrations, grants available, timing and method of use, cost effectiveness, benefits, local evidence
	Reduced cultivation		Benefits	
	Tramline management		Benefits	
	Cover crops		Suitable crop for rotation, timing in rotation, local evidence, establishment, management, benefits, signposting to information, more research evidence	
Infrastructure	**Resurfacing tracks**	Costings, payback time, cheap local contractors	None	Benefits, costings
	Roofing over yards	Costing, timescale, grants available		Grants available, size required, best contractors, location, regulations
	Re-siting gateway	Infrastructure plan, locations, benefits		Infrastructure plan, grants available, locations, benefits
	Biobed		How they work, costings, demonstrations, correct design, drainage mechanics, locations, photographs, contacts/suppliers, regulations	

Advice regarding finance, such as grant availability and cost-effectiveness was cited frequently by farmers for many measures, however it was apparent that financial facts and figures were not the only pieces of information farmers wanted from advisors. Another highly valued form of advice included a personalised farm map. A map which would show suitable locations for planting trees, re-siting gateways, creating sediment traps, tracks to re-surface etc.

As with other elements of the results from this thesis (Chapters 4, 5 and 6), it is evident variations in farmer responses existed between mitigation measures and catchments (Table 7.1). For some measures farmers requested lots of different advice, noticeably for measures considered as new or less common (e.g. cover crops, biobeds and subsoiling). However, tree planting which is neither new nor uncommon appears to need a lot of advice in the Eden and Tamar. For other measures (such as re-surfacing tracks), farmers in the various catchments wanted different amounts of advice.

7.2 Who do farmers want advice from?

Having discovered what information and advice farmers would find useful, it was then important to learn who farmers wanted the advice from. This information aids effective dissemination of knowledge. It is one thing to identify what advice farmers would like, but if delivered by an advisor they wouldn’t listen to or know to approach, this creates an immediate barrier and wasted effort in attempted knowledge exchange.

Table 7.2 summarises the dominant sources of advice farmers stated they would want for each measure. For particular measures, certain advisors were specified such as CSF for subsoiler lending schemes, ADAS specialists for biobeds or FC for tree planting, whereas for other measures e.g. re-siting gateways, anyone would be listened to (except contractors who were considered to be biased).

Table 7.2 Which WPA mitigation measures farmers want advice for and from who.

Advice wanted
Advice less desired
Text Source of advice requested

		Eden	Wensum	Tamar
Land use change	Land out of production	Government	Government	Government
	Tree planting	FC, CSF, Woodland Trust		FWAG, FC, CSF
	Sediment traps	CSF, Independent specialist	-	FWAG, WT
Management change	Subsoiling/ aeration	Colleges, Industry, CSF	-	Neighbour, CSF
	Reduced cultivation techniques	-	Agronomist, contractor	-
	Tramline management	-	Agronomist	-
	Cover crops	-	British sugar, ADAS, agronomist	-
Infrastructure	Resurfacing tracks			
	Roofing over yards		-	
	Re-siting gateway	Anyone [a]	-	Anyone [a]
	Biobed	-	Neighbour, CSF, ADAS specialist	-

[a] Not including contractors

Considering the responses displayed in Tables 7.1 and 7.2, land use change measures appear to require some degree of advice, predominantly provided by the Government and NGOs. Management change measures also require advice, some more than others, however preference exists for the advice to come from CSF, industry or to be taught in colleges. Lastly, infrastructure changes require less advice, with the majority of advice requested being financial or in the form of an infrastructure plan.

7.3 Who would farmers listen to?

After discussions of specific measures, Section C of the farmer survey raised the broader topic of attitudes towards advisors from different organisations. Figure 7.1 shows the differences in percentage of farmers in each catchment who would listen to advice from 'x' advisor regarding WPA mitigation.

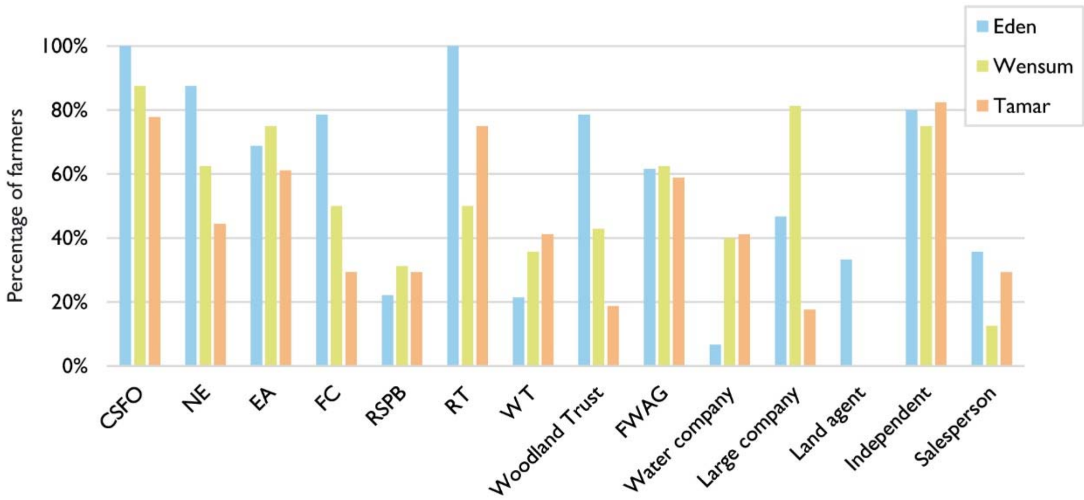


Figure 7.1 Percentage of farmers who would listen to advice on WPA mitigation measures from different advisors.

Overall, across all three catchments, CSFOs, EA, RTs and independent specialists had the greatest percentage of farmers that would listen to them for advice. Advisors which had the lowest overall percentages of farmers listening to them included the RSPB, salespeople, WTs and water companies. Differences between catchments in farmer responses can be seen in Figure 7.1. To draw upon two examples, the RT had larger percentages of farmers that would listen to them in the Eden and Tamar than in the Wensum, whereas, large agricultural companies, such as Frontier (a crop inputs and grain marketing business), had a greater percentage of farmers in the Wensum that would listen to them than in the other two catchments.

Knowing which advisors are most listened to by farmers is valuable for disseminating messages, however it is important to understand the reasons behind farmer responses, to know how such advisors could best deliver advice packages.

7.3.1 Reasons for adopting or not adopting advice from advisors

Farmers were asked what the reasons were for listening or not listening to advice from specific advisors. A wealth of vocabulary was provided by farmers to explain these reasons. In order to evaluate the vocabulary from the interviews, word clouds were chosen as an innovative method. A word cloud gives greater prominence (text size) to words or phrases with a higher frequency of use and are best used for exploratory qualitative data analysis (Heimerl et al., 2014). They provide a clear, visually rich representation of key words from interview transcripts for each respondent, enabling the reader to make quick comparisons.

Research on the effectiveness and perception of word clouds is discussed in Heimerl et al. (2014). They conclude that word clouds are a good visualisation technique to communicate an 'overall picture' of text contents. Banas and Brown (2012) also argue that such techniques can facilitate the process of content analysis and quite possibly expand reader comprehension. 'Phrase nets', 'tree clouds' and 'word trees' are examples of other visualisation techniques but were deemed inappropriate or unnecessary as they place emphasis on word connections and similarities (Kalmane, 2012).

The main limitations to word clouds are considered to be: 1) they emphasise frequency and not necessarily importance, 2) they do not accurately reflect the content of the text if slightly different words are used with the same meaning, 3) the lack of ability to account for the word length versus font size when analysing each word cloud and 4) viewers interpret images by focusing on the middle centre (discarding peripheral items) and reading left to right (in western cultures), undoubtedly causing particular words/phrases to stand out more (Weinschenk, 2011). These issues have been addressed as follows. Firstly, the main objective of the analysis was to highlight frequently used words/phrases. Secondly, key descriptive words were extracted and standardised from interview transcripts. Thirdly, words with an equal frequency but different font size due to variations in word length such as 'lack knowledge' and 'lack trust' (see Figure 7.2) were not thought to invalidate the method, as visually, the two phrases are still the most prominent. Finally, as viewers are comparing word clouds, the same method of visual interpretation will apply to each one.

A variety of word cloud generators are available for free on the internet, however one which allowed formatting of individual phrases was required to enable positive and negative words from the farmer transcripts to be distinguishable. Tagul (www.tagul.com) was the word cloud generator chosen as it provided such a function along with various other desirable features, such as, formatting word cloud shape, frequency of word repetition, font type, style and word angle. Tagul provides a simple self-explanatory user interface, whereby the individual imports text into the text box displayed, selects the formatting options desired and clicks the 'visualise' button. Clouds can then be saved and exported as pdfs. Figure 7.2 displays annotated examples of word clouds for CSFO, water company advisors and Natural England (NE) to explain various features.

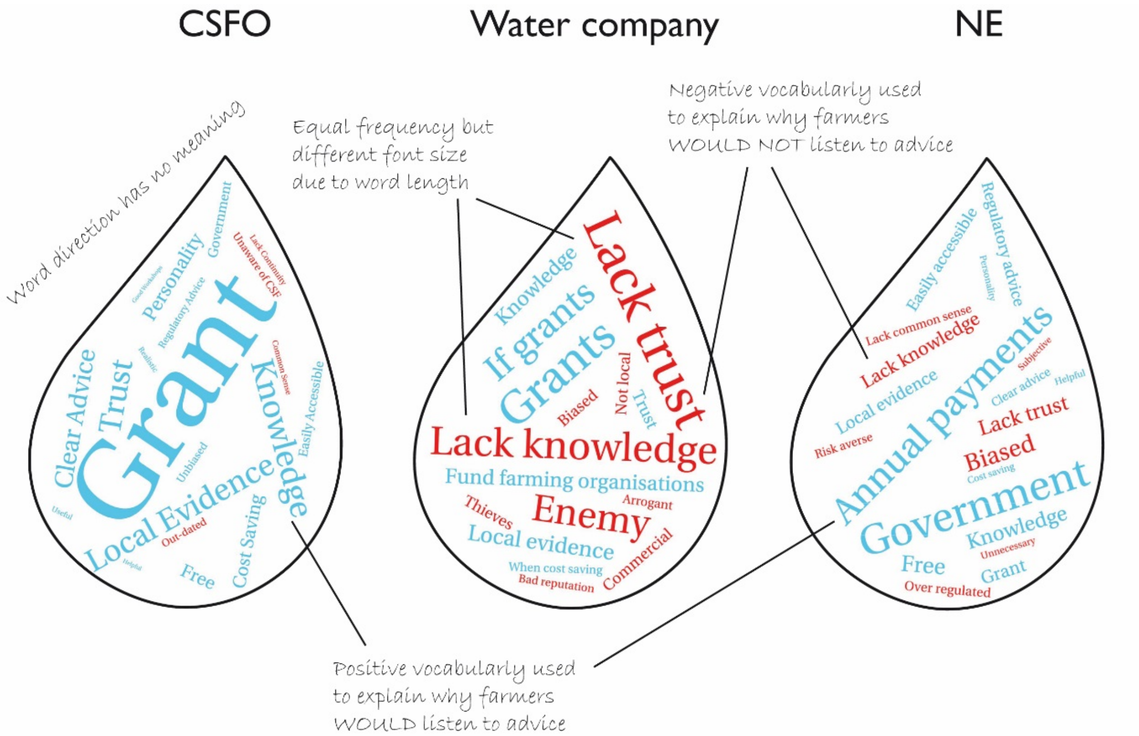


Figure 7.2 Annotated word clouds of vocabulary used by farmers as to why they would or would not listen to CSFOs, water company advisor and NE for WPA mitigation advice.

It was important to ensure consistency across word clouds for comparability, therefore the same font, style and overall shape were used, with only two variables changing: font size to depict word frequency and font colour to represent negative and positive words.

The colour red was selected to portray negative words and blue for positive words. Meanings associated with colours can be interpreted in multiple ways, however red was chosen for its connotation with warning, anger and thus negativity. Blue was chosen primarily to represent links with water, but consulting the literature of colour psychology (Nijdam, 2007), blue is also related to trust, honesty, loyalty and caring, all words of a positive nature. Furthermore, besides colour associations, colour blindness needed to be considered for colour choice.

Farmers were questioned regarding reasons for evaluating advice from thirteen organisations, with Figure 7.3 displaying each of the word clouds. Those most dominated by positive words (blue) include independent advisors, CSFOs and RTs. This supports the results shown in Figure 7.1, however provides greater detail regarding the different reasons for the positive appreciation. *Grant* was the most frequently used for CSFOs and RTs, whereas *knowledge* and *trust* dominate the word cloud for independent advisors. Considering the word clouds with negative words (red) the RSPB, water companies and salespeople have the largest quantity, with *lack of trust* and *bias* being dominant words.

Attitudes of farmers were most similar (represented by a less diverse vocabulary) for the FC, Woodland Trust and salespeople, whereas attitudes varied greatly for many of the other organisations. Some had one dominant attribute e.g. CSFOs with *grant*, whilst others had several dominant attributes e.g. large agri companies with *trust, knowledge, clear advice* and *local evidence*.

As this thesis aims to inform government policies, it is important to interpret farmer attitudes to government agencies. EA would be listened to but only because they have to, with NE perceived similarly but with the incentive of AES annual payments. CSFO would be most listened to due to the provision of grants.

Several of the advisors interviewed in Chapter 5, mentioned that services delivered by the private sector (even when they were government funded) are more credible to the farmers. However, the advisors also felt that credibility could be compromised by perceptions of commercial or political interest, and therefore cause farmers to be wary of government funded services. Although it was beyond the scope of the farmer survey to investigate whether particular government funded services were more credible being delivered by the private, NGO or government sectors, results were able to show which advisors would be listened to and are more trusted overall.

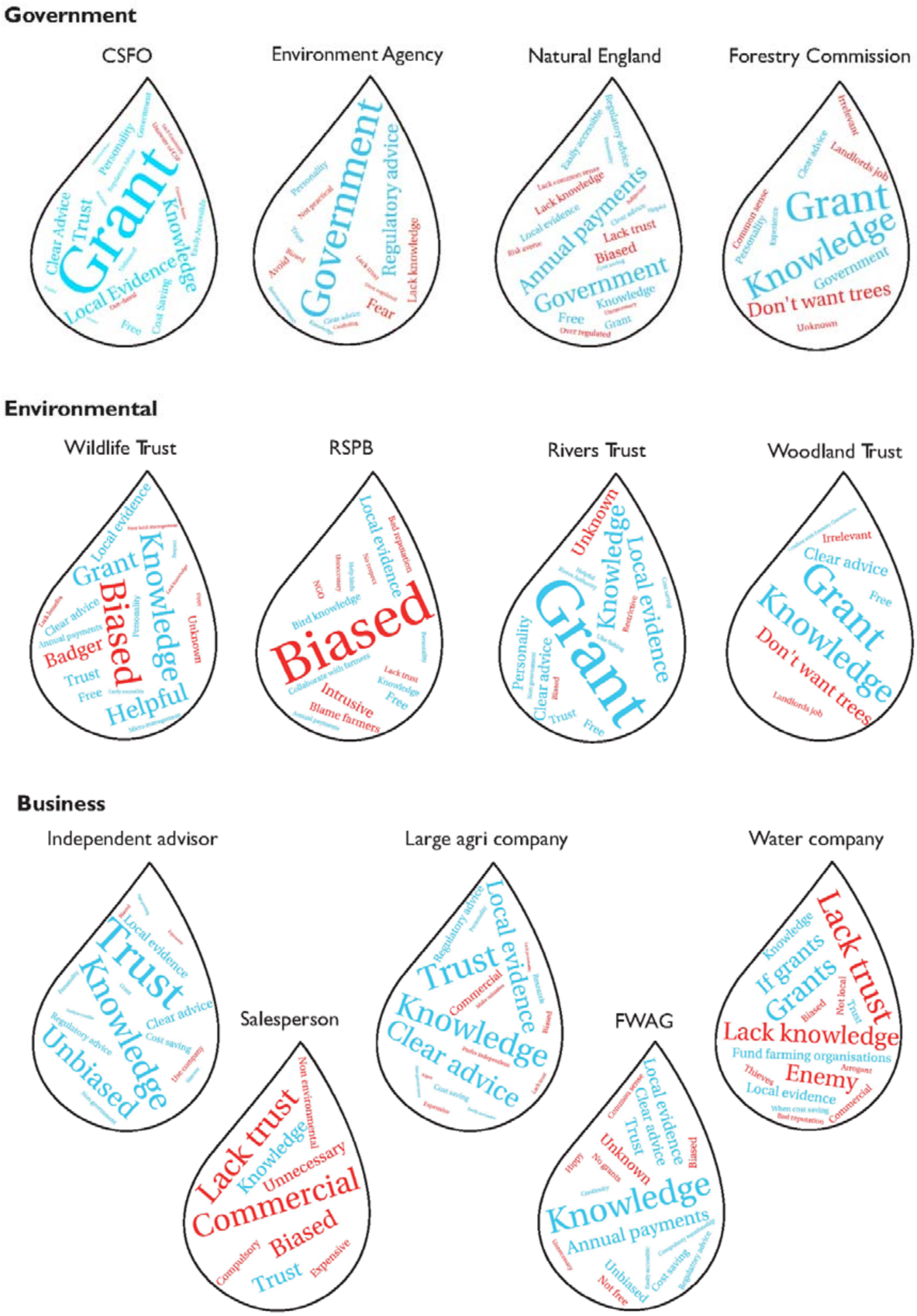


Figure 7.3 Word clouds for thirteen organisations showing farmers' comments which describe why they would (blue text) or wouldn't (red text) listen to advice from particular advisors.

7.3.2 Regional differences in attitudes towards advisors

In Chapter 5 it became apparent that certain organisations had different roles for delivering advice within the various areas. Views of farmers across the three catchments confirm such findings with different reasons being stated as to why they would listen to particular advisors. Figure 7.4 demonstrates the different vocabulary used by farmers for CSFOs and FWAG.

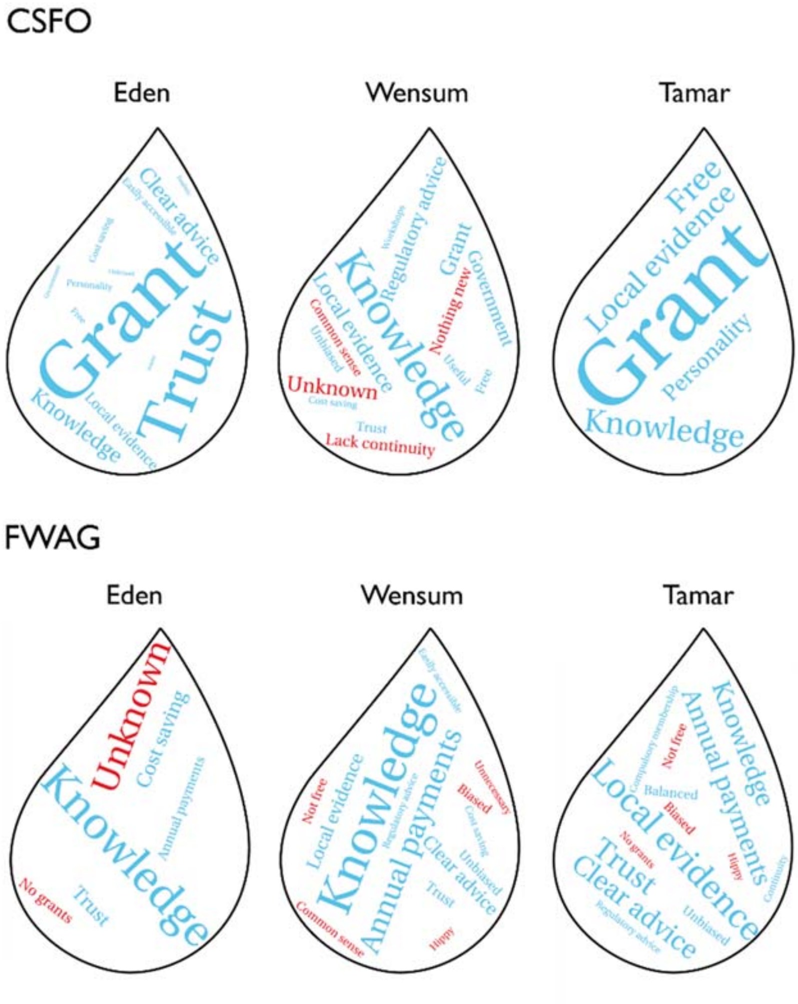


Figure 7.4 Word clouds representing the vocabulary used to describe CSFOs and FWAG by farmers in the three catchments.

It is visible from Figure 7.4, that farmers in the Wensum provided a greater number of negative words than the Eden or Tamar farmers, as to the reason why they wouldn't listen to CSFOs e.g. *unknown, lack of continuity and nothing new. Grants* on the other-hand were a key factor, along with *trust*, for Eden and Tamar farmers listening to advice. The contrasting views regarding advice from FWAG depicts regional differences in establishment within the farming communities (in a similar way to the RT). Thus altering their acceptance amongst farmers to deliver advice. From being *unknown* in the Eden, to providing *local evidence, clear advice* and being *trustworthy* in the Tamar.

Water companies also play a different role in each area (although were not included in the advisor interviews in Chapter 5). Desk based research identified the different approaches water companies use to reduce WPA (Section 2.3.1), and the farmer interviews highlighted how farmers perceive their local water company. Word clouds were not possible for individual catchments due to the low number of farmers providing reasons as to why they would not listen to them other than '*no way', 'not a chance', 'I would never listen to them'* and so on. From the responses that did contain reasons, in the Eden, farmers referred to the water company as having a *bad reputation*, *thieves*, *commercial agenda*, and employees are *not local*. In the Wensum, there were less negative responses with *knowledge* and *local evidence* being mentioned, however in the Tamar the water company had established a good reputation through the provision of *grants*. The general consensus amongst Tamar farmers was that it was a good idea for the water company to disseminate grants through other organisations such as the Westcountry RT.

7.3.3 Comparison with the views of advisors

During the farm advisor interviews (Chapter 5), questions were asked to discover what advisors perceived as important factors or characteristics which influenced why a farmer would take up their advice. Such responses can be compared with those of the farmers previously discussed (Figure 7.3) to evaluate whether the views align and therefore whether advisors have been promoting and emphasising the characteristics farmers perceived to be the most important.

For the majority of cases, views did match up. Advisors from government agencies (EA, NE and FC) used the words *government* and *AES annual payments* to describe why they believed farmers listened to their advice, with similar words being stated by farmers (Figure 7.3). CSFOs identified *grant* as a key factor, as did farmers, but advisors also stated *cost-saving* and *credibility* as important characteristics, whereas farmers did not. Several other organisations also specified *cost-saving* as an important reason why farmers listen to their advice, however farmers refrained from mentioning this, failing to make the connection between water pollution mitigation and cost-savings.

A further discrepancy occurred with responses provided by advisors from environmental organisations. Such advisors placed emphasis on *grants* as a key factor, however failed to appreciate the importance of *local evidence* and *knowledge* that farmers perceived in such organisations (Figure 7.3).

7.4 Farmers' perspectives on inefficiencies and improvements for advice

The last question of Section C from the farmer interviews asked for any experience of receiving conflicting advice. Farmers' responses have been categorised into: believed advice is always conflicting; received conflicting advice and provided an example; not received conflicting advice; and have not received advice. Table 7.3 below shows the percentage of farmers in each category from the three catchments.

Table 7.3 Response rate from farmers in three catchments to the question 'Have you received advice which has conflicted with other advice received?'

	Advice is always conflicting	Have received conflicting advice and provided an example	Not received conflicting advice	No advice received
Eden	0%	39%	61%	6%
Wensum	0%	41%	47%	12%
Tamar	11%	42%	37%	11%

A similar percentage of farmers in all three catchments reported receiving advice which conflicted (~40%) with an additional 11% in the Tamar claiming advice is '*always*' conflicting. Examples of conflicts provided by farmers have been summarised for each catchment in Figure 7.5 to demonstrate the range of topics and advisors involved. Conflicts of advice existed between: staff within the same organisation; staff from different organisations but with the same 'agenda'; and staff from different organisations and different 'agendas'.

Despite Table 7.3 showing a similar percentage of farmers from each catchment believed to receive conflicting advice, the range of conflicts is strikingly different. The Wensum farmers predominantly reported differences between independent advisors (e.g. agronomists and agri-suppliers) regarding crop requirements. Figure 7.5 illustrates that the Eden farmers experienced conflicting advice around a greater range of topics than the other two catchments, and predominantly occurring between government staff advice (NE, EA and CSFOs). It is important to highlight that the higher degree of collaboration amongst advisors in the Eden from Chapter 5 was also confirmed by farmers, but that principally cooperation occurred amongst environmental organisations and CSFOs.

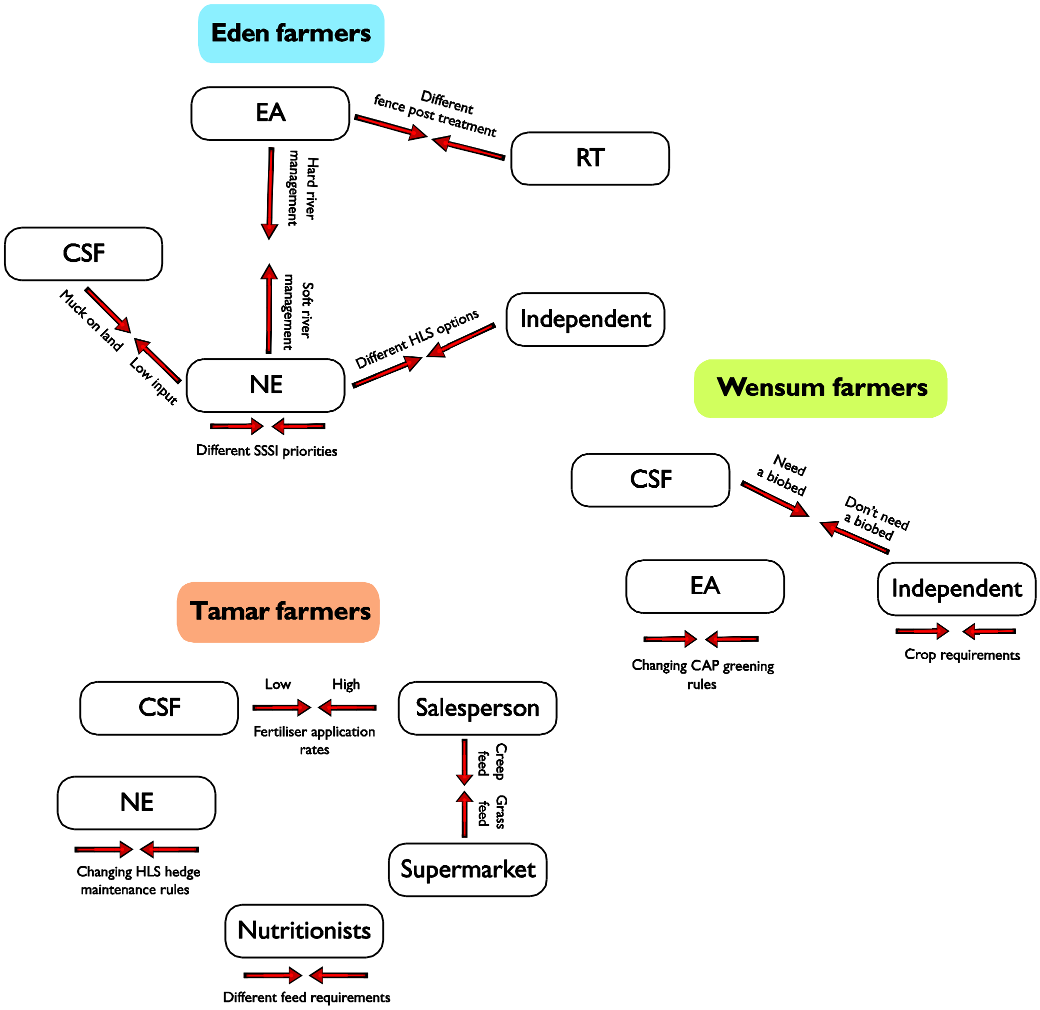


Figure 7.5 Examples of conflicting advice between sources of farm advice in each catchment.

Not only were farmers receiving conflicting advice, occasions were reported where good behaviour was actually discouraged. One example involves a farmer who did not want to use insecticide on their land but their agronomist recommended their use to ensure crop health and thus their own job security. A further example involved one farmer in the Tamar who had created a pond for trapping sediment. They accepted the area needed to be taken out from receiving SFP, however, as fencing was installed several meters from the pond's edge '*for good reason'* and with an access gate for dredging, a government inspector declared them as separate fields and stated that the entire area had to be taken out of SFP. Such advisor behaviour and government regulations discourage farmers from doing what they feel is right for the environment.

7.4.1 Improving advice provision

Many farmers during interviews made recommendations as to how the advice sector could be improved. Unsurprisingly, providing a clear, consistent message was recited time and time again, with idioms such as '*sing from the same hymn sheet'* being used. Requests for more demonstrations were made and the need for messages to be repeated for clarity. There was a general agreement that an advisor who knows the whole farm, is unbiased, provides signposting to grants, has a good personality and offers encouragement and enthusiasm is highly desirable. Although this is not new information, and such findings reiterate previous research messages (AIC, 2013), it is clear more still needs to be done to improve the advisory service for farmers. Such findings strengthen Chapter 5's results by highlighting inefficiencies within the farm advice sector. To address such issues, key recommendations are made below.

7.5 Implications for agri-environment policy

The aim of this study was to enhance the understanding of farmers' perspectives on advice provision, ultimately to improve dissemination of knowledge for reducing water pollution. Interviews with farmers across different catchments provided information on what advice farmers wanted and from whom for particular mitigation measures, why they would or wouldn't listen to advice from different advisors, where conflicts existed in the advisory system and suggestions for improvement.

Results presented in this chapter highlight that farmers wanted advice for new management and infrastructure change mitigation measures (e.g. cover crops, subsoiling, sediment traps and biobeds), with the most advice desired by livestock farmers for management changes. Less advice was sought for general infrastructure changes, however farmers requested advice on costs, farm maps and infrastructure plans, stating they would be beneficial for decision making. It is clear more advice is necessary to encourage mitigation measure uptake, but from whom?

Overall, CSFOs, EA, RT and independent specialists were highlighted as the most listened to for advice on WPA mitigation measures. Farmers believed the Government should provide advice on taking land out of production, but for other land use and management change measures, CSFOs or specialists were suggested (NGOs for environmental practices or industry specialist for more business orientated practices).

Through the use of word clouds, this research demonstrated an effective, novel visualisation technique to analyse qualitative data, showing that farmers' reasons for listening to various advisors greatly differs. Results also show that to disseminate advice effectively it is important to understand who farmers listen to in each area and why, as farmer attitudes towards advisors varied across catchments, with different attributes being of importance.

Comparing advisors' perceptions of themselves and farmers' perceptions of advisors identified similarities, as well as differences. Advisors believed farmers listen to them for their advice on cost-saving practices, however farmers failed to identify such a factor. Furthermore, advisors from environmental organisations failed to appreciate the importance farmers placed on their knowledge and local evidence. Such results suggest that the link between WPA mitigation advice and cost-savings need to be made more explicit, and that environmental organisations need to promote themselves to farmers by emphasising their local knowledge and evidence to encourage uptake of advice.

Finally, the evidence of advisory conflicts provided by farmers from the survey reinforces messages from Chapter 5 of inefficiencies within advice provision. The ability to analyse both the advisors and farmers views on conflicts of advice provides comprehensive insights into such a topic. Comparing the responses from government advisors in the Eden (believing they strongly collaborate efforts and work together ensuring efficiency), with the Eden farmers responses (who claimed they have received conflicting advice from different government staff), shows that differences in perceptions occurred. It cannot be emphasised enough that more needs to be done to encourage collaboration and communication between advisors, in order to provide farmers with efficient, clear, effective advice to achieve WFD goals.

7.6 Conclusion

Chapter 7 illustrated the benefits of surveying both farmers and advisors on the topic of advice provision. As results from previous chapters highlighted a need for greater efficiency in advice provision to farmers and that a lack of knowledge and capability created barriers to uptake for some of the mitigation measures, it was vital to identify what information farmers required to make informed choices for adoption, as well as discover who is best placed to deliver advice. Chapter 7 showed that farmer attitudes towards advisors differed between catchments. This supports Chapter 5's findings that advisors have different roles within the advice sector in the various regions of England, and that determining who is best placed to deliver policy objectives can therefore not be considered at a national scale. Such assessments should be carried out within CaBA.

Taking into account the accumulation of evidence presented in Chapters 4, 5, 6 and 7, the following chapter will address the overarching question of 'what needs to change to increase the uptake of WPA mitigation measures?'

Chapter 8

Chapter 8 Overall discussion: Policy improvements to increase the uptake of mitigation measures

The research presented in this thesis has highlighted a number of policy implications which need to be considered to tackle the issue of water pollution caused by agriculture. This chapter firstly discusses the use of Pike's (2008) framework in guiding this research. Secondly, three mitigation measures are used, as examples, to demonstrate how the knowledge gained from the empirical research presented in Chapters 4, 5, 6 and 7 can support the policy design process for influencing an increase in measure uptake. Finally, the overall implications from all of the research are presented.

8.1 Framework application

In Chapter 2, an evaluation of several frameworks (Section 2.1) and a review of the relevant literature (Sections 2.2, 2.3, 2.4) was presented to highlight gaps in existing knowledge (Section 2.5). It was clear from Chapter 2 that a full understanding of any desirable behaviour is needed if policy wants to influence and increase uptake. Several authors highlighted the importance of knowing the current uptake of a behaviour, whilst others emphasised the need to understand the factors which influence uptake, and the role particular interventions play. Pike's (2008) integrated framework which incorporates the 4Es, BE and a psychology based approach to behaviours was chosen as a framework to guide this research (Section 2.1). It was appropriate and desirable to use due to its comprehensive coverage of influencing behavioural factors, its links with policy interventions and its relevance to the farming context. Figure 8.1 demonstrates how the different elements of the framework have been investigated within this thesis. Chapter 4 focussed on *behaviours*, and *attitudes* by studying the current and likely uptake of mitigation measures. Chapter 5 examined the role of advisors and how advisors use an array of policy mechanisms alongside their advice *(4Es)* to influence measure uptake. Chapter 6 then took a broader perspective to investigate the relationships *(arrows)* and influencing factors *(boxes)* which impact farmer behaviour for specific mitigation measures, studying the factors which either motivate or create barriers regarding adoption. Finally, Chapter 7 looked at farmer attitudes towards advice, providing further detail and insight as to how to strengthen the *arrows* between the *4Es* and the resulting *behaviour*.

Figure 8.1 gives the impression that with each chapter the scope of the study increases. This is true in one respect, with the last two chapters investigating *all* the factors which motivate or act as barriers, but in order to gain greater detail regarding behaviours, it was essential that the number of measures/behaviours decreased with each study. Starting with 86 different mitigation measures in Chapter 4, the focus was reduced to the most recommended measures (35) in Chapter 5, and 11 measures in Chapters 6 and 7.

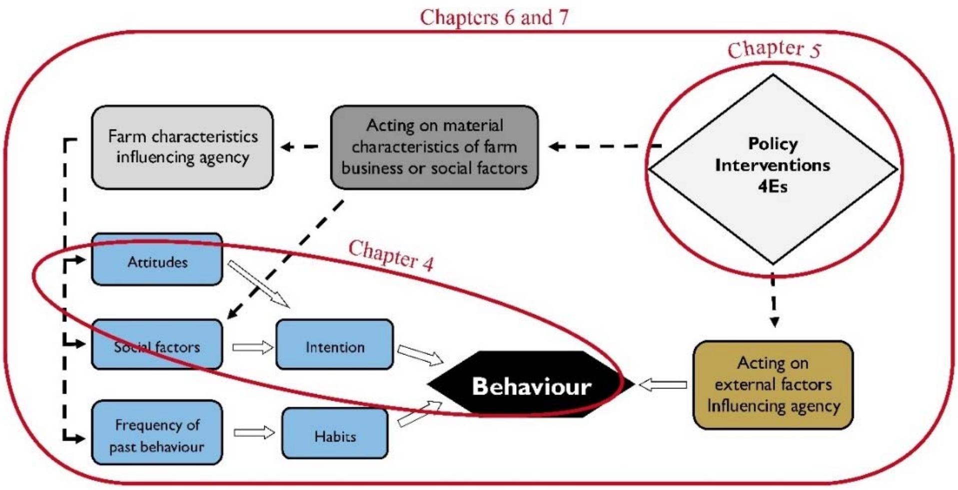


Figure 8.1 Elements of Pike's (2008) framework investigated within this thesis.

The research conducted for this thesis was primarily empirical and applied, and not a large theoretical exercise aiming to test the tens of dozens of theories or frameworks of behaviour change (e.g. Michie et al., 2014). Consequently, this thesis contributes to the empirical evidence base needed to complement such theories and frameworks.

At the beginning of this PhD, the Pike framework provided structure and guidance enabling the research to effectively conduct what Dolan et al. (2010:9) describes as the two additional Es to the original 4Es model - Exploration and Evaluation. The influencing factors shown in Pike's framework suggest what the focus for interventions could be, but without sufficient knowledge, interventions may target the wrong elements of behaviour. The empirical research within this thesis, guided by Pike's framework, therefore provides the necessary data and evidence to inform policy decisions on interventions. The broader framework of the Behaviour Change Wheel (BCW) discovered in Section 2.1 (Michie et al., 2011a), outlines an approach for policy makers aiming to change specific behaviours. It is vital to understand and identify precisely what elements of a behaviour need to be targeted and changed before designing interventions. Steps 1 to 4 of the BCW help achieve this.

Step 1 - Define the problem to be addressed in behavioural terms.

Step 2 - Select the target behaviour(s), i.e. the behaviour(s) most likely to bring about change to address the problem.

Step 3 - Specify the target behaviour in as much detail as possible.

Step 4 - Identify what needs to shift in order to achieve the target behaviour.

Three mitigation measures, which feature throughout this thesis, have been chosen to illustrate how the knowledge gained from each chapter provided greater insights into each of the specific behaviours - an area Michie, Atkins and West (2014) believe is often overlooked in the intervention design process. Such knowledge supports the evidence base required in order to identify what needs to change to increase uptake. The three were selected to demonstrate the main types of measure (management and infrastructure) and contexts (farm type) examined in the research. They are: 1) re-surfacing farm tracks, 2) subsoiling and 3) cover crops. Table 8.1 summarises the findings from each of the empirical chapters for the three measures.

Table 8.1 Findings from the four empirical chapters regarding re-surfacing tracks, subsoiling and cover crops.

		Mitigation measure		
		Re-surfacing tracks	**Subsoiling**	**Cover crops**
	***Measure type* and applicability**	*Infrastructure,* All farms with track issues	*Management,* Grasslands with compaction	*Management,* Arable
Chapter 4	**Current uptake (2012-13)**	High	Low	Low
Chapter 4	**Attitude to future uptake (2012-13)**	Positive (likely uptake)	Mixed	Mixed
Chapter 4	**Is it a priority amongst farmers?**	Yes	No	No
Chapter 5	**Frequently recommended by advisors**	Yes	Soil analysis and digging soil compaction pits, machines to use	No
Chapter 5	**Who recommends**	CSFOs, NE, RT, Land agents, FWAG	CSFOs, FWAG, independent advisors, RT and WT.	CSFOs, EA
Chapter 5	**Mechanisms to influence uptake**	CSF Capital Grant	Lending schemes of machinery, demonstrations/events	Signposting and voluntary
Chapter 6	**Current uptake (2014)**	High	High	Low
Chapter 6	**Attitude to future uptake (2014)**	Negative	Mixed	Mixed
Chapter 6	**Decision process by adopters**	Simple	Complex, lots of forms of advice with multiple stages.	Complex
Chapter 6	**Barriers for non-adopters**	Predominantly economics	Multiple barriers, internal and external (e.g. reflective motivation, environment, economics, social)	Multiple barriers, internal and external (e.g. capability, economics and environment)
Chapter 7	**Do farmers want advice?**	Costs	Yes on a wide variety of features	Yes on a wide variety of features
Chapter 7	**Advice from who?**	No-one specified	CSF, industry and neighbour	Industry

Results for the infrastructure change measure, re-surfacing tracks, were very different to those for the two management change measures in Table 8.1[21]. They indicated high rates of uptake, positive attitudes to future uptake (2012-13), high priority for farmers and frequent recommendation by advisors. Grants were being provided, decision processes were considered simple, with barriers predominantly perceived as economic and the advice requested focused on costs.

In comparison, the two management measures summarised in Table 8.1 both had mixed attitudes to future uptake, and were not a main priority amongst farmers who had not adopted them. Further similarities between the two management measures existed regarding the complexity of decision processes, the multiple barriers to uptake and the desire for advice on a wide variety of measure features. Besides CSFOs recommending both, the similarities end there. The role of advisors was different, with subsoiling frequently forming part of the recommendations made, with many advisors stating they recommended soil analysis and soil compaction pits first, to determine whether subsoiling was required. Cover crops, on the other hand, were only recommended by two of the surveyed advisors in the East Anglian region. An increase in cover crop recommendations will have undoubtedly occurred since the survey was conducted, as cover crops became a 'hot discussion topic' throughout 2015 due to changes in the CAP - discussed in Section 9.2. The mechanisms used by advisors at the time of surveying, included demonstrations and machinery lending schemes for subsoiling, whilst the two advisors who recommended cover crops expected voluntary uptake and/or signposted farmers to other sources of advice. Further differences occurred in the factors which influenced farmer uptake, despite both measures having complex decision processes and multiple barriers. The differences found between the infrastructure measure and management measures, as well as those found between the two management measures clearly demonstrates that to increase uptake, very different strategies will be required to increase uptake.

To demonstrate how the research findings inform policy intervention design, the BCW approach has been applied to the knowledge gained from each empirical chapter (Table 8.1). Steps 1 to 4 of the BCW were carried out for each of the three mitigation measures in Table 8.1. Steps 1 and 2 were the same for all three measures (Tables 8.2 and 8.3), whilst Steps 3 and 4 varied. The blank worksheets provided in Michie, Atkins and West (2014) were used to create the tables presented throughout Section 8.1, however the worksheet for Step 4 was only

[21] It is worth noting that for subsoiling a difference in uptake was recorded, with current uptake higher amongst Chapter 6 survey participants than farmers from Chapter 4, and re-surfacing tracks received negative attitudes from farmers in Chapter 6 for adoption in the future but positive attitudes from farmers in Chapter 4. Although it was beyond the scope of this thesis to study why such differences occurred, it can be presumed such alterations were due to a change in: catchments surveyed (Avon in Chapter 4 and Tamar in Chapter 6); survey participants and external influences over the two year period.

used as an initial guide. The categories of influencing factors (Step 4) were altered to match the categories used in Chapter 6's barrier wheels. Section 6.3.3 explained why Michie et al.'s (2011a) categories needed to be changed to ensure greater relevance in the agricultural context. The remainder of Section 8.1 presents Steps 3 and 4 for each of the three measures, alongside a discussion identifying the specific elements of the behaviours which need to change.

Table 8.2 Step 1- Define the problem in behavioural terms.

What behaviour?	Farming practices reducing water pollution caused by agriculture
Where does the behaviour occur?	Rural areas (directly).
Who is involved in performing the behaviour?	The farming community (directly), everyone (indirectly e.g. through varying degrees of involvement in the food supply and demand chain).

Table 8.3 Step 2- Select the target behaviour. Generate a long list of candidate target behaviours that could bring about the desired outcome.

Intervention designer response
See Newell-Price et al., (2011) and Appendix 1 for a list of 86 mitigation measures.

8.1.1 Re-surfacing tracks

Table 8.4 Step 3 - Specify and describe the target behaviour of re-surfacing tracks

Target behaviour	**Re-surfacing tracks**
Who **needs to perform the behaviour?**	Farmers, land owners and building contractors.
What **do they need to do differently to achieve the desired change?**	Invest resources to re-surface farm tracks which act as pathways for soil erosion and runoff.
When **do they need to do it?**	Can be performed any time of year when the ground is dry.
Where **do they need to do it?**	On problem tracks experiencing soil erosion and runoff.
How often **do they need to do it?**	Depends on frequency and use of tracks, weather conditions (frequency and timing of rainfall events).
With whom **do they need to do it?**	Farm staff and construction workers.

Taking in to consideration the content of Tables 8.4 and 8.5, to increase the uptake of re-surfacing tracks there is a need to focus on changing the *economic* component and *reflective motivation* amongst those who are negative towards re-surfacing tracks.

With different sectors of the industry experiencing highly volatile market prices and low incomes *economics* was substantially the greatest barrier, along with the belief tracks were '*fine as they are'* (Chapter 6). Farmers reported not wanting advice on such a measure (Chapter 7), and many felt they simply couldn't afford to do what they knew was needed (Chapter 6). From the decision process diagrams (Figure 6.25b), it was clear that some of the adopters had to experience a problem before they acted. This therefore implies that perceptions as to what qualifies as a *'bad enough track'* needs to shift in order for farmers to act sooner. Although regulations already existed which ensured a minimum standard of track quality (e.g. GAECs requiring farmers to reduce soil erosion risks), issues have still persisted. As the Government is trying to reduce red tape (Defra, 2015e), and advice has not been enough, providing financial incentives will need to continue. An additional strategy discussed during interviews was the provision of a Farm Infrastructure Plan (FIP). Several farmers claimed FIPs would be highly valuable, allowing them to assess which parts of their farm's infrastructure required immediate attention and would provide the greatest benefits (to the business and environment). Tailored advice of FIPs would ensure the right farms are being encouraged to adopt the most suitable measures.

<u>What needs to change?</u> Provide farm infrastructure plans and continue providing financial incentives.

Table 8.5 Step 4 - What needs to change to increase the uptake of re-surfacing tracks?

Influence Components	What needs to happen for the target behaviour to occur?	Is there a need for change?
Social/cultural	Allowed to Societal trust that it is the right thing to do No societal pressure to not resurface tracks Have more farmers doing it Pressure from society to resurface Create a tradition of track management Presence of young farmers to encourage the need to care about long-term outcomes of the farm business	No No No No Yes No Beyond the scope of behaviour
Economic	Afford time to plan resurfacing of tracks Being able to afford labour and materials Being able to afford maintenance (costs and time)	Yes Yes Yes
Institutional	Shown an example of a well-managed track Advertise where to go for materials, advice, labour Have access to advice Have access to financial support Make it compulsory Offer voluntary agreements Teach the costs and benefits in colleges and university Provided with a farm infrastructure plan	No No No Yes No No No Yes
Environmental	Have rainfall creating runoff and soil erosion Have greater frequency of storm events creating runoff and soil erosion Visible soil erosion without resurfacing tracks Visible soil and water runoff without resurfacing tracks Visible benefits of doing it	Not possible to change
Demographic	Encourage attendance to higher levels of education	Beyond the scope of behaviour
Automatic motivation	Develop a habit of resurfacing tracks Have no negative emotions e.g. stress or fear, towards resurfacing tracks	No - Behaviour is infrequent No
Reflective motivation	Feel the need to do it enough Believe it is easy to do Confidence to implement the techniques Have the desire to do it Intentions to make resurfacing a priority Believe they are able to do it Believe it is the right/ best thing to do Care about the negative consequences of not doing it Like seeing / helping the natural environment Aspiration to improve the business Believe the risk is low Desire to be known for caring about the environment Desire to be perceived as a successful business	Yes No No Yes Yes No No Yes No No Yes No No
Capability	Understanding the short and long-term benefits Knowledge of effective management Knowledge of appropriate design and materials Knowledge of costings Understanding the overall impact on the business	No No No No No
Behavioural diagnosis:	Focus on changing: economics and reflective motivation amongst those who are negative towards re-surfacing.	

8.1.2 Sediment traps

Table 8.6 Step 3 - Specify and describe the target behaviour of subsoiling.

Target behaviour	**Subsoiling**
Who **needs to perform the behaviour?**	Farmers and contractors.
What **do they need to do differently to achieve the desired change?**	Test for soil compaction, have access to and use of subsoiling machinery to loosen compacted areas, set up the machinery correctly (tyre pressure, tine spacing), use it appropriately (correct forward driving speed, tillage depth).
When **do they need to do it?**	During appropriate weather conditions (no precipitation), and when the sub soil is relatively dry.
Where **do they need to do it?**	On areas of land which suffer from soil compaction at a greater depth than 30cm.
How often **do they need to do it?**	Only when the area is suffering from compaction.
With whom **do they need to do it?**	Farm staff, machinery merchant.

Based on Tables 8.6 and 8.7, to increase the uptake of subsoiling there is a need to focus on changing the following components: i*nternal motivation*s (reflective and automatic); *capability* (knowledge) and s*ocial/cultural* (changing social norm) by improving i*nstitutional* provision of advice, demonstrations and access to machinery.

The multiple barriers and complex decision processes (Chapter 6) mean that numerous aspects need to change in order to increase uptake. *Economics* was seen as a barrier by non-adopters, but adopters did not require financial incentives as they believed the measure was sufficiently beneficial in itself. Lack of knowledge, the associated fear and risk of the unknown, the additional costs imposed for farmers without machinery or with contractors conducting the majority of work, constrained adoption in many cases (Chapter 6). Knowledge of the importance of soil health and how this relates to grass yields and long-term benefits, as well as knowledge of how, when and where best to carry out subsoiling is evidently needed (Chapter7). Chapter 5 indicated that advice is provided, but more education, training and advice would help address misconceptions of costs, negative attitudes of fear, and beliefs that it is difficult or not worth it. Those who had incorporated subsoiling into their farming regime had often had the opportunity to borrow and trial the machinery. The provision of lending schemes and demonstrations could substantially help (Chapter 5, 6, 7), providing local evidence of the benefits. However, there is risk of adoption without the expertise to ensure correct use. It is essential any lending schemes go hand-in-hand with training, which a multitude of organisations could become involved with (Chapter 7).

<u>What needs to change?</u> Increase resources to provide demonstrations and facilitate borrowing of machinery. Increase the number of advisors recommending subsoiling and providing appropriate training.

Table 8.7 Step 4 - What needs to change to increase the uptake of subsoiling?

Influence Components	What needs to happen for the target behaviour to occur?	Is there a need for change?
Social/cultural	Allowed to subsoil Societal trust that it is the right thing to do No societal pressure against subsoiling Have more farmers doing it Pressure from society to adopt subsoiling Create a tradition of subsoiling Presence of young farmers to encourage the need to care about long-term outcomes of soil quality	No Possibly No Yes Yes Yes Beyond the scope of behaviour
Economic	Afford time to plan business with the use of subsoiling Being able to afford the machinery and running costs Being able to afford to employ someone to subsoil	Yes Yes } but actual costs are low Yes
Institutional	Shown a demonstration Advertise the benefits of subsoiling Have access to advice Have access to financial support Have access to machinery Make it compulsory Offer voluntary agreements Teach the correct use and benefits of subsoiling in colleges and university	Yes Yes Yes No Yes Possibly Possibly Yes
Environmental	Have land available Have appropriate weather conditions to perform subsoiling Have appropriate topography Have an issue of soil compaction	Beyond ability to change
Demographic	Encourage attendance to higher levels of education	Beyond the scope of behaviour
Automatic motivation	Develop a habit of subsoiling the land Have no negative emotions e.g. stress or fear, towards carrying out the action	Yes but not a frequent behaviour Yes
Reflective motivation	Feel the need to do it enough Believe it is easy to do Confidence to implement the techniques Have the desire to do it Intentions to make it a priority Believe they are able to do it Believe it is the right/ best thing to do Care about the negative consequences of not doing it Like seeing / helping the natural environment Aspiration to improve the soil quality / business Believe the risk of subsoiling is low Desire to be known for caring about the environment	Yes Yes Yes Yes Yes No Yes Yes No Yes Yes No
Capability	Understanding the short and long-term benefits Knowledge of effective use of the machinery Knowledge of correct timing to perform subsoiling Knowledge of costings Understanding the overall impact on the business	Yes Yes Yes Yes Yes
Behavioural diagnosis:	Focus on changing: internal motivations (reflective and automatic), capability (knowledge) and social (creating a social norm) by improving institutional provision of advice, education, demonstrations and access to machinery.	

8.1.3 Cover crops

Table 8.8 Step 3 - Specify and describe the target behaviour of cover crops.

Target behaviour	Cover crops
Who **needs to perform the behaviour?**	Farmers and contractors.
What **do they need to do differently to achieve the desired change?**	Have an appropriate crop rotation and have the knowledge for correct management.
When **do they need to do it?**	During periods in their crop rotation when the soil is left bare.
Where **do they need to do it?**	On arable fields which would be bare.
How often **do they need to do it?**	Depends on crop rotation.
With whom **do they need to do it?**	Farm staff, seed salesperson, and agronomist.

Tables 8.8 and 8.9 suggest that to increase the uptake of cover crops there is a need to focus on changing the components *internal motivation* (automatic and reflective), *capability* (knowledge) and *social* (creating a social norm) by improving i*nstitutional* provision of advice.

The benefits of using cover crops are well established, but adoption was not widely practiced (Chapter 4 and 6). In some EU Member States requirements to have winter crops or cover crops on a percentage of arable land have been included in legislation (e.g. Germany). In England cover crops were part of the AES, however inclusion in such schemes was insufficient to increase cover crop adoption. Recent inclusion in CAP Pillar I (2015) requirements has increased interest and uptake (Defra, 2015f), however farmers still have a choice as to whether they adopt cover crops (explained in Section 9.2 – policy developments).

Prior to the CAP changes, the research results from Chapter 6 implied that long-term viability (not short-term market prices) heavily influenced decision processes amongst those who had already adopted growing cover crops. Nevertheless, more could be done to translate the decades of cover crop research into practical information for producers, especially those who are not yet convinced of the benefits (AAB, 2015). Education and tailored advice is necessary to overcome the perception of risk currently associated with investing time and funds in growing cover crops, and to ensure the best methods are used to incorporate such crops into the farm rotation. Reassurance of the benefits and evidence of effectiveness locally (through demonstrations and champion farmers), will take time to establish.

<u>What needs to change?</u> Provide advice and local demonstrations over a long period of time to establish and strengthen a change in social norm.

Table 8.9 Step 4 - What needs to change to increase the uptake of cover crops?

Influence Components	What needs to happen for the target behaviour to occur?	Is there a need for change?
Social/cultural	Allowed to Societal trust it is the right thing to do No societal pressure to not plant cover crops Have more farmers doing it Pressure from society to plant cover crops Create a tradition of using cover crops Presence of young farmers to encourage the need to care about long-term outcomes	No Yes Possibly Yes Yes Yes Beyond the scope of behaviour
Economic	Have time to plan business with cover crops Have time to perform operations Being able to afford seed	Possibly Possibly No
Institutional	Shown a demonstration of successful crop Advertise the benefits of cover crops Have access to advice Have access to financial support Make it compulsory Offer voluntary agreements Teach in colleges and university Have access to local evidence of the benefits	Yes Yes Yes No Possibly No Yes Yes
Environmental	Have land available Have appropriate crop rotation Have appropriate soil type Have appropriate weather conditions to drill	No No No No
Demographic	Encourage attendance to higher levels of education	Beyond the scope of behaviour
Automatic motivation	Develop a habit of including cover crops in rotation if they are needed Have no negative emotions e.g. stress or fear, towards growing cover crops	Yes Yes
Reflective motivation	Feel the need to do it enough Believe it is easy to do Confidence to implement the techniques Have the desire to do it Intentions to make it a priority Believe they are able to do it Believe it is the right/ best thing to do Care about the negative consequences of not doing it Like seeing / helping the natural environment Aspire to improve the business Believe the risk is low Desire to be known for caring about the environment	Yes Yes Yes Yes Yes No Yes Yes Possibly Yes Yes Possibly
Capability	Understanding the short and long-term benefits Knowledge of effective management Knowledge of costings/ cost effectiveness Understanding the impact on the business	Yes Yes Yes Yes
Behavioural diagnosis:	Focus on changing: internal motivation (automatic and reflective), capability (knowledge) and social (creating a social norm) by improving institutional provision of advice.	

The knowledge gained from this research has clearly demonstrated the sheer diversity and range of elements which contribute to farmers' decisions to adopt different mitigation measures. By using Pike's framework to guide the collection of empirical data, and then applying the BCW approach to the knowledge gained illustrates the merits of using such frameworks.

Using both Pike and BCW together has provided a framework for evaluating farmer behaviours of WPA mitigation measures and has enabled an assessment of what needs to change. The value of Pike has previously been discussed (Section 2.1.1 and at the beginning of Section 8.1), with the main role of the framework being to provide structure and guidance. The benefits of then applying the BCW approach were that it:

- Provided a useful checklist of behavioural components to compare.
- Identified key factors which need to change for each measure.
- Highlighted differences in key factors between various measures and therefore the contrasting strategies required.
- Helped identify which components can or cannot be influenced by changes in policy e.g. demographics.

In order to provide comprehensive guidance for policy makers, Steps 5 to 8 of the BCW approach should also be completed. It was beyond the scope of this research to conduct a full assessment of Steps 1 to 8, however suggestions are provided at the end of Chapter 9 for further research (Section 9.5).

Through the use of three empirical studies this research has contributed vital knowledge required to guide agri-environmental policy decisions to reduce WPA. At the end of each empirical chapter, the implications of the research were discussed to some extent, however the wider implications of the thesis findings are presented in the following section.

8.2 Implications of research

As a whole, this thesis demonstrates 'in spades' the great diversity amongst the farming community, the range of factors influencing mitigation measure uptake and the differing complexities of farmers' decisions to change their behaviours. Given such variation, measures should not be considered under a broad umbrella of 'pro-environmental behaviours' or 'WPA mitigation measures'. There is a need to consider each measure separately when designing policy interventions, to ensure essential information is obtained.

8.2.1 Selecting measures and interventions for policy

In order to select measures for policy focus and to design appropriate interventions to increase uptake, this thesis validates that frameworks such as Pike (2008) and the BCW (Michie et al., 2011a) are valuable guides.

The value of using such frameworks is increased when combined with a strong emphasis on stakeholder engagement. This PhD included farmers, farm advisors, policy makers and researchers from an array of subjects to study behaviours and the various factors influencing them. This enabled an investigation of the current situation: what measures farmers were already doing; what they are likely to do in the future and what efforts (by advisors) were being made to increase measure uptake. Stakeholder engagement also provided insight in to the factors that motivated or created barriers to further adoption of measures. Understanding of the current behaviour, efforts and factors influencing behaviour helped advance the knowledge required to make informed decisions on measures for policy focus and improve intervention design.

The survey presented in Chapter 4 was essential to help identify which mitigation measures to target for further research, and to ascertain the potential ease of changing behaviours. Results indicated that some measures had a high rate of uptake but were not included within government interventions (e.g. cultivating compacted tillage soils and maintaining field drainage systems). This suggested they were already part of the social norm and therefore required little to no intervention. Measures within regulatory requirements but not adopted by all farmers (e.g. many of the NVZ rules for timings and locations for spreading fertilizer or manure, shown in Figure 4.1), implied that greater enforcement of regulations is required. Measures with positive attitudes and claimed to be a priority ought to require only simple interventions such as leading by example and small incentives, whilst measures with low uptake and negative attitudes are likely to need a great deal of effort to increase uptake.

The measures from the baseline survey were categorised across the 4Es (Section 4.3.2) to indicate which combination of interventions could be appropriate to influence an increase in measure adoption. However, to achieve a more accurate and informed conclusion, research was needed to ascertain what motivating factors and barriers existed.

Chapter 6 investigated which factors contributed to the decision process or formed barriers to measure uptake. This research highlighted that if policy chooses to focus on measures with simple decision processes and barriers e.g. re-surfacing tracks (Table 6.6), then targeting the main barriers, which in the case of tracks is cost, would therefore potentially only require financial incentives to encourage many non-adopters (Section 8.1.1). However, if policy aims to increase the uptake of more complex measures e.g. subsoiling and cover crops (Table 6.6), interventions would need to encompass a greater number of strategies to influence farmers (Section 8.1.2 and 8.1.3). Pike (2008) describes how regulatory and market-based instruments should focus on external barriers, while internal barriers ought to be addressed through communication, advice and other engagement options to influence attitudes and social norms. As Chapter 6 provided details of whether barriers were more commonly internal or external, considering Pike's recommendations with the results provides guidance as to which mechanisms might be needed for specific measures.

In addition to considering barriers it is also important to understand the motivational factors when designing interventions. For instance, where financial barriers limit adoption, incentives can help, however offering incentives to intrinsically motivated behaviours can lead to undesirable financial motivations (Deci et al., 1999). This thesis examined the motivations for adopting eleven different mitigation measures, and highlights that those which were adopted without financial incentives and had intrinsically motivating factors influencing adoption (such as *long-term viability* and *aesthetic value*), should not be included within AES or other incentive schemes. Even though research such as Fish et al.'s (2003) study on land managers attitudes to AESs, believe extended periods of engagement with AESs can turn farmers' motivations from predominantly financial to intrinsically environmental, Burton and Paragahawewa (2011) claim this is unlikely to be widely applicable.

Once deciding on the type of intervention to apply for a measure, further factors must be considered. For example, success of financial incentives can depend on a range of factors such as scheme features, degree of fit with the farm operation, social context, farm structural features, farmers' motivation, attitudes and level of information (Mettepenningen et al., 2013; Wilson, 1996). Costs will vary from farm to farm, job to job, season to season, region to region, materials used and labour source. Therefore, flexibility of financial incentives is crucial to apply to the diversity of farmers' contexts and to ensure relevancy for providing effective outcomes. However, this needs to be balanced against costs and timeliness of implementation, as complexity caused by local tailoring can hinder incentives success (Smith, 2015).

Results from this thesis suggest that the Government should ensure interventions focus on influencing various stages of the farmers' decision processes. This could involve: providing the catalyst; encouragement along the way; the final push for adoption, or maintaining effort until the behaviour has become the social norm. Opportunities can be identified within the decision processes, presented in Chapter 6, as to what could be done to influence others. For example, providing education on the importance of soil could catalyse the thought process to adopt subsoiling. If there is already an understanding and a desire for long-term viability of the farm, advice in several forms could help encourage change. The opportunity to trial machinery could then act as the final push, allowing the individual to experience the benefits first-hand and thus persuading them to adopt the measure into their regime. It is possible that the Government may not be required to intervene at *all* stages of the decision process or to act as a direct provider of an influencing factor (e.g. financial incentive). One example is the measures that involve advances in technology such as reduced cultivation and tramline management. Results from this thesis imply that the Government does not need to be involved and it is suggested that supporting schemes such as the Agri Tech Catalyst[22] can be an effective strategy to advance such channels of innovation instead.

The word 'Government' is being used in the context of influencing measure uptake, but this raises the question, is it the role of the Government or should it be left to others? Ample literature exists which discusses bottom-up initiatives and networks, and their role in influencing behaviour change and social norms (e.g. Learning and Innovation Networks for Sustainable Agriculture in Tisenkopfs et al., 2014). As the overall objective of this PhD was to inform agri-environmental policy for increasing WPA mitigation measure uptake, the discussion will remain focussed on the research implications for policy improvements, however, the roles of other actors and how they can contribute to influencing behaviour change will be discussed in the subsequent sections.

Ideally, the ultimate goal would be for the Government to not need to intervene, with desired behaviours accepted as the social norm and carried out willingly. Such a goal seems far-fetched at present but, as other behaviour change campaigns have shown, is possible (e.g. drink-driving - Williams and Robbins, 2014). In order for this to happen, the desired

[22] https://www.gov.uk/international-development-funding/the-agri-tech-catalyst

behaviours need to become part of the social norm and culturally embedded (Burton and Paragahawewa, 2011)

8.2.2 Changing the social norm

Across the eleven mitigation measures studied in detail it was apparent that internal barriers were common obstacles for adoption. In order to overcome such barriers and to ensure an enduring change in behaviour, Stobbelaar et al. (2009) claims internalisation of policy is needed. Nelissen et al. (1988) as cited by Stobbelaar et al. (2009), define the internalisation of policy as *'the process in which norms and values…become incorporated in thought and behaviour. Complete internalisation occurs, when the person in question behaves according to aforementioned norms because he finds them just and self-evident'.* Stobbelaar et al. (2009) elaborate, stating that the implementer will then be internally motivated to adjust their behaviour in an autonomic way by volitional actions to reach the policy goals. Not only do measures with internal barriers require internalisation, but according to Wrong (1961), a behaviour adopted through fear of regulation is also a classic sign the behaviour is not internalised. Whilst the research within this thesis supports previous findings of internal barriers (e.g. Wilson et al., 2013) and fear of regulations (Barnes et al., 2013), it is clear that more needs to be done to internalise such behaviours and policy.

Internalisation of policy can be achieved through various strategies (Stobbelaar et al., 2009). For example, changing perceived control by offering choice and freedom is believed by Moller et al. (2006) to increase a sense of autonomy and self-determination to reach required policy goals. One example of achieving this is the use of a reverse auction, whereby farmers bid to secure funds for making farm improvements (Westcountry Rivers Trust, 2013:14). Another is the concept of 'payments by results' rather than payments to perform set management activities (Burton and Schwarz, 2013; de Snoo et al., 2013; Zabel and Holm-Muller, 2008). Farmers have been shown to favour a flexible approach towards AESs (Mettepenningen et al., 2013), and although such a concept has great potential, further research is required (Burton and Schwarz, 2013). Finer details need to be understood as to how best to provide flexible mechanisms to allow choices in reaching the end results (de Snoo et al., 2013), and how to over-come potential problems of increased risk to farmers and monitoring (Burton and Schwarz, 2013).

Interventions should not only place emphasis on the individual as a decision-maker, but ought to focus on the wider social context in which they operate as well (Morris et al., 2012). Farmers are known to constitute a judgemental peer group, often comparing their performance against others (Carruthers, 2003; Oreszczyn and Land, 2000; Seabrook and Higgins, 1988; Wynn et al., 2001). Therefore by altering what constitutes as the ‘norm’, and what is expected of a good farmer encourages others to act in a similar way of their own accord and thus internalising the choice to act.

One method used in the past for setting the ‘norm’ has been that of farm demonstrations. Examples include the monitor farm programmes in New Zealand[23] and Scotland[24]. Such programmes are believed to be highly successful at engaging with the farming community and disseminating best practices (Malcom Watson Consulting, 2014), with farmers valuing such engagement (Garforth et al., 2003). The findings from this thesis indicate that farm demonstrations positively contributed to adoption of measures (Chapter 6). Measures such as subsoiling were found to often require multiple forms of advice and demonstration, highlighting that an advisor simply recommending the measure will not always suffice. By demonstrating best practice, setting a good example, providing local evidence of the benefits and raising expectations of the farming community, interventions which support methods such as farm demonstrations help contribute to long-term social change. Progress has been made recently with more demonstration farms being created. For example, the AHDB Cereal and Oilseeds levy board in England and Wales established a new Monitor Farm Programme in 2014 (AHDB Cereals and Oilseeds, 2015), with expectations of more farms joining the programme due to their success and popularity (Farming Online, 2015). The Government have also acknowledged the benefits of local demonstrations funding research platforms on real working farms (e.g. the DTCs). Such efforts, along with building other forms of farmer networks (The Royal Agricultural Society of England, 2010), need to be carried forward and maintained in order to achieve successful dissemination of knowledge and to change social norms.

Placing emphasis on individuals and the wider context to achieve internalisation requires multiple strategies. CaBA will now be considered in light of the results from this thesis, and a discussion presented on how such a strategy can be improved to assist in delivering the multiple strategies required for meeting policy objectives.

8.2.3 The catchment-based approach (CaBA)

The great variability in behaviours and attitudes across the different farm types and catchments, evident in this research, suggests that the growing emphasis on CaBA is a step in the right direction. CaBA has provided momentum for the shift towards allowing decisions to be locally tailored, aiding policy internalisation through choice. However, diversity exists

[23] http://www.beeflambnz.com/farm/project-farms/monitor-farms/

[24] http://www.gov.scot/Topics/farmingrural/Rural/business/monitor

between catchments in terms of stakeholders successfully working together, the level of funding, maturity of organisations and approaches used. This all creates additional complexities to the management of such a strategy, but the overall benefits of the approach are believed to generate a compelling case for continuation and wider adoption (Cascade, 2013).

It is evident momentum in the CaBA remains strong (CaBA, 2015), but in order to deliver flexible, cost-effective interventions on the ground, the results from this research support Blake (1999) and Green et al.'s (2013) suggestions that greater emphasis must be placed on the negotiation of partnerships and social networks which are sensitive to local diversity. Such recommendations are already incorporated in CaBA but need to be made a greater priority. To accommodate the diversity amongst farmers, measures and factors influencing behaviour, it is important to ensure that people on the ground, with expertise and local knowledge, form resilient, trusting partnerships and networks. Evidence already exists of such networks. For example the advisor community in the Eden catchment (Section 5.3.6), or the Devonshire farmer case study in Box 4. This example illustrates how a partnership between a local initiative, water company and farmer tailored a bespoke solution producing a cost-effective and environmentally beneficial result.

Box 4 Locally tailored initiatives - Wildflower rich hay meadow

In 2014, the Devon WT was working with a landowner through the Upstream Thinking project funded by SWW, to implement several strategies to reduce the risk of DWPA from the steep land which drained directly into a reservoir. One solution, included trialling a new grassland management of wildflower rich meadow, however, such specific seed mixes are expensive. The strategy was so successful on the site, the landowner planned to collect seed and distribute it on more fields, in addition to selling it to neighbouring farmers. The WT provided the agronomic expertise, machinery and staff time, whilst the landowner bought the seed and moved the bales created. To encourage other farmers to 'buy-in' to the strategy, the landowner planned to sell it as an AES option for benefiting pollinators.

When interviewed, the landowner commented on government investments as follows *'NE pay all this money to a large seed company in York….but it would make sense for the Government to fund Devon Wildlife Trust to sell seed as it is more local than York, so more likely to take. The Wildlife Trust know what they are doing.'* Tamar farmer 19.

Chapter 5 collected data on the mechanisms advisors used to help increase measure uptake, identifying the diversity between organisations and regions. Such evidence indicates that flexible mechanisms were already being used. However, the data also highlighted that stronger partnerships and networks need to be created to make better use of the already established community of advisors.

8.2.4 Improving networks and advice delivery

The research results presented within this thesis suggest that catchment networks and advice provision need improving to further influence the uptake of WPA mitigation measures. It is evident from the literature (Section 2.4) and Chapter 5 that a great number of farm advisors exist in England. Identifying the gaps in advice provision, the different niches within the advisory sector and who farmers listened to for advice, all inform the important question of *'who is best placed to deliver policy objectives on the ground in different areas?'*

Determining who is best placed is a demanding task. Especially with a busy and fragmented advisor sector (AIC, 2013; Defra, 2013b; Dwyer et al., 2007; Foresight, 2011; Knierim and Prager, 2015). The inefficiencies identified in Chapters 5 and 7 imply that there is scope for policy interventions to make better use of the available network of advisors. Such recommendations have previously been made, suggesting that working 'with the grain' is more practical and feasible than radical reform (Smith et al., 2015:277). What this research adds is the insight that the roles of advisors and farmer attitudes towards such advisors differ across the country. Depending on the catchment, different organisations were listened to more for WPA advice (Chapter 7), implying it is essential to know who to collaborate with where, in order to deliver interventions and initiatives. In one catchment the WT may have sufficient trust amongst the farming community, whereas in another catchment, only industry professionals might. This thesis shows who is most listened to, and why, in three catchments, but also demonstrates an approach that could help identify which advisors are best placed in other areas. It is acknowledged that such a thorough investigation engaging with farmers and advisors is a costly and time-intensive exercise to conduct across the country (although it is recommended due to the benefits). An additional, or, if necessary, an alternative approach would be to ensure greater signposting and coordination between advisors in order to reduce overlap of efforts. Proctor et al. (2011) have previously argued that advisors need to be better informed of the networks and local contexts in which they are operating and their role within them. This is not only essential for reducing overlap but with farmer expectations of their advisors to 'act as an industrial Dyson' (Farmers Weekly, 2013) advisors need access to relevant knowledge and to know where to go for particular expertise.

It has been established that better coordination is required for advisors in the context of CaBA, but this research also found continuity to be crucial. *"Said does not mean it's heard – heard does not mean it's understood – understood does not mean it's agreed – agreed does not mean applied – applied does not mean retained"* (Erz, 1985 as cited by Prager and Posthumus, 2010).

Erz's statement highlights several levels of discrepancies between hearing about an innovation and acceptance, and has been supported by others. Petty et al. (1992) observed that simply providing information for farmers is unlikely to be sufficient to ensure behavioural change. This thesis showed that a single one-off transfer of knowledge was often insufficient (Chapter 6), and that advice is required as part of an iterative learning process.

Whilst influential factors are ever-changing (Section 1.2), advice for farmers needs to be continual to remain relevant. A discussion with Will Cleasby, a farmer and farm advisor from the Eden highlighted that advice needed to be a process and he believes for example that "*a good Nutrient Management Plan needs updating every year, unlike the consultant produced glossy document that sits on a shelf and doesn't get read – they completely miss the point.*" As circumstances alter during different weather conditions and times of year, advice needs to fully consider the farm business over time, so that different issues can be observed and prioritised. Considering the spectrum of time, evidence has shown that there is typically a lag of around three years from when a recommendation is first made to when the farmer implements the measure (CSF Evidence Team, 2014). Continuity of advisors is therefore essential.

Ensuring continuity, and allowing trusting relationships to establish and flourish provides many benefits. Whilst advisors conducting farm visits certainly helps to target interventions, it is essential to build a trusting relationship between the farmer and advisor (evident in Chapter 7). By having people on the ground who: have sufficient local knowledge; are accepted and trusted amongst the community; fully understand the farmers' contexts; know which stages individuals are at in decision processes; know what might be needed to provide a catalyst, nudge or final push, and are working to ensure government objectives are met, greatly improves policy efficiency. Such people can guide policy by knowing what content and mode of advice is required. Dwyer et al. (2007) found that advice requirements differ depending on the farmer. For some farmers positive reinforced messages are more effective than negative fear-provoking messages, or vice versa for others. Slagle et al. (2013) believed that providing information about the benefits of taking action to mitigate a risk is more powerful than focusing on fear-provoking appeals. On the other hand, Wilson et al.'s (2014) research on attitudes of Ohio farmers concluded that raising individual perceived risk would encourage uptake and that communication efforts should focus on the negative impacts of what they would lose if they didn't adopt measures to reduce nutrient loss. With farmer heterogeneity, the ability to adapt communication efforts to fit the personality of the farmer is essential and can only be achieved by having trusted advisors in the community.

Once it has been identified who is trusted and best placed within a catchment, and efforts are made to ensure continuity, to enhance communication and co-ordination amongst actors, training should be provided. The PROAKIS project which produced Figure 2.10 (displaying each EU Member State's AKIS on a spectrum of fragmented to integrated, and weak to strong), recommended provision of training for advisors. Knierim et al. (2015) suggest training on new skills, competences, innovative technical, social and organisational topics, networking, as well as on new policies and regulations would be beneficial. However, the results from this thesis suggest that since other actors can contribute to barriers for measure adoption, such as contractors, land agents, bank managers, supermarkets etc., training should also be provided for such actors. PINPOINT, which currently provides training for RT staff (see www.theriverstrust.org/pinpoint/index.html), is one example which could be expanded upon to deliver training to a wider audience.

Results obtained throughout this thesis imply that greater efforts are needed to increase advice on and awareness of the importance of soil. Chapter 4 and 6 found that measures such as cover crops and subsoiling (which can reduce WPA but also improve soil quality) have not yet become the social norm or internalised amongst the majority of farmers. As commitments have been made in the EU and beyond which focus on soil quality (Box 5), efforts to reducing WPA should be linked with improving soil quality. Additional avenues of linking policy objectives are also possible, with the need to identify messages with 'common hymn sheet topics'. Measures which benefit WPA can also benefit animal health and welfare, climate change, farming economics, biodiversity and so on.

Box 5 Commitments and focus on soil quality

Water quality issues are linked to multiple environmental factors such as flooding, climate, land use and soil quality. In September 2006, the EU Commission adopted a Soil Thematic Strategy which included a proposal for a Soil Framework Directive (SFD) to address the increasing pressures and degradation of soils across the EU. In April 2014, the SFD proposal was withdrawn by the Commission as the majority of the Council failed to vote in its favour. EU commitments instead, so far, come from the Seventh Environment Action Programme, (7th EAP) which states that by 2020 "*land is managed sustainably in the Union, soil is adequately protected*" and commits the EU and its Member States to "*increasing efforts to reduce soil erosion and increase organic matter, to remediate contaminated sites and to enhance the integration of land use aspects into coordinated decision-making involving all relevant levels of government, supported by the adoption of targets on soil and on land as a resource, and land planning objectives*". It also states that "*The Union and its Member States should also reflect as soon as possible on how soil quality issues could be addressed using a targeted and proportionate risk-based approach within a binding legal framework*".

Many of these commitments strongly relate to those involved in the reduction of WPA. It has become clear that it is increasingly being acknowledged soil quality is extremely important. 2015 was labelled as 'The International Year of Soil' by the UN, in an attempt to raise awareness of the importance of 'Healthy soils for a healthy life'

Bringing together all of the research implications outlined above, it is important for policy to: identify which measures to focus on; alter the social norm of what is regarded as good farming practice; continue building upon CaBA; and improve social networks and the role of advisors. The policy recommendations in light of the research implications are presented in the concluding chapter, following a summary of the research findings.

Chapter 9

Chapter 9 Summary, conclusions and recommendations for future research

This concluding chapter assesses the extent to which the aims of the research have been met, summarising the main findings and reformulating them to provide practical guidance as policy recommendations. Contributions of this research to policy and scientific knowledge are summarised in Appendix D.

9.1 Summary of key findings

The research presented in this thesis aimed to provide evidence from a social science perspective for policy makers tasked with re-designing interventions for agriculture to reduce water pollution. Through involvement with a research platform, the Demonstration Test Catchments, this research conducted three surveys to improve the knowledge base underpinning informed policy decisions. The following sections present the key findings from the main body of this thesis under the headings of the research questions initially set out in Chapter 2.

9.1.1 The current uptake of farm practices which mitigate water pollution (Chapter 4)

A baseline farm survey was conducted to assess the current uptake of 70 different WPA mitigation measures amongst 73 farmers across three contrasting catchments. The extent to which the measures were used varied widely. Those with the highest uptake were all concerned with fertiliser or manure management and formed part of Cross Compliance requirements for receipt of the CAP Pillar I SFP. Measures which were compatible with current farm practice were more likely to have been adopted than those which require radical management or land use change. There was no obvious difference in uptake of measures according to whether they related to pollution source minimisation, pathway reduction or receptor protection. Several measures with known benefits (e.g. cover crops) were less widely used than might have been anticipated.

9.1.2 Farmers' attitudes towards future uptake of mitigation measures (Chapter 4)

The 73 farmers from the baseline survey were asked how *'likely'* they would be to adopt a particular mitigation measure in the future if they were not currently practicing it. Overall, measures requiring land use change were less likely to be adopted than measures improving farm infrastructure. Those likely to be adopted in the future were those which decrease the use.

of fertiliser and fuel, therefore reducing costs. Farmers from the survey were more negative towards future adoption of livestock and manure management measures than soil and fertiliser management measures. The results highlighted several measures with relatively low current uptake but positive attitudes regarding future adoption, such as re-siting gateways, establishing cover crops and reduced cultivation systems.

The survey also asked participants to list three mitigation measures they would prioritise on their farm. Sixty-five farmers responded, with 22% having no priorities. Nearly two-thirds of the priorities identified involved changing farm infrastructure, particularly additional concrete areas. A variety of uses were identified, including concrete for manure heaps, diverting dirty water and track repair. Further priorities included manure and fertiliser management options relating to correct timing and application efficiency, as well as storage covers.

9.1.3 How the roles of farm advisors differ in the provision of mitigation measure advice (Chapter 5)

To investigate what needs to be done to improve farmer uptake of WPA mitigation measures it was vital to understand what current efforts are being implemented. Knowledge existed of regulations enforced and government financial incentives offered, but with the fragmented farm advisor sector there was a lack of insight as to who was advising what where. By interviewing 81 farm advisors from a wide range of organisations across three regions of England, this research was able to discover what WPA mitigation measures were being recommended.

The most commonly recommended mitigation measures amongst all advisors included soil analysis, separating clean and dirty water, roofing yards, implementing buffer strips and reducing fertiliser applications. Overlap existed between organisations in terms of recommendations, with certain measures being proposed by many different advisors (e.g. timing of field activities and buffer strips). However distinctions also occurred and suggested that niches existed in the roles of advisors. For example, soil analysis and nutrient management plans were unlikely to be recommended by an advisor who recommended tree planting. Additionally, advisors recommending in-field and field boundary mitigation measures were unlikely to be recommending farm yard measures.

Considering the various organisations, the EA were found to particularly focus their advice on regulatory requirement measures. The most similarities in advice occurred between NE and environmental NGOs (such as WT and RSPB), focusing on recommending AES options as an incentive to engage with farmers and provide the opportunity to influence land management and measure uptake. Regional differences in the role of advisors were identified, with Chapter 5 drawing upon the examples of CSFOs and environmental organisations.

Inefficiencies were found within the sector as advisors reported conflicts in recommendations between those with differing agendas (environment, government or business). Examples included differences amongst advisors with environmental or economic focus regarding the amount of fertiliser to spread and silage cutting times. Species and habitat priorities varied amongst environmental organisations, and advice regarding dates for closed periods in NVZs generally differed between advisors. Changing regulations were stated by many non-governmental advisors as causing confusion and difficulties with keeping up-to-date and delivering consistent advice. Conflicts also occurred within and between government organisations. The most common disagreements involved AES options and whether they were effectively targeted. For example, AES grassland management options resulting in over or under grazing. Such findings indicate that the advice sector could be more efficient as, collectively it does not provide consistent advice.

Differences existed between advisors regarding the mechanisms they used to influence uptake of measures. Many organisations focussed on one form of mechanism (e.g. RSPB encouraging AES options), whilst a select few used a variety of mechanisms (e.g. CSFOs used funding, voluntary approach, regulatory advice and signposting). The majority of advisors favoured specific mechanisms for certain measures (e.g. grants and AES for tree planting) but employed a combination of mechanisms in other instances (e.g. regulatory advice, AES, voluntary and signposting for timing of field activities). The mechanisms used by advisors varied across the three regions surveyed.

9.1.4 Which factors influence the uptake of specific water pollution mitigation measures (Chapter 6)

To aid decisions on re-designing policy, discovering what needs to change was necessary. Investigating motivations and barriers towards specific mitigation measures through 58 in-depth farmer interviews across three catchments allowed this research to construct narratives of what factors influenced decision making processes resulting in uptake and those which created barriers. Eleven mitigation measures were investigated in detail with findings showing the sheer diversity of factors which influence uptake.

It became apparent that no single influential factor caused adoption, but that it was an evolving combination of factors. The decision processes of farmers who had already adopted a measure were characterised by their complexity, with ‘simple’ decision processes considered to comprise of fewer stages and types of influential factors, whereas ‘complex’ decision processes involved more stages and factors. As well as the level of complexity, the order in which factors contributed to decisions was highlighted. Environment, personal factors and regulations tended to contribute to the catalyst of the decision process. Advice, education and market factors encouraged, whilst financial incentives provided the final push (when offered) for many. Such information identified *what* might be required to influence other farmers to adopt the measure and at *what stage* in their decision process it might be needed.

To determine which barriers needed to be overcome to influence greater uptake of particular mitigation measures, interviews with farmers who had not adopted a measure were conducted. Results highlighted a great diversity of barriers existed for measure uptake and whether internal or external influences were the most common constraints. Some measures were found to have many different types of both internal and external barriers - tree planting, subsoiling, cover crops, and biobeds, whereas other measures were identified as having one or the other as the most common type of barrier - sediment traps and re-siting gateways having more internal barriers and tramline management, re-surfacing tracks and roofing over yards having external barriers.

Identifying whether internal or external barrier factors dominate and whether numerous different factors act as barriers provides a greater understanding of what various mechanisms need to be tailored towards, in order to overcome such issues. Policy interventions for measures which have dominant internal barriers need to focus on altering social norms and attitudes and will often take time to achieve change. Measures with dominating external factors and positive attitudes can be expected to need less attention of changing attitudes and more focus on altering the context in which farmers are placed.

No obvious trends or relationships were found between types of barriers and the complexity of decision processes for adoption of measures. Nor was it found that a specific barrier occurs at a precise stage in a decision process. It was, however, possible to conclude that a multifaceted measure - complex decision process (many different factors and stages) and multiple barriers (both internal and external) – would require substantial effort (multiple channels of intervention) or drastic change (e.g. regulations), in order to increase the adoption of the behaviour.

9.1.5 What advice farmers want and what their attitudes are towards farm advisors delivering mitigation measure advice (Chapter 7)

The final empirical chapter examined which measures farmers wanted advice for, what types of advice for each measure and who they would listen to and why. Results showed that farmers want their advisors to be providing clear, consistent messages, repeated for clarity and with all advisors 'singing from the same hymn sheet'. Farmers also requested more demonstrations. They particularly wanted advice for new management and infrastructure change mitigation measures (e.g. cover crops, subsoiling, sediment traps and biobeds), with the most advice desired by livestock farmers for management changes. Less advice was sought for general infrastructure changes, however farmers requested advice on costs, farm infrastructure plans, stating they would be beneficial for decision making.

To disseminate advice effectively it is essential to appreciate who farmers listen to in each area and why. Through the use of word clouds, the research demonstrated a novel and effective visualisation technique for analysing the qualitative data collected on farmer attitudes towards advisors. The results showed that the reasons why farmers listen to advisors varied appreciably across catchments, with different attributes being of importance. Overall, important positive reasons for listening to advisors included: grants, knowledge, trust, continuity, clear advice and local evidence. The variations in why farmers listened to CSFOs across the three catchments illustrated the importance of building a trusting relationship through staff continuity.

Comparing advisor and farmer perspectives highlighted that the link between WPA mitigation and cost-savings needs to be made more explicit. It also highlighted that environmental organisations should emphasise their local knowledge and evidence to increase farmer uptake of advice.

9.1.6 What needs to change to improve the uptake of WPA mitigation measures (Chapter 8)

Applying Michie et al.'s (2011a) framework to the research findings from all four empirical chapters served as a practical tool to demonstrate how such knowledge can inform what needs to change to improve the uptake of three WPA mitigation measures (re-surfacing tracks, subsoiling, cover crops). Findings indicated that strategies should be tailored for each measure and may need to differ between catchments. The results suggest it is important for policy to: 1) identify which measures to focus on, 2) alter the social norm of what is regarded as good farming practice, 3) continue building upon the catchment-based approach, and 4) improve social networks and the role of advisors.

Since conducting this research, there have been several developments within policy. To ensure policy recommendations made in light of this research are of most use, the next section describes the recent developments. This is followed by the recommendations for policy interventions and the necessary political environment to help influence greater uptake of water pollution mitigation measures amongst the farming community.

9.2 Recent developments in policy

The research presented in this thesis portrays the agricultural sector at various times between February 2012 and December 2014. A number of socio-economic and political changes occurred during the period of this PhD, with new schemes in place and a reformed CAP, inevitably impacting upon the agricultural industry and farmer decision making. To improve current policy the recommendations made will consider the current policy environment as of December 2015.

9.2.1 CAP reform 2014 – Greening and Countryside Stewardship

The CAP reform of 2014 brought in a suite of changes to the system of agricultural subsidies and programmes from the EU. Firstly, the Basic Payment Scheme (BPS) replaced the SFP (see Section 1.2.2 for details of the previous CAP structure). The BPS (CAP Pillar I) can be claimed once a year by farmers with at least 5 ha of agricultural land (similar to SFP). However, farmers must adhere to new 'greening' rules to receive a part of their total BPS payment - in addition to the changed Cross Compliance GAECs and SMRs (Defra, 2015g). The greening payment is worth around 30% of a farmer's total payment.

The 'greening' rules are made up of three key stipulations, which, depending on farm type, size and land eligibility (RPA, 2015a), generally require:

1) Arable farmers to grow three different crops. The area of the main crop must not cover more than 75%.

2) Farmers with more than 15 ha of arable land must have 5% of agricultural land as 'Ecological Focus Areas' (EFAs). EFA features are those which the EU has decided are beneficial for the climate and the environment. Farmers can choose which areas and/or features they will use to make up their EFA. EFAs can be made up of: buffer strips; nitrogen-fixing crops; hedges; fallow land; catch crops and cover crops (from a specified list).

3) If the percentage of permanent grassland in England falls by more than 5%, farmers who have ploughed permanent grassland may have to re-instate it.

The decision process within the EU and Defra regarding implementation of the different elements of CAP funding and farmer requirements was reported in Countdown Leaflets as decisions were being made (2013-2015). This was to ensure transparency and keep all those affected up-to-date. However, the long decision process also resulted in appreciable speculations and confusion within the industry. In 2014, 57% of the farmers who participated in the Farm Practice Survey reported they had a good or full understanding of the 'greening' requirements, and only 20% believed the requirements would result in them doing more for the environment. The majority of farmers believed the EFA requirements would have no impact on their farm business (Defra, 2015f). Figure 9.1 illustrates the different EFA options and the proportion of farm holdings which planned to introduce/increase or already had them in place.

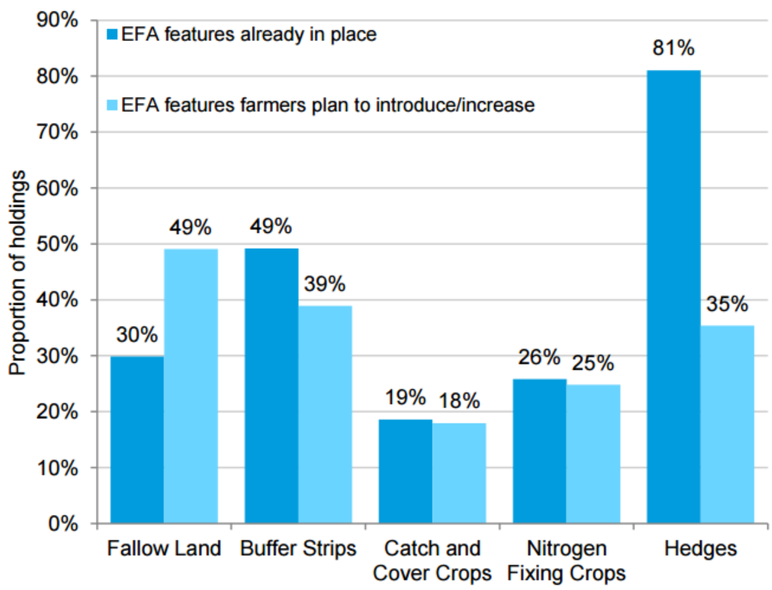


Figure 9.1 Ecological Focus Area features farmers plan to introduce/ increase or already have in place. Sourced from Defra (2015f).

The current inclusion of cover crops in EFA has contributed to an increase in uptake (Figure 9.1) however oilseed radish (a variety greatly promoted within the industry) was not initially included in EFA requirements. '*Oilseed radish seems to tick all the boxes, so why haven't Defra included it in the CAP's new EFAs?*' (Farmer at Frontier Cover Crop Open Farm event, Morley, Norfolk, June 2015). After much discussion within the farming industry and the Government, a BPS update document published in October 2015, stated that oilseed radish would count (as part of a mix) as an EFA catch and/or cover crop in 2016 (RPA, 2015b). With many farmers opting for different options for their EFAs (Figure 9.1) in 2015, it is possible that inclusion of oilseed radish will cause a substantial increase in cover crop uptake for 2016.

In additional to the BPS, farmers can voluntarily opt to apply for funding under the new CAP Pillar II AES. The Government has previously tried a broad brush approach to agri-environmental policy with the Entry Level Stewardship scheme (Figure 2.9), however the new Countryside Stewardship (CS) is a more locally targeted approach, in line with the old Higher Level Stewardship scheme. CS has been designed as part of a new programme which aims to incorporate the best elements of Environmental Stewardship, CSF Capital Grant and the England Woodland Grants scheme. Applicants have been encouraged to select options and capital items which are closest to the environmental priorities outlined by the Government for their area[25]. The scheme is competitive with Mid-Tier, Higher-Tier and Capital Grant applications being scored and ranked, with funding awarded to those with the greatest benefits to the environment. A 'water quality options' package has been created to include a range of options to improve water quality in CSF priority catchments.

In the first Scheme Development Bulletin produced in February 2013, it was stated that the new AES would be developed following extensive consultation with the farming industry, environmental organisations and other NGOs (Natural England, 2013). Despite consultation, the scheme has still received negative reviews. Figure 9.2 displays comments from the farming press describing the new scheme. Comments suggest why lower than anticipated level of applications were received - 2,314 applications of the 5,000 predicted (Case, 2015). During the countdown to the CS application deadline, details of the agreements had not been finalised and in a Farmers' Weekly article (30th October 2015), it was reported that the CS guide was being updated for the 14th time since the end of June (Davies, 2015). Such factors negatively impacting application rates could have detrimental impacts on the environment in the coming years as old AES agreements come to an end.

Figure 9.2 Farming press comments describing the new Countryside Stewardship scheme (Smith, 2015).

[25] https://www.gov.uk/government/collections/countryside-stewardship-statements-of-priorities

9.2.2 Water quality legislation and water industry changes

Since the start of this research there has been substantial promotion of the CaBA and a growing prominence of RTs across England. The DTC study catchments have experienced a substantial growth in activity across all four catchments (DTC, 2015a), with an ever rising number of stakeholders participating in catchment management. As for water companies, during 2013 plans were submitted to Ofwat (the regulators) to outline their targets for the next AMP cycle (see Section 1.2.1 for an explanation of the AMP cycles). Ofwat's response for AMP6 (2015-2020) was for water companies to spend more than £44 billion on improving efficiencies, reducing flooding and improving water quality. An increasing number of projects from the water companies have been including farmer engagement to tackle the water quality issues they face. There is now pressure for such catchment projects (e.g. Upstream Thinking and Slug it Out) to demonstrate their effectiveness in order to justify allocation of more resources in the next round of AMP.

Many wider issues play a large role in farmer decision making and adoption of farm practices which contribute to reduce WPA. Issues associated with tenancy agreements, the food supply chain and supermarkets, and global market trends are all important. If addressed, there is potential to make vast differences within the industry. However, whilst such factors are not so easy for the Government to alter, the policy recommendations made in the next section focus on relatively simple factors which the Government could change to improve uptake of mitigation measures amongst farmers.

9.3 Policy recommendations in light of new developments

The key objective of this thesis was to guide and inform agri-environmental policy which aims to influence farmer uptake of water pollution mitigation measures. It is therefore important to discuss the overall policy recommendations in light of this research.

9.3.1 Policy focus

Firstly, it is vital for policy to identify which mitigation measures to target to increase uptake. Once desired behaviours have been identified, an understanding is required of the decision processes of farmers for the adoption of the targeted measures to determine the interventions required. Having examined the decision processes and factors influencing farmer's uptake of eleven different measures and the role of advisors, improvements to current interventions can be made. It is recommended policy should:

- **Focus interventions for particular measures more specifically**, acknowledging that measure characteristics differ as well as those of farmers.
- **Consider the entire decision process** and support interventions at multiple stages in order to accelerate the process of adoption.
- **Better enforce current regulations,** as the negative impacts of farmers avoiding prosecution despite rule breaking can discourage others from abiding.
- **Continue to provide funds to research platforms** (such as the DTCs) who work with real farm businesses to provide local evidence and demonstration.

9.3.2 Catchment-based approach (CaBA)

The great diversity in terms of the level of funding, maturity of organisations and approaches used within the different catchments, creates an additional complexity to the management of CaBA. To overcome issues and complexities within catchments, CaBA should:

- **Provide clear information on the roles and expertise of the actor networks** within the catchments to enable correct signposting, greater collaboration and reduce inefficiencies. Such information should be frequently updated and is discussed in Section 9.5.3 under further research recommendations.

- **Improve exposure and communication with farmers** of what good farm practice is to set the social norms.
- **Provide more demonstration farms and champion farmers** to disseminate and exchange relevant local knowledge.

9.3.3 Improving advice delivery

Agri-environmental policy has acknowledged the need for more targeted interventions, reflected in the removal of the universal Entry Level Stewardships, replacing it with a more targeted scheme which prioritises different measures in each area. Although this is certainly a step in the right direction, it has received a large quantity of criticism for over doing the 'red tape' and creating strict rules for farmers to abide (C. Hill, 2015). Furthermore, it creates additional demands on advisors to make relevant recommendations to farmers and requires greater on the ground expertise for such schemes to be effective. The important role of advice has been demonstrated throughout this thesis and recommendations for policy to improve advice provision include:

- **Recognising that the advisory systems cannot be treated as homogenous.**
- **Providing advisors with adaptable mechanisms** to achieve high applicability, ensure the greatest outcomes and to adhere to the ever changing contexts e.g. flexible grants, such as those offered by Wildlife Trusts and Rivers Trusts.
- **Continuity of CSF funds.** As a whole, CSF has built a good reputation and is an element of the Government farmers like. Longer-term funding for the project is necessary to ensure the right people are in place and retained.
- Ensuring more funds are targeted towards organisations providing advice with well-established relationships with farmers, acting as intermediaries for the Government.
- **The need to increase knowledge exchange of soil related issues, increasing farmers' awareness and understanding of the problems and solutions.** Such activities take time, and the encouragement of soil testing and soil pits need to continually be reinforced to become part of a regime. On such note, it is also important to explain test results to ensure the best management decisions are made.

As the findings of this research imply, it can take multiple factors (evidently over time) from advice delivery to measure uptake, with the need for a trusting relationship between the advisor and farmer. Arguably, staff continuity is vital. CSF have experienced great difficulties planning for the future with concerns of underfunding or even removal of funding each financial year, therefore an obvious improvement would be to:

- Secure the role of CSFOs by offering 3-5 year contracts to staff.

Despite great successes achieved through the CSF initiative, it has only increased uptake of measures to a certain level. Their approach struggles with the 'hard to reach' farmers and this research shows that advice and small grants will not influence the uptake of certain measures. In order to ensure continuity but also overcome the apparent saturation of CSF's success, additional dimensions to the CSFOs role, could encompass:

- **Provision of training courses to a broader set of stakeholders** who interact with farmers on the ground. For example: bank managers; agronomists; seed merchants; vets; farming charities; supply chain actors (e.g. PepsiCo and supermarkets); insurance companies; RPA inspectors; Tenant Farmers Association; landlords; land agents; and staff from Local County Councils. Such a broad audience would ensure messages are consistent and are disseminated more widely. The benefits of CSFOs facilitating such training would be the use of the successful brand of CSF and their association with WPA.
- **Selecting champion farmers as demonstration farms** in each of their catchments to provide additional methods of disseminating local evidence and knowledge of good farm practice.

9.4 Recommendations for future research

Reflecting on the research conducted within this thesis, recommendations for future research have been formulated to build upon such work. To begin with, it is recommended to expand similar investigations to additional mitigation measures, catchments, and the role other potential mechanisms have on measure uptake, especially those which remain off the main political radar e.g. volunteer power, manure trading agreements, supermarket-farmer collaborative initiatives. Furthermore, studying farm types not investigated within this research, such as pigs, poultry and horticulture could be beneficial as very little attention in the literature has been given to such farming systems. Factors influencing their behaviour may be similar in terms of certain regulatory requirements. However, could be very different for others, such as consumer demands, international markets, welfare standards and technological developments.

Another research recommendation would be to monitor the actual implementation of measures (e.g. through the inclusion of farm walk overs). This would ground-truth survey responses and provide confirmation of farm activities. Simply asking a farmer what they do does not necessarily mean that measures are being carried out, or as Collins and McGonigle (2008) suggest, measures may not be targeted most appropriately for protecting water quality status. Therefore to add further value, it would be worthwhile for research to assess not only whether a measure has been adopted but also if it has been implemented effectively. Such information could also help determine whether farmers require improvements in advice delivery or stricter regulations to ensure the greatest benefits are achieved. Such work would not have been possible within this thesis, due to the large number of mitigation measures investigated within the baseline survey (86), and so it is recommended for future research to only conduct such a detailed investigation of uptake with a smaller subset of measures.

In addition to the recommendations already made, three further avenues of research needing investigation are: 1) changes in behaviour over time, 2) designing the most appropriate intervention and implementation strategies for increasing measure uptake, and 3) identifying advisor networks at catchment scale.

9.4.1 Changes in behaviour

The need for farmer behaviour baseline data was highlighted in Chapter 2, with Chapter 4 collecting such information. Needless to say, a greater number of participants would have been preferable to provide further insight into the farming community.

Baseline surveys are argued to be essential in order to build upon over time and monitor any changes in farm behaviour (Anthony, 2011). A repeat of the survey with farmers who contributed to the data collected in Chapter 4 would assess changes in behaviour and attitude given the changes in farming contexts[26]. A repeat survey will be conducted in the early months of 2016 as part of Work Package 3 of the DTCs' Phase 2 funding (DTC, 2015b). The main objectives of Work Package 3 build upon this thesis' contributions and aim to assess:

- The effect of the DTCs on farmers' attitudes towards mitigation measures.
- The role and effectiveness of local stakeholder groups in designing and implementing catchment plans.
- The practical and financial constraints to implementing mitigation measures.

To learn and improve upon the baseline survey, the DTCs Phase 2 survey needs to ensure the same methodology of data collection is used across all participating catchments. Literature confirms the satisfactory use of mixed methodologies, as the majority of the baseline survey was closed questions (Chapter 4). However, the use of telephone or face-to-face methods with all participants would address any confusion or misinterpretations, thus providing a greater completion rate of survey questions. A higher response rate would also be expected through the use of verbal communication (Mills and Birks, 2014), again ensuring a larger set of results.

9.4.2 Intervention and implementation strategies

It is one thing to discover the factors which influence farmers' uptake of mitigation measures, and to determine what needs to change to increase the uptake of specific behaviours. However, to build upon such findings policy makers need greater knowledge to enable successful intervention delivery. As the research presented in this thesis addresses gaps in knowledge to inform Steps 1 to 4 of Michie, Atkins and West's (2014) BCW methodology, the remainder of the approach (Steps 5 to 8) requires investigation. Not only does an intervention need to be effective at changing behaviour, it should also satisfy other criteria, such as: affordability, practicality, cost-effectiveness, acceptability, side-effects/safety and equity (Michie, Atkins and West, 2014:23,24). As Step 4 identifies what needs to change, Steps 5 to 8 go on to identify:

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[26] For example, during the interview period, the Government announced the Soil Protection Review would not be compulsory for farmers to receive the CAP Pillar I payments in 2015. Further research should be conducted to discover whether such changes negatively impacted upon the uptake of soil management plans.

Step 5 - Relevant intervention functions needed, such as, education, persuasion, enablement, modelling, coercion, training, restriction, incentivisation and environmental restructuring.

Step 6 - Appropriate policy categories based on the intervention functions i.e. communication/marketing, guidelines, regulation, legislation and service provision.

Step 7 - Intervention content.

Step 8 - Mode of delivery.

A greater working knowledge of policy intervention costings, government budgets and population of target audience would at least be needed to conduct an accurate assessment for the best solutions for behaviour change. It is proposed such investigations should be carried out within the Government, aided by tools such as the BCW.

9.4.3 Advisor networks at catchment scale

The diversity highlighted in this thesis suggests there would be merit in conducting further assessments of advisory services in other regions. This would identify and describe the relevant advisory actors within the topic of agricultural water pollution (e.g. education, research, advisory services, public and private knowledge providers and users). Such competencies would help policy makers, advisors and farmers to better navigate the existing advisory landscapes and identify potential sources and pathways for the dissemination of information on particular issues. Catchment Management Plans (CMP), which support the second round of River Basin Management Plans (2015-21), would significantly benefit from such work and organisations involved in creating CMPs should consider conducting similar advisory system assessments for their catchment. In England, many CMPs currently fail to consider the importance of advice provision to farmers (e.g. Norfolk Rivers Trust, 2014) and only a few summarise the current advisory landscape (e.g. Broadland Catchment Partnership, 2014) or include advice provision in their strategy (e.g. Tamar Catchment Plan, 2012). The Eden Rivers Trust (2014:12) acknowledges the need for developing a joined up advice programme and better co-ordination of existing initiatives, thus supporting the recommendation for further assessments. Although this thesis presents a diagnosis of the advisory system in particular regions of England in 2014, the landscape is ever changing and needs to be continuously updated. This would allow strengths and weaknesses to be acknowledged, and gaps and missing interactions among actors identified.

9.5 Concluding remarks

The research presented within this thesis has contributed new findings in previously unexplored avenues of research. Despite continuing changes in the farming context there will always be a need to investigate farmer behaviours and the factors influencing them to inform policy developments. There needs to be a continual process of evaluation for current policies and exploration for new ones. The research has shown that more needs to be done to encourage collaboration and communication between farm advisors and other actors within catchments. This will provide farmers with efficient, clear, effective advice and adaptable behaviour interventions to achieve water quality goals. It is hoped the work from this thesis will further feed into proposals for the re-design of agri-environmental schemes, and inform the development and assessment of scenarios regarding the wider adoption of combinations of mitigation measures at farm and catchment scales.

Appendix A

Appendix A.1 Defra User Guide mitigation measures and their categories

Key:

Type	Method	Location	Applicable regulation or AES
LU = Land use change	S = Source	I = In-field	CC = Cross Compliance
S = Soil management	P = Pathway	F = Field boundary	NVZ = Nitrate Vulnerable Zone rules
F = Fertiliser	R = Receptor	B = Farm yard	ELS = Entry Level Stewardship scheme option
L = Livestock		A = All farm	HLS = Higher Level Stewardship scheme option
M = Manure management			CSF = Catchment Sensitive Farming Capital grant option
I = Infrastructure			

	Mitigation measure	Type	Method	Location	Applicable regulation or AES
1	Convert arable land to unfertilised grass	LU	S	I	HLS
2	Arable reversion to low fertiliser input extensive grazing	LU	P	I	HLS
3	Establish permanent woodlands	LU	S	I	HLS
4	Grow biomass crops	LU	S	I	
5	Establish cover crops in autumn	S	P	I	ELS
6	Early harvesting/establishment in autumn	S	P	I	
7	Cultivate land for crops in Spring rather than Autumn	S	S	I	
8	Adopt reduced cultivation systems	S	S	I	
9	Cultivate compacted tillage soils	S	S	I	
10	Cultivate and drill across slope	S	P	I	
11	Leave autumn seedbed rough	S	P	I	CC
12	Manage over-winter tramlines to reduce run-off	S	P	I	
13	Maintain and enhance soil organic matter levels	S	P	I	
14	Establish in-field grass buffer strips	S	P	I	ELS
15	Loosen compacted soil layers in grassland fields	S	S	I	HLS
16	Establish riparian buffer strips	S	R	F	ELS, HLS
17	Allow field drainage systems to deteriorate	S	P	I	
18	Maintain field drainage systems	S	/	I	ELS
19	Ditch management	S	R	F	ELS
20	Make use of improved genetic resources	L	S	A	
21	Use plants with improved nitrogen use efficiency	F	S	A	
22	Fertiliser spreader calibration	F	S	A	
23	Use a fertiliser recommendation system	F	S	A	CC, NVZ

24	Integrated fertiliser and manure nutrient supply	F	S	A	CC, NVZ
25	Reduce fertiliser applications rates	F	S	I	HLS
26	Do not apply fertiliser to high-risk areas	F	S	I	CC, NVZ
27	Avoid spreading fertiliser to fields at high risk times	F	S	I	CC, NVZ
28	Use fertiliser placement technologies	F	S	I	
29	Use nitrification inhibitors	F	S	A	
30	Replace urea fertiliser with another nitrogen form (e.g. ammonium	F	S	A	
31	Incorporate a urease inhibitor with urea fertiliser	F	/	A	
32	Use clover in place of grass	F	S	I	
33	Do not apply P fertiliser to high P index soils	F	S	I	CC
34	Reduce dietary N and P intakes	L	S	A	
35	Adopt phase feeding of livestock	L	S	A	
36	Reduce the length of the grazing day/grazing season	L	S	I	
37	Extend the grazing season for cattle	L	/	I	
38	Reduce field stocking rates when soils are wet	L	S	I	HLS
39	Move feeders at regular intervals	L	S	I	ELS, HLS
40	Construct troughs with a firm but permeable base	L	S	I	CSF
41	Use of hormones and increased milking frequency	L	/	A	
42	Improved feed characterisation (nutrition) low methane	L	/	A	
43	Modification of rumen microbial fermentation (ionophores)	L	/	A	
44	Reduce overall stocking rates on livestock farms	L	S	I	
45	Increase scraping frequency in dairy cow cubicle housing	L	/	FY	
46	Additional targeted straw-bedding for cattle housing	L	P	FY	
47	Washing down of dairy cow collecting yards	L	/	FY	
48	Out-wintering of cattle on woodchip stand-off pads	L	P	FY	CSF
49	Frequent removal of slurry from beneath-slatted storage in pig housing	M	/	FY	
50	Part-slatted floor design for pig housing	M	/	FY	
51	Install air-scrubbers or to mechanically ventilated pig	M	/	FY	
52	Convert caged laying hen housing from deep storage to belt manure	M	/	FY	
53	More frequent manure removal from layer hen housing with belt clean	M	/	FY	
54	In-house poultry manure drying	M	/	FY	
55	Increase the capacity of slurry stores to improve timing of slurry applications	M	P	FY	CSF
56	Adopt batch storage of slurry	M	S	FY	
57	Install covers on slurry stores	M	S	FY	CSF

58	Allow cattle slurry stores to develop a natural crust	M	/	A	
59	Use anaerobic digestion for farm manures	M	S	FY	
60	Minimise the volume of dirty water and slurry produced	M	S	FY	CSF
61	Adopt field heap storage of solid manure	M	S	I	
62	Compost solid manure	M	P	A	
63	Site solid manure heaps away from watercourses/field drains	M	P	I	CC
64	Store solid manure heaps on concrete and collect effluent	M	P	FY	CSF
65	Cover solid manure stores with sheeting	M	S	FY	
66	Use liquid/solid manure separation techniques	M	S	FY	CSF
67	Use manure additives (e.g. alum poultry litter)	M	/	A	
68	Change from a slurry to solid manure handling system	M	P	A	
69	Change from solid manure to slurry handling system	M	/	A	
70	Manure spreader calibration	M	S	A	
71	Do not apply manure to high-risk areas	M	P	I	CC, NVZ
72	Do not spread slurry or poultry manure at high-risk times	M	P	I	CC, NVZ
73	Use slurry band spreading application techniques	M	S	I	
74	Use slurry injection application techniques	M	P	I	
75	Do not spread FYM to fields at high-risk times	M	P	I	CC, NVZ
76	Incorporate manure into the soil	M	P	I	
77	Transport manure to neighbouring farms	M	S	A	
78	Incinerate poultry litter	M	S	A	
79	Fence off rivers and streams from livestock	I	R	F	CSF
80	Construct bridges for livestock crossing	I	R	F	CSF
81	Re-site gateways away from high-risk areas	I	R	F	CSF
82	Farm track management	I	P	F	CSF
83	Establish new hedges	I	P	F	ELS
84	Establish and maintain artificial wetlands	I	R	F	HLS
85	Irrigate crops to achieve maximum yield	I	S	I	
86	Establish tree shelter belts around livestock housing and slurry storage	I	P	FY	CSF

Appendix A.2 DTCs Farm baseline survey

Hi, I'm (your name) from the Wensum Demonstration Test Catchment project. Thank you for agreeing to participate in our research and volunteering an hour of your time to answer our farm survey.

I will just tell you a little bit about our project to give you an idea as to what we will use the collected data for.

The overall objective of the Wensum Demonstration Test Catchment project is to assess the effectiveness of a variety of land management measures aimed at reducing water pollution whilst maintaining farm profitability.

The extensive monitoring work that is being undertaken in the Wensum Catchment will help provide the 'evidence base' to assess how well these measures are working. Members of the Wensum Alliance will evaluate the effectiveness of the various measures undertaken and develop recommendations that will help refine future agri-environmental policy. We are hoping to create a community of practice with effective communication between farmers, scientists and policy makers.

It is my job to survey a variety of farmers from different areas of the Wensum Catchment to create a baseline database of agricultural practices.

Your answers will be treated **confidentially** and used only for this research.

Farm Business Details (Section A)

ASSIGN A NUMBER TO THE FARM FOR SURVEY DATA ANALYSIS ☐

IF YOU HAVE FARM NAME, ADDRESS, TELEPHONE NUMBER, EMAIL AND FARMERS NAME: GO TO SECTION B

A.1. First of all I would like to ask some general questions regarding your farm business. Could you tell me the name of your farm please.

A.2. What is the name of your business?

A.3. And could you tell me your contact details please. Name, address, telephone number and email.

Contact name	
Address	
Postcode	
Telephone number	
Email	

Key Farm Attributes (Section B)

HAND OVER CARD BOOKLET – TURN TO CARD B.1.

B.1. From the list of farming systems, could you tell me which category your farm belongs to.

WRITE DOWN CORRESPONDING NUMBER ☐

HAND OVER OS MAP AND PENCIL

Here is an OS map of the local area, could you please draw a boundary around your land, indicating what belongs to your farm.

B.2. According to the national soil map (NATMap vector), the soil types found on your farm are [READ OUT SOIL TYPES]. To your knowledge, do you agree?

B.3. Do you have any streams or rivers which pass through your land? Y / N

B.4. As our research is investigating the river catchment, I would like to know about the drainage of your land. Is your agricultural land field-drained? Y / N

IF YES: What area is field-drained? ________ Hectares / Acres

What material are the drains made from? __________________________

IF NO: Is your agricultural land drained by ditches? Y / N

What area is drained by ditches? ________ Hectares / Acres

Environmental Schemes
(Section C)

C.1. Your farm is in [LIST RELEVANT REGULATIONS E.G. NVZ]. Are you aware of this?

IF YES: FILL OUT TABLE

Regulation	How long for?	How much land? (ha)	Impacted farm operations? How?
NVZ			

C.2. Is any of your farm in the following agri-environmental schemes: [ELS/HLS/ESA/CCS]?

IF YES: FILL OUT TABLE

Scheme	How long for?	How much land? (ha)	Impacted farm operations? How?

Mitigation Measures
(Section D)

I'd like to now ask for your opinion about water pollution and about mitigation options.

TURN TO CARD D.1.

D.1. The main river channel of the Wensum currently has 'poor' ecological status (and is also predicted to be 'poor' status in 2015). 40% of the water bodies in the catchment are at risk of failing drinking water quality standards for nitrate. 27% of the water bodies in the catchment are at risk of failing phosphorus (P) standards.

This card shows a list of potential sources of sediment or chemical pollutants. How important would you regard the following as sources of sediment or chemical pollutants in streams and rivers near your farm? Please give each source a star rating, 1* being of little importance and 5* a very important source of pollution.

Potential Source	**1* - 5* Rating**
Sewage treatment works	
Household septic tanks	
Industrial activities	
Farmyard activities	
Surface runoff from arable fields	
Percolation from arable fields via soils or groundwater	
Poaching by livestock	
Runoff from road verges	
Stream and ditch bank erosion	
Atmospheric deposition	

Although the water quality in UK rivers and lakes has improved over the last two decades, the improvement is principally due to the control of point source pollutants, such as outfalls from sewage treatment works. Further improvements are unlikely to be easy, as other pollution sources are diffuse – scattered across the landscape – and difficult to identify and control. Using state-of-the-art measuring devices our study hopes to both identify and record pollutants and to evaluate the effectiveness of measures to reduce it.

D.2 To reduce the pollution of surface-water bodies from farming operations a network of Catchment Sensitive Farming Officers has been created. They are responsible for individual catchments, co-ordinated at River Basin District Level.

Have you engaged with the local CSFO and do you know their name? Y / N

Name: ______________________________________

A number of options for **controlling pollution** from agriculture now exist. For the next part of the survey I would like to ask you some questions regarding pollution **mitigation measures** for your farm business.

We are interested to learn whether or not you currently use any of the measures and whether or not you would consider doing them in the future.

TURN TO CARD D.3.

D.3. The first set of mitigation measures are about **land use change**. If you could have a read of the options and please tell me if you do any of them on your farm. If there are any that you do not do, I'd like to know if you would consider doing them in the future.

TICK THE OPTIONS THEY CURRENTLY DO IN THE BOXES BELOW.

THE OPTIONS THEY DON'T DO: WRITE THE CORRESPONDING CODE FOR THEIR ANSWER

D.3.	A	B	C	D
Currently Do				
Don't				

TURN TO CARD D.4.

D.4. This card lists different **farm infrastructure** options. Can you please tell me which options you currently do and which you would consider doing in the future.

D.4.	A	B	C	D	E	F	G	H
Currently Do								
Don't								

IF FARM TYPE = ARABLE: ASK QUESTION D.5 and D.6. and D.8.

IF FARM TYPE = LIVESTOCK: ASK QUESTION D.7. and D.8.

TURN TO CARD D.5.

D.5. Now could you tell me whether or not you use any of these **soil management** options to help mitigate pollution, and whether or not you would use them in the future.

D.5.	A	B	C	D	E	F	G	H	I	J	K	L
Currently Do												
Don't												

TURN TO CARD D.6.

D.6. Next is a list of **fertiliser management options** for mitigation. Could you tell me which you currently use and whether you would consider doing any further ones in the future.

D.6.	A	B	C	D	E	F	G	H	I	J	K	L
Currently Do												
Don't												

TURN TO CARD D.7.

D.7. Livestock can cause poaching by having unrestricted access to wet areas, and can also cause problems when faecal pathogens enter the watercourse. There are several different **livestock management options** which can be used to help mitigate pollution. From the list on this card could you please tell me if you are presently doing any of the options on your farm and whether or not you would consider doing them in the future.

D.7.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Currently Do															
Don't															

TURN TO CARD D.8.

D.8. I'd now like you to consider the different **manure management options** listed in front of you. Do you currently do any of the options on your farm? Any that you do not do, would you consider doing them in the future?

D.8.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Currently Do																
Don't																

D.8.	Q	R	S	T	U	V	W	X	Y	Z	AA	BB	CC	DD
Currently Do														
Don't														

D.9. From all the mitigation options mentioned can you suggest a short list of say three priority options that would work for your farm business?

____

____

D.10. There may be some mitigation measures that we have not thought of. Can you suggest any additional practical measures that you think would be affordable and useful for your farm business?

____

____

Business Questions (Section E)

The final section of the survey contains questions regarding the business of your farm. We are interested to know about the energy usage of your farm, employment and the general running of your farm. If you do not feel comfortable answering any of the following questions feel free to say so.

E.1. Is the business structure of your farming entity a sole trader/ partnership/limited company?

____

E.2 How many full time partners are there in your farming business and how many full time workers?

Partners [ ] Workers [ ]

Could you also tell me approximately how many hours in total are worked per year (Hours worked/year).

Partners [ ] Workers [ ]

E.3. Do you hire any part-time employees? If so, how many employees and for how many hours in total during a season?

Number [ ] Hours worked [ ]

E.4. Have you made any farm business investments in the past three years? Y/ N

IF YES: What were they?

____

E.5. How do you feel about the future of your farm business?

1. Very Optimistic 2. Optimistic 3. Pessimistic 4. Very Pessimistic

What are the reasons for your answer?

____

E.6. How do you feel about the financial viability of your farm business today in comparison to 5 years ago?

____

How do you feel about the financial viability of your farm business today in comparison to 5 years in the future?

____

TURN TO CARD E.7.

E.7. There are many different factors which can **threaten** a farm business. How important would you rank each of the following as threats for your farming business over the next five years? Please give a star rating to each factor, 1* being of little importance and 5* very important.

Factor	**1* - 5* Rating**
Increasing input cost	
Volatility of product prices	
Exchange rate fluctuations	
Supermarket or food processor purchasing practices	
Negotiation of rent or tenancy agreements	
Changes in the Common Agricultural Policy	
Reduction of support via the Single Farm Payment	
Restrictions on water availability for irrigation	
Implementation of the Water Framework Directive	
Implementation of Nitrate Vulnerable Zones (NVZs)	
Increased government regulation of farming	
Climate change	

TURN TO CARD E.8.

E.8. Which of these measures are you planning to do in response to these challenges?

Measure	✓
Aim to increase yields	
Reduce input costs by changing cultivation practices	
Adopt precision farming techniques	
Collaborate with neighbouring farmers on equipment use	
Join a purchasing cooperative for inputs	
Invest in new equipment or buildings	
Seek to expand the farm business	
Contract out some farm activities	
Diversity into new farm enterprises	
Diversity into off-farm activities	
Negotiate longer-term agreements with customers	
Obtain more income from environmental schemes	
Other (please specify here)	

TURN TO CARD E.9.

E.9. Here is a list of different **long-term objectives** for a farm. How important would you regard the following longer term objectives for your farming business? Please give a star rating between 1* and 5* to each long-term objective, 1* being of little importance to your farm business and so on.

Objective	**1* - 5* Rating**
To produce more food	
To be a good steward of the land	
To increase profitability	
To improve soil quality	
To hand on a viable business to the next generation	
To increase wildlife on the farm	
To improve water quality in local streams and rivers	
To reduce the impact of farm activities on global warming	
To upgrade the farm buildings and equipment	

That is the last of my questions for you today. Thank you ever so much for you time. Do you have any questions for me?

Card B.1.

1. **Cereals**
2. **Combinable Crops**
3. **Horticulture**
4. **Specialist pigs**
5. **Specialist poultry**
6. **Dairy**
7. **Lowland grazing livestock**
8. **Mixed**
9. **Other**

Card D.1.

Potential Source	1* - 5*
Sewage treatment works	
Household septic tanks	
Industrial activities	
Farmyard activities	
Surface runoff from arable fields	
Percolation from arable fields via soils or groundwater	
Poaching by livestock	
Runoff from road verges	
Stream and ditch bank erosion	
Atmospheric deposition	

Card D.3.

Land Use Change Options

Have you done any of these options, if so which ones? – Would you consider doing any of the ones you are not currently doing?

Very Likely | Likely | Unlikely | Never

A. Convert arable land to unfertilised grass

B. Arable reversion to low fertiliser input extensive grazing

C. Establish permanent woodlands

D. Grow biomass crops (i.e. willow, poplar, miscanthus)

Card D.4.

Farm Infrastructure Options

Have you done any of these options, if so which ones? – Would you consider doing any of the ones you are not currently doing?

Very Likely | Likely | Unlikely | Never

A. Fence off rivers and streams from livestock

B. Construct bridges for livestock crossing over watercourses

C. Re-site gateways away from high-risk areas

D. Farm track management

E. Establish new hedges

F. Establish and maintain artificial wetlands

G. Irrigate crops to achieve maximum yield

H. Establish tree shelter belts around livestock housing and slurry storage

Card D.5.

Soil Management Options

Have you done any of these options, if so which ones? – Would you consider doing any of the ones you are not currently doing?

Very Likely | Likely | Unlikely | Never

A. **Establish cover crops in the autumn**
B. **Early harvesting/ establishment of crops in the autumn**
C. **Cultivate land for crops in spring rather than autumn**
D. **Adopt reduced cultivation systems**
E. **Cultivate compacted tillage soils**
F. **Cultivate and drill across the slope**
G. **Leave autumn seedbed rough**
H. **Manage over-winter tramlines to reduce run-off**
I. **Maintain and enhance soil organic matter levels**
J. **Establish in-field grass buffer strips**
K. **Establish riparian grass buffer strips**
L. **Loosen compacted soil layers in grassland fields**
M. **Maintain field drainage systems**
N. **Allow field drainage systems to deteriorate**
O. **Ditch management**

Card D.6.

Fertiliser Management Options

Have you done any of these options, if so which ones? –

Would you consider doing any of the ones you are not currently doing?

Very Likely | Likely | Unlikely | Never

A. Use plants with improved nitrogen use efficiency

B. Fertiliser spreader calibration

C. Use a fertiliser recommendation system

D. Integrated fertiliser and manure nutrient supply

E. Optimise fertiliser application rates

F. Avoid applying fertiliser to high-risk areas

G. Avoid spreading fertiliser to fields at high risk times

H. Use variable rate fertiliser technologies

I. Replace urea fertiliser with another nitrogen form

J. Incorporate a urease inhibitor with urea fertiliser

K. Use clover in place of grass

L. Avoid applying P fertiliser to high P index soils

Card D.7.

Livestock Management Options

Have you done any of these options, if so which ones? –

Would you consider doing any of the ones you are not currently doing?

Very Likely | Likely | Unlikely | Never

A. Reduce dietary N and P intakes

B. Adopt phase feeding of livestock

C. Reduce the length of the grazing day/grazing season

D. Extend the grazing season for cattle

E. Reduce field stocking rates when soils are wet

F. Move feeders at regular intervals

G. Construct troughs with a firm but permeable base

H. Use of hormones and increased milking frequency

I. Improved feed characterisation (nutrition)

J. Modification of rumen microbial fermentation

K. Reduce overall stocking rates on livestock farms

L. Increase scraping frequency in dairy cow cubicle housing

M. Additional targeted straw-bedding for cattle housing

N. Washing down of dairy cow collecting yards

O. Outwintering of cattle on woodchip stand-off pads

P. Make use of improved genetic resources in livestock

Q. Low methane livestock feeds

Card D.8.

Manure Management Options

Have you done any of these options, if so which ones? –

Would you consider doing any of the ones you are not currently doing?

Very Likely | Likely | Unlikely | Never

- **A. Frequent removal of slurry from beneath-slatted storage in pig housing**
- **B. Part-slatted floor design for pig housing**
- **C. Install air-scrubbers or biotrickling filters to mechanically ventilated pig**
- **D. Convert caged laying hen housing from deep storage to belt manure**
- **E. More frequent manure removal from layer hen housing with belt clean**
- **F. In-house poultry manure drying**
- **G. Increase capacity of slurry stores to improve timing of slurry applications**
- **H. Adopt field heap storage of solid manure**
- **I. Adopt batch storage of slurry**
- **J. Install covers on slurry stores**
- **K. Allow cattle slurry stores to develop a natural crust**
- **L. Use anaerobic digestion for farm manures**
- **M. Minimise the volume of dirty water and slurry produced**
- **N. Compost solid manure**
- **O. Site solid manure heaps away from watercourses/field drains**
- **P. Store solid manure heaps on concrete and collect effluent**
- **Q. Cover solid manure stores with sheeting**
- **R. Use liquid/solid manure separation techniques**
- **S. Use manure additives (e.g. Alum)**
- **T. Change from a slurry to solid manure handling system**
- **U. Change from solid manure to slurry handling system**
- **V. Manure Spreader Calibration**
- **W. Avoid applying manure to high-risk areas**
- **X. Avoid spreading slurry or poultry at high-risk times**
- **Y. Use slurry band spreading application techniques (e.g. dribble bars)**
- **Z. Use slurry injection application techniques**
- **AA. Avoid spreading manure at high-risk times**
- **BB. Incorporate manure into the soil**
- **CC. Transport manure to neighbouring farms**
- **DD. Incinerate poultry litter**

Card E.7.

Factor	**1* - 5***
Increasing input costs	
Volatility of product prices	
Exchange rate fluctuations	
Supermarket or food processor purchasing practices	
Negotiation of rent or tenancy agreements	
Changes in the Common Agricultural Policy	
Reduction of support via the Single Farm Payment	
Restrictions on water availability for irrigation	
Implementation of the Water Framework Directive	
Implementation of Nitrate Vulnerable Zones (NVZs)	
Increased government regulation of farming	
Climate change	

Card E.8.

Measures

A. Aim to increase yields

B. Reduce input costs by changing cultivation practices

C. Adopt precision farming techniques

D. Collaborate with neighbours on farm equipment use

E. Join a purchasing cooperative for inputs

F. Invest in new equipment or buildings

G. Seek to expand the farm business

H. Contract out some farm activities

I. Diversity into new farm enterprises

J. Diversity into off-farm activities

K. Negotiate longer-term agreements with customers

L. Obtain more income from environmental schemes

M. Other (please specify here)

Card E.9.

Objective	1* - 5*
To produce more food	
To be a good steward of the land	
To increase profitability	
To improve soil quality	
To hand on a viable business to the next generation	
To increase wildlife on the farm	
To improve water quality in local streams and rivers	
To reduce the impact of farm activities on global warming	
To upgrade the farm buildings and equipment	

Appendix B

Appendix B.1 Structure for Farm Advisor interviews

At the time of question development, the objectives were to discover:

1) What measures are being recommended?
2) How do recommendations differ between sources of advice? Are they similar or different?
3) How effective are recommendations? What has the success rate been of uptake?
4) What are the different organisations niches in the farm advice sector?
5) What is the most effective pathway to deliver advice? What sources of advice are most likely to be trusted?

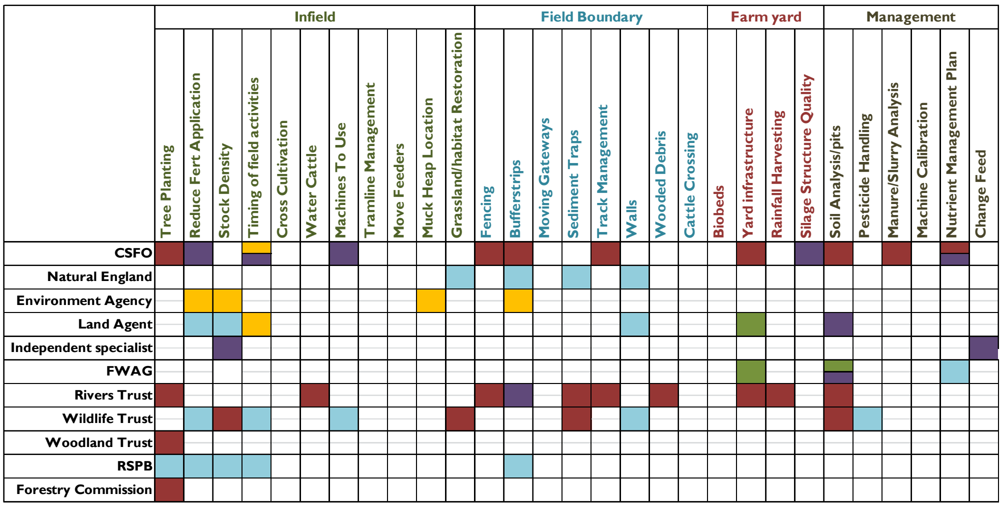
Semi structured interviews with farm advisors were conducted face-to-face or by telephone in three regions of England. Advisors from organisations which provide one-to-one farm advice were targeted and contacted to arrange an interview.

Questions for advisors (# indicates which objective the question helps answer):

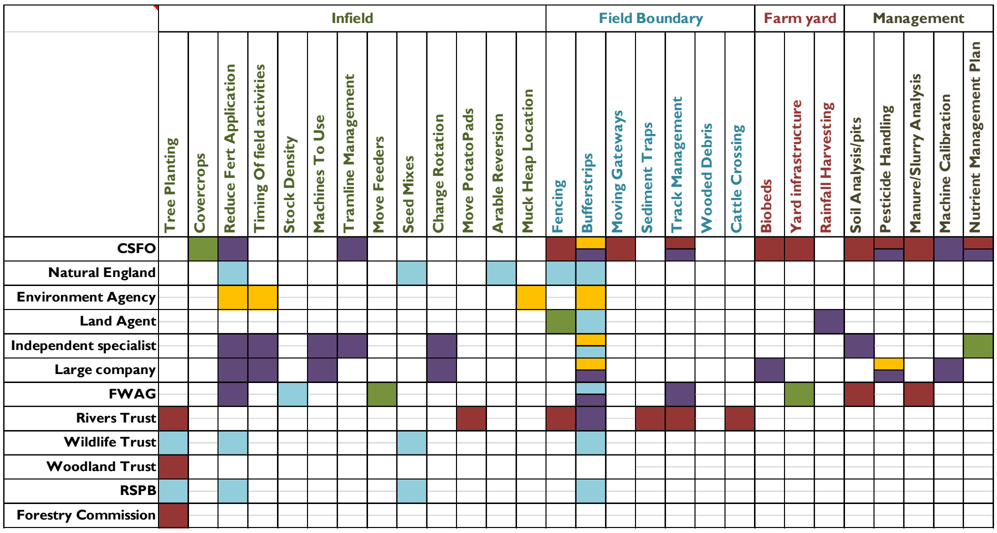
- What is your employment background? How long have you been in your current position?
- What are the predominant farm types you advise to? (question to clarify they are a desired respondent)
- How do you target which farmers to advise? (provides insight into the organisation and the area they work)
- What percentage of farmers in your area would you say the (organisation) provides advice to?
- How do you predominantly provide advice? (question to clarify they are a desired respondent)
- In terms of water pollution, what advice/ mitigation measures do you recommend the most (ask for up to 5)? (1,2,4)
- What other subjects do you provide advice on? (2, 4)
- What do you think most influences whether a farmer implements your advice? (5)
- Do you monitor the success of your advice? If so, how? (3)
- What do you think your organisation's niche is in the farm advice sector? (4)
- Can you think of any examples of when you have given advice which has conflicted with other advice the farmer has received? (2)
- Discussion about their views of CSF

Appendix B.2 Advisor recommendations and mechanisms used

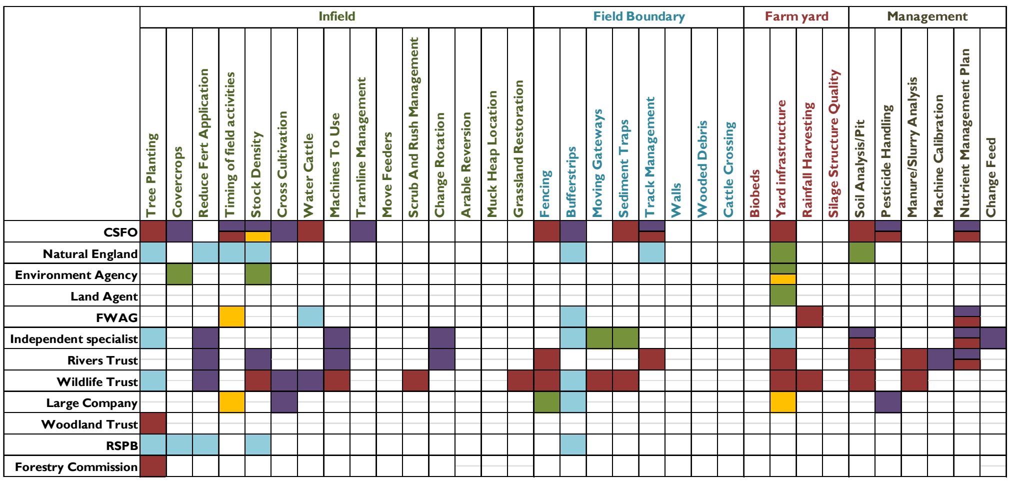
North West Advisors



East Anglian Advisors



South West Advisors



Appendix C

Appendix C.1 DTCs Farm survey on mechanisms to encourage uptake of farm practices to reduce water pollution.

Section A – Questions about your farm

1. Which of the following best describes your farm?
   a) Cereals
   b) General cropping
   c) Horticulture
   d) Lowland grazing livestock
   e) Pigs and poultry
   f) Dairy
   g) LFA grazing livestock
   h) Mixed
   i) Other

2. What is the overall area of land you farm? **EXPLAIN THAT THIS EXCLUDES ANY AREAS OF WATER, WOODLAND AND HARD STANDING**

3. How much of this agricultural area is…?
   a) Owned
   b) Tenanted – how long for? Who is the landlord?
   c) Farm business tenanted
   d) Grass eating
   e) Contracted
   f) Shared

ASK Q 4 IF ANSWER TO Q1 IS A, B, C, H (ARABLE FARMING).

ASK Q 5 IF ANSWER TO Q1 IS D, E, F, G, H (LIVESTOCK FARMING).

DETERMINE WHETHER FARM IS GOING THROUGH SUBSTANTIAL BUSINESS CHANGES AS THIS COULD IMPACT FARM PRACTICES.

4. What is your typical farm rotation? **ASK FOR CROP TYPES AND APPROXIMATE AREA OF EACH CROP**
5. How many head of livestock do you currently have? **IMPORTANT TO RECORD # of LIVESTOCK SEPERATELY FOR DIFFERENT LIVESTOCK E.G. CATTLE BREEDERS AND FATTENERS**
6. How would you describe the soils on your farm? **[SHOW THEM SHEET 1]**
7. Do you have any streams or rivers pass through your land?
8. Are you in a Nitrate Vulnerable Zone?
9. Do you receive Single Farm Payments?
10. Are you in / do you receive payments through an Agri-environment scheme? If yes, please state which scheme you are in, how long for and the area of land which is in the scheme.

Section B - Questions about mitigation measures

11. One set of possible issues on a farm relate to soil erosion and water pollution. **SHOW SHEET 2.** Sheet 2 shows a list of issues which can occur on farms, please tell me how much of an issue each one is on your farm, 1 being very infrequent, 5 being very common.

12. **SHOW SHEET 3.** Looking at this picture, what would you point out as being issues on this farm and could you suggest any possible solutions? **HAVE AN IN-DETH DISCUSSION ABOUT SHEET 3**

    IF THEY MENTION ANY POOR FARM PRACTICES ASK Q 12.

13. Which issue would you want the farmer to address first, and why?

14. There are a number of farm management plans and activities which can help identify issues on farm. Do you have or carry out any of the following? **IF YES, USE SEARCHING QUESTIONS E.G.TO LEARN WHO COMPLETED THE PLANS, HOW OFTEN THEY SOIL TEST AND DIG SOIL PITS, IF THEY DON'T WOULD THEY PAY FOR A CONTRACTOR TO DO SUBSOILING, OR JOIN A MACHINERY RING, HAVE THEY ALTERED FARM PRACTICE AS A RESULT OF DOING THIS ETC.**

    a) Have a soil management plan (in addition to the soil protection review)
    b) Have a nutrient management plan
    c) Have a slurry/manure handling plan and/or infrastructure audit
    d) Undertake soil testing
    e) Regularly use a spade to look for topsoil or sub soil compaction

15. There are many different ways in which the cause of water pollution can be reduced on farms. I am interested to know whether or not you have implemented any of the following features on your farm? If you currently do not do it then could you tell me whether you would be very likely, likely, unlikely or never consider doing it in the future.
    ASK ONLY CATCHMENT RELEVANT PRACTICES.

Land use change
- Land out of agricultural production - Tree planting - Sediment trap
Management change
- Cover crops - Sub soiling/grass aeration - Tramline management - Reduced cultivation techniques
Infrastructure
- Biobed - Track re-surfacing - Roofing over yards for clean and dirty water separation - Re-site gateways

SELECT 2 FARM PRACTICES WHICH THEY RESPONDED THEY HAVE IMPLEMENTED AND 2 THEY HAVE NOT. ASK THE RELEVANT QUESTIONS FROM PART A OR PART B DEPENDING ON WHETHER THEY RESPONDED YES OR NO TO CURRENT ADOPTION.

Section B - Part A – If participant responded YES to current adoption of ***

HAVE A DISCUSSION TO OBTAIN DETAILS OF THE FEATURE E.G. COST, ANY GRANTS INVOLVED, MAIN USE AND USE THE QUESTIONS BELOW AS PROMPT QUESTIONS.

16. When did you implement *** on your farm?

17. Why did you choose to implement this feature? **SHOW SHEET 4.** Whereby 5 strongly influenced decision and 1 did not influence decision.

18. Who was the key decision maker?

19. What first made you consider the implementation of ***?

20. What finally persuaded you?

21. Before you implemented ***, did you receive information from…

    a) A one to one visit from an advisor

    b) Reading about it in the press (farmers weekly, leaflet)

    c) Reading about it on the internet

    d) Speaking to someone at an event

    e) Talking to your neighbour/local farmer

22. Has implementing *** been worthwhile? If so, what are the benefits?

23. Do you think there are any short-term/ long-term disadvantages to ***

24. Do you know other farmers who have implemented ***?

25. Would you recommend *** to your friends?

26. If people have not adopted ***, in your opinion why do you think they have not?

27. Do you think there is enough information available to farmers about ***?

<u>Section B - Part B If participant responded No to current adoption of *</u>**

HAVE A DISCUSSION TO OBTAIN DETAILS OF THEIR VIEWS ON THIS FEATURE USING THE QUESTIONS BELOW AS PROMPTS.

28. Are there any particular reasons for you not adopting ***?

29. Do you feel there are any short-term / long-term disadvantages to ***?

30. What would encourage you to adopt ***? **SHOW SHEET 5**. Whereby 5 would strongly influence decision and 1 would not influence decision.

31. What would the payback time need to be for you to implement ***?

32. Who would be the key decision maker?

33. Have you received any information about *** from …

    a) A one to one visit from an advisor

    b) Reading about it in the press (farmers weekly, leaflet)

    c) Reading about it on the internet

    d) Speaking to someone at an event

    e) Talking to your neighbour/local farmer

34. What information would most help you if you were considering implementing ***?

35. Who would you ask for information on ***, and why would you ask them?

Section C – Questions about advice on water pollution

READ OUT THE PASSAGE BELOW

"The Government set up the Catchment Sensitive Farming Initiative (CSF) nearly 10 years ago in particular catchments across England. The initiative delivers practical solutions and targeted support to enable farmers and land managers to take voluntary action to reduce water pollution from agriculture to protect water bodies and the environment. As well as providing advice, this initiative has offered a capital grant to support the improvement or installation of facilities that would benefit water quality by reducing pollution from agriculture."

36. Are you aware of the CSF initiative and/ or the capital grant?

37. Are you aware of any other organisations/ businesses (excluding CSF) which provide advice or grants to farmers to help reduce water pollution? If yes, please state which organisation or business, and whether you have used or had dealings with them for advice/grants to tackle the causes of water pollution.

    IF A GRANT IS MENTIONED HAVE A DISCUSSION TO DISCOVER WHICH GRANT, WHAT IT WAS FOR, HOW MUCH DID THEY RECEIVE, BENEFITS TO THEIR BUSINESS AND THE ENVIRONMENT.

38. **LAYOUT INFLUENCE WORD CARDS IN FRONT OF INTERVIEWEE. READ OUT**

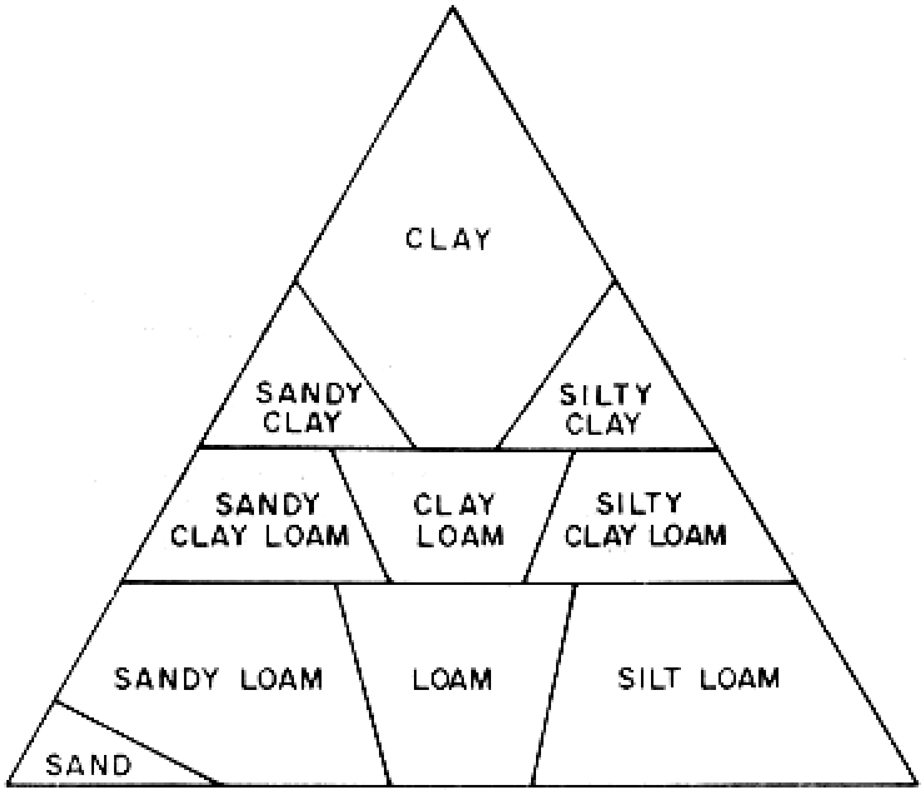
    I would now like to gain your opinions on different organisations and businesses which provide advice to farmers. I will show you one card at a time with a name and logo of an organisation/business. I would like you to first of all tell me whether or not you would listen to them for advice on water pollution and farm practices such as the ones we have been discussing. If you would listen to them, I would like you to point out from the selection of words in front of you, or to tell me any of your own words, which best describe why you would listen to them for advice.

    SHOW ORGANISATION FLASH CARDS ONE AT A TIME AND RECORD RESPONSE.

39. Have you ever received conflicting advice from different advisors on farm practices related to water pollution? If so, what farm practices and which organisations?

    ASK THE INTERVIEWEE TO FILL OUT SHEET 6 AND THANK THEM FOR PARTICIPATING IN THE SURVEY

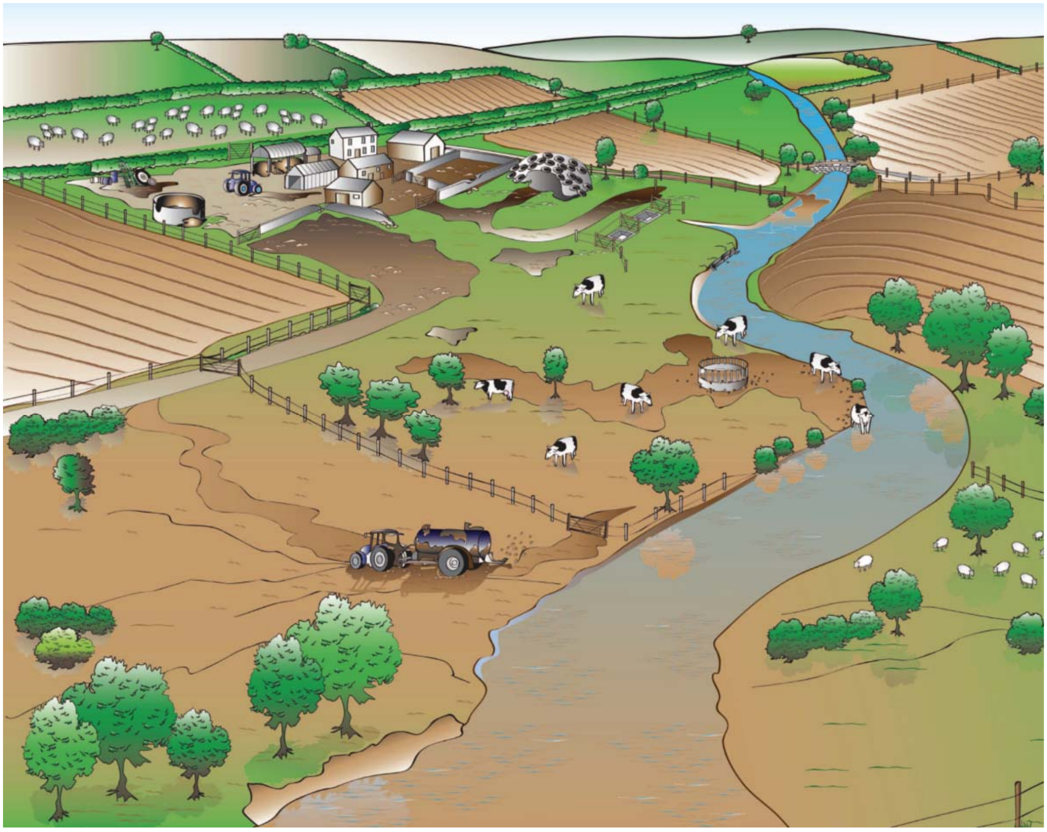
Sheet 1


CLAY
SANDY CLAY
SILTY CLAY
SANDY CLAY LOAM
CLAY LOAM
SILTY CLAY LOAM
SANDY LOAM
LOAM
SILT LOAM
SAND

Sheet 2

	Uncommon				Very common	
	1	2	3	4	5	n/a
Surface water runoff	❍	❍	❍	❍	❍	❍
Ponding of water at soil surface or waterlogged areas	❍	❍	❍	❍	❍	❍
Downslope movement of soil and or loss of top soil	❍	❍	❍	❍	❍	❍
Development of rills or gullies within fields	❍	❍	❍	❍	❍	❍
Soil compaction	❍	❍	❍	❍	❍	❍
Areas of poached soil	❍	❍	❍	❍	❍	❍

Sheet 3. Water Pollution Issues and Solutions



Sheet 4

Why did you choose to implement this feature? 5 being highly influential and 1 not influencing the decision.

	5	4	3	2	1
Inclusion in Agri-environment scheme	❍	❍	❍	❍	❍
Capital grant	❍	❍	❍	❍	❍
Press	❍	❍	❍	❍	❍
Regulatory requirement	❍	❍	❍	❍	❍
Advisors promoting it	❍	❍	❍	❍	❍
Quality assurance scheme	❍	❍	❍	❍	❍
Peer pressure	❍	❍	❍	❍	❍
Supportive attitude from landowner	❍	❍	❍	❍	❍
Neighbour recommended it	❍	❍	❍	❍	❍
Farm report recommended it	❍	❍	❍	❍	❍
To improve long-term viability of farm	❍	❍	❍	❍	❍
Other……..	❍	❍	❍	❍	❍

Sheet 5

What would encourage you to adopt this feature? 5 would strongly influence decision and 1 wouldn't influence decision.

	5	4	3	2	1
Inclusion in Agri-environment scheme	❍	❍	❍	❍	❍
Capital grant	❍	❍	❍	❍	❍
Press	❍	❍	❍	❍	❍
Regulatory requirement	❍	❍	❍	❍	❍
Advisors promoting it	❍	❍	❍	❍	❍
Quality assurance scheme	❍	❍	❍	❍	❍
Peer pressure	❍	❍	❍	❍	❍
Supportive attitude from landowner	❍	❍	❍	❍	❍
Neighbour recommended it	❍	❍	❍	❍	❍
Farm report recommended it	❍	❍	❍	❍	❍
To improve long-term viability of farm	❍	❍	❍	❍	❍
Other……..	❍	❍	❍	❍	❍

❍ Would never implement feature

Sheet 6

1. How many years have you worked in farming?

2. How old are you? Under 25 ☐
   25-50 ☐
   51-75 ☐
   Over 75 ☐

3. What is your gender? Male ☐ Female ☐

4. What is the highest level of education you have attained?
   Please tick the appropriate box:

   Secondary school ☐
   Further education (non-agricultural) ☐
   Further education (agriculture related) ☐
   University degree/higher educations (non-agricultural) ☐
   University degree/higher educations (agriculture related) ☐

5. Have you identified a successor? Please tick:

   Definitely ☐
   Possibly ☐
   Definitely not ☐
   Don't want a successor ☐

Interviewers Recording Sheet

Section A

<table>
<tr><th>Qu</th><th colspan="3">Response</th></tr>
<tr><td>1</td><td colspan="3"></td></tr>
<tr><td>2</td><td colspan="3"></td></tr>
<tr><td>3</td><td colspan="3"></td></tr>
<tr><td rowspan="2">4</td><td>Crop type</td><td colspan="2">Crop area</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td rowspan="2">5</td><td>Livestock type</td><td colspan="2">Head of livestock</td></tr>
<tr><td></td><td colspan="2"></td></tr>
<tr><td>6</td><td colspan="3"></td></tr>
<tr><td>7</td><td colspan="3"></td></tr>
<tr><td>8</td><td colspan="3"></td></tr>
<tr><td>9</td><td colspan="3"></td></tr>
<tr><td rowspan="4">10</td><td>Scheme name</td><td>Length of time</td><td>Area</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Section B

11.

	1	2	3	4	5	n/a
Surface water runoff	❍	❍	❍	❍	❍	❍
Ponding of water at soil surface or waterlogged areas	❍	❍	❍	❍	❍	❍
Downslope movement of soil and or loss of top soil	❍	❍	❍	❍	❍	❍
Development of rills or gullies within fields	❍	❍	❍	❍	❍	❍
Soil compaction	❍	❍	❍	❍	❍	❍
Areas of poached soil	❍	❍	❍	❍	❍	❍

12, 13.

Poor farm practices	Solutions	Comments

14.

	Comments
f) Have a soil management plan	
g) Have a nutrient management plan	
h) Have a slurry/manure handling plan and/or infrastructure audit	
i) Undertake soil testing	
j) Dig pits for topsoil or sub soil compaction	

15.

Farm Practice	**Yes, No, n/a**	**Very likely, likely, unlikely or never**
Land out of agricultural production		
Tree planting		
Sediment trap		
Cover crops		
Sub soiling/grass aeration		
Tramline management		
Reduced cultivation techniques		
Biobed		
Track re-surfacing		
Roofing over yards		
Re-site gateways		

<u>Notes page</u>

(Print x2) Part A - Farm measure……………………………………………………………

16. When implemented?...

17.	5	4	3	2	1
Inclusion in Agri-environment scheme	❍	❍	❍	❍	❍
Capital grant	❍	❍	❍	❍	❍
Press	❍	❍	❍	❍	❍
Regulatory requirement	❍	❍	❍	❍	❍
Advisors promoting it	❍	❍	❍	❍	❍
Quality assurance scheme	❍	❍	❍	❍	❍
Peer pressure	❍	❍	❍	❍	❍
Supportive attitude from landowner	❍	❍	❍	❍	❍
Neighbour recommended it	❍	❍	❍	❍	❍
Farm report recommended it	❍	❍	❍	❍	❍
To improve long-term viability of farm	❍	❍	❍	❍	❍
Other……..	❍	❍	❍	❍	❍

18. Decision maker ………..

19. First consider…………………………………………………

20. Finally persuade……………………………………………….

21. Receive information from

f) A one to one visit from an advisor
g) Read about it in the press (farmers weekly, leaflet)
h) Read about it on the internet
i) Speak to someone at an event
j) Talk to your neighbour/local farmer

22. Benefits…………………………………………………………….

23. Disadvantages……………………………………………..

24. Other farmers implemented………………………………………………

25. Would you recommend…………………………………………

26. If people have not, why not………………………………………………………………

27. Enough information………………………………………………………………..

Section C

36. CSF awareness…………………………………………………………….

37.

38.

Advisors	Influence
CSFO	
Environmental Stewardship Scheme (NE)	
Environment Agency	
FWAG	
RSPB	
Rivers Trust	
Wildlife Trust	
Water companies	
ADAS	
Forestry Commission	
Woodland Trust	
Land Agent	
Independent specialist	
Salesman	

39.Conflicts……………………………………………………………………………

……………………………………………………………………………………………

Word cards for Section C

Provide Grants	**Provide annual payments**
Knowledge	**Provide local evidence**
Advice on cost-saving	**Free**
Non – regulatory	**Non – government**
Easily accessible	**Advice on whole farm business**
Clear advice	**Trust**

Provides regulatory advice	**Government**
Water pollution focus	**Help with agri-environmental schemes**
Wildlife focus	**Unbiased**
Confidential	**Provide volunteers**
Large knowledge base	**Signposting to other advice**

Appendix C.2 Mitigation measure descriptions

Land out of agricultural production

What it is - To stop agricultural production on land by removing livestock, inputs and the growing of crops for a temporary period of time.

Benefits – Originally a mechanism to reduce food surpluses, land out of production is recognised as having some of the greatest environment benefits. Through halting agricultural activity, issues such as soil erosion, soil compaction, nutrient run-off, spreading of excess nutrients (manure/slurry or chemicals) are reduced and thus the risk of pollution. Allowing the land time to rest improves the soil's structure, nutrients and micro biodiversity if managed correctly (Natural England, 2015).

Use of mechanisms to encourage uptake – Set aside (Regulation (EEC) 1272/88) was the policy of taking land out of production to reduce crop surpluses, becoming compulsory after the McSherry CAP reform in 1992. Starting at 15% of land to be set aside, the amount was gradually reduced, with its abolishment in 2008. As regulatory requirements decreased, and the decoupling of CAP payments occurred, several management options to take land out of production were included in AES (Natural England, 2005). Farmers could receive payments for options such as: arable reversion to unfertilised grassland, nectar flower mixtures, wild bird seed mixtures, or extending buffer strips. Points awarded for such options tended to be greater than other options in AES due to their impact on agricultural production and farm profits. Further voluntary initiatives and schemes (e.g. Campaign for the Farmed Environment and LEAF) also promote the benefits of taking land out of production and currently offer advice to farmers.

Tree planting

What it is – To take land out of agricultural production to establish trees.

Benefits – Woodland contributes to mitigating water pollution by acting as a barrier and interceptor to pollutants but with mixed levels of evidence existing for effectiveness. Benefits include slowing down runoff, trapping and retaining nutrients and sediment in polluted runoff, and reducing soil disturbance once established, thus reducing erosion. Furthermore, riparian and floodplain woodland protect river morphology and mitigate downstream flooding (Nisbet et al., 2011).

Use of mechanisms to encourage uptake – No regulations exist, however the Government's FC offers advice on establishment and management of woodland for land managers, as well as The English Woodland Grant Scheme which encompasses a number of grants to encourage planting trees. The AES also contains options that involve creating, restoring and maintaining woodland, wood pasture, scrub and orchards. Additionally, incentives to plant trees for biomass energy increased in recent years with the Rural Development Programme funding installation of biomass boilers.

Sediment trap

What it is - A man-made feature which intercepts the pathway of surface water run-off and drainage through physical barriers such as ponds, scrapes and vegetation. They provide an area for run-off to pool, allowing sediment to settle.

Benefits – Sediment traps slow down the flow of surface run-off and trap sediment from different farm and field locations, thus capturing sediment, phosphorus, pesticides and faecal organisms before they enter the water course. Another water related benefit includes reducing the likelihood of flooding events (Nesaratnam, 2014).

Use of mechanisms to encourage uptake – The CSF Capital Grant offers financial support for the excavation and establishment of sediment ponds and traps, and AES options include the establishment and maintenance of wetlands. A number of projects have explored the measures potential and feasibility with landowners (e.g. MOPs, Netherton, Nafferton farm[27]) with many providing demonstration sites and promoting use in the local area.

Subsoiling

What it is - Subsoiling is a process of mechanical soil loosening for areas suffering from compacted soils. This research chose to focus on livestock farmers' use of subsoiling on grasslands. Three main types of devices loosen soil at various depths and have been termed as 'subsoiling' to encompass all within this research. The three types are: aerators working typically at a soil depth of 10 cm; sward lifters working between depths of 20-35 cm of soil; and subsoilers working between depths of 35-50 cm of soil. The timing of operations is critical. If conditions are too wet increased damage can occur through smearing and wheel slip. Equally, under dry soil conditions excessive surface heave and root damage can occur (Bhogal et al., 2011).

Benefits – As agricultural machinery has become larger and heavier and livestock numbers increased, greater pressure has been placed on soils creating more compaction. Mechanically loosening the soil reduces soil compaction, improves soil structure and drainage, thus reducing surface water runoff and water pollution.

Use of mechanisms to encourage uptake - No nationwide scheme existed to encourage adoption. It was not included in AES, regulations or government grant schemes. However some organisations offered the opportunity for farmers to trial or rent soil aerator machinery (e.g. WTs and FWAG). Several advisors recommended their use (Chapter 5), expecting farmers to adopt voluntarily as benefits are believed to be great enough to not warrant extra mechanisms to increase uptake. Farming press also featured many articles advising the use of subsoiling.

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[27] More information can be found at:

MOPS http://mops2.diffusepollution.info/

Netherton http://www.cheviotfutures.co.uk/phpdocuments/cf_casestudy_elilaw_december2013_web.pdf;
Nafferton farm at http://research.ncl.ac.uk/proactive/belford/.

Reduced cultivation systems

What it is - Reduced cultivation techniques encompass a broad range of tillage management options. Tillage is the agricultural preparation of soil by mechanical agitation before the sowing of seeds. Techniques predominantly discussed in this research include direct drilling (no agitation of the soil, leaving 100% of previous crop residue on the soil surface when drilling seed) and reduced tillage (which leaves over 15% crop residues on the soil). Such techniques are not appropriate everywhere, as soil type, structure and risk of weeds affect suitability. Reduced costs of fuel and labour are associated with reduced cultivation as less work is required to prepare the soil, however increased use of herbicides may be required as weed seeds are more likely to germinate.

Benefits – Reduced cultivation techniques can lower energy (cultivation) costs, decreased susceptibility to soil structural degradation, carbon sequestration and provide a richer biological community in the soil (Holland, 2004). Research has found reduced cultivations cause large reductions in runoff and erosion (Cools et al., 2011; Quinton and Catt, 2004).

Use of mechanisms to encourage uptake – No government financial incentives, regulations or advisory services included reduced cultivation systems. The agricultural industry have promoted the use of reduced cultivation systems, with more techniques and machinery available than ever before.

Tramline management

What it is - Tramlines are parallel unseeded lines in crops used to facilitate spraying operations without causing damage to surrounding plants. The lines are usually ~30cm wide and 2 metres apart while the distance between tramlines can vary from 12 - 30 metres. Tramlines have been identified as important pathways in the loss of sediment and phosphorus on certain soils and slopes. Tramline management methods exist to mitigate such risks. The three management methods discussed within this research included: minimising compacted wheel marks from autumn spraying by using low ground pressure tyres or wider tyres; reducing water channelling down wheel marks by drilling areas used for wheeling and spraying with the use of GPS tracking technology, and control traffic farming which allows machinery to follow the same tramlines across a field for all operations.

Benefits – Managing tramlines reduces soil compaction, bare soil exposure and thus the creation of pathways for surface water runoff, and sediment loads to waterways (Silgram, 2013).

Use of mechanisms to encourage uptake – No government financial incentives, regulations or advisory services include tramline management directly. Industry have begun to offer reduced rates for the sale of machinery as the technology advances.

Cover crops

What it is - Cover crops are planted between the summer harvest and when a spring-planted crop is sown, providing ground cover to prevent leaching and soil erosion, or to provide green manure to fertilise the soil.

Benefits – The crop variety sown determines the benefits gained. Examples include nitrogen fixation increasing levels available for the following crop and reducing nutrient losses, suppression of insect problems and nematode control, and all benefits reducing the need for agri-chemical application. Additionally, improved organic matter levels and soil structure aid the reduction of soil erosion and leaching (AAB, 2015; Singer et al., 2007).

Use of mechanisms to encourage uptake – Incentive payments under AES were available for farmers but during the interview period uncertainty surrounded cover crops and their inclusion within new regulatory requirements. Defra published a list of cover crop varieties to potentially be included as options for CAP pillar I payments, thus causing cover crops to be a 'hot topic' during 2014-15. An increase in experimental trials (within the private and public sectors) occurred, as well as, advisors from the industry promoting cover crops. Many more specie varieties and mixes became available on the market and the farming press (e.g. Farmers Weekly) increasingly featured articles stating the benefits of cover crops.

Track re-surfacing

What it is – Farm tracks allow access around a farm to carry out operations. Intensive rainfall and larger, heavier machinery and increased livestock numbers lead to degradation of track surfaces. Such degradation creates problems for a farm. For example a dairy farm with muddy tracks would cause cattle to choose alternative routes off the track, leading to lameness and bruising which in turn effects travel time and limits time in the parlour, finally resulting in decreased milk production. Re-surfacing of tracks improves access and can be done using a variety of materials sourced on or off farm, such as aggregate and concrete**.**

Benefits - Track re-surfacing reduces the pathways of surface water run-off and can reduce the amount of poaching and soil erosion adjacent to the track.

Use of mechanisms to encourage uptake – CSF Capital Grant scheme offer financial support for the creation of new livestock and farm machinery tracks, but do not cover repair of potholes or upgrade existing tracks, unless they are degraded bark/wood chipping tracks for livestock movement. The Soil Protection Review requires farmers to identify and take action to remediate damage caused to soil, such as poaching and soil erosion on tracks.

Roofing over yards

What it is – Placing a roof over a section of the farm yard which is used for farming operations such as manure/ slurry storage, livestock gathering areas or silage storage.

Benefits - Roofing helps separate clean and dirty water in the farm yard, reducing run off and the volume of dirty water to be managed. Additional benefits include saving storage and spreading costs

Use of mechanisms to encourage uptake – CSF Capital Grant offered financial support for construction and material costs of roofing over existing manure, slurry and silage storage and livestock gathering areas. Other organisations offer similar grants through funding from water companies or EU sources. Many advisors were found to recommend roofing (Chapter 5) with signposting to the CSF grant. No regulatory requirements exist for roofing, however NVZ rules require manure and slurry storage facilities to be of a large enough capacity to store 6 months (pigs and poultry) and 5 months (other livestock).

Re-siting gateways

What it is – Re-location of existing farm gateways away from high risk areas (bottom of a slope or near a watercourse) to a more appropriate position.

Benefits – Reduces the risk of run-off pathways and the potential for soil erosion.

Use of mechanisms to encourage uptake – CSF Capital grant scheme offers financial support to relocate gateways and gap up the original locations. The Soil Protection Review requires farmers to identify and take action to remediate damage caused to soil, such as poaching in gateways.

Biobeds

What it is – A biobed is a mixture of peat free compost, soil and straw (biomix) covered with turf that is placed in a lined pit to collect, retain and degrade pesticide residues in washings from pesticide handling activities e.g. filling or washing sprayers/applicators. Maintenance includes annual top up of the biomix as it will decompose and compact over time, with full replacement of the biomix every 5 years being recommended. A variety of designs exist and appropriateness of location is essential to ensure there is no risk to surface or groundwater (must not be within 10m of a watercourse of 50m from a spring, well or borehole).

Benefits – Losses from pesticide handling areas can cause serious harm to aquatic life and drinking water supplies. Correct design and management of a biobed can help keep pesticides out of water.

Use of mechanisms to encourage uptake – CSF Capital Grant Scheme offers financial support to establish a biobed. No regulations require a biobed however a statutory code of practice for using plant protection products outlines correct handling of pesticide disposal, as well as product labels which provide guidance. The Voluntary Initiative promotes responsible pesticide use, offering a source of advice and practical guides for biobeds.

Appendix C.3 Headings and data recording for farmer interviews analysis Microsoft Excel

Survey Section A - Excel sheet 1

Excel column		**Question topic**	**Data recording**
A	Farmer ID		#
B	Farm type		Coded
C	Farm size		#
D	Tenancy		Coded
E	Crops, Ha		text,#
F	Livestock, #		text,#
G	Soil type		Coded
H	In NVZ		Coded*
I	River through land		Coded*
J	Claim SFP		Coded*
K	AES participation		Text
L-Q	Soil and water issues on farm	Surface runoff	Rank 1-5
		Ponding,water logged	Rank 1-5
		Downslope movement	Rank 1-5
		Gullies	Rank 1-5
		Compaction	Rank 1-5
		Poaching	Rank 1-5
R- AE	Management tools	Soil management	Coded*
			Text
		Nutrient management	Coded*
			Text
		Slurry/manure plan	Coded*
			Text
		Infrastructure	Coded*
			Text
		Soil testing	Coded*
			Text
		Soil compaction pit	Coded*
			Text
AF-BA	Measure uptake and attitude to future uptake, any additional comments	Taken field out	Coded*
			Text
		Tree planting	Coded*
			Text
		Sediment traps	Coded*
			Text
		Subsoil	Coded*
			Text
		Reduced cultivation	Coded*
			Text
		Tramline maagement	Coded*
			Text
		Cover crops	Coded*
			Text
		Re-surfacing tracks	Coded*
			Text
		Roofing over yards	Coded*
			Text
		Re-siting gateway	Coded*
			Text
		Biobeds	Coded*
			Text

Excel column		**Question topic**	**Data recording**
BB-BL	Questioned in-depth on measure	Taken field out	Coded*
		Tree planting	Coded*
		Sediment traps	Coded*
		Subsoil	Coded*
		Reduced cultivation	Coded*
		Tramline management	Coded*
		Cover crops	Coded*
		Re-surfacing tracks	Coded*
		Roofing over yard	Coded*
		Re-site gateway	Coded*
		Biobeds	Coded*

* 0 = No, 1= Yes

Survey Section B – Spread sheets 2 – 23

(Repeat for each measure -11 times)

Adopted measure

Excel column		Discussion topic	Data recording
A	Farmer ID		#
B	When implemented		Years
C - N	What influenced decision	AES	Rank 1-5
		Grant	Rank 1-5
		Press	Rank 1-5
		Regulations	Rank 1-5
		Advisor	Rank 1-5
		Quality assurance scheme	Rank 1-5
		Peer pressure	Rank 1-5
		Landowner	Rank 1-5
		Neighbour	Rank 1-5
		Farm report	Rank 1-5
		Long-term viability	Rank 1-5
		Other	Rank 1-5
O	Decision maker to adopt measure		Text
P	What made you first consider the measure		Text
Q	Last persuaded you		Text
R - V	Received information from	Advisor	Coded *
		Press	Coded *
		Internet	Coded *
		Event	Coded *
		Neighbour	Coded *
W	Benefits from adoption		Text
X	Disadvantages from adoption		Text
Y	Do you know others who have implemented		Coded 1,0
Z	Would you recommend it		Coded 1,0
AA	Why do others not adopt		Text
AB	Is there enough information available		Text
AC	Any further comments		Text

* 0 = No, 1= Yes

Survey Section B (Repeat for each measure -11 times)

Measures not adopted

Excel column		Discussion topic	Data recording
A	Farmer id		#
B	Reason not adopted		Text
C	Disadvantages of measure		Text
D - O	What influence decision	Agri scheme	Rank 1-5
		Grant	Rank 1-5
		Press	Rank 1-5
		Regulations	Rank 1-5
		Advisor	Rank 1-5
		Quality assurance scheme	Rank 1-5
		Peer pressure	Rank 1-5
		Landowner	Rank 1-5
		Neighbour	Rank 1-5
		Farm report	Rank 1-5
		Long-term viability	Rank 1-5
		Other	Rank 1-5
P	Decision maker to not adopt measure		Text
Q - U	Received information from	Advisor	Coded *
		Press	Coded *
		Internet	Coded *
		Event	Coded *
		Neighbour	Coded *
V	Information you would like		Text
W	Who would you go to for advice		Text
X	Any further comments		Text

* 0 = No, 1= Yes

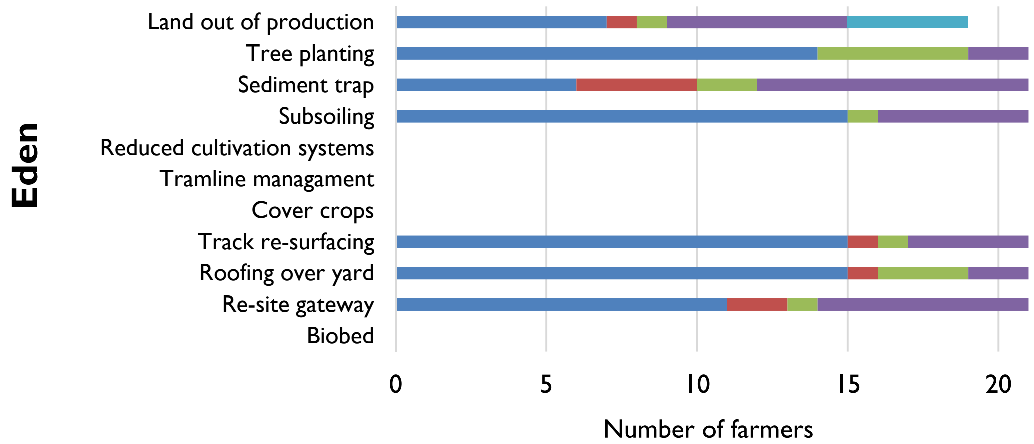
Survey Section C - Excel sheet 24

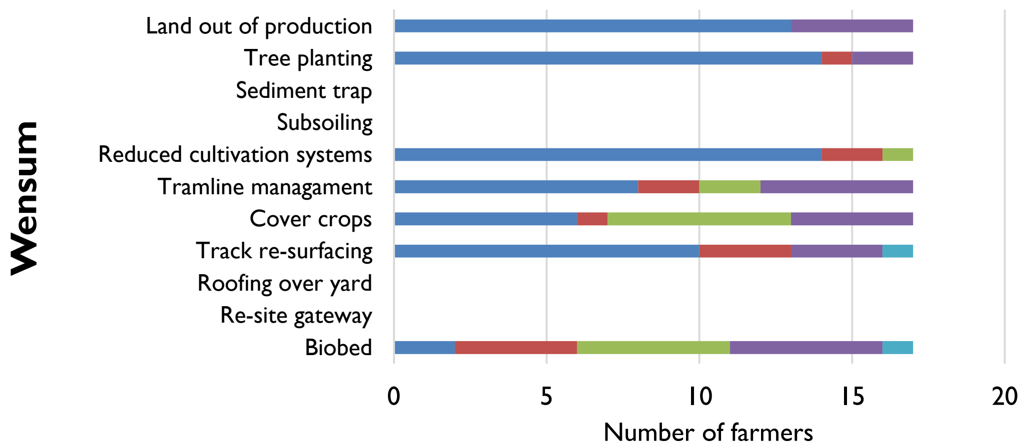
Excel column	Question		Data recording
A	Farmer ID		#
B	Have you heard of CSF		Coded*
C	Do you know of other grants/incentives		Text
D - AE	Would you adopt advice from.. (yes/no), and reasons for response	CSFO	Coded*. Coded
		NE	Coded*. Coded
		EA	Coded*. Coded
		FWAG	Coded*. Coded
		RSPB	Coded*. Coded
		River Trust	Coded*. Coded
		Wildlife Trust	Coded*. Coded
		Water company	Coded*. Coded
		Large agri-company	Coded*. Coded
		Forestry Commission	Coded*. Coded
		Woodland Trust	Coded*. Coded
		Land agent	Coded*. Coded
		Independent specialist	Coded*. Coded
		Salesmen	Coded*. Coded
AF	Experience of advice conflicting		Text
AG	Any further comments		Text

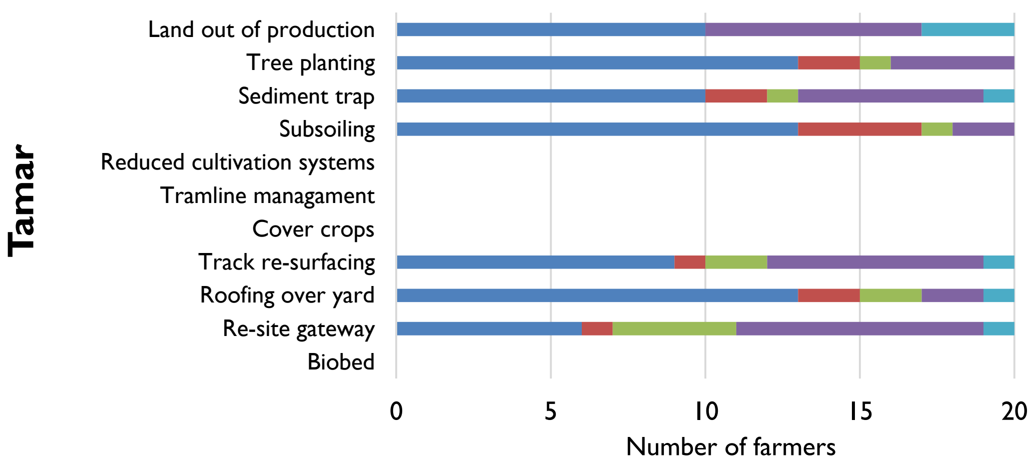
Survey Section D - Excel sheet 25

Excel column	Question	Data recording
A	Farmer ID	#
B	Years farming	#
C	Age group	Coded
D	Sex	Coded
E	Education	Coded
F	Successor	Coded

Appendix C.4 Current uptake of mitigation measure and attitudes to future uptake amongst farmers in the three catchments (Chapter 6).







Appendix D - Contributions to policy and scientific knowledge

This research made close and early links with various government bodies (NE, CSF and Defra) and was implemented to a timescale which allowed results to provide key information directly to departments and organisations when it would be most beneficial for policy and AES design. Frequent meetings throughout the phases of research design, implementation and following, enabled valuable discussions between relevant parties, providing a sounding board and opportunity for research feedback.

The interdisciplinary and multi-stakeholder format of the DTCs programme allowed results from this survey to be of benefit to other research fields such as economics. For example, interview results from Chapter 6, which revealed mitigation measures with 'cost' as a perceived barrier, guided economists from the DTCs. Economists considered such results in their calculations of measure cost-effectiveness, which in turn will inform policy of the costs needing to be thought-out and altered accordingly through the various mechanisms available (such as incentives).

The information gained from the baseline survey in Chapter 4 was an advance on existing knowledge and understanding regarding the adoption of mitigation measures, providing insights which complemented the data found in the measure inventory - the Defra User Guide (Newell-Price et al., 2011). Chapter 4's results were written as a government report (Vrain et al., 2014), published in Collins et al. (2016) and informed both Defra policy thinking and research directions within the DTCs programme (e.g. regarding the selection of measures for detailed field evaluation). The baseline data informed Defra as to what farmers would *actually* be willing to do. This enabled tighter recommendations for policy design and contributed to Defra's decisions during the selection of the 'basic measures'[28]. In 2013, the Government aimed to identify a suite of 'basic measures' (specific actions to be taken at farm level) that would be acceptable to the industry and be effective in addressing the most common water quality pressures and be unconstrained by current delivery mechanisms. The first filter stage to select the measures reduced the list of 708 potential measures to 138. The baseline survey results from Chapter 4 then contributed to the second filter stage, along with an industry stakeholder workshop which scored the 138 measures for acceptability, practicability and applicability, only reducing the number of measures to 71. The measures shown to be receptive from the baseline survey were used to subsequently run more realistic scenarios

[28] Article 11.3 of the WFD sets out the requirements for a Programme of Measures to implement necessary actions to prevent deterioration of the status of surface and ground waters. Measures are divided into basic and supplementary methods. Basic measures are described as minimum requirements including relevant existing EU legislation (e.g. the Nitrate Directive), which include controls over practices resulting in point and diffuse source pollutant losses.

through the FARMSCOPER model to see how beneficial to water quality such additional uptake would be over and above business as usual (Collins et al., 2016). This has then contributed to the current consultation (Defra, 2015e).

The advisor interviews from Chapter 5 made noteworthy contributions to research and policy development. Chapter text was published in Vrain and Lovett (2016) and the findings on the role of advisors were used to update the CSF evidence base and incorporated into the latest version of their evidence report (CSF Evidence Team, 2014: 42-44). Results highlighted the flexible approach used by the Government's CSF initiative, providing evidence of their ability to adapt to their catchment needs. The findings also identified CSFOs' niches within the advisor sector by comparing their recommendations to those of other advisors in the regions (CSF Evidence Team, 2014). Such findings have contributed to the design of the next phase of CSF's strategy and will feature within the CSFO's new training scheme starting in 2016.

The final set of empirical data - the farmer interviews which investigated specific measures of interest to the Government - were highly informative to a wide variety of organisations. Four presentations were given to staff from NE, CSF, Defra, water companies, NGOs and from within the agricultural industry between June and November 2015. Organisations who were involved in delivering farm advice or attempting to change farmer behaviour were provided with real insight as to what may have been the main reasons farmers were not changing their behaviours. The results also highlighted what worked in the past and therefore what might be needed in order to encourage greater uptake within the farming community. The work regarding farmer attitudes towards advisors was particularly well received during such presentations and workshop discussions. The word clouds were believed to be an innovative visualisation method, which clearly illustrated results. Again, results from Chapters 6 and 7 have helped contribute to the next CSF strategy and training programme, enabling the initiative to better understand what effort and resources might be needed to further increase the uptake of particular measures.

Over the three years, eleven presentations were given to staff from NE, CSF and Defra in London, whilst a further eight were presented during the DTCs national conferences, Wensum DTCs annual conferences and DTCs consortium meetings. Summarising the key points from the main body of text within this thesis, a series of policy briefings throughout the three years were created, providing concise two-page documents for interested stakeholders. The set of policy briefings are included in Appendix D.1 along with a scaled down version of a poster which featured at multiple national and international conferences.

Simon West, Head of Water Quality and Agriculture at Defra stated *'this research has contributed value in several aspects of Defra's policy and delivery landscape, providing a direct link between 'typical' farmers, researchers and policy makers, helping to convey messages top-down and bottom-up ….helping policy development in the areas of environment and food and farming. More broadly, through workshops and conferences the research has also increased understanding within policy and among a wider range of stakeholders of the value farmers place on advice from a variety of sources. That is helping with our engagement with industry representatives to target messages through appropriate channels.'* (pers. comms. 11th December 2015).

Value was also acknowledged by the Polish Government, with an invitation received to present at the EKOROB conference (Warsaw) in 2014, titled 'Innovative and system solutions for mitigation of diffuse pollution demonstration catchments in Europe'. The conference audience consisted of local, regional and national Polish Government officials, and was an opportunity for eight researchers from seven different EU Member States to demonstrate how lessons of WPA reduction could be learnt from other countries. The presentation from this thesis explained the benefits of engaging with farmers and the industry for intervention designs.

The impact of this research not only extended internationally through several conferences and seminars[29], but also ranged wider than the agricultural water pollution context within the British Government's policy making. In November 2015, Defra hosted a workshop in London for staff from different policy areas who deal with agricultural issues such as GM policy, animal identification and movements, agricultural economics, animal health and welfare, soils, biosecurity, food and farming evidence, agri-environmental schemes and health and safety. The research from this thesis was presented to: 1) provide an exemplar of experience and benefits of engaging farmers and farm advisors about water pollution, and 2) highlight qualitative methods which could be translated to aid understanding of how best to influence farmer behaviour in other topic areas, especially those which are highly contested. Informative two-way dialogue was achieved with all workshop attendees, with one stating '*it* [the workshop] *was very useful for bringing together policy areas and therefore messages, identifying who we can link efforts with.*' It was agreed more events should be held in the future to allow common sharing of knowledge between departments with a focus on influencing farmer behaviour.

[29] European Geosciences Union General Assembly, Austria 2013, Land Use and Water Quality conference, The Netherlands 2013 and Austria 2015, PRO AKIS synthesis seminar 'Enhancing services for rural innovation networks' Portugal 2015, EKOROB conference "Innovative and system solutions for mitigation of diffuse pollution demonstration catchments in Europe" Poland, 2014.

The Government have a difficult task to try and devise frameworks that work nationally and want procedures that can be applied operationally. As this research was conducted with a wide ranging spectrum of farmers, from highly commercial farming systems in the Wensum to the upland farmers in the Eden, the results help towards this objective. The frameworks identified (Pike and BCW) along with the methods used, such as the advisor niches using PROXSCAL and standard deviation ellipses (Chapter 5), the decision process diagrams and barrier wheels (Chapter 6), and the word clouds of farmer attitudes (Chapter 7), provide replicable methods which could be implemented in additional catchments and applied across all settings.

D.1 Policy briefings and scaled down poster

Demonstration Test Catchments

Attitudes of Farmers Towards Diffuse Pollution Mitigation Measures in the Demonstration Test Catchments

Extensive research has been carried out to determine the best agricultural practices for water pollution control. However it is recognised that the implementation of such measures will only be effective with the co-operation of stakeholders.

Whilst many agricultural management options remain voluntary, farmer participation is increasingly seen as a necessary ingredient for catchment management. There is a need for more information on the realistic farmer uptake and acceptability of different measures to enhance the potential for pollution mitigation.

Figure 1: Map showing the three DTC catchments

A survey was conducted as part of the Demonstration Test Catchments (DTC) project to create a baseline regarding current agricultural practices and give insight regarding farmer attitudes to the future adoption of other mitigation measures. 73 farmers were surveyed between February 2012 - 2013 in three contrasting DTC catchments: the grassland dominated Eden catchment; the arable dominated Wensum catchment and the mixed farming of the Hampshire Avon catchment (see Figure 1). There was a great variation in size amongst the surveyed farms, varying from relatively small livestock farms in the Eden to large arable farms in the Wensum. Overall 87% of farmers surveyed currently participate in Entry Level Stewardship (ELS) and 40% in Higher Level Stewardship (HLS).

Current uptake of mitigation measures amongst farmers

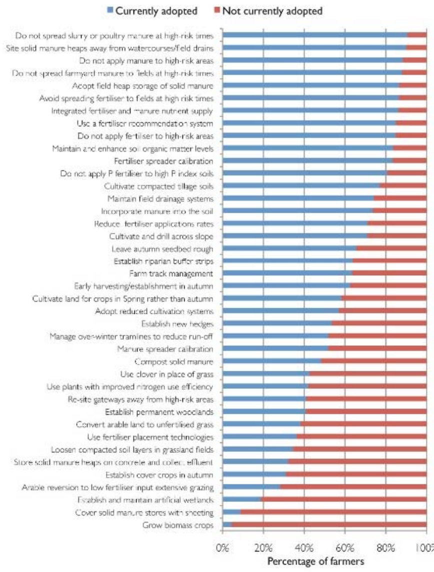


Figure 2: The current uptake of DWPA mitigation measures from the DTC baseline survey applicable to over 75% of participants.

Opinions were obtained on 70 diffuse pollution (DWPA) measures taken from a recent guide 'An Inventory of Mitigation Methods: User Guide' (see footnote). Farmers were asked:

"Do you currently do... mitigation measure? If not would you be likely or unlikely to consider doing it in the future?"

Of the 70 measures, the extent to which they are used varies widely. Figure 2 illustrates the current uptake of measures which are relevant to over 75% of participants.

- Measures with the highest uptake were all concerned with fertiliser or manure management and form part of cross compliance requirements for receipt of the CAP Pillar I Single Farm Payment.
- Measures which are compatible with current farm practice were more likely to have been adopted than those which require radical management or land use change.
- There was no obvious difference in uptake of measures according to whether they related to source minimisation, pathway reduction or receptor protection.
- Several measures with known benefits (e.g. cover crops) were less widely used than might have been anticipated. These could be particularly appropriate targets for increased adoption under advice campaigns or agri-environmental scheme support.

Wensum Alliance | Hampshire Avon | EdenDTC A National Demonstration Test Catchment | Environment Agency | Llywodraeth Cymru Welsh Government | Department for Environment Food & Rural Affairs | Living With Environmental Change

Available from Defra at: http://randd.defra.gov.uk/Document.aspx?Document=MitigationMethods-UserGuideDecember2011FINAL.pdf

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Farmers' attitudes to future adoption of measures

Survey participants currently not practicing in a particular mitigation measure were asked how *'likely'* they would be to adopt the measure in the future. Figure 3 outlines the responses given for a selection of measures which are considered to provide benefits to the wider environment.

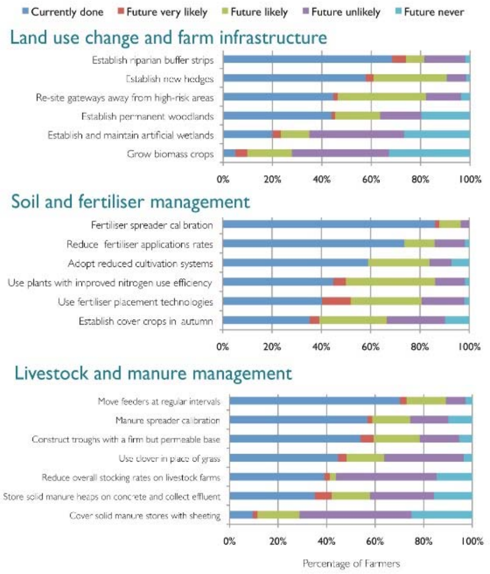


Figure 3: Farmer attitudes to future uptake of DWPA mitigation measures from the DTC baseline survey categorised by management type.

- Overall, measures requiring land use change were less likely to be adopted than measures improving farm infrastructure.
- Measures likely to be adopted in the future were those which decrease the use of fertiliser and fuel, therefore reducing costs.
- Farmers from the survey were more negative towards future adoption of livestock and manure management measures than soil and fertiliser management measures.

Farmer - priority mitigation measures

The survey requested participants to list three mitigation measures they would prioritise on their farm. 65 farmers responded, listing 105 priorities in total, each stating between 0 and 3 measures (22% of farmers had no priorities). The priorities stated by participants have been categorised into management type and location of measures (see Figure 4).

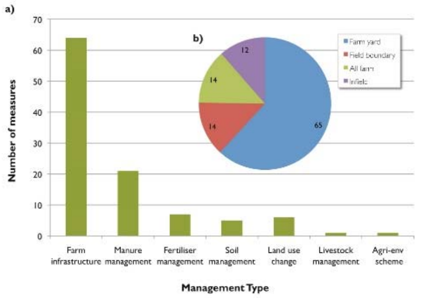


Figure 4: The number of measures respondents prioritised, categorised by a) management type and b) location

- Nearly two-thirds of the priorities involve changing farm infrastructure, particularly additional concrete areas. A variety of uses were identified, including concrete for manure heaps, diverting dirty water and track repair. Farmers suggested these are inexpensive options if grants are provided to assist with payment.
- Manure and fertiliser management included options related to correct timing and application efficiency, as well as storage covers.
- Location of priorities had a significant bias towards measures occuring in farmyards, whilst in-field and field boundary measures received less attention.

The baseline survey included questions about some measures which are not currently supported within agri-environment schemes. The results highlight several measures with relatively low current uptake but positive attitudes regarding future adoption, such as re-siting gateways, establishing cover crops and reduced cultivation systems, which could merit inclusion in such programmes. The findings also indicate that improvements in farmyard infrastructure are a priority for many farmers and suggest that radical changes in activities will not occur without substantial financial incentives or regulatory requirements.

It is intended that the DTC will repeat the survey in years to come to assess changes in attitudes.

Further Information: This survey was conducted as part of The Demonstration Test Catchment project which is a collaborative research project funded by the UK Department for Environment, Food and Rural Affairs (Defra). To find out more, or if you have any comments or queries, please contact Emilie Vrain (e.vrain@uea.ac.uk) or Andrew Lovett (a.lovett@uea.ac.uk) at the University of East Anglia.

Demonstration Test Catchments

The Role of Farm Advisors in Improving the Uptake of Water Quality and Other Environmental Measures

Delivering advice to farmers has been used as a mechanism to encourage uptake of environmental best management practices, however the farm advice sector has dramatically changed over recent years. Many organisations and businesses now offer advice and there is a risk that the sector has become fragmented. Recent research by the Demonstration Test Catchments programme investigated the role of various organisations and businesses which provide one to one advice on diffuse water pollution from agriculture (DWPA) mitigation measures through interviews with a variety of farm advisors (see Box 1) in three agriculturally contrasting regions of England: East Anglia, North West and South West. Interviews with 81 farm advisors were conducted during September and October 2013, either face to face or over the telephone. Objectives were to assess:

- What mitigation measures are being recommended by advisors?
- How do recommendations differ between sources of advice? Do they conflict?
- Which mechanisms (regulatory, financial incentives, signposting or voluntary approach) are being used to encourage uptake of measures?

Box 1. Organisations interviewed

Catchment Sensitive Farming
Natural England
Environment Agency
Rivers Trusts
Farmer network
Seed and fertiliser sales staff
Independent agronomists
Feed nutritionist consultant
Agri consultant companies
Forestry Commission
Land agents
Auction house
Ex FWAG
Woodland Trust
Levy Boards
Wildlife Trusts
Water companies
NFU
Vets
RSPB

What are farm advisors recommending?

The responses provided during interviews regarding the most commonly recommended measures were categorised under 35 different headings. The most common were buffer strips and reducing fertiliser applications. Analysis using a multidimensional scaling statistical tool (PROXSCAL) was carried out, which assigns each ***recommendation*** to a location in a conceptual two dimensional space dependent upon the advisors who recommend it.

Recommendations located near each other in Figure 1 are more likely to be recommended by the same advisor

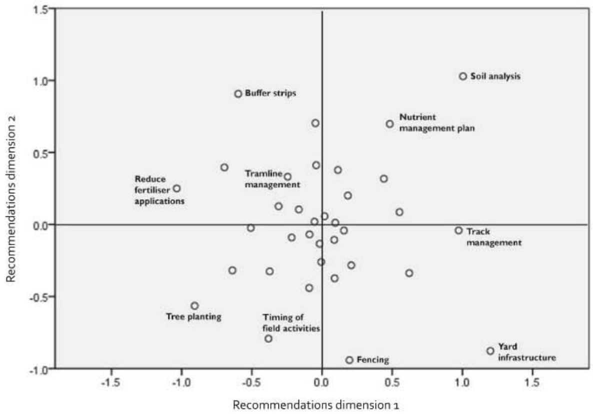


Figure 1. DWPA mitigation measures plotted on a 2D similarity scale using PROXSCAL based upon advisors recommending them.

- Many recommendations cluster near the central origin, suggesting no particular pattern exists.
- Peripheral measures (labelled on Figure 1) are more distinctive in terms of who does or does not recommend them.
- Groupings occur between measures in different quadrants, e.g. soil analysis and nutrient management plans (top right) are less likely to be recommended by an advisor who also recommends tree planting (bottom left).

PROXSCAL was also used to assign each ***advisor*** to a specific location in a conceptual two dimensional space dependent upon the recommendations most commonly made. To compare the similarities in recommendations between organisations *standard deviation ellipses* were created in ArcGIS using the PROXSCAL outputs. The ellipses define the core area of interest for a group of advisors.

Wensum Alliance
Hampshire Avon
EdenDTC A National Demonstration Test Catchment
Environment Agency
Llywodraeth Cymru Welsh Government
Department for Environment Food & Rural Affairs
Living With Environmental Change

Comparisons between shape, size and location of various ellipses help inform interpretation of the data (Figure 2)

- Overlap exists between organisations in terms of recommendations, with certain measures being proposed by many different advisors (e.g. timing of field activities and buffer strips,), however distinctions also exist, suggesting there are different niches.
- The Environment Agency is illustrated with a narrow ellipse reflecting the particular focus in their advice on enforcement of regulatory measures.
- The most overlap occurs between Natural England and organisations with an environmental agenda as many of the latter focus on recommending agri-environmental scheme (AES) options as an incentive to engage with farmers.

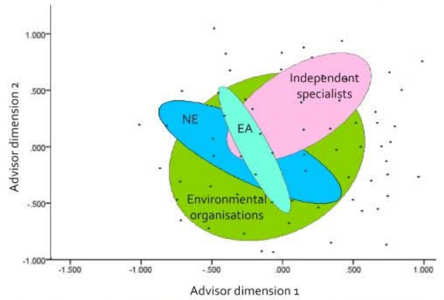


Figure 2. Advisors plotted on a 2D similarity scale using PROXSCAL based upon measures they recommend, with 1 standard deviation ellipses.

Conflicts in advice

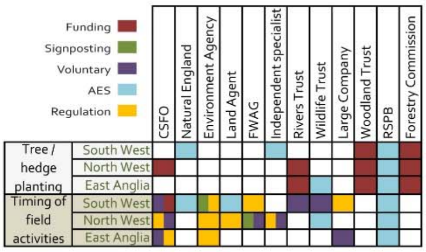
Advisors reported that conflicts in recommendations could exist between those with differing agendas (environment, government or economic).

- The amount of fertiliser to spread and silage cutting times varied greatly amongst advisors with environmental or economic agendas.
- Species and habitat priorities varied amongst environmental organisations, thus influencing recommendations. One example being tree planting to create shading for fish versus open spaces for wading birds.
- Advice regarding dates for closed periods in Nitrate Vulnerable Zones differed between advisors. Changing regulations were stated by many non governmental advisors as causing confusion and difficulties with keeping up to date and delivering consistent advice.
- Conflicts occurred within and between government organisations. The most common disagreements involved AES options and whether they were effectively targeted. For example, AES grassland management options resulting in over or under grazing of grasslands.

Such findings indicate that the advice sector could be more efficient, as collectively it does not provide consistent advice.

Mechanisms used by farm advisors

Table 1. Mechanisms used to encourage uptake of measures



Differences exist between advisors regarding the mechanisms they use to encourage uptake of measures.

- Many organisations focus upon one form of mechanism (e.g. RSPB encouraging AES options), whilst a select few use a variety of mechanisms (e.g. Catchment Sensitive Farming Officers use funding, voluntary approach, regulatory advice and signposting).
- The majority of advisors favour specific mechanisms for certain measures (e.g. grants and AES for tree / hedge planting) but employ a combination of mechanisms in other instances (e.g. timing of field activities).
- The mechanisms used by advisors varied across the three regions.

Advice delivered by different organisations is not homogeneous and some do indeed have particular niches within the farm advice sector. Policy makers therefore need to consider not only what environmental and DWPA mitigation measures need to be encouraged but also which organisations are best placed to deliver on the ground advice to the farmers through the various mechanisms available. There is scope to make better use of non-government advisors by maintaining communication and providing briefing sessions when new schemes are introduced. This, for instance, is likely to be important for the effective implementation of future agri-environmental policy.

Future Research

Interviews with farmers in each of the three DTC catchment will be conducted throughout 2014 to investigate which mechanisms best encourage the uptake of particular mitigation measures. Interviews will be conducted with farmers who have and who have not adopted specific measures of interest to understand their motivations.

Further information: This survey was conducted as part of the Demonstration Test Catchments project which is a collaborative research project funded by the UK Department for Environment, Food and Rural Affairs (Defra). To find out more, or if you have any comments or queries,please contact Emilie Vrain (e.vrain@uea.ac.uk) or Andrew Lovett (a.lovett@uea.ac.uk) at the University of East Anglia.

1. Defra (2013) Review of Environmental Advice, Incentives and Partnership Approaches for the Farming Sector in England

Demonstration
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The Niche of Catchment Sensitive Farming in the Provision of Advice to Farmers

Box 1. Organisations interviewed

- Catchment Sensitive Farming
- Natural England
- Environment Agency
- Rivers Trusts
- Farmer Network
- Seed and fertiliser sales staff
- Independent agronomists
- Feed nutritionist consultant
- Agri consultant companies
- Forestry Commission
- Land agents
- Auction house
- Ex FWAG
- Woodland Trust
- Levy boards
- Wildlife Trusts
- Water companies
- NFU
- Vets
- RSPB

Catchment Sensitive Farming (CSF) is one of a variety of organisations providing individual advice to farmers. Recent research by a PhD student from the University of East Anglia funded by the Demonstration Test Catchments programme has investigated the niche of CSF with regards to the diffuse water pollution from agriculture (DWPA) mitigation measures recommended to farmers.

The research interviewed farm advisors from different organisations and businesses (see Box 1) in three agriculturally contrasting regions of England: East Anglia, North West and South West. Interviews with 81 farm advisors were conducted during September and October 2013, either face to face or over the telephone. Objectives included:

- What mitigation measures are being recommended by advisors?
- How do recommendations differ between sources of advice? Do they ever conflict?
- Which mechanisms (regulatory, financial incentives, signposting or voluntary approach) are being used to encourage uptake?

What are CSF Officers Recommending?

Responses provided during interviews regarding the most commonly recommended mitigation measures have been summarised in Table 1 for the Catchment Sensitive Farming Officers (CSFOs). The variety of measures recommended by all the different organisations are listed in the columns to indicate those being suggested outside of the CSF initiative. Key features to be highlighted are:

- CSFOs make a broad range of recommendations.
- Differences in recommendations exist between CSFOs in the three regions of England.
- Yard infrastructure measures are commonly recommended by CSFOs, but also by other advisors who often signpost to Catchment Sensitive Farming capital grants.
- Many organisations and businesses interviewed focus on specific mechanisms to encourage uptake of measures. CSFOs utilise an array of mechanisms.

Key: Funding, Signposting, Voluntary, Regulation

		East Anglia CSFO	North West CSFO	South West CSFO
Infield	Tree planting		Funding	
	Cover crops	Signposting		Voluntary
	Reduce fertiliser application		Voluntary	
	Appropriate stock density			
	Timing of field activities	Voluntary / Regulation	Voluntary / Regulation	Voluntary / Funding
	Cross cultivation			Voluntary
	Water for cattle			Funding
	Machines to use		Signposting / Voluntary	
	Tramline management	Voluntary		
	Move feeders			
	Scrub and rush management			
	Bird/flower seed mixes			
	Change rotation			
	Move potato pads			
	Arable reversion			
	Muck heap location			
	Grassland/habitat restoration			
Field Boundary	Fencing	Funding	Funding	Funding
	Buffer strips	Voluntary / Regulation	Voluntary / Regulation	Voluntary
	Moving gateways	Funding		
	Sediment traps			Funding
	Track management	Voluntary / Funding	Funding	Voluntary / Funding
	Fixing walls			
	In-stream wooded debris			
	Cattle river crossing			
Farm yard	Biobeds	Funding		
	Yard infrastructure	Funding	Funding	Funding
	Rainfall harvesting		Funding	
	Silage structure quality		Voluntary	
Management	Soil analysis/pits	Funding	Funding	Funding
	Pesticide handling	Voluntary / Funding		Voluntary / Funding
	Manure/slurry analysis	Funding	Funding	
	Machine calibration	Voluntary		
	Nutrient management plan	Voluntary / Funding	Voluntary / Funding	Voluntary / Funding
	Change feed			

Table 1. Mitigation measures most commonly recommended by CSFOs and the predominant mechanisms to encourage uptake stated during interviews.

CSFOs compared to other advisors

To further analyse the responses provided during interviews, a multidimensional scaling statistical tool (PROXSCAL) has been used. This method assigns each advisor to a specific location in a conceptual two dimensional space dependent upon the DWPA mitigation measures they recommend, thus enabling analysis of the similarities between advisors.

Advisors located near each other in the space are more likely to have recommended similar measures.

To compare the similarities of recommendations between organisations, *standard deviation ellipses* were created in ArcGIS using the PROXSCAL outputs. The ellipses define the core area of interest for a group of advisors.

Comparisons between the shape, size and location of the various ellipses help to inform interpretation of the data.

In the diagrams below, Natural England (NE) and Environment Agency (EA) ellipses represent national results, using advisors from all three regions. This is appropriate as the national role of NE is to advise on agri-environment scheme (AES) options and EA is to enforce regulatory measures. The ability to compare where CSFOs are placed in relation to these two government organisations highlights that they are focussing on different (often broader) sets of measures. Organisations with an environmental agenda have been grouped (e.g. Rivers Trust; Wildlife Trust; RSPB; Woodland Trust and FWAG in the South West) and are also displayed for regional comparisons.

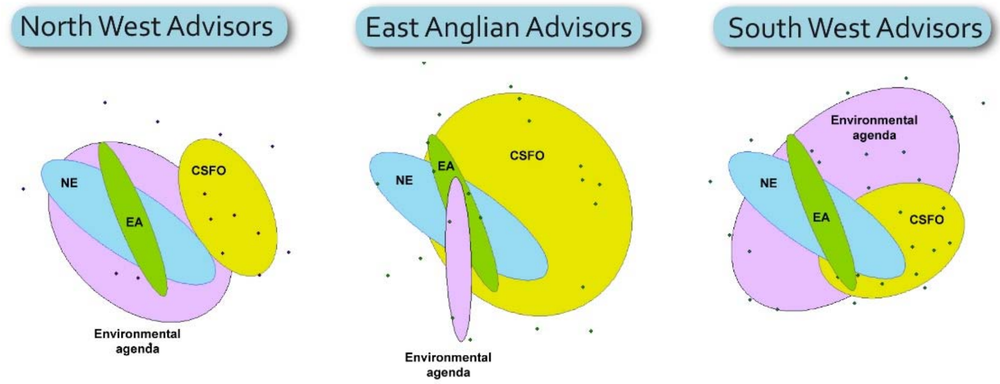

Figure 1. Advisors from each region plotted on a 2D similarity scale using PROXSCAL based upon the diffuse water pollution mitigation measures they recommend, with one standard deviation ellipses for CSFOs, Natural England, Environment Agency and environmental organisations.

- The diagrams indicate that some overlap does occur between organisations in terms of recommendations, however there are distinctions, suggesting organisations are fulfilling different niches. The most overlap occurs between NE and organisations with an environmental agenda as many of the latter focus on recommending AES options as an incentive to engage with farmers.

- Larger sized ellipses imply that advisors within the organisation are making different recommendations to one another, covering a broader remit. In East Anglia, many of the CSFOs interviewed recommended a smaller number of measures that they specialised in. This often depended upon farmer requirements in their catchment e.g. pesticide management.

- The least overlap with CSFOs occurs amongst independent specialists and agricultural companies as they provide particular advice on topics such as animal nutrition, crop rotation and nutrient requirements.

Results from the farm advisor interviews indicate that Catchment Sensitive Farming is well defined in the realm of the farm advice sector, fulfilling a different niche to other organisations. The contrasts in advisor recommendations between regions indicate that CSFOs are adapting their approach within their catchments/ region depending upon farmer needs. This emphasises the importance of working at a local scale and in sympathy with the catchment based approach.

Further information: This survey was conducted as part of the Demonstration Test Catchment project which is a collaborative research project funded by the UK Department for Environment, Food and Rural Affairs (Defra). To find out more, or if you have any comments or queries, please contact: Emilie Vrain (e.vrain@uea.ac.uk) or Andrew Lovett (a.lovett@uea.ac.uk) at the University of East Anglia.

Demonstration Test Catchments — Farmer attitudes towards farm advisors

Research conducted as part of the Demonstration Test Catchment (DTC) project has explored the factors influencing farmer adoption of diffuse water pollution mitigation measures by conducting 58 in-depth farmer interviews in three contrasting DTC catchments: the grassland dominated Eden; the arable dominated Wensum and the mixed and dairy farming of the Tamar. This policy briefing focusses on the farmers' attitudes towards farm advisors.

Who would farmers listen to and why?

During the interviews, farmers were asked whether they would listen to advice from particular advisors about mitigation measures and why. To evaluate response vocabulary, word clouds were chosen as an innovative visualisation method. Word clouds give greater prominence (text size) to words or phrases with a higher frequency of use, providing a clear, visually rich representation of key words from interview transcripts. Fig. 1 below shows the word clouds generated, with red text representing negative reasons as to why farmers wouldn't listen to the advisor and blue indicating positive factors.

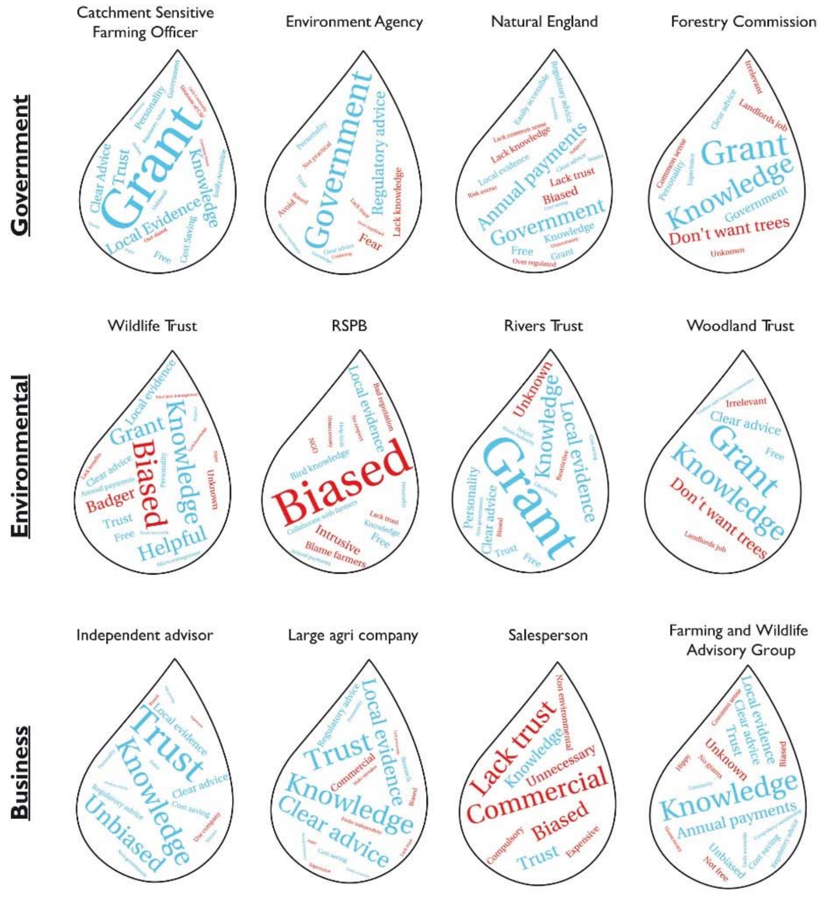

Fig. 1. Word clouds showing farmers' comments to describe why they would (blue text) or wouldn't (red text) listen to advice from advisors.

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Regional differences in attitudes towards advisors

A previous DTC research which interviewed farm advisors, found that the role of the advisors and organisations changed across the different catchments. In line with such findings, farmer attitudes towards advisors also differed between catchments. Fig. 2 demonstrates the different vocabulary farmers used for Catchment Sensitive Farming Officers (CSFOs) in the three catchments.

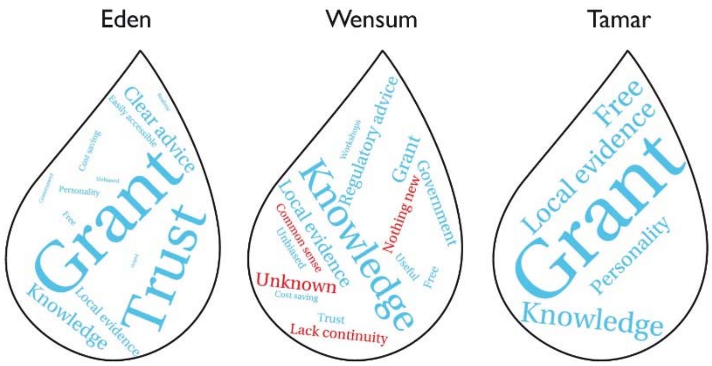


Fig. 2. Word clouds representing the vocabulary used to describe CSFOs by farmers in the three catchments.

Farmer and advisor attitudes

During the farm advisor interviews the advisors were asked what they thought influenced why a farmer would take up their advice. These responses were compared with those from farmers to evaluate whether the views align, and therefore whether advisors have been promoting and emphasising the characteristics farmers perceived to be important.

For the majority of cases, views did match up. CSFOs identified ***grant*** as a key factor, as did farmers in the Eden and Tamar, but CSFOs also stated ***cost-saving*** and ***credibility*** as important characteristics, whereas farmers did not. Several other organisations also specified ***cost-saving*** as an important reason why farmers listened to their advice, however farmers refrained from mentioning this, failing to make the connection between water pollution mitigation and cost savings. A further discrepancy occurred with responses provided by advisors from environmental organisations. Such advisors placed emphasis on ***grants*** as a key factor, however they failed to appreciate the value of l***ocal evidence*** and ***knowledge*** that farmers perceived in such organisations (see Fig. 1).

Through the use of word clouds, this research has demonstrated a novel and effective visualisation technique for analysing qualitative data. The farmer survey results show:

- The reasons why farmers listen to advisors vary appreciably.
- Important positive reasons for listening to advisors included: grants, knowledge, trust, continuity, clear advice and local evidence.
- The variations in why farmers listen to CSFOs across the three catchments highlights the importance of building a trusting relationship through staff continuity.
- Comparing advisor and farmer perspectives suggests the link between diffuse water pollution mitigation advice and cost-savings needs to be made more explicit.
- Environmental organisations should emphasise their local knowledge and evidence to increase farmer uptake of advice.

To disseminate advice effectively it is essential to appreciate who farmers listen to in each area and why, as farmer attitudes towards advisors varied across catchments, with different attributes being of importance.

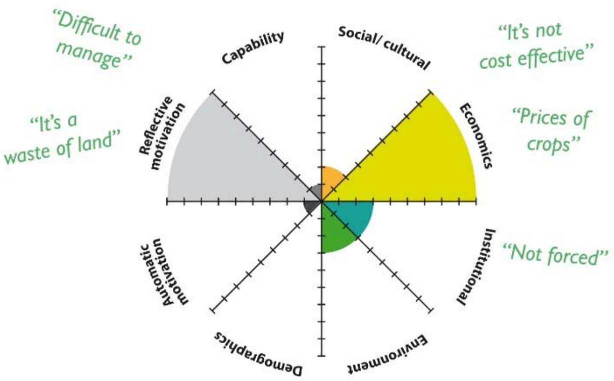
University of East Anglia

Further information: This survey was conducted as part of the Demonstration Test Catchments project which is a collaborative research project funded by the UK Department for Environment, Food and Rural Affairs (Defra). To find out more, or if you have any comments or queries, please contact Emilie Vrain (e.vrain@uea.ac.uk)

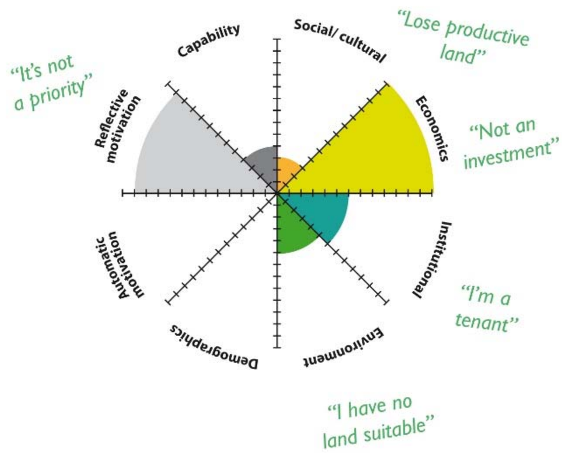
Barriers to land use change

From a DTC survey with 58 farmers in the Eden, Wensum and Tamar catchments.

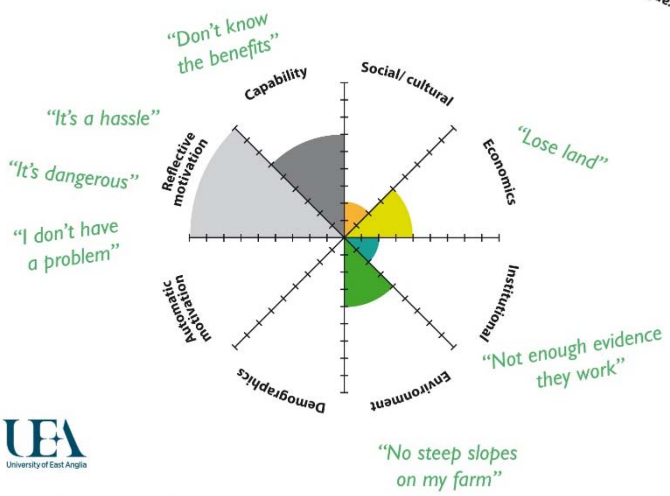
Land out of production



Tree planting



Sediment trap



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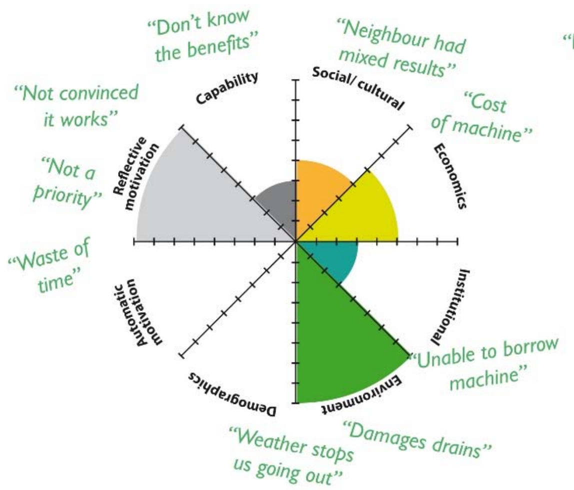
Created by PhD student Emilie Vrain.
Please contact: e.vrain@uea.ac.uk

Demonstration Test Catchments

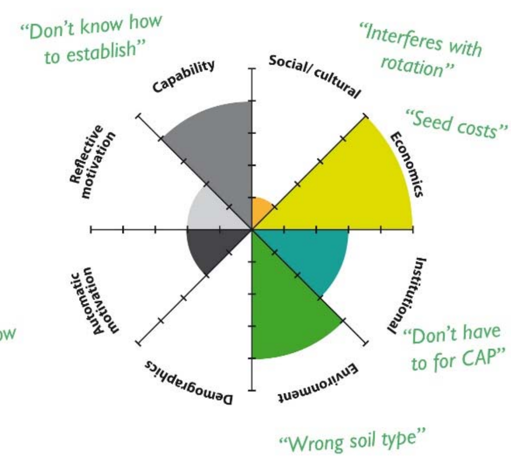
Barriers to management change

From a DTC survey with 58 farmers in the Eden, Wensum and Tamar catchments.

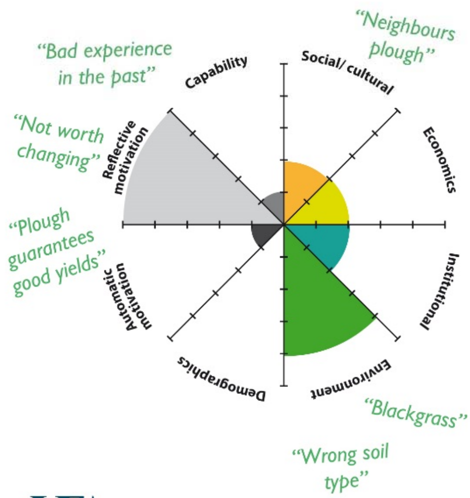
Subsoiling



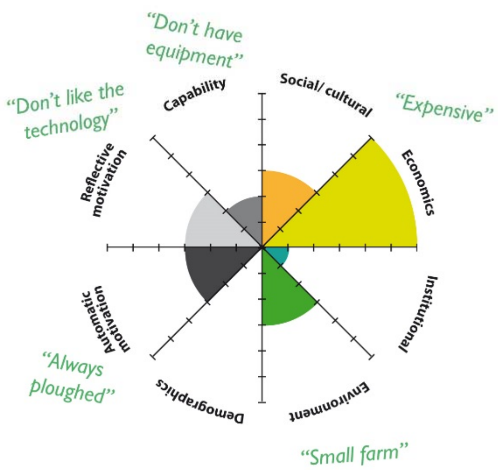
Cover crops



Reduced cultivation systems



Tramline management



Created by PhD student Emilie Vrain.
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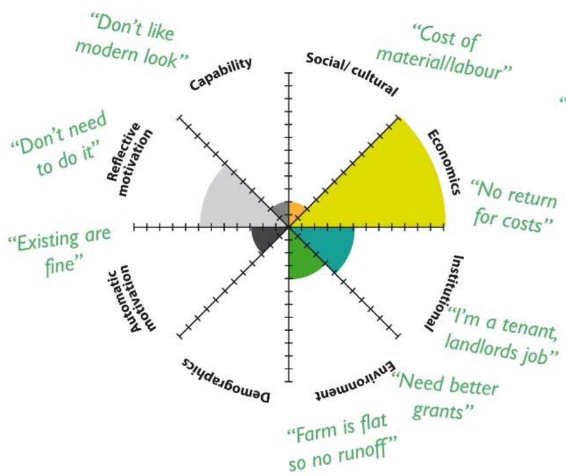
Demonstration Test Catchments

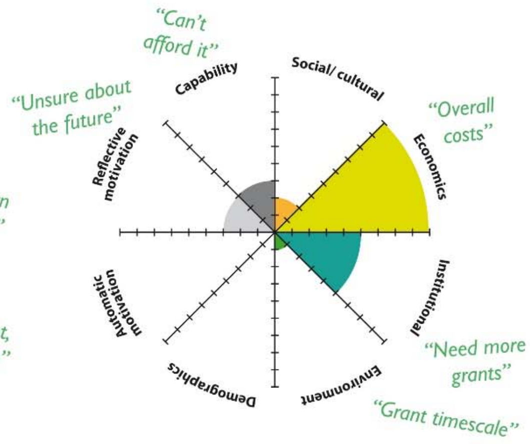
Barriers to infrastructure change

From a DTC survey with 58 farmers in the Eden, Wensum and Tamar catchments.

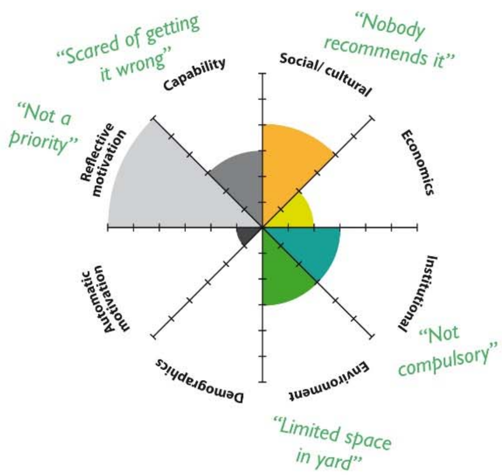
Track re-surfacing



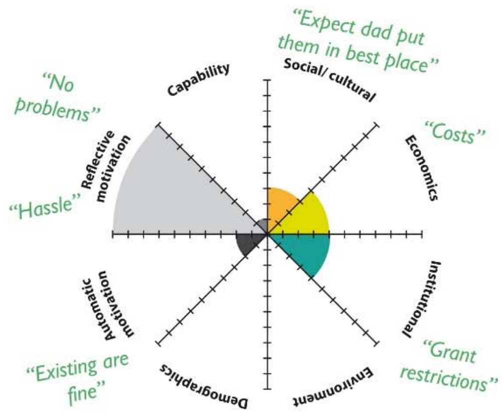
Roofing over yard



Biobed



Re-siting gateways



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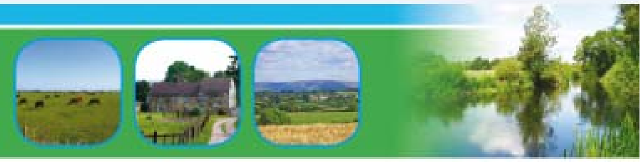
Demonstration
Test
Catchments

Engaging Farmers to Inform Future Diffuse Pollution Policy in England

E. Vrain, A. Lovett, L. Noble, F. Grant, P. Blundell & W. Cleasby



Introduction

Stakeholder knowledge and engagement is increasingly seen as a necessary ingredient for catchment management. Whilst many agricultural management options remain voluntary, the implementation of diffuse pollution mitigation measures will only be effective with the cooperation of stakeholders. There is a need for more information on the realistic uptake and acceptability of different measures to enhance the potential for pollution mitigation.

Objectives and Methodology

In England, the Demonstration Test Catchment (DTC) programme conducted a survey to gain a better understanding of farming practices and the current utilisation and potential future acceptability of a wide variety of mitigation measures. 73 farmers were surveyed during 2012-13 in three contrasting catchments (see map below).

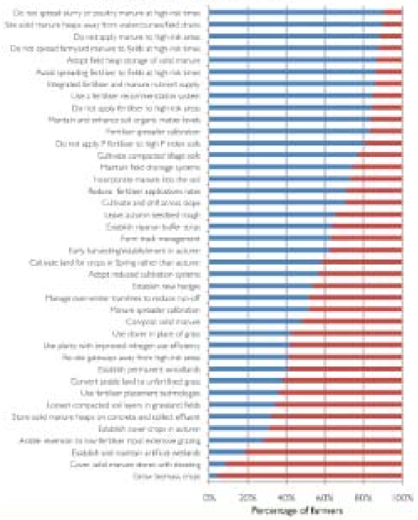
A structured questionnaire was used which covered questions relating to business organisation, enterprises, participation in agri-environmental schemes, currently practiced mitigation measures and acceptability of additional or alternative measures.

Opinions were obtained on 70 different diffuse pollution measures taken from a recent guide to possible measures prepared for the UK government[1].

Results

Figure 1 shows the current uptake of mitigation measures that were applicable to over 75% of participants in the survey.

Figure 1. Current uptake of mitigation measures amongst farmers



Results

Figure 2 illustrates responses from farmers who were asked how 'likely' they would be to adopt measures in the future if they were not currently practicing them.

Figure 2. Farmers' attitudes to future adoption of measures

Conclusion

There were wide variations in the extent to which the 70 measures were used. Measures with the highest uptake were compatible with current farm practice and did not impede profit or management. Many included fertiliser or manure management and formed part of cross compliance requirements for receipt of Single Farm Payments. Measures requiring land use change were less likely to be adopted in the future than those improving farm infrastructure. Measures likely to be adopted in the future were those which decreased the use of fertiliser and fuel, therefore reducing costs. Several measures with known benefits (e.g. cover crops) were less widely used than might have been anticipated, but received positive attitudes regarding future adoption. Such measures could merit inclusion in advice campaigns and agri-environmental scheme to encourage adoption.

By engaging farmers and collecting baseline data, survey results have benefited researchers, policy makers and farm advisers, particularly aiding decision making with respect to strategies for future implementation of programmes of measures.

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